CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

FACULTY OF ECONOMICS AND MANAGEMENT

Czech University Of Life Sciences Prague

Faculty of Economics and Management

AGRARIAN PERSPECTIVES XXIX.

TRENDS AND CHALLENGES OF AGRARIAN SECTOR

PROCEEDINGS

of the 29th International Scientific Conference

September 16 - 17, 2020

Prague, Czech Republic

Czech University of Life Sciences Prague

Faculty of Economics and Management

PROCEEDINGS - of the 29th International Scientific Conference Agrarian Perspectives XXIX. Trends and Challenges of Agrarian Sector

Publication is not a subject of language check.

Papers in individual sections are sorted by authors' names in alphabetical order.

Czech University of Life Sciences Prague, Faculty of Economics and Management

Agrarian perspectives XXIX. Trends and Challenges of Agrarian Sector

Publisher
Czech University of Life Sciences Prague
Kamýcká 129, Prague 6, Czech Republic

Papers in individual sections are sorted by authors' names in alphabetical order.
Publication is not a subject of language check.
All papers passed a double-blind review process.

ISBN 978-80-213-3041-2; ISSN 2464-4781 (Online); ISSN 1213-7960 (Print); ISSN 1213-7979 (CD-ROM)

ETHICS GUIDELINES

The conference AGRARIAN PERSPECTIVES is committed to the highest ethics standards.

All authors, reviewers, and editors are required to follow the following ethical principles. In case of any doubts do not hesitate to contact the editors of the conference AGRARIAN PERSPECTIVES.

The editors (co-editors) have the following responsibilities:

- The editor(s) clearly identify contributions that are fully with the scope and aim of the conference AGRARIAN PERSPECTIVES. The editor(s) should treat all contributions fairly without any favour of prejudice. The editor(s) only authorise for review and publication content of the highest quality.
- The editor(s) should recuse himself or herself from processing any contribution if the editor(s) have any conflict of interest with any of the authors or institutions related to the manuscripts.
- The editor(s) should provide advice to the author(s) during the submission process whennecessary.
- The editor(s) should be transparent with regards to the review and publication process withan appropriate care that individuals will not be identified when it is inappropriate to so do.
- The editor(s) should not use any parts or data of the submitted contribution for his or her ownfuture research as the submitted contribution is not published yet.
- The editor(s) should respond immediately and take reasonable action when ethical problemsoccur concerning a submitted or a published contribution. The editor(s) should immediatelycontact and consult these issues with the author(s).

The author(s) have the following responsibilities:

The author(s) ensure that submitted contribution is original, prepared to a high scholarly standard and fully referenced using the prescribed referencing convention. Therefore, the author(s) should carefully read the instructions for authors published on the website of the conference AGRARIAN PERSPECTIVES.

- The author(s) should not submit similar contributions (or contributions essentially describingthe same subject matter) to multiple conferences or journals. Furthermore, the author(s) should not submit any contribution previously published anywhere to the conferences orjournals for consideration.
- The author(s) are represented accurately and other appropriate acknowledgements are clearlystated including sources of funding if any.
- The author(s) state the source of all data used in the submitted contribution and how the datawas acquired. Moreover, the author(s) should clarify that all the data has been acquiredfollowing ethical research standards.

- The author(s) recognise that the editors of the conference AGRARIAN PERSPECTIVES. have the final decision to publish the submitted, reviewed and accepted contribution.
- The author(s) should immediately inform the editor(s) of any obvious error(s) in his or heraccepted contribution. The author(s) should cooperate with the editor(s) in retraction orcorrection of the contribution.

The reviewers have the following responsibilities:

- The reviewer(s) who feel unqualified to review the assigned contribution or if the reviewer(s) feel that cannot meet the deadline for completion of the review should immediately notify theeditor(s).
- The reviewer(s) should inform the editor(s) if there is any possible conflict of interest relatedto the assigned contribution. Specifically, the reviewer(s) should avoid reviewing anycontribution authored or co-authored by a person with whom the reviewer(s) has an obviouspersonal or academic relationship.
- The reviewer(s) should treat the contribution in a confidential manner. Read the contributionwith appropriate care and attention and use his or her best efforts to be constructively critical.The contribution should not be discussed with others except those authorized by the editor(s).
- The reviewer(s) should agree to review a reasonable number of contributions.
- The reviewer(s) should not use any parts or data of the reviewed contribution for his or herown future research as the reviewing contribution is not published yet.
- The reviewer(s) should immediately notify the editor(s) of any similarities between thereviewing contribution and another manuscript either published or under consideration byanother conference or journal.

Any report of possible ethics conflicts is a major issue for the conference AGRARIAN PERSPECTIVES. All ethics conflicts reported by reviewer(s), editor(s), co-editor(s) or reader(s) will be immediatelyinvestigated by the editors of the conference.

If misconduct has been committed the published contribution will be withdrawn. In addition, the author(s) may be excluded from having any future contribution reviewed by the conference AGRARIAN PERSPECTIVES.

FOREWORD

Agriculture, one of the oldest undertakings in recorded human history, still remains a strategic and integral part of every economy on earth. The 21st century, which has been characterized by turbulent changes in in every aspect of life, has brought a number of new challenges to the agricultural sector. It is not only the world's rapidly rising population and increasing demand on food supplies, but the sustainability of agricultural production that is closely intertwined with environmental and social requirements. The answers to these complex challenges require new and unorthodox approaches. The implementation of the latest scientific research findings, as well as comprehensive problem-solving utilizing the knowledge of various disciplines will be necessary to address the issues that currently face the agrarian sector.

Scientific conferences and professional seminars are an ideal platform for sharing opinions, experiences and the latest information in response to current challenges. The international scientific conference “Agrarian Perspectives”, organized by the Faculty of Economics and Management at the Czech University of Life Sciences Prague, has a long tradition in this regard that began in 1992. Since that time, the conference has become popular among scientists and experts from all around the world.

The 29^{th} annual “Agrarian Perspectives” conference, held on the 16^{th} and 17^{th} of September 2020, will be focused on the topic of “Trends and Challenges in the Agrarian Sector”. Although the conference will not be held in its traditional format due to the current pandemic, the interest of the participants clearly demonstrates the usefulness and significance of this scientific meeting.

We strongly feel that the 29^{th} annual Agrarian Perspectives conference will create an inspirational framework for all of the participants and contribute to the further development and expansion of agricultural research.

Karel Tomšík
Vice-dean for International relations
Faculty of Economics and Management, CULS Prague

THE RELATIONSHIP BETWEEN CARBON DIOXIDE EMISSIONS, ELECTRICITY CONSUMPTION, AND ECONOMIC GROWTH IN SYRIA

Ahmed Altouma

Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

altouma@pef.czu.cz

Annotation: The 21st century has seen environmental degradation as one of the main challenges experienced today. Syria, which is in a peculiar situation due to the ongoing war, is not exempt from this predicament. The objective of this article is to examine the relationship among carbon dioxide, electricity consumption, and economic growth for the time 1971 to 2014. In reaching this objective, the paper applied a cointegration test (which was done after the ARDL long- run bounds Test) and found the existence of cointegration amongst the variables, which was significant and adjusted to long-run equilibrium at -0.94 as expected consumption of electricity and economic growth all have a positive increment towards carbon dioxide emissions. These raise concern amongst policymakers who need to build environmentally friendly means of energy use and economic activities.

Key words: Carbon dioxide emissions, electricity consumption, economic growth, Syria.

JEL classification: O13, F43

1. Introduction

There is no doubt that countries are striving for economic growth, achieving their goals in development, devoting all possible efforts to that. They sometimes overlook the environmental impacts of this growth. This issue gave continuous importance to navigating the relationship between environmental risks and economic variables and making them a major arrangement, decade after decade. (Ali, and de Oliveira, 2018).

Through the literature, the researchers developed three categories for the relationship between environmental pollutants and the economy (Heil, and Selden, 1999). The first one discusses the link between environmental pollutants and economic growth; in other words, it tests the Kuznets environmental curve. The second is economic development and energy consumption. The third is a common approach to both scenarios.

And to understand the relationship between economic development and environment pollutants, both Dinda (2004) and Stern (2004) explain Kuznets curve model, the model has three stages. In the first stage, countries are working to increase economic growth and accompanied by energy consumption. Whereas countries use fossil energy to provide fair prices. Using this type of energy increases your CO2 emissions. In the second stage, despite the countries achieving a certain level of economic growth, the use of carbon dioxide continues to increase significantly. In the final stage, countries are working to raise the diminishing economic growth of carbon.

The most prominent cause of global warming is the rapid increase in the proportion of gases. And that the emission of carbon dioxide into the atmosphere increases the earth's temperature. (Yavuz, 2014)

According to IPCC, carbon dioxide emissions are the most prominent of these environmental hazards affecting climate change. IPCC has determined the distribution of global greenhouse gas emissions for the year 2010 at 25% for electricity and heat production, 24% for agriculture, forestry, and other land uses, 14% for transportation, 6% for buildings, and the remaining 10%. Mainly goes to fuel extraction, refining, treatment, and transportation.

According to the global carbon project, china tops the list of countries most contributing to carbon dioxide emissions, followed by the United States, India, and Russia.

In the past decade, Macao, Libya, Nauru, Ireland, and Northern Marian Islands and Rwanda have alternated over the pyramid of GDP growth countries. Where each of Macao, Libya, and Nauru remained for two years and one year for others according to the World Bank database.

In the past decade, China's consumption of electricity increased to 170% compared to 2010 as the most consumer of electricity globally, while the United States succeeded in maintaining almost the same consumption to remain second according to Global Energy Statistical yearbook, 2019.

Syria, like other countries in the Middle East, has worked to raise the economic growth, and after the crisis began in Syria in March 2011, the economic growth started to fall and reached the bottom in 2012 and 2013 in -26.3%. Then it started increasing and recovering until it reached -1.460% in 2017 according to ceicdata database. In regard to the consumption of electrical energy for the Syrian citizen's, It isn’t considered high compared to other countries of the world, with an average of 989 kWh per year per person according to the CIA, the World Factbook in the 2014 update.

Twenty-five conferences of parties were held starting in the nineties under the umbrella of the United Nations, which permeates the adoption of the Kyoto Protocol in 1997 which entered into force in 2005. However, the failure to reach an agreement binding on all parties continued until 2011, when an important shift occurred through the approval of a legally binding deal by all countries in 2015. All negotiations culminated in the Paris Climate Agreement, which was ratified by consensus of delegations.

Since the relationship between economic development and environmental pollutants was presented, many studies have discussed this relationship. Some researchers studied a single developing or developed country like Mikayilov, Galeotti, and Hasanov (2018) study about Azerbaijan. Some took a group of countries that have ties such as MENA countries like Farhani (2013).

Magazzino (2015) studied the Italian experience between 1970 and 2006 among economic growth, CO_2 emissions, and energy consumption to examine the relationship between them by using Toda-Yamamoto approach and Granger causality test. Farhani (2013) studied the same variables as panel data for 12 MENA countries from 1975 till 2008 by using Pedroni cointegration test, Granger causality test, DOLS, and FMOLS to find linkages among the studied variables. Odugbesan and Murad (2019) added urbanization to the studied variables. The study discussed variables between 1993 and 2014 for 23 Sub-Saharan African countries by using pooled OLS regression test and fixed/random effect model. The purpose of this study was to explain interacting the combination of the studied variables. Mikayilov, Galeotti, and Hasanov (2018) investigated the relationship between economic growth and CO_2 emissions for the case study of Azerbaijan between 1992 and 2013 by implementing Johansen cointegration approach, ARDLBT, DOLS, FMOLS, and CCR. Bouznit and Pablo-Romero (2016) which talked about Algeria between 1970, 2010 using ARDL to examine the relationship between CO_2 emissions and economic growth in Algeria, taking into account imports and exports in addition to energy use and electricity consumption. Shaari (2017) study which aims to investigate the effects of both electricity consumption and economic growth on carbon dioxide emission between 1971 to 2013 in Malaysia

This study consists of four parts. A theoretical discussion of the types of relationship between environmental pollutants and the economy and the form of the relationship according to Kuznets' environmental curve. It is followed by subtracting the main cause of global warming and distributing emissions according to industries in percentages. In addition, data is presented and explained regarding research variables globally in the last decade. The most important conferences related to climate change were discussed, and the purpose of the study was clarified. Besides, reviewing some previous studies discussed the same variables. The second section of the running paper is a description of the methods used. In the third part of the study, the results are presented and discussed with the results of previous studies. The last part of this study shows a summary of the study and the proposed topics for future studies.

2. Materials and Methods

Data set used in this study includes the period 1971-2014, and analyses have been studied on an annual data basis. CO_2 emissions data have obtained from the world bank database as well as both economic growth from 1971 until 2007 have taken from the same source while years data from 2008 till 2014 have obtained from ceicdata database. While the electricity consumption data have obtained from trading economics data base. The researcher used both Excel 2010 and Eviews 11 for arranging the data and implementation of econometric analyses.

Our empirical model examines the relationship among economic growth, and electricity consumption. The functional link between these variables yields:

$$CO_2 = f(GDPt,\ ECt) \tag{1}$$

Where, CO_2, GDP, EC represent carbon dioxide emissions, economic growth, and electricity consumption.

The natural logarithmic transformation of Eq. (1) yields the following equation:

$$LnCO2 = \alpha 0 + \alpha 1 LnGDPt + \alpha 2 LnECt \tag{2}$$

Where α_0 = Intercept; α_1, α_2 are coefficients

In this paper, researcher uses ARDL cointegration approach to investigate the long-run relationship amongst CO_2 emissions, economic growth, and electricity consumption.

Unit root test:

There are many methods for this test. One of the most famous is Augmented Dickey-Fuller (ADF-1979) test method. Through this test, we can decide whether the Ho hypothesis is accepted. This happened by comparing the statistics obtained by the test with critical value. Ho hypothesis shows that series is not stationary and has a unit root, alternative hypothesis shows that series is stationary. If the calculated value is bigger than the absolute critical value, then Ho hypothesis is rejected, a series is decided to be stationary.

H0: Series is not stationary (There is unit root).

H1: Series is stationary (There is no unit root).

ARDL approach, the Autoregressive Distributed Lag is a cointegration test for examining long-run relationship that suggested by Persan and Pesaran (1997). We use this approach when dealing with variables that are I (0) or I (1) or fractionally integrated. Long run relationship of the series is acceptable when F-statistic exceeds the critical value band. The ARDL framework of Equation 3 of the model is as follows:

$$\Delta \mathrm{LnCO2t} = \mathrm{a0} + \sum_{i=1}^{n} \mathrm{a1i}\Delta \mathrm{LnCO2t} - 1 + \sum_{i=1}^{n} \mathrm{a2i}\Delta \mathrm{LnGDPt} - 1 + \sum_{i=1}^{n} \mathrm{a3i}\Delta \mathrm{LnECt} - 1 + \lambda\, \mathrm{ECMt} - 1 \qquad (3)$$

According to Woodridge (2004), the Model needs some extra tests for examining the quality of it. based on that, diagnostic tests particularly will be implemented for this purpose and mainly for the error term of the model. These tests included mainly the presence of autocorrelation in the error term, homoskedasticity, and for normality. H0 indicates the absence of serial correlation, heteroskedasticity, and the presence of normality. Moreover, for checking the model's level of stability, the Cusum of squared test has done.

3. Results and Discussion

In this empirical study, we used Augmented Dickey-Fuller Stationary unit root tests to check for the integration order of each variable. Researcher has used the ADF unit root test to check for stationarity. The results in Table 1 indicate that all variables except GDP growth are non-stationary at their level form and stationery at their first differences.

Table 1. UNIT ROOT RESULTS (ADF RESULTS)

Variable	Test	Level		1st difference	
		Statistic	5% critical	Statistic	5% critical
CO_2 emissions (Kt)	Cons	-2.3988	-2.9314	-6.2191	-2.9332
	Cons & Trend	-0.0908	-3.5181	-7.8305	-3.5208
	None	1.1897	-1.9487	-5.9797	-1.9489
Electric power consumption (kWh per capita)	Cons	-1.9038	-2.9332	-4.1871	-2.9332
	Cons & Trend	0.7766	-3.5181	-4.7572	-3.5208
	None	1.1590	-1.9489	-3.9335	-1.9489
GDP growth	Cons	-4.2807	-2.9332	-	-
	Cons & Trend	-4.7250	-3.5208	-	-
	None	1.1590	-1.9489	-	-

Source: Author computations (2020)

In this study, the computed F – statistic, which is greater than the upper critical values of entire significant levels. The guideline says that if the computed F- statistic is greater than I1 critical values, the results showed a cointegration status.

Table 2. ARDL LONG – RUN BOUNDS TEST OF COINTEGRATION

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	19.04137	10%	3.17	4.14
k	2	5%	3.79	4.85
		2.5%	4.41	5.52
		1%	5.15	6.36

Source: Author computations (2020)

With optimal lag length selected, the long – run equation was estimated using the ordinary least squares, its residue (error correction term) determined, and the error correction model estimated. The error correction model results are indicated in Table 4 below:

Table 3. VAR Lag Order Selection Criteria

Endogenous variables: LCO_2						
Exogenous variables: C LEC LGDP						
Sample: 1971 2014						
Included observations: 40						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	19.3404	NA	0.0259	-0.8170	-0.6904	-0.7712
1	31.5606	21.9963*	0.0148	-1.3780	-1.2091*	-1.3170*
2	32.6173	1.8493	0.0147*	-1.3809*	-1.1698	-1.3045
3	32.6427	0.0432	0.0155	-1.3321	-1.0788	-1.2405
*** indicates lag order selected by the criterion**						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Source: Author computations (2020)

The results in table 4 indicate that all estimated coefficients are statistically significant. Based on that, both economic growth and electricity consumption lead to increase in CO_2 emissions. Moreover, the estimates indicate that 1% increase in economic growth leads to higher CO_2 emissions by 0.61%, as well as 1% increase in electricity consumption leads to higher CO_2 emissions by 0.37%.

Table 4. Long-run estimation results

Dependent variable Lco_2				
Variable	**Coefficie**	**Std. Error**	**t-Statistic**	**Prob.**
C	5.5348	1.0478	5.2829	0.0000
LEC	0.3765	0.1039	3.6249	0.0017
LGDP	0.6136	0.1146	5.3532	0.0000

Source: Authors computations (2020)
Significance at 5 percent probability

As the results in Table 5 indicate, the effect of electricity consumption and economic growth on carbon emissions adjusted to long – run equilibrium at a speed of -0.94 and was significant. In addition, the coefficient of economic growth has a significant impact with a positive sign.

Table 5. Error correction model (ECM) for short-run elasticity ARDL

ARDL Error Correction Regression				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	5.5348	0.6981	7.9286	0.0000
D(LEC)	-0.2184	0.2441	-0.8947	0.3816
D(LGDP)	0.1276	0.0240	5.3112	0.0000
CointEq(-1)*	-0.9400	0.1186	-7.9270	0.0000
The Short-Run Diagnostic Test Results				
R-squared	0.8371	**Mean dependent var**		0.0195
Adjusted R-squared	0.7409	**S.D. dependent var**		0.1459
S.E. of regression	0.0743	**Akaike info criterion**		-2.0771
Sum squared resid	0.1213	**Schwarz criterion**		-1.4613
Log likelihood	51.3874	**Hannan-Quinn criter.**		-1.8621
F-statistic	8.6982	**Durbin-Watson stat**		1.8341
Prob(F-statistic)	0.000007			

Source: Author computations (2020)
Significance at 5 percent probability

Table 6 shows the results of autocorrelation, heteroskedasticity, and abnormality. The tests indicate p – values of 0.5291, 0.1261, and 0.8235, respectively, which are all greater than 5 percent, which articulate the rejection of the N0.

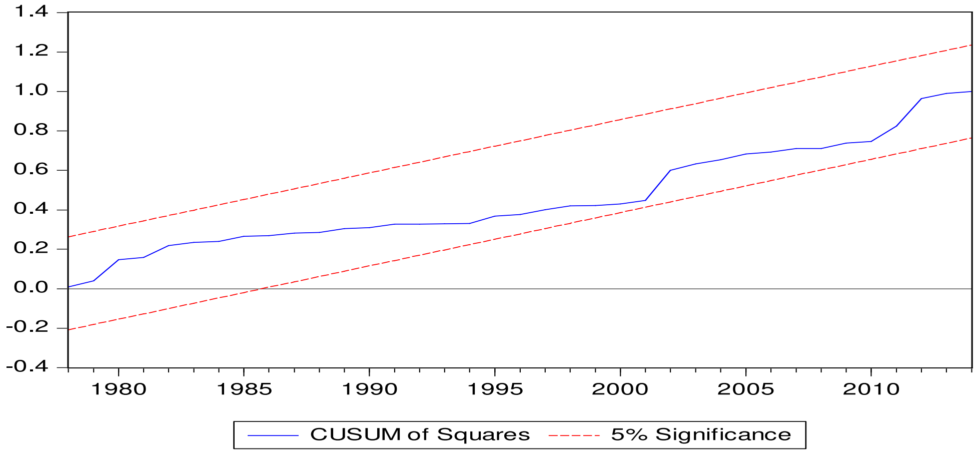
Table 6. DIAGNOSTIC TESTS

Problem	Test	p-value
Autocorrelation	Breusch-Godfrey LM	0.5291
Heteroskedasticity	Breusch-Godfrey LM	0.1261
Normality	Histogram (Jarque – Bera)	0.8235

Source: Author computations (2020)
Significance at 5 percent probability

The figure below, which is cusum of squares, shows us stability.

Figure 1. Stability Test



Similar to the paper, Odugbesan and Murad (2019), Mikayilov, Galeotti, and Hasanov (2018) and Shaari (2017) research papers agreed with the results in regard to the cointegration. In contrast, Magazzino(2015) was non-cointegrated among the studied variables. Therefore, it can be concluded that there is a long run relationship among the variables in the first three studies.

Whereas Shaari (2017), Mikayilov, Galeotti, and Hasanov (2018) and this paper said that the increase in GDP leads to an increase in carbon emissions, Odugbesan and Murad (2019) indicated the opposite. With respect to the other variable, which changes from a study to another (the fixed variables usually economic growth and CO2 emissions), which is electricity consumption in this paper. Shaari (2017) and Bouznit and Pablo-Romero (2016) studied the same extra variable and indicated that an increase in electricity consumption could cause carbon dioxide emission, which has found in this paper. Apart from the long-run relationship, Shaari (2017) results show that economic growth and electricity consumption do not have any effect on carbon dioxide emissions on the short-run. In the running study, there is only effect between economic growth and carbon dioxide emission. While in Farhani (2013), there is an effect between CO2 emissions and renewable energy consumption.

4. Conclusion

This study aims to examine the relationship among electricity consumption and economic growth on carbon dioxide emission in Syria from 1971 to 2014. The analyses started with the unit root test, and the results showed that the studied variables used are stationary. Part of them are stationary at the form level and others at the first difference. Subsequently, the ARDL bound testing approach was implemented. The results indicated that in the long run, all variables are statistically significant, and each of them leads to lead to increasing CO_2 emissions. In the short run, only economic growth has a significant impact with a positive sign. Policy makers can use these results as a justification to manage the electricity consumption and have environmentally friendly, sustainable electrical solutions

References

Ali, S. H. and de Oliveira, J. A. P. (2018), "Pollution and economic development: an empirical research review", *Environmental Research Letters*, Bristol, vol. 13, no. 12, DOI 10.1088/1748-9326/aaeea7

Bouznit, M. and Pablo-Romero, M. D. P. (2016), CO_2 emission and economic growth in Algeria, *Energy Policy*, United Kingdom, vol. 96, pp. 93 – 104, ISSN 0301-4215, DOI 10.1016/j.enpol.2016.05.036

CEIC, Syria Real GDP Growth, 2020, [Online], Available: http://www.ceicdata.com/en/indicator/syria/real-gdp-growth ,[Accessed: 3 April. 2020]

Central Intelligence Agency, The World Factbook Archive, Middle East: Syria, 2015, [Online], Available: http://www.cia.gov/library/publications/the-world-factbook/geos/sy.html, [Accessed: 12 April. 2020]

Dinda, S. (2004), "Environmental Kuznets curve hypothesis: a survey". *Ecological economics*, vol. *49, no.* 4, pp. 431- 455, ISSN 0921-8009, DOI 10.1016/j.ecolecon.2004.02.011

Edenhofer, O. (2015), "*Climate change 2014: mitigation of climate change",* vol. 3, Cambridge, Cambridge University Press, ISBN 978-1-107-05821-7

Farhani, S. (2013), "Renewable energy consumption, economic growth and CO_2 emissions: Evidence from selected MENA countries", *Energy Economics Letters*, vol. *1, no.* 2, pp. 24 – 41, E- ISSN 2308-2925

Global Carbon Project, CO_2 emissions, 2019, [Online], Available: http://www.globalcarbonatlas.org/en/CO2-emissions, [Accessed: 1 April 2020]

Global Energy Statistical Yearbook, Electricity Consumption, 2019, [Online], Available: http://yearbook.enerdata.net/electricity/electricity-domestic-consumption-data.html, [Accessed: 4 April. 2020]

Heil, M. T. and Selden, T. M. (1999), "Panel stationarity with structural breaks: carbon emissions and GDP", *Applied Economics Letters*, vol. 6, E-ISSN 1466-4291, DOI 10.1080/135048599353384

IPCC, Intergovernmental Panel on Climate Change (2014), "Mitigation of climate change", *Contribution of working group III to the fifth assessment report of the intergovernmental panel on climate change*, Geneva, Switzerland

LIFEGATE, the history of climate changes conferences, 2010, [Online], Available: https://www.lifegate.com/people/news/history-climate-change-conferences, [Accessed: 14 April. 2020]

Magazzino, C. (2015), “Economic growth, CO_2 emissions and energy use in Israel”, *International Journal of Sustainable Development & World Ecology*, vol. 22, no. 1, pp. 89 - 97. ISSN 1350-4509, E-ISSN 1745-2627, DOI 10.1080/13504509.2014.991365

Mikayilov, J. I., Galeotti, M. and Hasanov, F. J. (2018), “The impact of economic growth on CO_2 emissions in Azerbaijan”, *Journal of Cleaner Production*, vol. 197, pp. 1558 - 1572. ISSN: 0959-6526, DOI 10.1016/j.jclepro.2018.06.269

Odugbesan, J. A. and Murad, B. (2019), “Economic Growth, CO_2 Emissions, Energy Consumptions and Urbanization in Sub-Sahargan Africa”, *International Journal of Research in Social Sciences*, vol. 9, no. 4, pp.635 – 653, ISSN 2454-4671. DOI 10.15640/jeds.v3n2a7

Pesaran, M. H. and Pesaran, B. (1997) “*Working with Microfit 4.0: interactive econometric analysis; [Windows version]”,* Oxford University Press, Oxford, United Kingdom

Shaari, M. S., Razak, N. A. A. and Hasan-Basri, B. (2017), “The effects of electricity consumption and economic growth on Carbon Dioxide emission”, *International Journal of Energy Economics and Policy*, vol. 7, no. 4, pp. 287 - 290, ISSN 2146-4553

Stern, D. I. (2018), “The environmental Kuznets curve”, *Companion to Environmental Studies”,* vol. 49, no. 54, pp. 49 - 54. ROUTLEDGE in association with GSE Research, ISBN-13: 978-1138192201, ISBN-10: 1138192201

World Bank, GDP Growth, 2020, [Online], Available: http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG, [Accessed: 6 April. 2020]

Yavuz, N. Ç. (2014), “CO_2 emission, energy consumption, and economic growth for Turkey”: Evidence from a cointegration test with a structural break”, *Energy Sources, Part B: Economics, Planning, and Policy*, vol. 9, no. 3, pp. 229 - 235. ISSN 1556-7249, E- ISSN 1556-7257, DOI 10.1080/15567249.2011.567222

THE INFLUENCE OF EXCHANGE RATE ON ECONOMIC GROWTH: EVIDENCE FROM INDIA

Denim Umeshkumar Anajwala[1] and Seth Nana Kwame Appiah-Kubi[2]

[1, 2] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]denimanajwala91@gmail.com, [2]appiah-kubi@pef.czu.cz

Annotation: In the globalization time frame conversion scale is the essential factor influencing on financial development of each nation. This examination is embraced to inspect the effect of conversion scale on financial development of India during 1995 to 2018. As indicated by standard deviation it is seen that the GDP development is more predictable than conversion scale, loan cost and swelling rate during the examination time frame in India. The coefficient of connection 0.037426 demonstrates that the relationship between conversion standard and GDP development is sure however not critical. Be that as it may, the financing cost and expansion rate have reverse impact on monetary development of India during the examination time frame. It is watched structure the investigation that the conversion scale and loan cost has negative however not critical effect on financial development of India (Showing $\beta = -0.0733305$ and $t = -0.4152$ and $\beta = -0.0113661$, $t = -0.07231$ individually) during the examination time frame. In any case, it is discovered that the swelling rate has positive however not huge effect on financial development of India with ($\beta = 0.0262511$, $t = 0.6584$). Connection investigation shows positive, yet various relapse examination shows negative connection between swapping scale and GDP development in India during the investigation time frame.

Keywords: Exchange Rate, Inflation Rate, Interest Rate, GDP

JEL classification: C01, F06, N01

1. Introduction

India has a free market and fare situated economy and is presently perhaps the best economy. There has been a significant enthusiasm among policymakers and specialists in India in understanding the effect of loan fee on India's monetary development. Be that as it may, writing of the exact econometric examination on monetary development changes as far as informational collections, econometric procedures, and regularly delivers clashing outcomes (Mussa, 1977). The nation's logical and innovative improvement is contended to be appealing to remote direct speculation.

Prior to moving to the exact examination, it is valuable to audit the writing on the nexus between genuine trade rates and monetary development, both hypothetical and experimental. Eichengreen (2008) offers an amazing survey of the discussion, including the job of conversion scale systems and swapping scale instability. Thusly, we center around later investigations and those closer to the target of this paper.

Jayachandran (2013) conducted a study on The Impact of Exchange rate on Trade and GDP for India a Study of Last four decade. This research has provided empirical estimates of the Economic relationship between Exchange Rate, Inflation, Government Revenue and Income growth in India. In the long-run the exchange rate and income may not drift apart, but in the short run their relationship is weak and indirect. Together these results provide confirmation that there is no evidence of a strong direct relationship between changes in the exchange rate and GDP growth. Rather India’s Economic growth has been directly affected by fiscal and monetary factors.

Stotsky et al. (2012) examines the relationship between the foreign exchange regime and macroeconomic performance in India. They found that lagged inflation, broad money growth and fiscal position are key macroeconomic determinants of inflation. They observe that the actual exchange rate regime in place, with flexible and intermediate foreign exchange regimes producing lower inflation than the pegged exchange rate regime. They also found the evidence of a significant relationship between exchange rate movements and inflation, there is no evidence for full pass-through, both in the short and long run.

There is a direct relationship of inflation differential with domestic exchange rate (Alquist and Chinn, 2008). In other words, a higher domestic inflation relative to that of other nations results into depreciation of domestic currency (Soenen and Aggarwal, 1989). This is so because an increase in domestic inflation as compared to world inflation would increase the domestic demand for foreign commodities and lowers the foreigner and for domestic commodities, as more and more domestic consumer will shift toward foreign goods, supply of domestic currency in foreign exchange market will increase when these consumers will sell domestic currency for foreign currency (Babar and Khandare, 2012). This process would require depreciation of domestic currency to maintain the exchange rate as per the purchasing power theory. By same token, a decrease in domestic inflation as compared to world inflation causes appreciation of domestic currency. Therefore, the higher the inflation differential between domestic and foreign countries, the higher will be the depreciation of domestic currency and vice versa. This theory is called the Purchasing Power Parity. In another study Jain (2012) investigates the impact of bank rate policy of the Reserve Bank of India (RBI) and interest yield differentials between the India and the US securities. This paper also studied the impact of broad money supply and foreign exchange reserves.

Goyal (2010) concluded that exchange rate in India can be stabilized by raising interest rate. But even if the raising of interest rates lead to appreciation of exchange rate, the costs of raising interest rates in terms of large recession due fall in domestic consumption on account of reduced household borrowings, decline in business investment, corporate failures as many projects will turn unprofitable due to increase in discount rate, financial system bankruptcies or fragility may completely offset the benefits of an appreciated exchange rates So, there is cost of maintaining exchange rate by increasing the interest rate while the market determined exchange rates does not lead to such costs (Razzaque et al. 2017). However, in case of India, an increase in interest rates can lead to exchange rate appreciation without causing any adverse effects.

Higher government use account with enormous getting might contribute decidedly to the general execution of the economy. Government spending represses advancement. The private area continually arrangement for new thoughts, feelings and openings due to extreme fruition. For example, if government expands obtaining so as to back its enormous consumption, it will swarm out the private area, consequently decreasing private speculation or it might spend substantive sum on adjusting its current liabilities that can generally be utilized for venture. At the point when the administration acquires from another nation, financing cost in that nation goes up because an expansion popular for credits, subsequently pushing up the costs.

Moreover, in an offer to score modest notoriety and guarantee that they keep on staying in force, legislators and governments authorities here and there increment consumption and interest in useless undertakings or in products that the private area can create more proficiently. Along these lines, government movement once in a while creates misallocation of assets and blocks the development of national yield (State Bank of India, 2012). In such cases, shockingly, rising open obligation for consistently mounting open use won't converted into significant development and advancement. This paper researches the impact of open obligation and open consumption independently on monetary development (GDP) in India.

While there have been various hypotheses and exact investigations the impacts of exchange on monetary development and its impact on general execution of the nation (Aggarwal, 1981), not many have tended to the significant issue of real estimations that plainly shows supportability. My goal here is to inspect whether loan fee is vigorous determinant of cross-country financial development.

This examination utilizes econometrics to investigations the effect of Interest rate on monetary development in India concentrating on today and tomorrow. This is on the grounds that econometrics is the unification of financial matters, arithmetic, and insights. This unification creates more than the total of its parts. Econometrics adds observational substance to monetary hypothesis enabling speculations to be tried and utilized for gauging and arrangement assessment.

2. Materials and Methods

2.1 Measurement of variables

The present study is based on secondary data collected from world data bank. The secondary data regarding GDP growth rate, Exchange rate, Interest rate and Inflation rate were collected from World Bank Data Publication. The required data collected for the period 1995 to 2018. For analysing growth performance of macroeconomic indicators average and compound annual growth rate has been used. The models used in this study are estimated using annual Indian data on some macro-economic indicators, which includes: Gross Domestic Products (GDP); Exchange Rate (EXR); Interest Rate (INR) and Inflation Rate (IFR) for the period 1995 to 2018. The correlation and multiple regression analysis of the ordinary least square (OLS) are used to determine the impact of exchange rate on economic growth of India. For determine the impact of selected macroeconomic indicators on economic growth of India the specifies model formulated as under;

$$GDP = f\,(EXR, INT, INF)$$

$$GDP = \beta_0 + \beta_1\,EXR + \beta_2\,INR + \beta_3\,INF$$

GDP = Gross Domestic Product

EXR = Exchange Rate

INR = Interest Rate

INF = Inflation Rate

β = intercept

2.2 GDP growth rate, Exchange rate, Interest rate and Inflation rate in India

Table shows the information on GDP development, Exchange rate, Interest rate and Inflation rate in India during the period from 1995 to 2018. It is seen from the table that the on a normal yearly development pace of GDP in India was 6.68 percent during the examination time frame with decrement of 0.34 occasions. While on a normal conversion scale was 48.92 per $ with increment of 1.8 occasions during 1995 to 2018 it was high than GDP development rate during this period. During the examination time frame on a normal Interest rate was 5.43 percent and Inflation rate was 6.88 percent. It is discovered that Interest rate and Inflation rates are diminished in 2018 with contrast with the underlying year 1995. It is seen from the information that the most noteworthy compound development rate recorded by Exchange rate for example 3.16 percent followed by GDP development rate -0.34 percent and Interest rate and Inflation rate recorded – 0.61 percent and – 1.24 percent compound yearly development rate individually during the investigation time frame. The Exchange rate developed during this examination period with a normal 3.46 percent every year while GDP developed by 8.62 percent, Interest rate and Inflation rate developed by – 1.24 percent every year during the investigation time frame. In this way, the conversion standard became so more than GDP development during the examination time frame. The Minimum and the most extreme trade rates were 32.43 and 68.39 separately. On account of this wide scattering of the conversion scale, the standard deviation 10.11 of the swapping scale from the mean conversion standard 48.92 was extremely high. Such high scattering of the information gives just feeble relationship and relapse coefficients. On account of swelling, the information was progressively dispersed.

Table 1. GDP growth rate, Exchange rate, Interest rate and Inflation rate in India

Year	Exchange Rate	Inflation Rate (%)	Real Interest rate (%)	GDP Growth Rate (%)
1995	32.43	10.22	5.86	7.57
1996	35.43	8.98	7.79	7.55
1997	36.31	7.16	6.91	4.05
1998	41.26	13.23	5.12	6.18
1999	43.05	4.67	9.19	8.85
2000	44.94	4.00	8.34	3.84
2001	47.19	3.78	8.59	4.82
2002	48.61	4.29	7.91	3.80
2003	46.58	3.80	7.30	7.86
2004	45.32	3.77	4.91	7.92
2005	44.10	4.24	4.85	7.92
2006	45.31	5.79	2.57	8.06
2007	41.35	6.37	5.68	7.66
2008	43.50	8.35	3.77	3.09
2009	48.40	10.88	4.80	7.86
2010	45.73	11.99	1.98	8.49
2011	46.67	8.86	1.32	5.24
2012	53.48	9.31	2.47	5.45
2013	58.60	10.91	3.86	6.38
2014	61.03	6.35	6.69	7.41
2015	64.15	5.87	7.55	7.99
2016	67.20	4.94	6.35	8.17
2017	65.12	2.49	5.46	7.17
2018	68.39	4.86	5.06	6.98
Average	48.92	6.88	5.43	6.68
Minimum	32.43	2.49	1.98	3.09
Maximum	68.39	13.23	9.19	8.85
CAGR	3.16	-3.05	0.61	-0.34
AAGR	3.46	3.32	1.24	8.62
Standard Deviation	10.11	3.04	2.57	1.70

Source: World data bank

The Minimum and the maximum exchange rates were 32.43 and 68.39 respectively. Because of this wide dispersion of the exchange rate, the standard deviation 10.11 of the exchange rate from the mean exchange rate 48.92 was very high. Such high dispersion of the data gives only weak correlation and regression coefficients. In the case of inflation, the data were more scattered.

The Minimum and the maximum rate of inflation were 2.49 percent and 13.23 percent respectively. However, the mean was 6.88 percent and the standard deviation was only 3.04 percent, which is more consistent. The data on growth rate of GDP were consistent. The Minimum and the maximum growth rate of GDP was 3.09 percent and 8.85 percent respectively. Average growth rate of GDP from 1995 to 2018 was 6.68 percent while the standard deviation was only 1.70 percent. The Minimum and the maximum rate of interest were 1.98 percent and 9.19 percent respectively. However, the mean was 5.43 percent and the standard deviation was only 2.57 percent, which is also more consistent. According to standard deviation it is observed that the GDP growth is more consistent than exchange rate, interest rate and inflation rate during the study period in India.

3. Results and Discussion

This chapter presents the results of the data analysis and discussion. The study provided two types of data analysis; namely descriptive analysis and inferential analysis. The descriptive analysis helps the study to describe the relevant aspects of the phenomena under consideration and provide detailed information about each relevant variable. For the inferential analysis, the panel regression was used. The first part highlights descriptive statistics. The second part focuses on the regression results of the fixed and random effect models. The last section presents the discussion of results.

3.1 Regression Results

Pearson coefficient of correlation between the exchange rate and the growth rate of GDP is 0.304 (30.4 percent) with a significance level of 0.149 or 14.9 percent. The coefficient of correlation 0.304 indicates that the correlation between exchange rate and GDP growth is negative but not significant. But the interest rate and inflation rate have inverse effect on economic growth of India during the study period. The correlation between interest rate and inflation is 0.906 and 0.165 respectively. This implies that the higher the interest rate and inflation rate the lower the level of gross domestic product of India.

Table 2. Correlation results

		GDP Growth Rate	Exchange Rate	Interest Rate	Inflation Rate
GDP Growth Rate	Correlation	1	-0.304	-0.025	0.165
	Sig.(2-tailed)		0.149	0.906	0.441
	N	24	24	24	24
Exchange Rate	Correlation	-0.304	1	-0.535	-0.008
	Sig.(2-tailed)	0.149		0.007	0.969
	N	24	24	24	24
Interest Rate	Correlation	-0.025	-0.535	1	-0.104
	Sig.(2-tailed)	0.906	0.007		0.629
	N	24	24	24	24
Inflation Rate	Correlation	0.165	-0.008	-0.104	1
	Sig.(2-tailed)	0.441	0.969	0.629	
	N	24	24	24	24

Source: Authors' own calculation

The results of OLS show that Exchange Rate has positive relation with the GDP growth of India. One percent increase in Exchange Rate will increase GDP by 0.026 percent. Interest rate has also negative relation with the GDP of India. It shows that one percent increase in Interest rate will decrease GDP by 0.073 percent. It found that inflation rate and interest rate have negative impact on economic growth of India during the study period. But the exchange rate has positive impact of economic growth of India but not significant. The inflation rate shows that one percent decrease in inflation rate will 0.011 percent raise in economic growth of India. The value of R2 (coefficient of determination) in our model represents that 3.7 percent of the variations in the dependent variable (ln GDP) is due to independent variables included in the model.

Table 3. Summary of Regression Result of the model of the study

Variables	**Co-efficient**	**t-value**	**P**
Constant	5.87184	1.888	0.0736
Exchange Rate	0.0262511	0.6584	0.5178
Interest Rate	-0.0733305	-0.4152	0.6824
Inflation Rate	-0.0113661	-0.07231	0.9431
R^2	0.037426		
Adj. R^2	-0.106960		
F-Value	0.259207		

Source: Authors' own calculation

4. Conclusion

This research study examined the impact of exchange rate on economic growth from 1995 to 2018. The result revealed that exchange rate has positive impact (β =0.0262511, t = 0.6584, Pns) this is not affirming previous studies that developing countries are relatively better off in the choice of flexible exchange rate regimes. The result also indicated that interest rate has negative impact on economic growth with (β = - 0.0733305, t = - 0.4152, Pns). The regression result indicated that the inflation rate has negative impact but not significant with (β = -0.0113661, t = -0.07231, Pns) on economic growth of India. From the empirical reviewed work, some authors argued that exchange rate is positively related to economic growth, while some authors argued that it is negatively related. However, from empirical analysis of the study, it was found that exchange rate is positively related to output growth. Therefore, this paper recommended that government should change the strategies in order to maintain sustainable interest rates in the country. It is also necessary to the government to take appropriate measures to control exchange rates through effective fiscal and monetary policy.

Suggestion for further studies:

This study only uses OLS to estimate the panel data. Future research can use the multiple method. Future research can include new variables and number of years to investigate the dividend policy decision.

References

Alquist, R. and Chinn, M. D. (2008), “Conventional and unconventional approaches to exchange rate modelling and assessment”, *International Journal of Finance & Economics*, vol. 13, no. 1, pp. 2-13. E-ISSN 1099-1158, DOI 10.1002/ijfe.354

Aggarwal, R. (1981), “Exchange Rates and Stock Prices: A Study of The US Capital Markets Under Floating Exchange Rates”, *Akron Business and Economic Review*, vol. 12, pp. 7 - 12. ISSN 0044-7048, [Online], Available: https://www.sid.ir/en/journal/ViewPaper.aspx?ID=363021, [Accessed: 25 March, 2020]

Babar, S. N. and Khandare, V. B. (2012), “Structure of Foreign Direct Investment in India during globalization period”, *Indian Streams Research Journal*, vol. 2, no. 2, pp. 1-4. [Online], Available: https://d1wqtxts1xzle7.cloudfront.net/43359980, [Accessed: 25 March, 2020], ISSN 2230-7850, DOI 10.9780/22307850

Eichengreen, B. (2007), “The real exchange rate and economic growth”, *Social and Economic Studies 56*, pp. 7-20. [Online], Available: https://www.jstor.org/stable/27866525, [Accessed: 20 March, 2020], ISSN 0037/7651

Goyal, A. (2010). “Evolution of India's exchange rate regime”, *Indira Gandhi Institute of Development Research (IGIDR)*, WP-2010-024. [Online], Available: http://www. igidr. ac. in/pdf/publication/WP-2010-024. pdf. , [Accessed: 20 March, 2020]

Gurusamz, J. (2013) “Impact of Exchange rate on Trade and GDP for India a study of last four decade”, *International Journal of Marketing, Financial & Management Research*, vol. *2,* no. 9, pp. 154-170. [Online], Available: https://pdfs.semanticscholar.org/efde/8218a8cad3e3f106b918b9ad95e9f4cd13b6.pdf [Accessed: 10 Feb., 2020]

Jain, A. (2012), “Exchange Rate and Its Determinants in India”, [Online], Available: http://ssrn.com/abstract=2177284 [Accessed: 18 March, 2020], DOI 10.2139/ssrn.2177284

Mussa, M. (1977), “The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating”, *In Herin, J. “Flexible Exchange Rates and Stabilization Policy“,* pp. 97-116, Palgrave Macmillan, London, ISBN 978-1-349-03359-1

Razzaque, M. A., Bidisha, S. H. and Khondker, B. H. (2017), “Exchange rate and economic growth: An empirical assessment for Bangladesh”, *Journal of South Asian Development*, vol. *12,* no. 1, pp. 42-64. DOI 10.1177/0973174117702712

Soenen, L. A. and Aggarwal, R. (1989), “Financial Prices as Determinants of Changes in Currency Values, *25th Annual Meeting of Eastern finance Association, Philadelphia*, [Online], Available: http://www.iioa.org/conferences/17th/papers/4743149_090505_155551 [Accessed: 18 March, 2020]

Stotsky, J. G. and Ghazanchyan, M. and Adedeji, O. and Maehle, N. O. (2012), “The Relationship between the Foreign Exchange Regime and Macroeconomic Performance in Eastern Africa”, IMF Working Paper No. 12/148, [Online], Available: https://ssrn.com/abstract=2127040 [Accessed: 20 March, 2020]

POLICY DIVIDENDS AND PERFORMANCE: A CASE STUDY OF LISTED AGRICULTURE FIRMS IN GHANA

Seth Nana Kwame Appiah-Kubi[1], Maitah Mansoor[2], Karel Malec[3], Sandra Boatemaa Kutin[4], Eylül Güven[5] and Joseph Phiri[6]

[1, 2, 3, 5, 6] Department of Economics, [4] Department of Humanities, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]appiah-kubi@pef.czu.cz, [2]maitah@pef.czu.cz, [3]maleck@pef.czu.cz, [4]sbkutin@st.ug.edu.gh, [5]guven@pef.czu.cz, [6]phiri@pef.czu.cz

Annotation: This paper aims to assess the relationship between policy dividends and agribusiness firms' performance in Ghana. The issue of dividend policy is one of the very essential elements in economics and business that cannot be overlooked. The dividend, which is the benefit of shareholders in return for their risk and investment, is determined by different factors in an organization. These factors include financing limitations, investment chances and choices, firm size, pressure from shareholders, and regulatory regimes, however, the dividend pay-out of agribusiness firms is not only the source of cash flow to the shareholders, but it also offers information relating to firm's current and future performance. Two specific objectives were coined to i) establish the relationship between dividend policy and agriculture firms' performance (ROE) for listed companies on GSE. ii) examine the effect of size, leverage, and growth on financial performance (ROE) of listed agriculture companies on GSE. The study used data collected from annual reports of five (5) agriculture companies listed on the Ghana Stock Exchange (GSE) for the period of nine (9) years (2010-2018) and employed panel data regression models to estimate the observed relationships. The study results show that dividend policy was a highly significant predictor in explaining the agriculture firms' performance (ROE). The firm size and leverage had a positive and statistically insignificant effect on the financial performance of listed agribusiness firms. The results seem to suggest that, for listed agriculture firms' on GSE, size and leverage do not necessarily influence their return on equity. The study recommended that listed agriculture firms should invest in profitable assets that will yield higher returns in the future to enhance their financial performance and attract investments in the future and investors should not rely on the number of dividends paid to ascertain the financial stability of the agribusiness firms.

Keywords: Ghana Stock Exchange, dividend, return on equity, leverage, panel data, firm size, agribusiness

JEL classification: C1, M2, O1

1. Introduction

The payment of dividends is the most significant part of the company's decision-making since management must make an informed decision that benefits both the company and the shareholders (Adu-Boanyah, et al., 2015). Dividends are rewards, which are given to shareholders for the time and risks assumed when making investments with a company (Khan et al., 2016). It is believed to be one of the main decisions that management must make to ensure that the director of the going concern continues to maintain (Wahla et al., 2012). The Modigliani-Miller theorem (M&M) holds that the dividend payout policy does not affect dividends earned by shareholders, assuming there is a perfect market (Shisia et al., 2014). According to Bremberger et al., (2016), the assumption of bird in hand theory state that the relationship between the firm's valuation to dividends is determined by an individual investor's preference for dividends rather than capital gains.

A study by Shisia et al. (2014) in Kenya analyzed the effect of dividend policy on firm profitability. Their study concluded an occurrence of a significant association linking dividend payout ratio to the profitability of listed firms, but the study covered all the listed firms. Mashayekhi & Bazazb (2008) analyzed factors influencing profitability among Agricultural Firms listed on NSE where the study concluded that liquidity, firm size, and tangibility are the major determinants of profitability, but the study excluded dividend policy as a determinant. In Ghana, studies on dividend policy have been limited to the determinants of dividend payout ratios of listed firms (Adu-Boanyah et al, 2015), how does dividend policy affect the performance of the firm on Ghana Stock Exchange? (Amidu, 2007), dividend policy and share price volatility (Asamoah, 2010), dividend policy and bank performance (Marfo-Yiadom & Agyei, 2011), and dividend policy and firms' performance of listed banks in Ghana (Oppong, 2015).

Despite providing varied results on correlation linking dividend policies to profitability, there are few or no context of studies in Ghana that covers all the Agriculture Development Banks (ADB) listed on the Ghana Stock Exchange. This study again seeks to fill the gap by expanding the horizon to Agriculture firms listed on the Ghana Stock Exchange.

The main objective of the study is to examine the relationship between dividend policy and financial performance of Agriculture firms listed on the Ghana Stock Exchange (GSE) in Ghana. To wholly address the overall goal of the study, the following specific objectives have been coined to: i) Establish the relationship between dividend policy and Agriculture firm performance (ROE) for listed companies on GSE. ii)Examine the effect of size, leverage, and growth on financial performance (ROE) of listed Agriculture companies on GSE.

2. Materials and Methods

The study draws its population from companies listed on the Ghana stock exchange. To reach the objectives of the study, all five agriculture firms listed on the Ghana Stock Exchange (GSE) were sampled. Data for the study was collected from past annual reports which included Statement of Financial Position, Income Statement, Financial ratios and other information. The data was sampled over the recent years that is, 2010 – 2018.

This study adopts the panel data regression model since it is seen to be superior over time series and cross-sectional regression models. More specifically, fixed effects technique is used to examine the impact of dividend policy on the performance of Agriculture firms listed on the Ghana Stock Exchange (GSE). The fixed effects model was used in order to capture unobserved firm specific effects in the model. Also, to correct for both heteroskedasticity and autocorrelation, fixed effects model is most appropriate compared to OLS estimator. Upon conducting the Hausman test for random effects and fixed effects, we failed to reject null hypothesis meaning there is constant variance confirming the use of fixed effects methodology.

The firms sampled include; Agricultural Development Bank Ltd (ADB), Benso Oil Palm Plantation Ltd (BOPP), Cocoa Processing Company Limited (CPC), Hoards Ltd (HORDS), and Samba Foods Limited (SAMBA). These agriculture firms were sampled because of data availability data. This study adopts the models of Amidu (2007). Dependent and independent variables as well as variables controlled in the study are as below:

Table 1. Variables, Measurement and Symbols used to represent them

Variable	Measurement	Symbol
Dependent Variable		
Return on Equity	The ratio of net profit after tax to total equity capital	ROE
Independent Variable		
Dividend Policy	Dummy variable for dividend policy 1= Dividend payment policy 0= No dividend payment policy	DPOLICY
Payout	Distributed Dividend/Number of Shares	DPOUT
Control Variables		
Firm size	Natural logarithm of total assets	SIZE
Leverage	The ratio of total liabilities to total assets	LEV
Growth	growth in sales for firm	GRTH

Source: Authors' own definitions

Model Specification

In concordance with the model used by Amidu, (2007), the specific panel regression equation used for the study is as follows:

$$ROE_{i,t} = \alpha + \beta_1 DPOLICY_{i,t} + \beta_2 DPOUT_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LEV_{i,t} + \beta_5 GRTH_{i,t} + e_{i,t}$$

Where:

$ROE_{i,t}$ = Ratio of Profit before interest and tax by the book value of assets for firm i in period t

$DPOLICY_{i,t}$ = Dummy variable for dividend policy

$DPOUT_{i,t}$ = Dividend per share divided by earnings per share for firm i in period t;

$LEV_{i,t}$ = The ratio of total debt to total assets for firm i in period t;

$SIZE_{i,t}$ = The natural logarithm of total assets for firm i in period t;

$GRTH_{i,t}$ = Growth in sales for firm i in period t.

$e_{i,t} = \eta_i + \lambda_t + u_{i,t}$

η_i = the time invariant (firm effects) variables

λ_t = the time effects

$u_{i,t}$ = stochastic error term.

3. Results and Discussion

The study provided two types of data analysis; namely descriptive analysis and Regression analysis.

Descriptive Statisitics

Table 2. Descriptive Statistics of the Dependent, Independent, and Control Variables

	ROE	DPOUT	SIZE	LEV	GRTH
Mean	0.1924775	0.399979	7.124613	0.519853	4.522768
Maximum	0.291932	2.073884	9.573962	0.840700	5.946731
Minimum	-0.494565	0.000000	5.272348	0.194000	1.067838
Std. Dev.	0.4566995	0.683431	1.012696	0.832095	0.426566

Source: Authors' own calculation from annual reports of listed Agriculture firms

The table shows an average ROE of 19.24% for Ghanaian listed agriculture firms with a minimum and maximum returns of -49.5% and 29.2% respectively. This means that on average, stockholders receive Ghc0.19 of every Ghc1 invested annually. Some investors make profit while others incur losses on their investment. Firm size (SIZE) measures the spatial dimensions, proportions, and the magnitude of the firm.

Growth (GRTH) has been measured in relation to Amidu 2007, as the percentage increase in sales revenue over the previous year. The table shows that the listed agriculture companies were able to record a significant increase of 5.9 in revenue while observing a gradual movement in sales revenue of 1.1. On average, the agriculture firms recorded a substantial increase of 4.5 over the previous year. Leverage (LEV) measures the proportion of debt in the overall capital structure. This has been measured as the ratio of total liabilities to total assets of the company. From the table, the selected agriculture companies could be said to be less leveraged for a successful investment. However, a maximum and minimum of 84.1% and 19.4% were recorded respectively. This implies that agriculture firms are highly geared, and this makes it riskier for safe investments. On average, the firm is leveraged at 52%.

Discussion of Regression Results

Table 3 reports regression results between the dependent variable and explanatory variables. An adjusted R square of 81.1% indicates that the model is strong fit and the variations in the dependent variable (ROE) can uniquely or jointly be explained by the independent variables (Pallant, 2007). The F-statistic (60.13) at p-value of 0.0000 explains the overall significance of the model. This indicates that there is a significance relationship between the dependent variable (ROE) and all the independent variables (DPOLICY, DPOUT, SIZE, LEV, and GRTH).

Table 3. Summary of Regression Result of the model of the study

Variable	Coefficient	Robust Std. Error	t-Statistic	Prob.
DPOLICY	0.5176407	0.042773	4.401	0.0000
DPOUT	-0.100401	0.019271	-1.286	0.2027
SIZE	0.169474	0.072747	2.332	0.0245
LEV	0.049822	0.056902	0.877	0.1907
GRTH	0.167813	0.146890	-0.764	0.3912
C	-7.138656	1.543144	-6.574	0.0000
Number of obs			45	
Number of groups			5	
R-sq:		Obs per group:		
within = 0.1650		min = 9		
between = 0.0436		avg = 9		
overall = 0.0389		max = 9		
F (3,44) = 2.2387				
corr (u_i, Xb) = -0.8830				
Prob > F = 0.0003				

Source: Authors' own calculation from annual reports of listed firms

The results portray a positive and statistically significant relationship between Return on Equity (ROE) and dividend policy (DPOLICY). When dividend policy (DPOLICY) increases by 1% Return on Equity (ROE) increase by 51.56%. This implies that when a firm has a policy to pay dividend it influences its performance or profitability, and this may be a sign of good corporate governance system in place. This finding is consistent with empirical evidence of (Ross, et al 2002; Azam & Abbasi, 2011; Bremberger et. al, 2016). The results indicate a statistically insignificant and negative relationship between Return on Equity (ROE) and dividend payout (DPOUT). The negative coefficient means that if a firm pays more dividends relative to earnings, its performance deflates. High dividend payout agriculture firms in Ghana end up with low retained earnings for financing capital projects. Such agriculture firms may lack the financial capability to raise funds internally and may rely on debt financing to fund capital projects. The finding is congruent with the results of Amidu, (2007), Grullon et al., (2005) and Farsio et al., (2004). However, it disaffirms the findings of Amidu (2007), Agyei and Marfo-Yiadom, (2011), and Adu-Boanyah et al., (2013).

Also, the results show that the coefficient of firm size and leverage are positive and statistically significant at 5%. A percentage increase of a firms' size increases ROE by 16.95%. The results seem to suggest that, for listed Agriculture firms on GSE, leverage does not necessarily influence their return on equity. The positive association of a firm's size and return on equity indicates that increasing size is associated with an increase in performance (profitability). Growth (GRTH) in sales reports an insignificant positive relationship between ROE and growth. It reports a coefficient of (0.167813) from the regression table above. This indicates that as firms increase its sales revenue by 1%, the return of equity is more likely to increase. This is indicative of the fact that growing firms have a prospect of generating more returns for their owners. This is also consistent with studies by Marfo (2010) and Odalo et. al (2016).

4. Conclusion

The objective of the study was to establish the effect of dividend policy on the financial performance of listed Agriculture firms in Ghana. Dividend policy, dividend pay-out, firm size, leverage, growth were the independent variables and the dependent variable, return on equity. The results of the study revealed that dividend pay-out had no effect on the financial performance of listed Agriculture firms in Ghana. Thus, the number of dividends paid does not affect the financial performance of Agriculture firms but should pay dividends when they are financially strong. These findings were consistent with the research finding of Oppong (2015) which found that dividend policy does not affect companies' return on equity.

The findings of the study confirmed that dividend policy is a major factor that influences the financial performance of Agriculture firms. It was observed that dividend policy was a highly significant predictor in explaining the Agriculture firms' performance (ROE). Other factors such as firm size, leverage, and growth had an insignificant impact on the return of equity of listed Agriculture firms. Hence, agriculture firms should ensure that they have good and effective strategies that will lead to increased total assets and other factors that will result in the improved financial performance of banks and non-banking firms in the future.

The results of the study have these recommended policy implications. As dividend pay-out is still an important determinant of financial performance, management should, therefore, be mindful of the dividend policy decisions taken. Optimal dividend policy will better the lots of shareholders both in the short-run and long-run and more attract investors.

Also, agriculture firms should invest in profitable assets that will yield higher returns in the future to enhance their financial performance and attract investments in the future.

Again, the research findings revealed that there was no weighty impact of dividend pay-out on the financial performance and hence, investors should not rely on the amount of dividend paid to ascertain the financial stability of firms.

Acknowledgement

This paper was supported by the Internal Grant Agency (IGA) of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2020A0004 "Foreign direct investment and corporate governance structures: Evidence from Africa"

References

Adu-Boanyah, E., Ayentimi, D. and Osei-Yaw, F. (2013), “Determinants of dividend payout policy of some selected Manufacturing firms listed on the Ghana Stock Exchange”, *Research Journal of Finance and Accounting,* vol. 4, no. 5, pp. 20-29. ISSN 2222-1697, E-ISSN 2222-2847

Agyei, S. K. and Marfo-Yiadom, E. (2011), “Dividend Policy and Bank Performance in Ghana”, International Journal of Economics and Finance, vol. 3, no. 4, pp. 20-31. DOI 10.5539/ijef.v3n4p202, ISSN 1916-971X, E-ISSN 1916-9728

Amidu, M. (2007) “How does dividend policy affect performance of the firm on Ghana stock Exchange”, *Investment Management and Financial Innovations*, vol. 4, no. 2, pp. 104 – 112, ISSN 1812-9358

Azam, M., Usmani, S. and Abassi, Z. (2011), “The impact of corporate governance on firm’s performance: Evidence from Oil and Gas Sector of Pakistan”, *Australian Journal of basic and applied science*, vol. 5, no. 12, pp. 2978 - 2983. [Online], Available: http://ajbasweb.com/old/ajbas/2011/December-2011/2978-2983.pdf, [Accessed: 25 Feb, 2020], ISSN 1991-8178

Bremberger, F., Cambini, C., Gugler, K. and Rondi, L. (2016). “Dividend policy in regulated network industries: Evidence from the EU”, *Economic Inquiry*, vol. 54, no. 1, pp. 408 - 432. E-ISSN 1465-7295, DOI 10.1111/ecin.12238

Farsio, F., Geary, A. and Moser, J. (2004), “The relationship between dividends and earnings”, *Journal for Economic Educators*, vol. 4, no. 4, pp. 1 - 5. ISSN 0022-0485

Grullon, G., Michaely, R., Benartzi, S., and Thaler, R. H. (2005), “Dividend changes do not signal changes in future profitability”, *The Journal of Business*, vol. *78, no.* 5, pp. 1659 - 1682. ISSN 0021-9398, DOI 10.1086/431438

Marfo, Y. (2010), “Dividend policy and the performance of banks in Ghana”, *Journal of Economics and Accounting*, vol. 10, no. 4, pp. 23 – 35, ISSN 0165-4101, DOI 10.22004/ag.econ.97084

Mashayekhi, B. and Bazazb, M. S. (2008), “Corporate governance and firm performance in Iran”, *Journal of Contemporary Accounting & Economics,* vol. 4, no. 2, pp. 156 - 172. ISSN 1815-5669, DOI 10.1016/S1815-5669(10)70033-3

Odalo, S. K., George, A. and Njuguna, A. G. (2016), “Relating Company Size and Financial Performance in Agricultural Firms Listed in the Nairobi Securities Exchange”, *United States University of Africa Digital Resipotry*, vol. 2, no. 4, pp. 6-15, ISSN 1916-971X, E-ISSN 1916-9728, DOI 10.5539/ijef.v8n9p34

Oppong, K. (2015), “Dividend policy and firms’ performance: a case of listed”, *Doctoral Dissertation, Kwame Nkrumah University of Science and Technology*, Kumasi- Ghana, [Online], Available: http://dspace.knust.edu.gh/handle/123456789/8651, [Accessed: 25 Feb, 2020], ISSN 1991-8178

Pallant, J. F. and Tennant, A. (2007), “An introduction to the Rasch measurement model: an example using the Hospital Anxiety and Depression Scale (HADS)”, *British Journal of Clinical Psychology*, vol. 46, no. 1, pp.1 - 18. 0144-6657, DOI 10.1348/014466506X96931

Shisia, A., Sang, W., Sirma, K. and Maundu, C. N. (2014), “Assessment of Dividend Policy on Financial Performance of Telecommunication Companies Quoted At the Nairobi Securities

Exchange", *International Journal of Economics, Commerce and Management*, vol. 2, no. 10, pp. 1 - 21. ISSN 2348-0386, [Online], Available: http://ir.mksu.ac.ke/handle/123456780/4204, [Accessed: 28 Feb, 2020], ISSN 1991-8178

Wahla, K.-U.-R., Shah, S. Z. A. and Hussain, Z. (2012), "Impact of ownership structure on firm performance evidence from non-financial listed companies at Karachi Stock Exchange", *International Research Journal of Finance and Economics*, vol. 84, pp. 6 - 13. ISSN 1450 2887, DOI 10.5296/ajfa.v6i1.4761

EFFECTS OF THE MARKETING CHANNEL SELECTION ON PRODUCTIVITY AND EFFICIENCY IN COCOA PRODUCTION IN TOCACHE, PERU

Alejandro Aybar[1], Rocío Maehara[2] and Angie Higuchi[3]

[1, 2, 3] Universidad del Pacífico, Peru

[1]a.aybarf@up.edu.pe, [2]rp.maeharaa@up.edu.pe, [3]a.higuchi@up.edu.pe

Annotation: On a global scale, the demand for cocoa requests a fulfillment of international quality standards. Thus, cocoa collection centers are established by commercial operators -the cooperative or intermediaries- with the objective of integrating the crop from many small farmers into relatively large batches for efficient handling. In Tocache, there is a specific structure of cooperatives that is led by the Central Aroma Cooperative, followed by small cooperatives located within the province. The objective of this study is twofold: 1) analyze the cocoa production between the Peruvian cocoa farmers who commercialize through a cooperative and intermediaries and 2) determine if technical assistance and socio-economic variables influence their decision-making process of belonging to a marketing channel. A survey of 469 cocoa farmers (275 cooperative members and 194 who commercialize through intermediaries) in six different districts in Tocache, San Martin was carried out between January and June 2015. A production function for each marketing channel was first performed. Then, independent *t-test* and *Chi-Square test* models were used in order to show how these characteristics impact on the farmers' choice of which marketing channel they use at the post-harvest stage. Results of the production functions were similar between farmers from both marketing channels. Outcomes also demonstrated that farmers do not have significant differences in their education. Nonetheless, those farmers who possess willingness to receive technical assistance would like to participate as cooperative members. Moreover, farmers with more experience in cocoa cultivation, possess a property title and have more yield contributes to the cooperative membership. Contemplating these factors are important for the development of farmers' organizations as well as the long term improvement of the region as a whole.

Keywords: Cooperative, Production Function, Independent Sample Tests, Marketing Channel, Peru

JEL classification: Q13

1. Introduction

Quality and productivity trends in the international demand have been increasingly affected by large-scale agro-food value chains transformations, with a tendency to exert a rising pressure on the quality and volumes requested to farmers (Dolan and Humphrey, 2000). Hence, cocoa collection centers are established by commercial operators with the objective of gathering crops from small farmers into relatively large batches for efficient handling and sustainable production. Nonetheless, the low bargaining power of cocoa growers is a big problem in the Peruvian jungle (Martin et al., 2015). Being cocoa production predominantly a smallholders' activity, individual farmers without collective actions struggle to meet stricter buyer demands for product quality, volume, and timeliness of delivery across a range of agri-food sectors (Donovan and Poole, 2014). Furthermore, the Peruvian Amazon is a region that has been relatively understudied, with increasing socioeconomic inequalities and complex issues of access and property rights (Porro et al., 2015).

In Tocache, there is a specific structure of cooperatives that is led by the Central Aroma Cooperative, followed by small cooperatives located in diverse districts within the province. These cooperatives are in charge of collecting cocoa from their members to supply the Central Aroma Cooperative's cocoa orders, concentrating on production for exports with the maximum quality control possible. Nonetheless, cooperatives are not the unique actors in the cocoa marketing channel. In the past, intermediaries took advantage on one hand of the absence of competition, lack of knowledge of market prices, poverty and weak bargaining power and on the other, the monopsony or oligopsony type of the cocoa marketing system (Pokhrel and Thapa, 2007). Nowadays, intermediaries collect beans mainly for the domestic market just focusing on getting good prices without concern on the quality of the beans (IICA, 2009).

Cocoa yields depend on how farmers combine optimally their resources to maximize output. Further, farmers in different agro-ecological zones have different socio-economic backgrounds and endowments which might impact their resource use efficiency (Danso-Abbeam et al., 2012). Additionally, studying the socio-economic characteristics that influence the decision-making process of a farmer should be one of the preliminary steps towards the development of extension programs to promote sustainability among rural population (Füsun Tathdil et al., 2009). Therefore, the main objective of this paper is unfolded on two: (1) estimate the productivity of cocoa farming households depending if the farmer is a cooperative member or commercializes through an intermediary and (2) analyze the socio-economic motivations that influence cocoa farmers to choose their main distribution channel.

2. Materials and Methods

A structured questionnaire that covered a range of farm, marketing and socio-economic characteristics (Table 1 and 2) of cocoa producers was carried out between January and June 2015 at six different districts (Polvora, Tocache, Cholon, Uchiza, Mishollo and Nuevo Progreso) where cooperatives are located. Primary data was collected with the support of authorities of Prodatu II-DEVIDA at Tocache, San Martin, which is one of the best cocoa production areas in Peru. As a result, a total sample of 469 farmers was collected (275 cooperative members and 194 who commercialize through intermediaries).

Table 1. Descriptive characteristics of the quantitative socio-economic factors of the sample

		Total (n = 469)	**Coop member (n = 275)**	**Non-coop member (n = 194)**
Variable	**Description**	**Mean (S.D.)[b]**	**Mean (S.D.) [b]**	**Mean (S.D.) [b]**
Production	Total cocoa production of farm (Tm)	2.82 (2.36)	3.16 (2.72)	2.33 (1.6)
Capital	Investment in maintenance (sol/year)	5178.37 (5369.52)	5886.24 (4898.53)	4174.95 (5841.32)
Labour	Number of full-time workers	9.39 (18.31)	7.96 (18.08)	11.41 (18.49)
Material	Cost of standard fertilizers and chemicals (sol/ha)	1728.12 (1586.61)	1837.09 (1707.8)	1573.66 (1386.46)
Land	Number of hectares of cocoa land	4.69 (4.32)	5.07 (4.74)	4.14 (3.57)
Experience	Experience in cocoa cultivation (years)	7.23 (3.77)	7.87 (4.16)	6.33 (2.93)
Yield	Yield of a crop per unit area of land cultivation	0.77 (0.52)	0.83 (0.57)	0.69 (0.42)
Education	Farmer's education (years)	7.44 (3.44)	7.49 (3.43)	7.38 (3.46)

Source: Authors' research, 2020

Note: Percentage frequencies are in parenthesis (Percent). [b] Standard errors are in parenthesis (Std. Error).

Table 2. Descriptive characteristics of the qualitative socio-economic factors of the sample

Variable	**Description**	**Total (n = 469)**		**Coop member (n = 275)**		**Non-coop member (n = 194)**	
		Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Cooperative	1 = Member of a cooperative / 0 = Not a member	469	100.00%	275	58.60%	194	41.40%
Proptitle	1 = Have the property title of the lands	346	73.80%	227	82.50%	119	61.30%
	0 = No property title of the lands	121	25.80%	48	17.50%	73	37.60%
Coca	1 = Have cultivated coca	281	59.90%	167	60.70%	114	58.80%
	0 = Haven't cultivated coca	180	38.40%	105	38.20%	75	38.70%

Distance	1 = Distance to gathering center > 2km	334	71.20%	191	69.50%	143	73.70%
	0 = Distance to gathering center < 2km	120	25.60%	76	27.60%	44	22.70%
Machine	1 = Have machinery and equipment for cultivation	138	29.40%	79	28.70%	59	30.40%
	0 = No machinery and equipment for cultivation	305	65.00%	180	65.60%	125	64.40%
Pricecocoa	1 = Have information about final prices of cocoa	10	2.10%	5	1.80%	5	2.60%
	0 = No information about final prices of cocoa	433	92.30%	254	92.40%	179	92.30%
Technical Assistance	0 = No technical assistance per year	91	19.40%	15	5.45%	76	39.18%
	1 = Technical assistance once per year	65	13.86%	36	13.09%	29	14.95%
	2 = Technical assistance twice per year	66	14.07%	43	15.64%	23	11.86%
	3 = Technical assistance three or more per year	128	27.29%	88	32.00%	40	20.62%
	4 = Technical assistance monthly per year	101	21.54%	93	33.82%	8	4.12%
	5 = Unaware of technical assistance	5	1.07%	0	0.00%	2	1.03%

Source: Authors' research, 2020

The production function is a function that summarizes the process of combining inputs of capital, labour and other factors in order to create an output. In general, the study of the production function and the factors involved is important to explain the differences in productivity between farmers who commercialize through cooperatives and intermediaries, to make economic policy decisions (Kalirajan and Shaud, 1999). To accomplish the first objective of this study, stochastic production functions for cocoa producers will be carried out and compared to determine if there is a difference in the productivity depending of the marketing channel chose by the farmer. The productivity was analyzed using the stochastic frontier production (SFP) function based on the stochastic frontier analysis (SFA), which was first proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and Van den Broeck (1977). SFA was used in order to show the magnitude of the effect of the various factors on total output. The SFP function involves the technical efficiency (TE) of an individual farm that can be defined in terms of the ratio of the observed output to the corresponding frontier output, given the available technology (Amos, 2007). TE is thus empirically measured by decomposing the deviation into a random component, where $0 \leq$ TE ≤ 1 (the closer the value is to 1, the greater the efficiency of the production factors and, thus, the productivity). The SFP function is specified as a Cobb-Douglas functional form (1):

$$y_i = \boldsymbol{x_i}\boldsymbol{\beta} + \varepsilon_i \tag{1}$$

$$\varepsilon_i = v_i - u_i \tag{2}$$

Where y_i stands for the natural logarithm of the production of the i-th cocoa produce; $\boldsymbol{x_i}$ is a $(1\ x\ k)$ vector of productive determinants of the i-th cocoa producer (land; capital was investment in maintenance such as land clearing and shading to preserve biodiversity; labour, and finally, material) (Table 1); $\boldsymbol{\beta}$ is a $(k\ x\ 1)$ vector of technological production (unknown) parameters to be estimated and ε_i (2) is the stochastic disturbance term (a non-negative error term) within the control of the decision unit (where v_i is a random variation in output due to the factors outside the control of the farm that is assumed to be identically and independently distributed as $N(0, \sigma_v^2)$ random variables, independent of u_i, and u_i is the effect of factors responsible for production inefficiency which is distributed as a truncated model (at zero) of the $N(u_i, \sigma^2)$ distribution, independently but not identically distributed). On the other hand, it is broadly accepted that socio-economic variables are commonly used to study the influence of different factors on some behaviors of a specific group of people (Füsun Tathdil et al., 2009). An unpaired two-sample *t*-test was performed to determine if there is a significant difference between quantitative factors of cocoa producers who belong to a cooperative or an intermediary (Table 1). Finally, a *Chi-Square test* (χ^2) was used to assess the significance of relationship between qualitative factors (Table 2).

3. Results and Discussion

Following the generalized SFP presented in equation (1), the productivity estimates (coefficient) of the independent variables for both models were explained in terms of output elasticities (Wollni and Brümmer, 2012). Table 3 shows that all explanatory variables exhibit a significant and positive relationship with cocoa output for both intermediaries and cooperatives models, respectively. The observed signs of the coefficients were consistent and statistically significant with a-priori expectation to previous results (Danso-Abbeam et al., 2012; Wollni and Brümmer, 2012). Increasing their own labor input by recruiting more hired labor for harvesting and other on-going maintenance tasks suggests, as well as investment in capital, size of the cocoa land (farm) and the use of fertilizers, enhances the cocoa yield. From these results, it can be identified that one of the main components affecting cocoa production is the investment in maintenance done by the farmers for both types of marketing channels. Table 4 shows the Wald chi-square values for both marketing channels show the overall significance of the estimated model in the Cobb-Douglas functions. Intermediaries' farmers produce 61.36% of potential output given the level of factors available while, cooperative members 72.07% of potential output given the level of factors available. This suggests that the coop. members are in a slightly better position than the intermediaries. A considerable level of variation exists in technical efficiency among cocoa producers for both models considering the standard deviations. Finally, the results of the production functions showed that there are chances for improving the productivity in 38.64% and 27.93% in the cocoa sector in Tocache for the intermediaries and the cooperatives, respectively.

Table 3. Results of stochastic frontier analysis by marketing channel

	Intermediaries channel				**Cooperative channel**			
Variable	**β (Std. Error)[b]**	**z**	**95% CI**		**β (Std. Error)[b]**	**z**	**95% CI**	
			Lower	Upper			Lower	Upper
Intercept	-3.75 (0.64)***	-5.86	-5.01	-2.5	-3.93 (0.51)***	-7.69	-4.94	-2.93
Ln(Capital)	0.40 (0.06)***	6.26	0.27	0.52	0.46 (0.05)***	8.8	0.36	0.57
Ln(Labour)	0.05 (0.03) *	1.94	0	0.11	0.07 (0.03)**	2.35	0.01	0.13
Ln(Material)	0.18 (0.06)***	3.32	0.08	0.29	0.15 (0.04)***	3.33	0.06	0.23
Ln(Land)	0.33 (0.08)***	4.34	0.18	0.47	0.11 (0.06) *	1.92	0	0.23

Source: Authors' research, 2020

*Note: * p<0.10, ** p<0.05, *** p<0.01; [b] β are the estimated coefficients. Standard errors are in parenthesis*

Table 4. Parameterization of stochastic frontier analysis by marketing channel

	Λ	**σu**	**σv**	**γ**	**Log likelihood**	**Wald chi2(4)**
Intermediaries	2.02	0.52	0.13	0.8	-159.38	132.4 ***
Cooperative	0.86	0.21	0.28	0.42	-247.29	175.2 ***

Source: Authors' research, 2020

*Note: * p<0.10, ** p<0.05, *** p<0.01*

In terms of the second part of the objective, the socio-economic motivations that influence cocoa farmers for choosing their main distribution channel were empirically analyzed. Table 5. presents the results of the unpaired two-sample *t-tests* of the mean difference of the quantitative socio-economic factors (Table 1). Empirical results from Ethiopian cooperatives indicate that the probability of participation in a cooperative increase when the household head is literate (Bernard and Spielman, 2009). Results show that education (years) of both marketing channels are not statistically significant ($p>0.10$) (Table 5). Nonetheless, outcomes reveal that the cooperative members have more years of experience in cocoa cultivation ($p<0.01$). Furthermore, the cooperative members have more yields than those who commercialize through intermediaries ($p<0.01$) suggesting that the former are more likely to work in the agriculture sector.

Table 5. Unpaired two-sample t-tests results

Unpaired two-sample t-tests				
Variable	**Cooperative member mean**	**Non-cooperative member mean**	**Mean difference**	**t-statistics**
Experience	7.8727	6.3299	1.5428	4.7157 ***
Yield	0.8259	0.6913	0.1346	2.9237 ***
Education	7.5055	7.3763	0.1292	0.4002^{ns}

Source: Authors' research, 2020

*Note: * p<0.10, ** p<0.05, *** p<0.01, ns: non-significant*

Table 6. Chi-Square/Fisher test results

Variables	Technical Assistance [b]	Property title	Coca	Distance	Machine	Pricecocoa [b]
χ^2	124.16***	24.18***	0.06^{ns}	0.99^{ns}	0.99^{ns}	0.08^{ns}

Source: Authors' research, 2020

*Note: * p<0.10, ** p<0.05, *** p<0.01, ns: non-significant*

[b] In the case when the number of observations in the contingency table cells for the Chi-Square test were equal or lower than 5, Fisher tests were conducted to assess the significance of relationship of those variables.

Access to technical assistance through a cooperative, aim at raising farmers' total factor productivity and provide growers with price information (Wollni and Zeller, 2007). Outcomes from the *Chi-Square/Fisher tests* (Table 6) of the qualitative socio-economic factors (Table 2) revealed that the marketing channel membership decision depends on the technical assistance received by the farmers and also the possession of a property title ($p<0.01$). Additionally, factors like 1) previous experience in coca cultivation, 2) distance between the gathering center and the farmlands, 3) the use of machinery and 4) information received about the final prices of cocoa have no influence on objective evaluation of the marketing channel membership decision (>0.10).

4. Conclusions

This study demonstrated that the productivity of a cooperative member or otherwise is the same. This is mainly due to the fact that the farmers use the same combination of inputs for the cocoa production at a similar scale and pattern, which results in comparable yields. Moreover, the potential yield can still be boosted by increasing the input factors (mainly, the capital). A relevant differentiation occurs at the post-harvesting stage, where the improvement of the quality of the cocoa crop for exports takes place. The second analysis showed that farmers who possess the following attributes were more likely to join a cocoa marketing cooperative: 1) have experience in cocoa cultivation, 2) own of a property title, 3) have more yield and, especially, 4) receive technical assistance. Some implications can be extracted from the literature review and results of this study. Regarding the government, the supply increment of relevant alternatives for the development of technical-productive skills by the regional and local government in a participatory community is needed. Organizations as cooperatives should look for ways to improve the extension component in order to improve agricultural productivity through training and knowledge as management, finance, accounting skills and marketing research. Despite the shown outcomes, the study has some limitations, as for instance, the costs or profit efficiency of cooperative members compared to nonmembers. Future studies should be focus in analyzing cocoa farmers in different geographical areas to broaden the scope of this particular study.

References

Aigner, D., Lovell, K. and Schmidt, P. (1977), “Formulation and estimation of stochastic frontier production function models”, *Journal of Econometrics*, vol. 6, no. 1, pp. 21 - 37, ISSN 0304-4076, DOI 10.1016/0304-4076(77)90052-5

Amos, T. T. (2007), “An Analysis of Productivity and Technical Efficiency of Smallholder Cocoa Farmers in Nigeria”, *Journal of Social Sciences*, vol. 15, no. 2, pp. 127 - 133, ISSN 0971-8923, DOI 10.1080/09718923.2007.11892573

Bernard, T. and Spielman, D. J. (2009), “Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia”, *Food policy*, vol. 34, no. 1, pp. 60 - 69, ISSN 0306-9192, DOI 10.1016/j.foodpol.2008.08.001

Danso-Abbeam, G., Aidoo, R., Agyemang, K. O. and Ohene-Yankyera, K. (2012), “Technical efficiency in Ghana´s cocoa industry: Evidence form Bibiani-Anhwiaso-Bekwai District”, *Journal of Development and Agricultural Economics*, vol. 4, no. 10, pp. 287 - 294, ISSN 2006- 9774 , DOI 10.5897/JDAE12.052

Dolan, C. and Humphrey, J. (2000), “Governance and trade in fresh vegetables: the impact of UK supermarkets on the African horticulture industry”, *Journal of Development Studies*, vol. 37, no. 2, pp. 147 - 176, ISSN 00220388, DOI: 10.1080/713600072

Donovan, J., Poole, N. (2014), “Changing asset endowments and smallholder participation in higher value markets: Evidence from certified coffee producers in Nicaragua”, *Food Policy,* vol. 44, pp. 1 - 13, ISSN 0306-9192, DOI 10.1016/j.foodpol.2013.09.010

Füsun Tathdil, F., Boz, I. and Tatlidil, H. (2009), “Farmers’ perception of sustainable agriculture and its determinants: A case study in Kahramanmaras province of Turkey”, *Environment, Development and Sustainability*, vol. 11, no. 6, pp. 1091 - 1106, ISSN 1573-2975, DOI 10.1007/s10668-008-9168-x

IICA, Instituto Interamericano de Cooperación para la Agricultura (2009), Situación y perspectivas de la cadena cacao-chocolate en el Perú, [Online], Available: http://webiica.iica.ac.cr/peru/publicaciones/libros/Publicacion_cacao_final_sm.pdf, [Accessed: 08 Apr. 2020]

Kalirajan K. P. and Shaud, R. T. (1999), “Frontier production functions and technical efficiency measures”, *Journal of Economic Surveys*, vol. 13, no. 2, pp. 149 - 172, ISSN 1467-6419, DOI 10.1111/1467-6419.00080

Martin, S, Rieple, A., Chang, J., Boniface, B., Ahmed, A. (2015), “Small farmers and sustainability: Institutional barriers to investment and innovation in the Malaysian palm oil industry in Sabah”, *Journal of Rural Studies,* vol. 40, pp. 46-58, ISSN 0743-0167, DOI 10.1016/j.jrurstud.2015.06.002

Meeusen, W. and Van der Broeck, J. (1977), “Efficiency estimation from Cobb-Douglas Production Functions with Composed Error”, *International Economic Review*, vol. 18, no. 2, pp. 435 - 444, ISSN 1468-2354, DOI 10.2307/2525757

Pokhrel, D. M., and Thapa, G. B. (2007), "Are marketing intermediaries exploiting mountain farmers in Nepal? A study based on market price, marketing margin and income distribution analyses", *Agricultural Systems*, vol. 94, no. 2, pp. 151 - 164, ISSN 0308-521X, DOI 10.1016/j.agsy.2006.08.004

Porro, R., Lopez-Feldman, A. and Vela-Alvarado, J. W. (2015), "Forest use and agriculture in Ucayali, Peru: Livelihood strategies, poverty and wealth in an Amazon frontier", *Forest Policy and Economics*, vol. 51, pp. 47-56, ISSN 1389-9341, DOI 10.1016/j.forpol.2014.12.001

Wollni, M. and Brümmer, B. (2012), "Productive efficiency of specialty and conventional coffee farmers in Costa Rica: Accounting for technological heterogeneity and self-selection", *Food policy*, vol. 37, no. 1, pp. 67 - 76, ISSN 0306-9192, DOI 10.1016/j.foodpol.2011.11.004

Wollni, M., and Zeller, M. (2007), "Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica", *Agricultural Economics*, vol. 37, pp. 243 - 248, ISSN 1574-0862, DOI 10.1111/j.1574-0862.2007.00270.x

IMPACT OF PLANTING FOR FOOD AND JOBS PROGRAMME ON PRICE TRANSMISSION IN GHANA

Emmanuel Bangmarigu[1], Miroslava Rajcaniova[2] and Artan Qineti[3]

[1, 2, 3] Department of Economic policy, Slovak University of Agriculture in Nitra, Slovakia

[1]banmariguemma@yahoo.com, [2]miroslava.rajcaniova@gmail.com, [3]artan.qineti@uniag.sk

Annotation: In 2017, the government of Ghana introduced the flagship programme Planting for Food and Jobs (PFJ), to revamp the agricultural sector which has dwindled in recent times. The objective of this paper is to (i) investigate how price transmission changes before and during the Planting for Food and Jobs programme, and to (ii) analyse horizontal price transmission from the world market to local markets. Time series data was employed in this study and monthly observations of world and local retail market prices of maize and rice (local and import) were obtained from the World Bank source and the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture in Ghana for the period 01st January, 2009 to 31st, December 2019. We used Vector Error Correction model to estimate the long run relationship among analysed price series. Our empirical findings show one long run relationship among local and world rice prices in the period before the PFJ, while the times series in the period during PFJ are much more interconnected and we find three cointegration relationships. Maize prices were not cointegrated in the period before PFJ, but in the period during PFJ we observed one long run relationship between local and world maize prices. Agro-commodity prices in Ghana react with different speed to positive and negative deviations, while world prices do not react to shocks in Ghanaian prices. Ghana as a price taker in the global trade has limited policy instruments to respond to the global food price volatilities. The main policy advice is to increase budgetary support to PFJ in order to improve the programme and increase productivity of agriculture in Ghana.

Key words: agro-commodities, price transmission, world prices, local prices, times series, cointegration

JEL classification: C32, Q02, Q10, Q11, Q17, Q18

1. Introduction

The interest of policy makers to associate price changes and transmission process from world to domestic agricultural markets has recently provoked large body of research globally (Braha et al., 2015; Minot, 2010; Amikuzunu et al., 2013; Abdulai, 2000). In Sub Saharan Africa the dramatic rise in agricultural price volatilities have forced governments of many agro-commodity importing countries to respond to rising food prices by adopting or strengthening specific policy measures (Tangermann, 2011), such as the Block farm concept and Planting for food and Jobs programme (Rantso & Seboka,2019; Tanko et al., 2019), in order to keep prices low within domestic food markets. Food commodities have a dominant position on the structure of imports in Ghana since independence in 1957. Ghana still imports about 70% and 15% respectively of rice and maize consumed (Darfour et al., 2016). To ensure self-sufficiency in food production and keep prices of agricultural commodities low the government of Ghana in 2017 implemented the Planting for Food and Jobs (PFJ), a flagship policy in the agricultural sector with the main goal of addressing the declining growth of agriculture in Ghana by modernising the agriculture sector to lead structural transformation of the national economy through food security, employment opportunities and reduced poverty (Esoko 2015-2019 report). According to Tanko et al (2019) the policy is focused on increasing food production and ensuring food security in the country as well as reducing the food import bills to the barest minimum. The project consists of five significant pillars; supply of improved seeds to farmers at subsidised prices (50% subsidy), supply of fertiliser at subsidised prices (50% price cut out), free extension services to farmers, marketing opportunities for produce after harvest, and E-Agriculture - a technological platform to monitor and track activities and progress of farmers through a database system (PFJ, 2017). The five main crops selected are maize, rice, soybeans, sorghum and vegetables including tomato, onion and chili pepper in line with priority crops as proposed in Food and Agriculture Sector Development Policy II (FASDEP II) and its investment programme, the Medium-Term Agricultural Sector Investment Plan (METASIP) (PFJ, 2017).

PFJ seeks to motivate and encourage farmers to adopt certified seeds and fertilisers through a private sector-led marketing framework, by raising the incentives and complimentary service provisions on the usage of inputs, good agronomic practices, and marketing of outputs over an E-Agriculture platform (PFJ, 2017). The PFJ programme empower the beneficiaries with knowledge and skills on maximising the benefits of the usage of subsidised inputs like fertiliser through proximity extension services (MOFA, 2017). The outcome of the PFJ programme is measurable in terms of increased productivity, agricultural income, and the trickle-down effect on consumption expenditure, among other variables. The development of the agriculture sector is a priority to the government of Ghana (FAO, 2015). In rising up to this challenge, the government of Ghana proposed an average annual budget of GH¢ 765 million (or US$ 160 million) to support the Planting for Food and Jobs (PFJ) policy. These interventions, however, raise serious concerns about their actual direct effects in terms of lowering agricultural commodity prices across agricultural markets. Therefore, the objective of this paper is to (i) investigate how price transmission changes before and during the Planting for Food and Jobs programme and to (ii) analyse horizontal price transmission from the world market to local markets. The paper is organized as follows: Section 1 provides a descriptive background into the studied topic, Materials and Methods are presented in section 2, Section 3 presents the empirical results and discussion, Concluding remarks are presented in Section 4 of the paper.

1.1. Previous studies on Price Transmission

Horizontal price transmission means the linkage occurring among different markets at the same position in the supply chain. The notion of horizontal price transmission usually refers to price linkages across market places ie. spatial price transmission, however, can also concern transmission across different agricultural commodities markets (Listorti, 2012).

In recent times research on price transmission has been motivated largely due to the belief that co-movement of prices in different markets can be interpreted as a sign of efficient and competitive markets, while absence of co-movement is an indication of market failures. There is a relatively large number of studies that have sought to examine the degree of price transmission between markets within a country (see Rashid, 2004; Meyers, 2008; Negassa and Meyers, 2007; Moser et al, 2009).

Early studies of price transmission used simple correlation coefficients of contemporaneous prices. Mundlak and Larson (1992) estimated the transmission of world food prices to domestic prices in 58 countries using annual price data from the FAO. Their findings revealed a very high rate of price transmission: the median elasticity of transmission was 0.95, implying that 95% of any change in world market was transmitted to domestic markets.

Around the 1980s, researchers became aware of the problem of non-stationarity. Standard regression analysis assumes that the mean and variance of the variables are constant over time. This signifies that the variable seeks to return toward its mean value, so the best estimate of the future value of a variable is its mean value. However, in the analysis of time-series data, prices including many other variables are often non-stationary, denoting that they move randomly instead of attempting to return to a mean value. One implication of this random walk behavior is that, the best estimate of the future price is the current price. When standard regression analysis is performed with non-stationary variables, the estimated coefficients are unbiased but the distribution of the error is non-normal, so the usual tests of statistical significance are invalid. As a matter of fact, with samples large enough, any pair of non-stationary variables would appear to have a statistically significant relationship, even if they are actually not related to each other (Granger and Newbold, 1974; Phillips, 1987).

Conforti (2004) explored price transmission in 16 countries, including three in sub-Saharan Africa, using the error correction model. He found statistically significant long-run relationships between international and local prices in four out of the seven cases in Ethiopia, including retail prices of maize, sorghum and wheat. In Ghana, there was a long-run relationship between world and local wheat prices, but no such relationship for maize and sorghum. And in Senegal, he found a long-run relationship in the case of rice, but not maize. Generally, the degree of price transmission in the sub-Saharan African countries was less than in the Latin American and Asian countries. This current study attempt to use the error correction model to analyse the rate of price transmission before and after the planting for food and jobs policy intervention initiated by the government of Ghana.

2. Materials and Methods

2.1. Methodology

We apply time-series modeling techniques to evaluate horizontal price transmission from world market to local markets in Ghana and vice versa. As the first step, we test the stationarity of time series using the augmented Dickey-Fuller (ADF) unit root test. The number of lags of a dependent variable is determined by the Akaike Information Criterion (AIC). If both time series are not stationary, they are suitable to test for cointegration relationship between them. We employ the Johansen approach to test for cointegration. The Johansen approach starts with a vector autoregressive model and reformulates it into a vector error correction model:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \varepsilon_t \quad (1)$$

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-k} + \varepsilon_t \quad (2)$$

where Z_t is a vector of non-stationary variables, A different matrices of parameters, t is time subscript, k is the number of lags and ε_t is the error term assumed to follow i.i.d. process with a zero mean and normally distributed N (0, σ2) error structure. The estimates of Γ_i measure the short-run adjustment to changes in the endogenous variables, while Π contains information on the long-run cointegrating relationships between variables in the model. We test the adequacy of our model by a series of diagnostic tests: the Lagrange multiplier test for autocorrelation in the residuals, the Jarque-Berra test for normality of the residuals, and the stability test of the VEC model estimates.

2.2. Data

Data used in this analysis is based on monthly observations of local and world prices of maize and rice. We selected the following local markets to represent the local prices in Ghana: Agbogbloshie Market (Accra), Kumasi Central Market (Kumasi), Techiman central Market

(Techiman), Tamale Aboabo market (Tamale) and Wa central market (Wa). Local price series were obtained from the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture in Accra, Ghana. The data cover the period from 01st January, 2009 to 31st, December 2019. World market monthly price data of maize and rice (Vietnams rice 5%) for the period spanning from January 2009 to December 2019 was obtained from the World Bank source. All prices were expressed in Cedis per kilogram and transformed into logarithms, therefore the estimated coefficients on explanatory variables may be interpreted as elasticities. All calculations were performed using the Stata software. The descriptive statistics of price series are presented in Table 1.

Table 1. Descriptive Statistics of Price Series

Variable	Obs	Mean	Std. Dev.	Min	Max
Maize local Accra	132	1.358	0.614	0.460	2.400
Maize local Kumasi	132	1.386	0.597	0.460	2.672
Maize local Techiman	132	0.923	0.428	0.200	1.809
Maize local Tamale	132	0.897	0.470	0.230	2.292
Maize local Wa	132	0.881	0.423	0.230	1.800
Rice local Accra	132	3.175	1.431	1.265	5.000
Rice local Techiman	132	2.147	1.113	0.600	5.460
Rice local Tamale	132	1.954	0.780	0.567	3.214
Rice local Kumasi	132	2.620	1.078	1.100	4.974
Rice local Wa	132	2.294	0.938	0.920	3.700
Maize world	132	0.569	0.197	0.220	1.050
Rice world	132	1.336	0.499	0.620	2.460

Source: Author's result

3. Results and Discussion

3.1. Testing the stationarity of time series.

The initial step of our empirical approach involves test on stationarity of time series using the Augmented Dickey-Fuller (ADF) unit root test. The results of the unit root test are presented in Table 1. The results confirm that all our time series are non-stationary; we stationarized them by taking first differences. The test indicated that all variables were stationary in first differences. The number of lags of the dependent variable was determined by Akaike Information Criterion (AIC). The implication of this finding is that all the price series were generated by similar stochastic processes and can exhibit the tendency toward long-run equilibrium. This result is well supported by earlier findings that food commodity price series are mostly stationary after first-differencing in Ghana and elsewhere (Alexander & Wyeth, 1994; Ogundare, 1999) perhaps owing to the possession by such series of trends arising from price inflation and cyclical variations from season leading to mean non-stationarity.

Table 2. Results of ADF Unit Root Tests on the Monthly Price Series

	Level		1st Diff	
	ADF_c	ADF_t	ADF_c	ADF_t
Maize local Accra	-1.398	-2.634	-8.776***	-8.767***
Maize local Kumasi	-1.579	-2.919	-8.780***	-8.753***
Maize local Techiman	-2.120	-2.854	-9.204***	-9.321***
Maize local Tamale	-1.843	-2.092	-8.466***	-8.542***
Maize local Wa	-1.619	-0.564	-4.937***	-5.080***
Rice local Accra	-1.082	-2.027	-9.196***	-9.192***
Rice local Techiman	-1.893	-2.105	-5.404***	-5.488***
Rice local Tamale	-2.092	-1.813	-8.754***	-8.880***
Rice local Kumasi	-1.072	-2.559	-8.584***	-8.557***
Rice local Wa	-1.707	0.075	-5.151***	-5.392***
Maize world	-1.559	-2.329	-8.115***	-8.116***
Rice world	0.028	-3.296*	-7.598***	-7.615***

*Source: Author's estimation result: Note: ADF_c is the ADF with an intercept and ADF_t with an intercept and a deterministic trend. *, **, *** denote significance at the 10%, 5% and 1% significance levels. All variables are expressed in logarithms.*

3.2. Cointegration Test Results

In the second step we tested for the existence of long-run relationship between local and world prices both for rice and maize price series. We performed the multivariate Johansen cointegration test for two periods, before and after the 30. October 2017.

Table 3. Cointegration Results for Local and World Rice Prices in the Period before 30. October 2017

maximum rank	**trace** statistic	**5% critical** value	**1% critical** value
0	136.572	114.900	124.750
1	81.473***	87.310	96.580
2	37.976	62.990	70.050
3	17.895	42.440	48.450
4	8.648	25.320	30.450
5	3.182	12.250	16.260

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

From the Table 3 we can see that the trace statistics at the rank 0 is higher than the 5% and 1% critical values and we can reject the null hypothesis about zero cointegration relationships. However, at the rank 1, the trace statistics is lower than the critical values and we cannot reject that because there is one cointegration relationship among local and world rice prices in the first period, the period before 30, October 2017.

Table 4. Cointegration Results for Local and World Rice Prices in the Period after 30. October 2017

Maximum Rank	Trace statistic	5% critical Value	1% critical Value
0	227.690	76.070	84.450
1	129.667	53.120	60.160
2	52.593	34.910	41.070
3	15.810***	19.960	24.600
4	4.791	9.420	12.970

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels. The local price of Accra market had been dropped from the estimation in the second period because of collinearity.*

The time series in the second period, the period after 30. October 2017 as shown in Table 4, were much more interconnected and we found three cointegration relationships. The findings imply that similar stochastic processes, possibly induced by efficient information flow, drive the dynamics of prices in the system of markets (Motamed et al., 2008). In this way, world and local prices do not drift apart in the long run. In Table 5 the results of the cointegration test for Maize prices in the period before 30. October 2017 show that maize prices were not cointegrated in the first period.

Table 5. Cointegration Results for Local and World Maize Prices in the Period before 30. October 2017

maximum rank	trace statistic	5% critical value	1% critical value
0	113.054***	114.900	124.750
1	69.849	87.310	96.580
2	35.922	62.990	70.050
3	20.747	42.440	48.450
4	10.658	25.320	30.450
5	4.896	12.250	16.260

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

In the second period, the period after 30. October 2017 (see Table 6) we can observe two long run relationships between local and world maize prices.

Table 6. Cointegration Results for Maize prices in the Period after 30. October 2017

maximum rank	**trace** statistic	**5% critical** value	**1% critical** value
0	228.662	94.150	103.180
1	114.509	68.520	76.070
2	46.7136***	47.210	54.460
3	17.270	29.680	35.650
4	4.980	15.410	20.040
5	0.344	3.760	6.650

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

3.3. Vector Error Correction Model

The evidence of significant cointegrating relation among the variables provides a precondition for the use of Vector Error Correction Model to identify long run relationships and the nature of price transmission and market integration between the markets.

As seen in Table 7, there is one long run relationship among the prices in the first period and three cointegrating relationships in the second period. We can observe one cointegrating relationship interconnecting several variables, there is a long run relationship between local rice prices in WA, in Kumasi and local rice prices in Tamale. The rice prices observed in Accra and Techiman do not share the joint long run relationship with other local prices. The speeds of adjustment of price transmission (Table 8), which measure the response of price shock show varying degrees of price relationships and faster adjustment in the second period compared to the first period.

Table 7. Cointegrating Equations for Rice Prices

	1st period	2nd period		
	_ce1	_ce1	_ce2	_ce3
Rice world	1	1	omitted	2.22e-16
Rice local Wa	14.129***	-0.718***	-0.634**	-1.169***
Rice local Kumasi	-12.515***	-0.633***	0.479**	1.800***
Rice local Tamale	-3.208***	omitted	omitted	1
Rice local Techiman	1.448	-1.10E-16	1	3.33e-16
Rice local Accra	-0.074	-	-	-
Cons	1.399**	1.014***	-0.962***	-1.975***

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

Table 8. Speed of Adjustments for Rice Prices

	1st period	2nd period		
	_ce1	_ce1	_ce2	_ce3
D_rice world	-0.001	-0.874 ***	0.735 *	-0.373
D_rice local Wa	-0.024 ***	-6.873 ***	6.798 ***	-3.597 ***
D_rice local Kumasi	0.030 ***	1.943 ***	-0.375	-0.364
D_rice local Tamale	0.010	-0.025	-0.082	-0.056
D_rice local Techiman	-0.006	-0.536	-0.478	0.013
D_rice local Accra	0.005	-	-	-

Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.

It is important to note that there was no cointegration equation for maize in the first period, because there was no evidence of cointegration relationship detected in the price series. As presented in Table 9 the results of the econometric estimation of the VECM for maize price transmission in the second period in selected markets revealed that in the period during PFJ maize prices in Kumasi and Tamale experienced a long run impact and share two cointegrating relationships. The speed of adjustment for maize price transmission in the second period as presented in Table 10 was relatively moderate.

Table 9. Cointegrating Equations for Maize Prices

	2nd period	
	_ce1	_ce2
Maize world	1	omitted
Maize local Wa	-0.045	0.663***
Maize local Kumasi	-0.562***	-0.534***
Maize local Tamale	-1.274***	-0.724***
Maize local Techiman	-0.016	-0.327***
Maize local Accra	omitted	1

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

Table 10. Speed of Adjustments for Maize Prices

	2nd period	
	_ce1	_ce2
D_maize world	0.125	0.012
D_maize local Wa	0.915	-1.922 ***
D_maize local Kumasi	-0.051	1.643 **
D_maize local Tamale	0.739 ***	0.089
D_maize local Techiman	-0.140	0.315
D_maize local Accra	0.295	-0.238

*Source: Author's estimation results. Note: *, **, *** denote significance at the 10%, 5% and 1% significance levels.*

3.4. Granger Causality Test between Price Series

Using cointegration test we revealed there is a long-term equilibrium relationship between the variables, but to know the causal relationship, further testing is needed. To analyse the causality between the prices we employed Granger causality test. Past and present values of one variable provide information for explaining and predicting the other variable. If it is possible to explain the variable x by its past values better than by using the past values of the variable y, we say that y does not Granger cause x.

The table 11 shows that while in the first period most of the rice prices are not Granger caused by other market price, in the second period the markets Granger cause each other in much higher extent. Local prices in Wa market are Granger caused by Techiman market in both periods, prices in Techiman Granger cause also prices in Kumasi and Tamale in the second period, Techiman prices are Granger caused by world prices and Tamale prices in the second period. Thus we can conclude there is a bi-causal relationship between Tamale and Techiman markets.

Table 11. Granger Causality of Rice Prices

Equation	Excluded	1st period			2nd period		
		chi2	df	Prob	chi2	df	Prob
Rice world	Rice local Wa	0.079	2	0.961	6.995	2	0.030
Rice world	Rice local Kumasi	0.270	2	0.874	3.578	2	0.167
Rice world	Rice local Tamale	2.050	2	0.359	9.587	2	0.008
Rice world	Rice local Techiman	1.052	2	0.591	2.749	2	0.253
Rice world	Rice local Accra	4.355	2	0.113	-	-	-
Rice world	ALL	7.428	10	0.684	16.825	8	0.032
Rice local Wa	Rice world	2.246	2	0.325	0.269	2	0.874
Rice local Wa	Rice local Kumasi	0.162	2	0.922	0.089	2	0.956
Rice local Wa	Rice local Tamale	0.477	2	0.788	1.709	2	0.426
Rice local Wa	Rice local Techiman	5.856	2	0.053	4.911	2	0.086
Rice local Wa	Rice local Accra	3.619	2	0.164	-	-	-
Rice local Wa	ALL	13.857	10	0.180	7.108	8	0.525
Rice local Kumasi	Rice world	1.314	2	0.518	2.295	2	0.317
Rice local Kumasi	Rice local Wa	2.852	2	0.240	1.589	2	0.452
Rice local Kumasi	Rice local Tamale	1.150	2	0.563	3.989	2	0.136
Rice local Kumasi	Rice local Techiman	0.997	2	0.607	14.224	2	0.001
Rice local Kumasi	Rice local Accra	0.702	2	0.704	-	-	-
Rice local Kumasi	ALL	6.389	10	0.782	21.521	8	0.006
Rice local Tamale	Rice world	2.871	2	0.238	4.367	2	0.113
Rice local Tamale	Rice local Wa	0.075	2	0.963	0.571	2	0.751
Rice local Tamale	Rice local Kumasi	0.026	2	0.987	5.073	2	0.079
Rice local Tamale	Rice local Techiman	3.107	2	0.212	6.570	2	0.037
Rice local Tamale	Rice local Accra	4.080	2	0.130	-	-	-
Rice local Tamale	ALL	11.279	10	0.336	16.626	8	0.034
Rice local Techiman	Rice world	0.751	2	0.687	9.767	2	0.008
Rice local Techiman	Rice local Wa	0.215	2	0.898	2.288	2	0.318
Rice local Techiman	Rice local Kumasi	1.600	2	0.449	4.120	2	0.127
Rice local Techiman	Rice local Tamale	2.075	2	0.354	8.240	2	0.016
Rice local Techiman	Rice local Accra	2.150	2	0.341	-	-	-
Rice local Techiman	ALL	6.531	10	0.769	18.764	8	0.016
Rice local Accra	Rice world	0.071	2	0.965	-	-	-
Rice local Accra	Rice local Wa	2.925	2	0.232	-	-	-
Rice local Accra	Rice local Kumasi	0.162	2	0.922	-	-	-
Rice local Accra	Rice local Tamale	2.551	2	0.279	-	-	-
Rice local Accra	Rice local Techiman	1.463	2	0.481	-	-	-
Rice local Accra	ALL	7.116	10	0.714	-	-	-

Source: Author's estimation results. The local price of Accra market had been dropped from the estimation in the second period because of collinearity.

Table 12. Granger Causality of Maize Prices

Equation	Excluded	2nd period		
		chi2	df	Prob
Rice world	Rice local Wa	6.710	2	0.035
Rice world	Rice local Kumasi	2.362	2	0.307
Rice world	Rice local Tamale	6.395	2	0.041
Rice world	Rice local Techiman	6.199	2	0.045
Rice world	Rice local Accra	13.585	2	0.001
Rice world	ALL	43.745	10	0.000
Rice local Wa	Rice world	0.131	2	0.937
Rice local Wa	Rice local Kumasi	11.230	2	0.004
Rice local Wa	Rice local Tamale	7.083	2	0.029
Rice local Wa	Rice local Techiman	37.690	2	0.000
Rice local Wa	Rice local Accra	0.502	2	0.778
Rice local Wa	ALL	69.518	10	0.000
Rice local Kumasi	Rice world	0.508	2	0.776
Rice local Kumasi	Rice local Wa	8.266	2	0.016
Rice local Kumasi	Rice local Tamale	5.165	2	0.076
Rice local Kumasi	Rice local Techiman	2.069	2	0.355
Rice local Kumasi	Rice local Accra	0.188	2	0.910
Rice local Kumasi	ALL	13.893	10	0.178
Rice local Tamale	Rice world	3.149	2	0.207
Rice local Tamale	Rice local Wa	4.349	2	0.114
Rice local Tamale	Rice local Kumasi	2.080	2	0.353
Rice local Tamale	Rice local Techiman	8.078	2	0.018
Rice local Tamale	Rice local Accra	2.845	2	0.241
Rice local Tamale	ALL	30.092	10	0.001
Rice local Techiman	Rice world	7.808	2	0.020
Rice local Techiman	Rice local Wa	5.910	2	0.052
Rice local Techiman	Rice local Kumasi	5.140	2	0.077
Rice local Techiman	Rice local Tamale	7.094	2	0.029
Rice local Techiman	Rice local Accra	18.246	2	0.000
Rice local Techiman	ALL	57.649	10	0.000
Rice local Accra	Rice world	3.565	2	0.168
Rice local Accra	Rice local Wa	8.986	2	0.011
Rice local Accra	Rice local Kumasi	6.443	2	0.040
Rice local Accra	Rice local Tamale	0.310	2	0.856
Rice local Accra	Rice local Techiman	0.646	2	0.724
Rice local Accra	ALL	19.341	10	0.036

Source: Author's estimation results.

Maize price in local markets in Ghana are often Granger caused by each other. The table 12 reveals similar results to that from rice markets, the only market directly Granger caused by world market is the local market in Techiman. Techiman market later impacts the other local markets in Tamale and Wa. Techiman prices are Granger caused also by other local markets of Wa, Kumasi, Tamale and Accra.

4. Conclusion

The objective of this paper was to first of all investigate how price transmission changes before and during the Planting for Food and Jobs programme and secondly to analyse horizontal price Transmission from the world market to local markets and among the markets. For this purpose, we chose five local regional markets: Accra market, Kumasi market, Techiman Market, Tamale market and Wa market, and two agricultural commodities maize and rice. Selection of commodities reflected their importance connected on local food diet. Analysis consisted of unit root tests, cointegration tests, Granger causality tests and estimation of error correction models.

The main findings show that there was one long run relationship among local and world rice prices in the first period, whilst in the second period the times series were very much more interconnected and we find three cointegration relationships. This implies that world and local prices do not drift apart in the long run. Maize prices were not cointegrated in the first period but in the second period we observed two long run relationships between local and world maize prices. However, the cointegration analysis could not predict the direction of causality between the price series. For this reason we employed the Granger causality test. We found out, that for both commodities the market in Techiman is Granger caused by world prices and later Techiman market Granger caused other local markets. There is also a couple of bi-causal relationships between prices in different local markets.

The main policy advice is to increase budgetary support to PFJs in order to improve the programme and increase productivity of agriculture in Ghana.

Acknowledgements

The authors gratefully acknowledge financial support received from the Slovak Research and Development Agency under the contract No. APVV-18-0512 and VEGA 1/0422/19.

References

Abdulai, A. 2000. “Spatial price transmission and asymmetry in the Ghanaian maize market”, *Journal of Development Economics, vol.* 63, no. 2, pp. 327 - 349. ISSN 0304-3878, DOI 10.1016/S0304-3878(00)00115-2

Amikuzuno, J., Issahaku, G., and Daadi B. (2013), ‘’Price Transmission between Imported and Local Rice Markets in a Liberalised Economy: Are Ghana’s Rice Wars Just Much I Do About Nothing?’’, *Journal of Economics and Sustainable Development*, vol. 4, no. 20, ISSN 2222-1700, E-ISSN 2222-2855

Braha, K., Qineti, A., Cupák, A. and Lazorčáková, E. (2017), “Determinants of Albanian Agricultural Export: The Gravity Model Approach", *AGRIS on-line Papers in Economics and Informatics*, vol. 9, no. 2, pp. 3 - 21. ISSN 1804-1930. DOI 10.7160/aol.2017.090201

Conforti, P. (2004), “*Price Transmission in Selected Agricultural Markets*”, FAO Commodity and Trade Policy Research Working Paper No. 7, Basic Foodstuffs Service, Commodities, and Trade Division, Food and Agriculture Organization, Rome

Darfour, B. and Rosentrater, K. (2016), “Agriculture and Food Security in Ghana”, *2016 ASABE Annual International Meeting 162460507*, DOI 10.13031/aim.20162460507

Esoko (2015-2019), “Price-Trend-Analysis-for-Q1”, [Online]. Available: https://esoko.com/wp-content/uploads/2019/05/Price-Trend-Analysis-for-Q1_2015-2019.pdf [Accessed: 15 May, 2020]

FAO. Food and agriculture organisation of the united nations (2015), “*Country fact sheet on food and agriculture policy trends - March*”, Ghana

Granger, C. W. J. and Newbold, P. (1974), "Spurious Regressions in Econometrics", *Journal of Econometrics*, vol. 2, pp. 111-120, ISSN 0304-4076, DOI 10.1016/0304-4076(74)90034-7

GLSS6 (2014), "Ghana living standard survey round 6 –main report", Ghana Statistical Service August, 2014. [Online]. Available: https://statsghana.gov.gh/gssmain/fileUpload/Living%20conditions/GLSS6_Main%20Report.pdf, [Accessed: 15 May, 2020]

Listorti, G. and Esposti, R. (2012), "Horizontal price transmission in agricultural markets: fundamental concepts and open empirical issues", *Bio-based and Applied Economics*, vol. 1, no. 1, pp. 81-108, ISSN 22806108, DOI 10.22004/ag.econ.125721

Meyers, R. (2008), "Evaluating the efficiency of inter-regional trade and storage in Malawi maize markets", Report for the World Bank. Michigan State University, East Lansing, MI

MOFA. Ministry of food and agriculture, Ghana (2007), "Agricultural sector progress report (2017)", [Online]. Available: http://mofa.gov.gh/site/wp-pontent /uploads/2018/09/MoFA%202017%20AGRICULTURAL%20PROGRESS%20REPORT_Final. PPMED.MoFA.pdf [Accessed: 22 May, 2020]

Moser, C., Barrett, C. and Minten, B. (2009), "Spatial integration at multiple scales: Rice markets in Madagascar", *Agricultural Economics*, vol. 40, pp. 281–294. E-ISSN 1574-0862, DOI 10.1111/j.1574-0862.2009.00380.x

Motamed (2008), "Applying cointegration and error correction to measure trade linkages: Maize prices in the United States and Mexico", *Agricultural Economics*, vol. 39, no. 1, pp. 29 – 39, ISSN 0139-570X, E-ISSN 1805-9295, DOI 10.1111/j.1574-0862.2008.00312

Minot, N. (2010). ''Transmission of World Food Price Changes to African Markets and Its Effect on Household Welfare'', Food Security Collaborative Working Paper No. 58563, Department of Agricultural Food and Resource Economics, Michigan State University

Mundlak, Y. and Larson, D. F. (1992), "On the Transmission of World Agricultural Prices", *The World Bank Economic Review*, vol. 6, pp. 399 - 422. ISSN 1564698X

Negassa, A. and Myers, R., (2007), "Estimating policy effects on spatial market efficiency: An extension to the parity bounds model", *American Journal of Agricultural Economics,* vol. 89, pp. 338 - 352. ISSN 0002-9092, E-ISSN 1467-8276

PFJ (2017), "Planting for food and jobs strategic plan for implementation (2017–2020)", Ministry of Food and Agriculture, Ghana: Republic of Ghana

Phillips, P. C. B. (1987), "Time series regression with a unit root", *Econometrica*, vol. 55, pp. 277 - 301. ISSN 0012-9682, E-ISSN 1468-0262, DOI 10.2307/1913237

Rantšo, T. A. and Seboka, M. (2019), "Agriculture and food security in Lesotho: Government sponsored block farming programme in the Berea, Leribe and Maseru Districts", Food and Science Technology, vol. 5, ISSN 2331-1932, DOI 10.1080/23311932.2019.1657300

Rashid, S. (2004), "Spatial Integration of Maize Markets in Post-Liberalised Uganda Markets", Trade and Institutions Division (MTID), Accra: IFPRI discussion Paper No. 7L

Tanko, M., Ismaila, S. and Sadiq, S. A. (2019), "Planting for Food and Jobs (PFJ): A panacea for productivity and welfare of rice farmers in Northern Ghana", *Cogent Economics & Finance*, vol. 7, DOI 10.1080/23322039.2019.1693121

Tangermann, S. (2011), "Policy Solutions to Agricultural Market Volatility: a Synthesis", International Center for Trade and Sustainable Development, Issue Paper No. 33

CONSUMER PREFERENCES AND TRENDS IN THE PURCHASE OF SELECTED COMMODITIES OF PLANT AND ANIMAL PRODUCTION IN THE CZECH REPUBLIC

Markéta Beranová[1], Miroslava Navrátilová[2] and David Brož[3]

[1, 2] Department of Trade and Accounting, [3] Department of Statistics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]mberanova@pef.czu.cz,[2]navratilovam@pef.czu.cz, [3]brozd@pef.czu.cz

Annotation: The global economy has been changing dynamically in recent decades. The structure of the national economy of the Czech Republic underwent major changes in the period of transformation in the 1990s and the structure of the agri-food complex also underwent a radical transformation. EU accession also played an important role. These facts have brought many challenges. In the area of food sales, the range of the offer of all products was expanded and their imports also increased significantly. In the last decade on the Czech market we can meet new forms of vending sales. Consumer interest in Czech production has increased strongly, especially in the area of fresh food, which has become a trend. Thus, in many cases, local production becomes a competitive advantage for the producer. The trend of recent years, however, is the preference of local production, whether national or local.

Key words: consumer, coronavirus COVID-19, food, plant and animal production, trend

JEL classification: Q13, F1

1. Introduction

At present, the agricultural sector, agrarian trade and agriculture face many challenges such as increasing crop productivity, expanding of organic farming, intensification of ties with other sectors, but also the competitiveness of the sector itself and many others (Smutka, Maitah, Svatoš, 2019; Bhat, 2017).

Agricultural production, is divided into lifestock production and plant production, this forms of production are necessary for food production in the Czech Republic (Špička, 2014). The agri-food industry follow-up structure by processing raw materials, stabilizing production, and adapting nutritional habits. In final form, the consumer receives food products, "Food is a key product of humanity, with the majority of people all around the world being primarily focused on trying to obtain or produce it" (Golebiewska and Stefańczyk, 2017). The food market in the Czech Republic was significantly changed over last decade. Asioli et al. (2017) and Turčínková and Stávková (2009) agree that from consumer's point of view, is possible to recognize the trend in the growth of demand for foods with higher added value and increasing of consumer interest in quality, longer durability and special product properties. In area of food purchase, in recent years we can also observe a growing interest in the origin of products in general and preference for local production at national or local level (Aprile, Caputo, Nayga, 2015). Schjøll (2017) believes that most consumers probably believe that domestic food production has a higher standard than foreign ones. This shift in terms of consumer preferences is possibly reaction of population of individual countries to a certain unification of the market in an international context. In frame of globalized market, there are still significant differences in consumer preferences in individual regional markets (Kita el al., 2017). According to Hobbs (2020), the trend of "local food" preferences will be intensified at least in the short to medium term after COVID-19, and that food security and the desire to support local businesses may also become more important as an incentive to sponsor local food supply chains.

Currently, given the current situation in the context of the global coronavirus pandemic (COVID-19), changes in consumer preferences can be observed, especially in the area of food, medicine and sanitary purchases (Nielsen, 2020). The coronavirus pandemic (COVID-19) will inevitably affect further economic, political and social developments around the world, so changes in consumer behavior towards health and safety can be expected in the near future (Deloitte, 2020). Routine life of the citizens of each country will certainly return to the "new normal", but there will be some changes in the area of the supply chain, especially towards the wider use of e-commerce (Nielen, 2020). In frame of agri-food complex, self-sufficiency will probably be a much-discussed topic at the level of individual countries and regions. In the conditions of economically developed countries is possible to expect increase in food self-provisioning in the form of alternative cultivation of crops. Those activities are traditional for Global North countries (Vávra, Daněk and Jehlička, 2018). The fact that consumer behavior when purchasing food will pandemics affected COVID-19 is highly probable, as is noted by Hobbs (2020). He also adds that *„access to safe, nutritious, and affordable food is a fundamental element of food security and ensuring that agricultural and food supply chains are designated as "essential" becouse it is critically important."*

The aim of the article is to evaluate the preferences of the general Czech population in the area of consumer preferences in terms of purchasing Czech food in two groups of food commodities. Plant production is represented by the product group "fruits and vegetables" and animal production is represented by a group of "meat and sausages."

The introduction of this paper includes a theoretical background of the examined issue. Section of materials and methods describes how primary data were analyzed and research was made. Section of results and discussion present results obtained, in discussion are compared final results of own research with similar studies of other authors on similar topics.

2. Materials and Methods

The theoretical background of this paper was based on an analysis of secondary sources gained from scientific papers, specialised literature and official internet portals. The data was obtained by quantitative research using a questionnaire survey among the general population in the Czech Republic (it is not a quota selection). The research was realized in 2019 with use of an electronic questionnaire.

Basic sociodemographic factors of the respondent reference group are summarised in the following table:

Table 1. Sociodemographic factors of the respondents in %

Gender	Females	51.9
	Males	48.1
Age category	15 – 24 Years	25.2
	24 – 34 Years	18.7
	35 – 44 Years	15.1
	45 – 54 Years	19.4
	55 – 64 Years	10.6
	65 Years and more	11.1
Highest education level obtained	Elementary	4.8
	Secondary with no graduation exam	17.5
	Secondary with graduation exam	53.5
	University	24.3
Permanent residence	Prague	51.2
	Central Bohemian region	14.6
	Ústí nad Labem region	7.8
	South Bohemian region	2.0
	Hradec Králové region	2.6
	Pardubice region	4.0
	Vysočina region	4.3
	Plzeň region	2.3
	Moravian-Silesian region	0.8
	Karlovy Vary region	2.3
	Liberec region	4.8
	South Moravian region	1.5
	Zlín region	1.1
	Olomouc region	0.8

Source: Own research, 2019

The paper will be processed using the methods and tools of descriptive and inferential statistics. A contingency table is used to test the mutual degree of association of (usually) a pair of variables that can only take a small final number of values. In its simplest form, which compares only binary values, this table is also called a four-field table (or 2x2). The tested criterion is the sum of normalized differences of the marginal frequencies and their translated values, which in the case of independency has an asymptotic distribution of $\chi 2$. The calculated value is then compared to the critical value $\chi 2$ (α) with (r-1)(s-1) degrees of freedom, where α = the required probability level of the test, r = number of rows of the table, s = number of columns of the table. The potential correlation (or absence thereof) was tested by the way of contingency tables, with an$\chi 2$ test at the 0.05 level. Various coefficients may be used to measure the strength of correlation; we have opted for Cramer's V.

Stated hypotheses, which are to be analyzed are presented in the following table.

Table 2. Summary of stated hypotheses

Nr. of Hypothesis	Text of Hypothesis
	Food in general
$H0_1$	The preference for knowledge of the origin of purchased food does not depend on the gender of the respondent
$H0_2$	The preference for knowledge of the origin of purchased food does not depend on the age of the respondent
$H0_3$	The preference for the composition of purchased food does not depend on the gender of the respondent
$H0_4$	The preference for the composition of purchased food does not depend on the age of the respondent
$H0_5$	The preference for the price of purchased food does not depend on the gender of the respondent
$H0_6$	The preference for the price of purchased food does not depend on the age of the respondent
$H0_7$	The preference for the availability of purchased food does not depend on the gender of the respondent
$H0_8$	The preference for the availability of purchased food does not depend on the age of the respondent
	Plant production – fruit and vegetable
$H0_9$	The preference of Czech / domestic production when buying fruit and vegetables does not depend on the gender of the respondent
$H0_{10}$	The preference of Czech / domestic production when buying fruit and vegetables does not depend on the age of the respondent
$H0_{11}$	The preference for regional production in the purchase of fruit and vegetables does not depend on the gender of the respondent
$H0_{12}$	The preference for regional production in the purchase of fruit and vegetables does not depend on the age of the respondent
$H0_{13}$	The preference of farm production when buying fruit and vegetables does not depend on the gender of the respondent
$H0_{14}$	The preference of farm production when buying fruits and vegetables does not depend on the age of the respondent
	Livestock production – Meat and sausage
$H0_{15}$	The preference of Czech / domestic production when buying meat and sausages does not depend on the gender of the respondent
$H0_{16}$	The preference of Czech / domestic production when buying meat and sausages does not depend on the age of the respondent
$H0_{17}$	The preference for regional production in the purchase of meat and sausages does not depend on the sex of the respondent
$H0_{18}$	The preference for regional production when buying meat and sausages does not depend on the age of the respondent
$H0_{19}$	The preference of farm production when buying meat and sausages does not depend on the sex of the respondent
$H0_{20}$	The preference of farm production when buying meat and sausages does not depend on the age of the respondent

Source: Own research, 2019

3. Results and Discussion

From the point of view of buying food in general, the price of food is the most preferred for consumers. The results of the research show that out of the total number of 651 respondents, price has still an important role in purchase of food for 391 of respondents (60.06%), which represents more than half. The price of food as a basic consumer good is one of the main criteria in its selection and purchase (Jones and Coffey, 2019; Bekkers et al., 2017). Aschemann-Witzel and Zielke (2017) state that in the case of organic food, high price is considered as main perceived obstacle to their purchase. The preference for price and availability when buying food proved to be dependent on the age of the respondents (see Table 3). $H0_6$ can be rejected because the calculated value of the statistic (15.40) is higher than the critical value of 11.07 at 5 degrees of freedom (at the significance level of 5 %). Cramer´s V is at the level of 0.15 and it is therefore a weaker dependence. Price preference in case of buying food depends on the age group of the respondent. $H0_8$ can also be rejected because the calculated value of the statistic (11.11) is higher than the critical value of 11.07 at 5 degrees of freedom (at a significance level of 5 %). The preference for the availability of food therefore depends on the age group of the respondent. Cramer´s V is at the level of 0.13 and it is a weaker dependence.

Table 3. Results of tested hypothesis – food in general

Category	**Value types**	**Values - results**			
Gender	Degree of freedom	1	1	1	1
	$\chi 2$	0.68	1.71	0.64	3.34
	Critical value	3.84	3.84	3.84	3.84
	Cramer´s *V*	-	-	-	-
	Hypothesis	$H0_1$ cannot be rejected	$H0_3$ cannot be rejected	$H0_5$ cannot be rejected	$H0_7$ cannot be rejected
Age category	Degree of freedom	5	5	5	5
	$\chi 2$	5.33	8.87	15.40	11.11
	Critical value	11.07	11.07	11.07	11.07
	Cramer´s *V*	-	-	0.15	0.13
	Hypothesis	$H0_2$ cannot be rejected	$H0_4$ cannot be rejected	**$H0_6$ can be rejected**	**$H0_8$ can be rejected**

Source: Own research, 2019

In case of buying fruits and vegetables, as selected representatives of plant production, consumers prefer domestic production to foreign production (out of 651 respondents, there is preference for 268 of them, which is 41.17 %). Massaglia et al. (2019) state that origin is a decisive factor in the case of preferences for the purchase of fruit and vegetables. The same conclusion is given by Bogomolova et al. (2018), with domestic and local foods still being preferred to imported ones among consumers. As Table 3 shows, in the case of $H0_{10}$, the calculated value of the statistic $\chi 2$ is 16.17 and is significantly higher than the critical value at the significance level of 0.05. The null hypothesis can be rejected. Dependence between the preference of domestic production when buying fruit and vegetables over foreign production and the age group of respondents was proved. The dependence measured by Cramer's V reaches 0.16 and is weaker. Other hypotheses in relation to preferences for fruit and vegetables cannot be rejected. In contrast, Sandlin et al. (2017) found in research that the preference for origin when buying fruits and vegetables depends on gender, not age.

Table 4. Results – food, plant production

Category	Value types	Values - results		
Gender	Degree of freedom	1	1	1
	$\chi 2$	0.87	2.06	0.91
	Critical value	3.84	3.84	3.84
	Cramer´s *V*	-	-	-
	Hypothesis	$H0_{9}$ cannot be rejected	$H0_{11}$ cannot be rejected	$H0_{13}$ cannot be rejected
Age category	Degree of freedom	5	5	5
	$\chi 2$	16.17	4.04	2.77
	Critical value	11.07	11.07	11.07
	Cramer´s *V*	0.16	-	-
	Hypothesis	**$H0_{10}$ can be rejected**	$H0_{12}$ cannot be rejected	$H0_{14}$ cannot be rejected

Source: Own research, 2019

Similar trend in purchases can be observed in the case of meat and sausages. Even in this case, from the point of view of consumers, the most preferred aspect is the origin of domestic production of animal production. Out of the total number of 651 respondents, 265 respondents expressed their favor for origin of domestic production, which represents 40.71 % of them. Predanocyová et al. (2019) state that the country of origin is one of the factors determining the purchase of meat and meat products, as well as the quality, price and freshness. In the case of meat and meat products confirm the statement, Chiciudean et al. (2018). As Table 4 shows, in the case of $H0_{16}$, the calculated value of the statistic $\chi 2$ is 21.41 is significantly higher than the critical value at the significance level of 0.05. The null hypothesis can be rejected. Dependence between the preference of domestic production when buying meat and sausages over foreign production and the age group of respondents was proved. The dependence measured by Cramer's V reaches 0.18. Other hypotheses in relation to meat and sausage preferences cannot be rejected.

Table 5. Results of tested hypothesis – food livestock production

Category	Value types	Values - results		
Gender	Degree of freedom	1	1	1
	$\chi 2$	0.75	0.36	0.04
	Critical value	3.84	3.84	3.84
	Cramer´s *V*	-	-	-
	Hypothesis	$H0_{15}$ cannot be rejected	$H0_{17}$ cannot be rejected	$H0_{19}$ cannot be rejected
Age category	Degree of freedom	5	5	5
	$\chi 2$	21.41	3.56	10.63
	Critical value	11.07	11.07	11.07
	Cramer´s *V*	0.18	-	-
	Hypothesis	**$H0_{16}$ can be rejected**	$H0_{18}$ cannot be rejected	$H0_{20}$ cannot be rejected

Source: Own research, 2019

Ahani and Nilashi (2020) highlight the important role of communication and information technologies during the coronavirus pandemic that is caused by COVID-19. Based on this is possible to predict for near future some conditions for long- term success in retail business, for stakeholders will be necessary to adapt quickly to new trends, especially in the field of sales channel integration (Deloitte, 2020).

4. Conclusion

The aim of this article was to evaluate the preferences of the general Czech population in the area of consumer preferences in terms of purchasing Czech food in two groups of food commodities. Plant production is represented by the product group "fruits and vegetables" and animal production is represented by a group of "meat and sausages."

The results show that in terms of preferences when buying food, the trend of taking food prices into account generally persists (60.06 % of respondents). For the specific production of plant production - fruit and vegetables and animal production - meat and sausages, the aspect of the origin of food is preferred (domestic food) - for fruit and vegetables it is 41.17 % of respondents and for meat and sausages 40.71 % of respondents. These results confirm the current trends in consumer behavior in the market of plant and livestock production. In the current global crisis caused by a pandemic of a new type of coronavirus (COVID-19). The question for all stakeholders remains – what will be new trends in consumer behavior in case of buying food and how it will affect the future shape of the entire agri-food complex and retail trends? This situation will be a challenge for individual producers, but also for entire sectors.

The space for further research is the repetition of a questionnaire survey with a time lag after the critical wave of COVID19, where it will be possible to define specific changes in consumer behavior. The limiting factor of the contribution is the imbalance from the point of view of permanent residence, where Prague predominates.

Acknowledgements
This work was also supported by the Internal Grant Agency of Faculty of Economics and Management, Czech University of Life Sciences Prague - grant number 2020B0002 – “The impact of climate change on the economic performance of the viticulture and wine-making sector in the Czech Republic”.

References

Ahani, A., and Nilashi, M. (2020), “Coronavirus Outbreak and its Impacts on Global Economy: The Role of Social Network Sites”, *Journal of Soft Computing and Decision Support Systems*, vol. 7, no 2, pp. 19-22. E-ISSN 2289-8603

Aprile, M. C., Caputo, V. and Nayga, R. M. (2015), “Consumers’ Preferences and Attitudes Toward Local Food Products. *Journal of Food Products Marketing*”, vol. 22, no. 1, pp. 19 - 42. ISSN 1540-4102, DOI 10.1080/10454446.2014.949990

Aschemann-Witzel, J. and Zielke, S. (2017), “Can't Buy Me Green? A Review of Consumer Perceptions of and Behavior Toward the Price of Organic Food”, *Journal of Consumer Affairs*, vol. 51, no. 1, pp. 211 – 251, ISSN 0022-0078, DOI 10.1111/joca.12092

Asioli, D., Aschemann-Witzel, J., Caputo, V., Vecchio, R., Annunziata, A., Naes, T. and Varela, P. (2017), “Making sense of the “clean label” trends: A review of consumer food choice behavior and discussion of industry implications”, *Food Research International*, vol. 99, no. 1, pp. 58 - 71, ISSN 0963-9969, DOI 10.1016/j.foodres.2017.07.022

Bhat, R. (2017), “*Sustainability challenges in the agrofood sector*“, Hoboken, NJ: John Wiley, ISBN 9781119072751

Bogomolova, S., Loch, A., Lockshin, L. and Buckley, J. (2018), "Consumer factors associated with purchasing local versus global value chain foods", *Renewable Agriculture and Food Systems*, vol. 33, no. 1, pp. 33 - 46. ISSN 1742-1705, DOI 10.1017/S1742170516000375

Deloitte (2020), "Situational Thinking + Phased Preparation + Motivated Rally" | How consumer products & retail enterprises can win the battle against COVID-19, [Online], Available: https://www2.deloitte.com/cn/en/pages/strategy-operations/articles/how-consumer-industry-fights-against-20pr19-ncov.html, [Accessed: 25 March. 2020]

Golebiewska, B. and Stefańczyk, J. (2017), "Determinants of self-sufficiency and food security in Poland", *Proceedings of the international conference Agrarian perspectives XXVII*, FEM CULS, Prague, ISBN 978-80-213-2787-0, E-ISSN 2464-4781, ISSN 1213-7960

Hobbs, J. E. (2020), "Food supply chains during the COVID-19 pandemic", *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, pp. 1 - 6, ISSN 0008-3976, DOI 10.1111/cjag.12237

Chiciudean, D., Arion, F., Muresan, I. and Chiciudean, G. (2018), "Consumer Behaviour of Local Meat and Meat Products", *ProEnvironment*, vol. 11, no. 34, pp. 63 – 69, ISSN 2066-1363

Jones, Ch., L. and Coffey, M. C. (2019), "Consumer choice as experienced in the user-choice food pantry environment: motivations and situational influences on food selection", *Public Health Nutrition*, vol. 22, no. 13, pp. 2479-2488, DOI 10.1017/S1368980019000909, ISSN 1368-9800

Kita, P., Furková, A., Reiff, M., Konštiak, P. and Sitášová, J. (2017), "Impact of consumer preferences on food chain choice: An empirical study of consumers in Bratislava", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 65, no. 1, pp. 293 - 298. ISSN 2464-8310, DOI 10.11118/actaun201765010293

Massaglia, S., Borra, D., Peano, C., Sottile, F. and Merlino, V. M. (2019), "Consumer Preference Heterogeneity Evaluation in Fruit and Vegetable Purchasing Decisions Using the Best-Worst Approach", *Foods*, vol. 8, no. 7, ISSN 2304-8158, DOI 10.3390/foods8070266

Nielsen, The Nielsen Company (2020) "Key Consumer Behavior Thresholds Identified as the Coronavirus Outbreak Evolves", [Online], Available: https://www.nielsen.com/us/en/insights/article/2020/key-consumer-behavior-thresholds-identified-as-the-coronavirus-outbreak-evolves/, [Accessed: 04 Apr. 2020]

Predanocyová, K., Ľ Kubicová, Ľ., Kádeková, Z. and Košičiarová. I. (2019), "Key factors affecting consumption of meat and meat products from perspective of Slovak consumers", *Potravinarstvo Slovak Journal of Food Sciences*, vol. 13, no. 1, pp. 1001-1012. ISSN 1337-0960, DOI 10.5219/1198

Sandlin, M. R., Lindner, J. R., Dooley, K. E., Odom, S. F., Lombardini, L. and Perez, K. (2017), "Consumer Perceptions of Fruit and Vegetable Origin, Growing Methods, and Willingness to Pay in Trinidad and Tobago Marketplaces: Implications for Extension Programming", *Journal of Human Sciences and Extension*, vol. 5, no. 3, pp. 35-52. ISSN 2325-5226

Schjøll, A. (2017), "Country-of-origin preferences for organic food", *Organic Agriculture,* vol. 7, pp. 315-327. ISSN 1879-4238

Smutka, L., Maitah, M. and Svatoš, M. (2019), "The Czech Agrarian Trade Comparative Advantages Distribution Based on Value and Volume Approach", *Acta Universitatis*

Agriculturae et Silviculturae Mendelianae Brunensis, vol. 67, no. 6, pp. 1613 - 1625. ISSN 1211-8516. DOI 10.11118/actaun201967061613

Špička, J. (2014), “The Regional Efficiency of Mixed Crop and Livestock Type of Farming and Its Determinants”, *Agris on-line Papers in Economics and Informatics*, vol. 6, no. 1, pp. 99-109. ISSN 1804–1930. DOI 10.22004/ag.econ.167102

Turčínková, J. and Stávková, J. (2009), “Changes in consumer behavior on the market with food”, *Acta Universitas Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 57, no. 3, pp. 173 - 178. ISSN 1211-8516. DOI 10.11118/actaun200957030173

Vávra, J., Daněk, P. and Jehlička, P. (2018), “What is the contribution of food self-provisioning towards environmental sustainability? A case study of active gardeners”, *Journal of Cleaner Production*, no. 185, pp. 1015 - 1023. ISSN 0959-6526

CHALLENGES IN THE TEA INDUSTRY IN BURUNDI: UPGRADING AND SUSTAINABILITY POLICIES

Pierre Claver Bitama[1] and Philippe Burny[2]

[1, 2] Economics and Rural Development Unit, University of Liege-Gembloux Agro-Bio Tech, Belgium

[1]pierreclaverbitama@yahoo.fr, [2]philippe.burny@uliege.be

Annotation: Since its introduction in Burundi in 1963, the tea bush has been a strategic cash crop for the country in terms of foreign exchange export earnings. Tea sector is one of the main employment sectors, providing regular income to more than 60,000 farmers. This article develops the different challenges identified in the tea sector and discusses the upgrading measures to meet demand and maintain its sustainability. The study is based on interviews with the managers of the Burundi Tea Board (OTB), factory managers, 120 tea farmers and secondary data especially experiences from countries that produce and sell tea on international markets. As an integral part of the Global Value Chain (GVC), the results showed that the tea sector faces multiple challenges that could jeopardize its sustainability and competitiveness. Internationally, price volatility is a challenge for Burundian tea given its low production and buyers (price-makers) are more rigorous in terms of quality and certification standards. Upstream, several challenges are worth mentioning: labour shortages, scarcity of land for expansion, high production and transaction costs, old tea bushes, low application of fertilizers, etc. In order to increase productivity, the country needs to replace old tea bushes with high yield varieties and strengthen the training of extension workers and tea growers. To reduce production costs, government should invest in infrastructure and other energy sources must be harnessed. In addition, diversification of supply and systematic adaptation to certification standards are needed to meet demand.

Key words: Burundi, challenges, competitiveness, sustainability, tea

JEL classification: Q10

1. Introduction

The tea plant was introduced in Burundi in the 1930s. One of Burundi's eleven natural regions - the Mugamba natural region - was found to be suitable for the tea bush, thanks to studies carried out at the Agricultural Research Centre (ISABU) of Gisozi in Mwaro Province (Flémal, 1986). Since then, the tea bush has been cultivated in five zones -as-Tora, Ijenda, Teza, Rwegura and Buhoro - of the natural region. The tea bush is a cash crop of great importance to the country. It is the country's second important strategic commodity in terms of foreign exchange export earnings, accounting on average for 17.4% of the value of exports after coffee (42.1%) in 2018 (OBR, 2019). The tea bush provides regular income for tea farmers and employment opportunities: nearly 60,000 small tea farmers exploit the tea bush while nearly 1,000 employees are employed full time in the sector.

The tea bush (*Camellia sinensis*) is produced and consumed in different tea varieties (black tea, green tea, white tea, oolong tea, pu'ehr tea and red tea). These different varieties differ slightly in the processing of the green leaf of the tea bush. Green tea (31%) and black tea (61%) are the most produced in the world (Sharangi, 2009). Burundian tea plant is exploited on a small area (10,005 hectares), the state plantations are of a small proportion compared to those (more than 80%) of small tea growers. The total production of green leaves has increased continuously due to small extensions over time, from 18,728 tons in 1990 to 50,820 tonnes in 2018. Global productivity (kg/ha) has also increased from 2.8 tons/ha in 1990 to 4.5 tons/ha in 2018. In 2018, 10,753 tons of black tea were sold: 80% on the auction markets in Mombasa (Kenya), 15% on foreign direct markets and 5% on local markets. Overall, black tea from Burundi is of better quality in Africa. In 2015, it was of higher quality at the Mombasa auction market while in 2016 it ranked 3rd after Kenya and Rwanda.

Internationally, the market for tea (black and green) has evolved considerably over time. After the colonial period, several developing countries, particularly in Africa, intensified tea production between 1960 and 1970. The 1980s were characterized by extensions of tea plantations and export promotion efforts that led to an oversupply on foreign markets, resulting in low prices (Mohan, 2018). Despite severe droughts in India, Sri Lanka and Kenya, world tea production increased continuously at a rate of 1.8% up to 2009 (Groosman, 2011). In 2013, world tea production increased by 6% from the previous year to 5.07 million tonnes. Black tea increased by 5.4% despite price's rigidity, while green tea increased by 5.1%. Between 2007 and 2016, tea production increased at an annual rate of 4.4%. Although China and India are the major tea producing countries, they are also major consumers (Table 1): in 2013, 84% and 83.4% of their production are consumed domestically. International tea exports reached 1.8 million tonnes in 2015.

Table 1. Top ten ranked leading countries in tea production, exportation and consumption (by thousand tonnes)

	Production (2018)			**Exportation (2017)**			**Consumption (2013)**		
	Country	Quantity	Share (%)	Country	Quantity	Share (%)	Country	Quantity	Share (%)
1	China	2,610.4	45.0	Kenya	467.0	25.6	China	1,614.2	33.3
2	India	1,344.8	23.1	China	355.2	19.5	India	1,001.4	20.7
3	Kenya	492.9	8.4	Sri Lanka	286.8	15.7	Turkey	228.0	4.7
4	Sri Lanka	303.8	5.2	India	261.4	14.3	Russia	159.1	3.3
5	Turkey	270.0	4.6	Vietnam	146.4	8.0	USA	127.4	2.6
6	Vietnam	270.0	4.6	Argentina	74.9	4.1	Pakistan	126.6	2.6
7	Indonesia	141.3	2.4	Uganda	59.2	3.2	Japan	119.1	2.5
8	Iran	109.4	1.9	Indonesia	52.8	2.9	UK	116.2	2.4
9	Myanmar	109.0	1.9	Malawi	41.2	2.2	Egypt	99.0	2.0
10	Japan	83.0	1.4	UAE	33.6	1.8	Iran	83.4	1.7
	Others	65.4	1.1	Others	41.5	2.3	Others	1167.7	24.1

Source: Chang, 2015; FAOSTAT, 2019

Kenya and Sri Lanka are the major exporters of black tea followed by China, India, Vietnam. World tea consumption has increased nearly 5% in 2013 to reach 4.84 million tonnes. This growth is mainly explained by consumption growth in China, India and other emerging countries (Chang, 2015). FAOSTAT reports that 50 countries around the world grow tea bush. However, only a few countries produce more than 98.9% (table 1), while Burundi produces 0.2% of world production. The Intergovernmental Group on Tea (IGT, 2018) projects that black tea production will increase continuously until 2027 at an annual rate of 2.2% mainly in China, Kenya and Sri Lanka to reach 4.42 million tonnes. Green tea could increase by 7.5% per year to reach 3.65 million tonnes. On the export side, the IGT (2018) projects that the major exporting countries will be: Kenya (leader), India, Sri Lanka, China, Argentina and Vietnam. Black tea could reach 1.66 million tonnes in 2027 with a small annual increase (0.91%) for African countries. Green tea exports could increase by 5% annually to reach 605,455 tonnes in 2027, with China the leader (416,350 tonnes) followed by Vietnam (148,498 tonnes), Indonesia (12,889 tonnes) and Japan (10,445 tonnes).

Despite the fact that Burundi's black tea is of better quality on African markets, the major producing and exporting countries are a significant threat to the positioning of its tea exports.

How can Burundian tea remain competitive on the markets and maintain the sustainability of the sector? The objective of this article is twofold: it highlights the challenges in the sector and discusses the measures to upgrade the value of the tea to satisfy demand and maintain the sustainability of the sector.

2. Materials and Methods

The study was conducted with primary and secondary data collected in 2018-2019 period from three categories of actors in the value chain through semi-structured interviews and observation on the challenges of the tea sector. The first category is made up of downstream actors (at the national level): the different technical directors of the OTB. The OTB is the public body created in 1971 and under the authority of the Ministry of Agriculture and Livestock. It is in charge of the management and control of almost the entire tea sector (more than 95% of the village tea farms and its own plantations) through six units: the head office located in Bujumbura and five factories (Teza, Ijenda, Tora, Rwegura and Buhoro) located in five tea complexes. The second category of actors are those in charge of collecting and processing tea and two factories - the Ijenda and Teza factories - have been chosen. Due to time and financial constraints, the rational choice of these factories is their geographical position (they are located near the capital of Burundi). In these factories, interviews were conducted using a semi-structured questionnaire with the factory managers and agronomists. Before identifying the challenges faced by these factories, a detailed understanding of the value chain from seeding to black tea has been a priority. The last category of actors are tea farmers. 120 tea farmers in the Ijenda and Teza area (60 in each area) were randomly selected. Socio-demographic data indicate that the average household size is seven individuals in Teza and five in Ijenda. The level of education in this sample is very low: more than 95 percent have a basic level of education. Tea growers have small tea farms: more than 80% farm less than 10 ares due to the demographic pressure on arable land (the total agricultural area is 0.5 hectare per household on average) while agriculture is the main means of their livelihood. For these actors, we conducted semi-structured interviews and focus groups were organized, under the central topic of the challenges they face in exploiting the tea bush. Particular attention was paid to the observation of the field. Collected data were enriched by in-depth documentary research (articles, books, reports, etc.) in the tea sector, particularly with leading countries in tea production and marketing. Data were qualitatively analysed by content analysis (Duriau, Reger and Pfarrer, 2007).

3. Results and Discussion

International Market Related Challenges

Price Volatility

The dry tea market, as for other agricultural commodities, is characterized by recurrent price fluctuations. For example, the price of black tea increased significantly from 2006 to 2012 and reached a peak of USD 3.18 per kg in September 2009 as demand exceeded supply. Since then, it has fallen to an average of USD 2.65 per kg in 2014, which is still considerably higher than the average prices of the previous two decades (Chang, 2015). Factors related to the downward price are the oversupply on the market, a threat to small producing countries. Market demand reveals that the prices of green and black tea are inelastic. The price elasticity of black tea varies between -0.32 and -0.80 while that of green tea varies between -0.69 and -0.98. The upward price is explained by unfavourable weather conditions in the major producing countries, increased demand, lower oil prices, etc. (Chang, 2015; Jayaratne, 2015). The price volatility is closely linked to the uncontrollable nature of price setting by producers.

They are price takers vis-à-vis a small number of price makers who are stringent in terms of quality and compliance with certification standards.
In Burundi, the tea bush - *Camellia sinensis* of the variety *Assamica* - is cultivated and the environmental conditions (rain, temperature) are favourable to the best quality tea. To maintain the high quality of the dry tea, measures have been tightened such as the respect of plucking standards, the application of mineral fertilizers and the maintenance of the plantations. Leaf plucking, i.e. imperial plucking (bud + one leaf) and fine plucking (bud + 2 leaves) are the only accepted. However, price volatility remains a major challenge for the country. This challenge is affecting upstream actors: the price of green leaf is acquired at 250 BIF/kg for a whole decade and the annual payment in the form of a bonus is not guaranteed.
To remain competitive and sustainable, quality upgrading must be coupled with other marketing strategies across product and market diversification (Chocholoušek and Huml, 2019). Sri Lanka has moved to packaging and branding activities in the downstream chains. The country has built its competitiveness in value-added and high-quality tea exports, with over 50% of exports in 2016 in value-added packaged form. In addition to black tea, Sri Lanka sells green, organic and specialty teas (Jayaratne, 2015). Due to its significant value addition, Kenya exported more tea in volume than Sri Lanka in 2013 by 20 percent but Sri Lanka earned 10 percent more from its exports than Kenya did (Chang, 2015). In 2009, Sri Lanka sold 61 percent of her tea in bulk and 39% in value added form (Kagira, Kimani and Githii, 2012). OTB is progressively integrating new strategies: in 2018, green tea production was launched at Buhoro factory. The country needs to further diversify its offer by a thorough study of the market.

International Certification

Exported tea must be certified to international standards in order to obtain high prices. Consumers are now more concerned with factors such as health, food quality, safety of food, product traceability and sustainability of the production processes (Jayaratne, 2015). Burundi is still at an infancy stage of certification. Its dry tea is certified only by *Rainforest alliance*. The adoption of several international certification standards is one of the strategies adopted to upgrade the value of tea on the markets. Kenya is simultaneously putting a strong emphasis on certification and product upgrade, which has enabled the country to move from low quality bulk tea to high quality bulk tea. Currently, Kenyan's dry tea ranks first at the Mombasa auction (Mohan, 2018). Certification has a positive role in facilitating market access and therefore acts as a licence to trade. Certification schemes help producers to sell tea to large companies (e.g. Unilever) that require certified products and coming from sustainable environment. In 2015, 538,000 hectares (14.2% of the global tea area) were certified by the four major certification schemes (*Fairtrade, Organic, Rainforest Alliance* and *UTZ)* and 717,000 hectares (18.9% of the global tea area) were compliant with one of these schemes. Kenya, India, and China accounted for the largest area of certified tea production in 2015 (IGT, 2018). The trend towards certification will increase over time and Burundi will lose further its current position. Burundi's progressive adoption to other types of certification (the most important) is crucial for upgrading the quality and maintaining the sustainability of the sector, an advantage for all actors.

Local Market Related Challenges

Infrastructures

The poor road network can be seen as one of the challenges for the industry in the country as green leaves must be delivered to the factories within 6 hours after harvest. The rehabilitation of the roads is a priority. However, these roads become slippery during the rainy period and the green leaves collection becomes challenging. Another challenge is the overloading of trucks to minimize fuel costs. The green leaves lack aeration and burn, which deteriorates the quality of the processed tea. Investment in infrastructures as Kenya does (Mohan, 2018) is a challenge for Burundi given its low production and the scattering of small tea farmers. Partnerships with developed countries could subsidize this investment. Burundi is landlocked and transportation costs.

Processing Equipment

The increase in production due to small extensions was not followed by the investment in the processing equipment. Until 2005, the industry was faced with long-term debts (from 4.6 to 6.5 billion BIF) due to the poor performance. In order to prevent its collapse, STABEX funded OTB with a grant of USD 3.6 million between 2007 and 2010. This grant enabled to rehabilitate and replace some equipment, thus enabling to process tea using CTC (Cut, Tear, Curl) technology. Since then, the transformation coefficient improved from 5 to 4.6 between 2008 and 2011, the ideal being 4.2:1. Presently, it is the replacement of defective equipment that is carried out. During high production, the factories are experiencing processing challenges, the bottleneck being mainly at the withering troughs. The quality of tea depends simultaneously on environmental conditions, harvesting standards and the performance of the equipment. Investment in processing equipment needs to be planned.

Energy

The tea processing is energy consuming. To process tea, the OTB uses hydroelectric power and firewood to minimise the cost of production. OTB has its own tree plantations but sometimes purchases wood from households. Eucalyptus is mostly used due to its high calorific value. The use of wood leads to deforestation in the medium and long term, with erosion, drought, fauna and flora extinction, food insecurity, etc. (Sabuhungu, 2016; Jin et al., 2017). Factories consume nearly one hectare of wood for the processing of 3 hectares of tea plant (IGG, 2018). To reduce production costs from fuel oil and electricity, the Kenya Tea Development Agency (KTDA) factories use firewood and deforestation is causing serious impacts (Kagira, Kimani and Githii, 2012). Reforestation must be a permanent concern. As Burundi is endowed with sustainable and environmentally friendly energy sources, investment in alternative energy sources such as solar and wind power should reduce costs and negative externalities.

Variety

Since its introduction in the country in 1963, tea plantations have never been replaced by young plants. Tea is a perennial crop with 40 years of economic life, sometimes kept in production 60-70, or even 100 years (UNCTAD, 2016), but it is essential to regularly replace the plantations by more productive varieties (hybrids) with appropriate mineral fertilizers to increase productivity. To increase productivity, Vietnam has replaced 49% of the plantation area with new tea plants in 2009: PH1 (10 tonnes/ha), TRI 777 (8 tonnes/ha) and Shan (6 to 7 tonnes/ha) varieties, LDP1 and LDP2 hybrids producing 15 tonnes/ha. The Vietnamese government plans to reach 90% of hybrid tea bush by 2030 (Le, 2018). In Kenya and Sri Lanka, publicly funded research into new tea bush varieties, and policies that provide subsidies for the replacement with the new ones, improved the productivity of farming. In Kenya 50 tea clones have been tested for quality, yield, disease and pest resistance (Mwangi, 2014; Mohan, 2018). OTB has to regularly replace the tea with the new ones and the appropriate fertilizers. Once replaced, tea growers should be subsidised for at least 5 years. To boost productivity, organic manure and mulch should complement mineral fertilizers. As an incentive, the OTB could subsidise (currently subsidised to 70%) fertilisers provided on credit. In addition, extension workers should initiate the planting of trees (e.g. *Grevillea*) that are not harmful to the tea bush, allowing income diversification and natural mulching.

Costs of Labor

The problem of manual labor is only raised among small tea farmers in village areas. Typically, smallholders use family-based labor, but they sometimes use hired labor. In Ijenda 47% use paid labor, 21% use family-based labor and 33% use both. In Teza 63% use the family-based labor, 5% the paid labor and 12% use both. The difference in labor utilization is explained by the size of the households. In addition, Ijenda has many intellectuals who pay the labor for their parents and mutual assistance is more practiced in Teza than in Ijenda. A hired labor is paid 2000 BIF in Teza and 2500 BIF in Ijenda per day. With 250 BIF/kg of the green leaf, small tea farmers make less profit by hiring labor. In fact, the most efficient ones can harvest 20 to 25kg per day. The workers do not desire a remuneration at 100 BIF/kg as they incur an opportunity cost especially during the period of lower production. In addition, harvesting in village areas is constrained by the lack of clothes against the rain. The use of paid labor during plucking is mandatory if small tea farmers do not have sufficient family-based labor. In fact, a plantation that is not regularly plucked leads to overgrowth, thus an entire pruning and the harvest is restarted after six months.

The job satisfaction depends on a number of factors, including conditions and remuneration of labor, career opportunities, etc. (Blinova and Vyalshina, 2019). In Sri Lanka the shortage of labor in state-owned plantations is due to the workers' poor living conditions. They prefer working elsewhere. The absenteeism rate is high despite the bonuses' incentives while the younger generations do not want to work in the sector considered more stressful and less comfortable (Jayaratne, 2015). Hired labor is becoming more and more expensive, making tea farmers less profitable. In Kenya, for example, the payment for pluckers' labor per kg has successively increased on average to 5.50 Kenyan shilling ($0.06) in 2009 to KSh8 ($0.09) in 2012. On the other hand, green leaves are paid at KSh12 ($0.15)/kg the annual payment excluded (roughly $ 0.5/kg) referred to as bonus. Workers consider the remuneration less attractive and solicit a continuous increase or leave the sector (Kagira, Kimani and Githii, 2012). In India, hired labor has increased considerably from 17 to 43% (in 2011), while productivity has decreased drastically (Rymbai et al., 2012). The use of plucking machines affects productivity in quantity and quality. It leads to injuries on stems that prevent bud development. Moreover, the use of plucking machines results in coarse rather than fine and selective plucking (Obanda and Owuor, 1995; Burgess and Carr, 1998).

To cope with labour shortage, tea farmers have to group together in associations/cooperatives (small groups of 5 to 10 tea farmers for example). The OTB should be aware of the working conditions of small tea growers by providing them with equipment (clothes, shoes, gloves) payable in instalments.

Training

On village farms, some small-scale tea farmers do not apply mineral fertilizers at the dosage recommended due to its diversion to food crops by ignorance (low level of education) or lack of financial means to buy fertilizers for food crops. Others do not take care of the tea bush in real time. While the environment is favourable, the productivity and quality of the tea depend heavily on the care given to it. The supervision of small tea farmers by extension workers by visiting the plantations needs to be supported by seminars and training. Thus, the tea growers should internalize the needs of the tea bush: fertilization, weeding, pruning and harvesting standards. The efficiency of knowledge via training develops and maintains the sustainability of the sector. In addition to these trainings, actors must have a seamless collaboration (Petrovic-Lazarevic, Sohal and Baihaqi, 2007).

4. Conclusion

Burundian tea has potentials despite the low country's production. This paper analyses the different challenges encountered by the tea industry and discusses strategies to maintain the sector competitive and sustainable. In the GVC, Burundian tea sector is extremely small in the universe of the theiculture worldwide. The continuous growth of world tea production makes prices volatile, threatening the production and marketing of the country's tea. This situation is exacerbated by conglomerates that set prices and impose quality and certification standards. To maintain the competitiveness and sustainability of the sector, product and market diversification and the progressive adoption of the most important certification standards are essential. Internally, an effort of investment in infrastructure and machinery as well as the gradual replacement of plantations with new and more productive varieties (hybrids) are a necessity. Reforestation in both village and state areas must be a permanent concern. In order to reduce energy production costs, the OTB must invest in sustainable energy, which will strengthen environmental protection. All actors must undergo continuous training and put into practice the knowledge learned in seamless collaboration. With labor shortage, tea growers have to organize themselves into small associations (or producers' cooperatives) rather than working in isolation. The implementation of these different strategies will alleviate the different challenges and enable the maintenance of the competitiveness and sustainability of the sector.

References

Blinova, T. and Vyalshina, A. (2018),"Employment in enterprises of different size in rural Russia: Socio - demographic features ", *Proceedings of the Agrarian Perspectives XXVIII*, Prague, pp. 21-28, ISBN 978-80-213-2973-7

Burgess, P. and Carr, M. (1998), "The use of leaf appearance rates estimated from of air temperature to determine harvest intervals for tea", *Expl Agr*, vol. 34, no. 2, pp. 207-218. DOI 10.1017/S0014479798002075

Chang, K. (2015), "Contribution of tea production and exports to food security, development and smallholder welfare in selected producing countries", Rome: FAO

Chang, K. (2015), "World tea production and trade, current and future development", Rome: FAO

Chocholoušek, M. and Huml, J. (2019), "Farmers business scale relation with product differentiation in the Czech Republic.", *Proceedings of the Agrarian Perspectives XXVIII*, Prague, pp. 21 - 28, ISBN 978-80-213-2973-7

Duriau, V. J., Reger, R. K. and Pfarrer, M. D. (2007), "A content analysis of the content analysis literature in organization studies: Research themes, data sources, and methodological refinements", *Organizational Research Methods*, vol. 10, no. 1, pp. 5-34. DOI 101177/1094428106289252

Flémal, J. (1986), "La culture du théier au Burundi", Bujumbura: Institut des Sciences Agronomiques du Burundi

Groosman, M. (2011), "Tea. Sector overview". Idh the sustainable trade initiative, [Online], Available: http://www.bibalex.org/Search4Dev/files/432041/460374.pdf [Accessed: 10 April 2020]

IGT (2018), "Fostering sustainability in tea production and trade: Assessing the impact of certification schemes on farm income, inclusive rural development and market access*", 23rd Session, 17-20 May 2018, Committee on Commodity Problems*, Hangzhou, the People's Republic of China

IGT (2018), "Current market situation and medium term outlook*", 23rd Session, 17-20 May 2018, Committee on Commodity Problems*, Hangzhou, the People's Republic of China

Jayaratne, M. D. (2015), "Identifying the influencing factors in sustainable tea supply in the Sri Lankan tea industry", PhD diss., University of Wollongong, Sydney, Australia

Jin , S. J., Schure, J., Ingram, V., and Yoo, B. I. (2017), "Sustainable woodfuel for food security. A smart choice: green, renewable and affordable", Rome: FAO. ISBN 978-92-5-109962-9

Kagira, E. K., Kimani, S. W. and Githii, K. S. (2012), "Sustainable methods of addressing challenges facing small holder tea sector in Kenya: A supply chain management approach", *Journal of Management and Sustainability*, vol. 2, no. 2, pp. 75 – 89, ISSN 1925-4725, E-ISSN 1925-4733, DOI 10.5539/jms.v2n2p75

Le, T. K. O. (2018), "The contract farming as a determinant promoting tea production and marketing at a farm household in Vietnam: a case study in Phu Tho provinc, PhD Diss, Liege University, Belgium

Mohan, S. (2018), "Value chain upgrading for competitiveness and sustainability: A comparative study of tea value chains in Kenya, Sri Lanka and Nepal", Switzerland: International Centre for Trade and Sustainable Development (ICTSD)

Mwangi, G. (2014), "Sociocultural factors affecting tea productivity at Iriaini tea factory company limited Othaya K*e*nya*",* Kenya: Nairobi University

Obanda, M. and Owuor, P. (1995), "Clonal variations in the response of black tea quality due to plucking standard", *Food Chemistry*, vol. 53, pp. 381-384. DOI 10.1016/0308-8146(95)99831-J

OBR (2019), "*Bulletin trimestriel des statitiques du commerce extérieur des marchandises du Burundi*", Bujumbura, juillet 2019, [Online], Available: https://obr.bi/images/PDF/Bulletin_Douane_11_site_web.pdf [Accessed: 13 April 2020]

Petrovic-Lazarevic, S., Sohal, A. and Baihaqi, I. (2007), "Supply chain management practices and supply chain performance in the Autralian manufacturing industry*",* Monash University, Department of Management Working Paper 21/07, ISSN 1327-5216

Rymbai, D., Singh, R., Feroze, S. M. and Debbarma, B. (2012), "Factors associated with labour supply for tea plantation and productivity: A case study of tea growers in Meghalaya", *Indian Journal of Hill Farming* , vol. 25, no. 2, pp. 6-9 . ISSN 0970-6429

Sabuhungu, E. G. (2016), "Analyse de la demande en charbon de bois par les ménages urbains de Bujumbura au Burundi", Thèses: Université de Liège, Belgique

Sharangi, A. B. (2009), "Medicinal and therapeutic potentialities of tea (*Camellia sinensis* L.) - A review", *Food Research International,* vol. 42, no. 42, pp. 529 - 535. ISSN 0963-9969

UNCTAD (2016), "Tea: An INFOCOMM commodity profile", New York and Geneva: UNCTAD Trust Fund on Market Information on Agricultural Commodities

ECONOMIC VALUATION OF MODEL CASES OF RAINWATER UTILIZATION

Veronika Brecklová[1] and Zdeňka Gebeltová[2]

[1, 2] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]brecklova@pef.czu.cz, [2]gebeltova@pef.czu.cz

Annotation: The aim of the article is to quantify the savings of drinking water in agriculture on selected model cases of production and administrative buildings. The partial goal is to quantify the savings of water and sewer rates and then calculate the payback period of the investment in equipment for water collection and filtration. The article uses this data: CHMI (frequency and abundance of precipitation), estimate of the average price of water, price of collection and filtration equipment, water consumption when feeding 40 and 110 dairy cows, parameters of the hall/non-production building. Rainwater harvesting is affected by losses (runoff coefficient) given the type of roofing. The equation RWH is used to calculate the volume of allocated rainwater. The volume of rainwater tanks is based on the daily precipitation interval. This simulation is suitable for creating a design for different climatic conditions. Water savings (m^3) will be derived from the consumption of drinking water and collected rainwater. The area of the stable roof (40 dairy cows) was calculated to be 970 m^2 and the larger one (110 dairy cows) 2,320 m^2. By using his buildings with specified dimensions to feed the cows, the farmer saves 17-23 % of drinking water on average (depending on the type of roof surface). The return on investment in the use of the above equipment and type of roofing is 4.3 years on average for a small stable and 1.4 years for a large one. In case of the administrative building (impermeable roof area), a 16 % annual water saving for toilet flushing was found. The investment in the system components of this building would return in 1.2 years.

Key words: Rainwater harvesting, runoff coefficient, rainwater collection system, return on investment, payback period.

JEL classification: Q25

1. Introduction

The aim of this article is to quantify savings of drinking water in agriculture on selected model cases of production and administrative buildings. The partial aim is to also quantify savings of water and sewer rates and then calculate the payback period of the investment in equipment for water collection and filtration.

Gregory and Di Leo (2003) state that the apparent awareness of water inexhaustibility, based on its availability leads to wastage. Crettaz, Jolliet, Cuanillon and Orlando (1999) report lower energy consumption and a lower environmental impact with conventional water supply. Stránský (2013) points to an unused outflow of 55 % of rainfall over the impermeable surface of the urbanized river basin. In Finland, they solve the problem of rainwater infiltration in urban areas with a new permeable concrete that resists in Arctic conditions. It is able to permeate a large amount of precipitation during torrential rains (Kuosa and Holt, 2014). However, changing the surface in urban areas is too costly. The most common way to use rainwater is to collect it from roofs, including other measures to increase its quality (Helmreich and Horn, 2009). Li et al. (2010) report a possibility to replace up to 94 % of domestic water by rainwater and treated wastewater in Ireland. According to Villaerreal and Dixon (2005), in Norrköping, Sweden, a comprehensive rainfall collection system can save up to 40 % on toilet flushing. Herrmann and Uwe (2000) calculated tank volumes, efficiencies and drinking water savings within households in Germany. According to Domènech and Saurí (2011), a family in Barcelona would fully cover their demand for toilet water (with a small tank) by collecting rainfall, and would meet up to 60 % of the demand for garden irrigation. Jones and Hunt (2010) demonstrate a return of investment in the rainfall water use for an office building in the UK, after 6-11 years. Authors Ibrahim (2009) and Jones and Hunt (2010) use the RWH (rainwater harvesting) system as an alternative source of water in public buildings in large cities. A study by Rahman et al. (2010) examines the sustainability of the RWH system in multi-storey residential buildings in Sydney. According to Stránský et al. (2008), several conceptual applications of rainfall management can be found in the Czech Republic, and are mostly part of international projects. Unfortunately, individual urban localities do not have a comprehensive modernization system of water drainage (Vítek et al., 2010). Although there are many analyses of the potential of rainwater management, its use is rather an individual matter for households or individual companies (Kopp, 2016). This fact is a reflection of social, economic and legislative developments in the Czech Republic. According to Stránský et al. (2008), there are no technical rules in Czech legislation that transpose European legislation. The "polluter pays" principle is also missing. As part of rainwater collection, the EU provides subsidies for owners or builders of family and apartment houses for flushing toilets and watering the garden. Since 2017, 4 000 households have been supported under the “Dešťovka” program in the Czech Republic, with a total amount of CZK 185 million (EUR 6.8 million). The Ministry of the Environment also supports municipalities and cities in the fight against drought in the “Velká Dešťovka” program (MoE, 2019). Based on analyses of the current water situation, the EU Commission is involved in the modernization of water supply infrastructure. Reuse of treated wastewater is included in 50 % of projects and rainwater harvesting is part of 30 % of river basin management plans for the 2014-2020 period (EK, 2012). Farmers also have large land areas, especially those raising cattle. In these cases, it is possible to drain water from the roofs of stables, milking parlours, barns, and the living areas. Machálek (2015) states that the amount of rainwater that could be collected from roofs of livestock breeding stables could, after filtration, replace drinking water by 15 %. This represents savings of 2 000 000 m^3 of drinking water in the Czech Republic.

2. Materials and Methods

Experimental stables (40 and 110 pieces of cattle) and an administration building will be involved in the research. The normative space for a dairy cow is 7.82 m^2 and the normative water consumption per dairy cow is at the level of h = 150 l/day (Doležal, 2007). The total width of the stable is 14 m for both herds of dairy cows with parallel housing. Trough width 80 cm, range between troughs with a span of 2.6 m (for self-propelled forage wagon), box length 3.4 m and grates 1.5 m on both sides of the stable. The length of the stable depends on the number of dairy cows, under conditions of a stable box with a width of 2.3 m and a feeding box with a width of 3 m located after a maximum of 20 m. For 40 dairy cows the stable length is 49 m, the gable is still 7 m high. The roof, at an angle of 45 ° has an overlap of 20 cm.

The calculation of water savings will be derived from the roof surface [m^2] and the type of surface for the runoff coefficient - tile, aluminum, metal sheet, PVC (Farreny et al., 2011). The area of the administrative building will be determined on the basis of a cadastral map at a scale of 1: 1,000 (REC, 2020 online). The actual annual precipitation will be drawn from the Hydrometeorological Institute of the Czech Republic (CHMI, 2020 online).

To calculate operating costs, estimates of the price of water and sewerage for 2020 according to the MoA (2018) will be used. The data for calculating the investment costs are:
a) underground tank (the farmer may use a submersible pressure pump with a solenoid valve, an electrical switchboard and a level sensor),

b) filters for treatment of rainwater into drinking water (administrative building - sand filter, farmer - filter with activated carbon and reverse osmosis),
c) the connection of filtered rainwater to the water supply system by a three-way ball valve is ensured by a fully automatic operating and monitoring unit with a pump and a control unit (in case of lack of rainwater it switches to a source of drinking water).
(d) the farmer may use an external underground tank to be placed between the second filter and the monitoring unit (2 000 l and 4 000 l with ribbed structure).

Calculation of the total volume of allocated rainwater according to Farreny et al. (2011)

$$RWH = P * A * RC \tag{1}$$

Where:
RWH… annual allocated amount of water [liter], can be stated in m^3 after conversion
P… volume of rainfall [mm] ≅ [l/m^2]
A…roof area [m^2]
RC… runoff coefficient: clay and concrete tile (RC = 0.75), aluminum (RC = 0.7), galvanized metal sheet (RC = 0.8), impermeable roofs (eg PVC) with a slope of 1–5 % (RC = 0.95)

Water requirement (S) for flushing in the administrative building according to (Campisano and Modica, 2015):

$$S = (Z * E * T * d) + (X * T * d) + (Y * G * T * a) \tag{2}$$

Where:
S… annual water consumption [liter], Z… number of employees, X… number of external employees, Y…. number of students, E… absence of employee at the workplace [%], G… absence of students in the educational institution [%], T… use of toilet [l / person / day], d… number of working days per year, a… number of working days of the academic year September - June

The area of the administrative building is 2,700 m^2 (divided into a part D 958 m^2 and a part E 1,742 m^2 according to the possibility of rainwater collection). The roof is covered with PVC waterproofing foil with a slight slope to the center of the building to drain the accumulated water. According to Farreny et al. (2011), this is a roof with an impermeable top layer with a runoff coefficient of RC = 0.95. The amount of water consumed in the office building is based on the volume of the flush toilet tank, the number of toilets and the daily number of people in the building according to (Campisano and Modica, 2015). A variable (seasonality) is taken into account in regards of water consumption which occurs in community buildings such as offices, recreational buildings, hospitals, schools, etc. According to Vickers (2001), an average person visits a toilet 5 times a day with an average consumption of 6 liters of disposable water toilet. The office building (in this article) is an educational facility. The building is attended by about 6,300 students, 340 full-time employees and 220 external teachers. With the optimistic occupancy of the faculty, 221 working days for employees are calculated (10 % of the daily absence of employees is given: personal reasons, holidays, sick day, illness, business trips…). 205 working days are counted for students in the period September - June (25 % absence of full-time students due to their schedule). For external staff, the average length of employment is 0.2, ie 50 days for 2020.

The size of the tank will be based on the use of the daily precipitation interval according to the authors Liaw and Tsai (2004). When selecting a filter, in addition to its type, the filter flow rate is also used, which determines the maximum inflow of rainwater in 1 hour according to the technical parameters of the filter.

$$F = \frac{V}{24} \tag{3}$$

Where:
V…daily allocated amount of water in the tank [l ∨ m^3/day], when V = RWH/365
F… rainwater inflow [l ∨ m^3/1h]

The effects of the investment will be a quantified cost saving before and after the investment (Δ Costs) reduced by newly incurred depreciation costs and other operating costs (repairs, maintenance).

$$\Delta\ Costs = \Delta K - \Delta O - \Delta C \tag{4}$$

Where:
K… cost savings resulting from water collection K = RWH * water price [CZK]
O… average annual straight-line tax depreciation[1]
C… other operating costs, eg repair of components, system maintenance, electrical supply of pumps and monitorization units, etc., C = 10 % of the purchase price of the rainwater collection system (authors' estimate)

The return on investment will be based on the change in profit $\Delta\ \pi$.

$$ROI = \Delta\ \pi / CI \tag{5}$$

Where:
ROI… return on investment
CI… investment costs
Δ π … the annual change in profit corresponds to Δ Costs (4) at constant yields

The payback period (PP) can be calculated according to:

$$PP = 1/ROI \tag{6}$$

3. Results and Discussion

Rainwater could be one of the sources of water for livestock in the future. It is possible to use the roofs of farm buildings to collect it. There are two model stables in the presented case study. Based on the parameters of the stable (see Materials), the roof area (A) was calculated for a stable with 40 pieces (A_1 = 970 m^2) and 110 pieces of cattle (A_2 = 2 320 m^2). Roofing plays an important role. Each type of roofing has different physical properties of reflection and slip. When collecting rainfall, it is necessary to take losses into account. These are calculated using the so-called runoff coefficient. The study with a stable roof uses 3 of its most common types (Table 1). Rainfall [mm] enters the calculation in the value of the average rainfall between the years 2015 - 2019, ie 645 l/m^2 (CHMI, 2020). The total volume of allocated rainwater was determined according to the RWH calculation [1], (Table 1). The annual water consumption in dairy farming (H) is based on the daily standard Doležal (2007). 40 dairy cows are found to have 2.19 million liters of water consumption (H_1) and 110 dairy cows have a water consumption of 6.02 million liters (H_2). The study considers a galvanized roof on both agricultural buildings. Based on that, a smaller farmer can save 22.9 % of drinking water by collecting rainwater and a larger farmer 19.9 % of drinking water (according to precipitation conditions for the period 2015-19 (CHMI, 2020), see Table 1).

[1] Act No. 586/1992 Coll. on income taxes, as amended (In Czech)

Table 1. Amount of allocated rainwater to feed dairy cows

Types of roofing	40 dairy cows		110 dairy cows		Building D, E	
	RWH_1 [m^3]	Share of H_1 [%]	RWH_2 [m^3]	Share of H_2 [%]	RWH_3 [m^3]	Share of S [%]
Clay tile, slate	469.238	21.4	1 122.300	18.6	-	-
Aluminium	437.955	20.0	1 047.480	17.4	-	-
Galvanized metal sheet	500.520	22.9	1 197.120	19.9	-	-
PVC	-	-	-	-	1 654.425	16.2

Source: authors according to Doležal (2007) and formula [1]

The administration building is suitable for collecting rainwater for the use of flushing toilets. The value of rainwater RWH_3 = 1,654,425 l/year was determined according to RWH [1] (see Table 1). According to the formula [2], the annual consumption of water (S) for flushing toilets in the administrative building is 10,219,709 liters per year. The administrative building can save 16.2 % of drinking water by collecting rainwater (according to the precipitation conditions of the period 2015-19 (CHMI, 2020), see Table 1.

Rainwater collection costs and return on investment

The user pays both water and sewage rates of the consumed drinking water. In 2020, the average price of water can be assumed to be approximately CZK 90/m^3 (MoA, 2018). According to the above-calculated consumption of rainwater and its prices, it is possible to quantify the monetary savings (K) according to individual types of roofs for both farmers and the administrative building (Table 2).

Table 2. Cost savings of drinking water using rainwater (K) in 2020 (CZK)

Types of roofing	40 dairy cows	110 dairy cows	Building D, E
Clay tile, slate	42 047	101 007	-
Aluminium	39 416	94 273	-
Galvanized metal sheet	45 047	107 741	-
PVC	-	-	148 898

Source: authors according to MoA (2018) using part of the formula [4]:

Rainwater runoff is stored in tanks (ie cisterns). Storage in a cool, dark place helps to maintain the hygiene of the collected water. Water tanks above ground level are cheaper, but they are exposed to temperature fluctuations, light and possible pollution. For these reasons, more expensive tanks located under ground are recommended. (Dvořáková, 2007) The most common parameters for water tank selection are volume and availability on the market. In this case study, the choice of the minimum tank size is based on the use of the daily interval of the collected volume of rainwater V [3]. (Liaw and Tsai, 2004). A small farmer captures an average of 1.37 m^3 per day and a large farmer 3.28 m^3 of water on galvanized metal sheet, according to the average daily RWH. For the administrative building, two tanks will be needed in terms of separation of collection areas. A tank of 1.61 m^3 volume is recommended for part D, and a tank with a capacity of 2.92 m^3 for part E (according to the value of V [3]). During torrential rains or longer minimum consumption period, excess water will be detected by a level switch and then drained to the sewer. Underground tanks with possible accessories will be used: suction filter with non-return valve, submersible pressure pump, float switch and electric pressure valve.

Most studies show (eg Meera and Ahammed, 2006) that harvested water is microbiologically contaminated with various indicators and pathogenic organisms. It is therefore necessary to use filters to remove dirt and bacteria. When converting rainwater into drinking water, it is appropriate to use two types of filters, namely: a) to remove precipitation of coarse impurities, b) to remove undesirable chemical substances (sand, membrane filter, etc.). When selecting a filter, in addition to its type, the filter flow F [3] is also important, as it determines the maximum water flow in 1 hour according to the technical parameters of the filter. A filter with a minimum flow of 0.06 m^3/h is recommended for farmers with 40 dairy cows and 0.14 m^3/h for farmers with 110 dairy cows. Part D of the administrative building should use a filter with a minimum flow of 0.07 m^3/h and part E a filter with a flow rate of at least 0.12 m^3/h.

The connection of the filtered rainwater to the water supply system is ensured by a fully automatic operating and monitoring unit with a pump, a control unit, and an integrated system. One of the technical parameters is the minimum flow F from formula [3]. In the farmer's case, an external storage tank is connected to the monitoring unit, which is located between the external filter and the monitoring unit of the same recommended volume as the collection tank.

Table 3. Model design of technical parameters and prices of components for rainwater utilization (CZK)

Type of equipment	40 dairy cows	110 dairy cows	Building D, E
AS-REWA Kombi 2EO* water tank	44 800	-	-
AS-REWA ECO 2EO** water tank	-	-	20 800
AS-REWA ECO 4EO** water tank	-	-	29 400
AS-REWA Kombi 4EO* water tank	-	52 500	-
AS-MONA 2000 VERTICAL water tank	14 950	-	-
AS-MONA 4100 VERTICAL water tank	-	23 400	-
Aqua Medic Easy line 190 water filter	1 500	1 500	-
BestBlue Sand 0.5 water filter	-	-	8 980
AS-RAINMASTER 20 Monitoring unit	42 955	42 955	85 910
Total cost	104 205	120 355	145 090
Average annual depreciation	10 421	12 036	14 509
Other operating costs (10 % of total costs)	10 421	12 036	14 509

Sourcej: AQUA MEDIC (2015); ASIO, spol. s.r.o. (2018); Vodni filtry.cz (2020)

Note: The tank is included in the 3rd depreciation group (Act on Income Taxes of the Czech Republic). The costs do not include the connection of the gutters to the tank and the connecting pipes between the tank and the monitoring unit. Prices without VAT.

** Price of the tank contents plastic non-lockable lid DN950, filter with stainless steel screen AS-PURAIN, inlet pipe, safety overflow, pump, solenoid valve, el. switchboard and level sensor.*

*** The price of the tank includes a plastic non-lockable lid DN600 and a filter with a stainless steel screen AS-PURAIN.*

When assembling the components of the rainwater supply system according to the above parameters, the total cost for farmers with 40 dairy cows is CZK 104,205. A farmer with 110 dairy cows has to spend CZK 120,355 and CZK 145,090 is invested in the supply system in the administration building (see Table 3). However, the total costs do not include the one-off costs of transport and assembly, the operating costs of the filtration and pump, the costs of repair and maintenance, etc. For this reason, additional operating costs were added (10 % of the total costs). In this way, a small farmer will reduce the cost savings of drinking water by CZK 10,421, while a large farmer will then reduce by CZK 12,036. The administration building eliminates savings of CZK 14,509 per year.

The calculation of the return on investment [5] is based on the change in profit [4]. The return on ROI investment (Table 4) is 23.2 % for 40 dairy cows in the first year and the return on this investment is 4.3 years according to the formula [6]. Farmers with 110 dairy cows will return the investment in 1.4 years, due to the ratio of lower costs for the rainwater harvesting system and savings in drinking water costs compared to a smaller farmer, ie the return on investment is 69.5 %. If all components of the collection system at the administration building are used, the investment will return within 1.2 years with a return of 82.6 %.

Table 4. Overview of the achieved annual profit, profitability and return on investment

Value	40 dairy cows	110 dairy cows	Building D, E
Profit (CZK)	24 206	81 970	119 880
Profitability of investment (%)	23.2	69.5	82.6
Return on investment (years)	4.3	1.4	1.2

Authors according to formula [4], [5], [6]

4. Conclusion

By using the buildings with specified dimensions to feed the cows, the farmer saves on average 17-23 % of drinking water (depending on the type of roof surface). The return on investment in the use of the above equipment and type of roofing is on average 4.3 years for a small stable and 1.4 years for a large one. In the case of the administrative building (impermeable roof area), a 16 % annual water saving for flushing toilets was found and the investment will be recouped in 1.2 years. The amount of investment can be adjusted by choosing components available on the market, in terms of quality, performance or price of the product. Despite these changes and the unpredictable intensity of precipitation, the use of rainwater is not only ecological but also economically beneficial for Czech farmers.

Acknowledgements

This paper was supported by the Internal grant agency (IGA) of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019B0011 "Economic analysis of water balance of the current agricultural commodities production mix in the Czech Republic".

References

AQUA MEDIC (2015), "*Reverse osmosis*", (In German), [Online], Available: https://www.aqua-medic.de/index.php?r=catalog/category&cid=44, [Accessed: 26 Apr., 2020]

ASIO (2018), "*Water purification and treatment: Rainwater management and land drainage*" (In Czech), [Online], Available: http://www.asio.cz/cz/hospodareni-s-destovymi-vodami-mesto, [Accessed: 26 Apr., 2020]

Campisano, A. and Modica, C. (2015), "Appropriate resolution timescale to evaluate water saving and retention potential of rainwater harvesting for toilet flushing in single houses", *Journal of Hydroinformatics*, vol. 17, no. 3, pp. 331 -346, ISSN 1464-7141, E-ISSN 1465-1734, DOI 10.2166/hydro.2015.022

CHMI, Czech Hydrometeorological Institute Czech Republic (2020), “*Territorial precipitation*“, (In Czech), [Online], Available: http://portal.chmi.cz/historicka-data/pocasi/uzemni-srazky, [Accessed: 10 Jan., 2020]

Crettaz, D., Jolliet, O., Cuanillon, J.-M. and Orlando, S. (1999), “Life cycle assessment of drinking water and rain water for toilets flushing“, *Journal of Water Supply, Research and Technology, Aqua,* vol. 48, no 3, pp 73-83. ISSN 0003-7214, DOI 10.2166/aqua.1999.0008

Doležal, O. (2007), “*Agricultural advisor in the stable”* (In Czech), Prague: Institute of Animal Sciences, ISBN 978-80-86454-86-3

Domènech, L. and Saurí, D. (2011), “A comparative appraisal of the use of rainwater harvesting in single and multi-family buildings of the Metropolitan Area of Barcelona (Spain): social experience, drinking water savings and economic costs“, *Journal of Cleaner production*, vol. 19, no. 6-7, pp. 598.-.608, ISSN 0959-6526, DOI 10.1016/j.jclepro.2010.11.010

Dvořáková, D. (2007), “*Rainwater utilization (I) - quality and purification: Possibilities of rainwater utilization and necessary technical equipment*“ (In Czech), [Online], Available: http://voda.tzb-info.cz/destova-voda/3902-vyuzivani-destove-vody-i-kvalita-a-cisteni, [Accessed: 03 Jan., 2018]

EK, European Commission (2012), “*Report on the review of European policy to tackle water scarcity and droughts”* (In Czech), [Online], Available: http://eur-lex.europa.eu/legal-content/cs/ALL/?uri=CELEX%3A52012DC0672, [Accessed: 03 Jan., 2018]

Farreny, R., Morales-Pinzón T., Guisasola, A., Tayà, C., Rieradevall, J., Gabarrell, X. (2011), “Roof selection for rainwater harvesting: quantity and quality assessments in Spain“, *Water research*, vol. 45, no. 10, pp. 3245-3254, ISSN 0043-1354, DOI 10.1016/j.watres.2011.03.036

Gregory, G. D. and Di Leo, M. (2003), “Repeated behavior and environmental psychology: The role of personal involvement and habit formation in explaining water consumption”, *Journal of Applied Social Psychology,* vol. 33, no. 6, pp. 1261-1296, ISSN 1559-1816, DOI 10.1111/j.1559-1816.2003.tb01949.x

Helmreich, B. and Horn, H. (2009), “Opportunities in rainwater harvesting“, *Desalination*, vol. 248, no 1 - 3, pp. 118 - 124, ISSN 0011-9164, DOI 10.1016/j.desal.2008.05.046

Herrmann, T. and Uwe, S. (2000), “Rainwater utilization in Germany: efficiency, dimensioning, hydraulic and environmental aspects“, *Urban water*, vol. 1, no. 4, pp. 307 - 316, ISSN 1462-0758, DOI 10.1016/S1462-0758(00)00024-8

Ibrahim, M. B. (2009), “Rainwater harvesting for urban areas: a success story from Gadarif City in Central Sudan“, *Water resources management*, vol. 23, no. 13, pp. 2727 - 2736, ISSN 1573-1650, DOI 10.1007/s11269-009-9405-6

Imteaz, M. A., Shanableh, A., Rahman, A. and Ahsan, A. (2011), “Optimization of rainwater tank design from large roofs: A case study in Melbourne, Australia“, *Resources, Conservation and Recycling*, vol. 55, no. 1, pp. 1022-1029, ISSN 0921-3449, DOI 10.1016/j.resconrec.2011.05.013

Jones, M. P. and Hunt, W. F. (2010), “Performance of rainwater harvesting systems in the southeastern United States“, *Resources, Conservation and Recycling*, vol. 54, no. 10, pp. 623 -629, ISSN 0921-3449, DOI 10.1016/j.resconrec.2009.11.002

Kopp, J. (2016), “Current trends in ecohydrological urban management: a case study of Pilsen“ (In Czech), *Trendy v podnikání,* vol. 6, Special Issue, pp. 51 - 62, ISSN 1805-0603

Kuosa, H. and Holt, E. (2014), “Development of durable pervious concrete Finland´s stormwater management needs“, *Concrete Innovation Conference* (CIC2014) 2014, Oslo, Conference Paper**,** DOI 10.13140/2.1.3797.9840

Li, Z., Fergal, B., Anthony, R. (2010), “Rainwater harvesting and greywater treatment systems for domestic application in Ireland”, *Desalination*, vol. 260, no. 1-3, pp. 1-8, ISSN 0011-9164, DOI 10.1016/j.desal.2010.05.035

Liaw, Ch.-H. and Tsai, Y.-L. (2004), “Optimum storage volume of rooftop rain water harvesting systems for domestic use 1”, *JAWRA Journal of the American Water Resources Association*, vol. 40, no. 4, pp. 901-912, ISSN 1752-1688, DOI 10.1111/j.1752-1688.2004.tb01054.x

Machálek, A. (2015), “*Evaluation of various ways of using rainwater implemented in model stables and services“* (In Czech), Certified methodology, Prague, VÚZT, v.v.i.., ISBN 978-80-86884-90-5

Meera, V. and Ahammed, M. M. (2006), “Water quality of rooftop rainwater harvesting systems: a review”, *Journal of Water Supply: Research and Technology-AQUA*, vol. 55, no. 4, pp. 257-268, ISSN 0003-7214, DOI 10.2166/aqua.2006.008

MoA CR, Ministry of agriculture Czech Republic (2018), *“Report on the state of water management in 2018”* (In Czech), Prague, 2019, *ISBN* 978-80-7434-523-4

MoE CR, Ministry of the Environment of the Czech Republic (2019), “*Not ready for drought yet? Ask for Dešťovka*“ (In Czech), [Online], Available: https://www.mzp.cz/cz/news_01042019_nejste-pripraveni-na-sucho-pozadejte-si-o-destovku, [Accessed: 06 Feb., 2020]

Rahman, A., Dbais, J. and Imteaz, M. (2010), “Sustainability of rainwater harvesting systems in multistorey residential buildings“, *American Journal of Engineering and Applied Sciences*, vol. 3, no.1, pp. 73-82, ISSN 1941-7039. DOI 10.3844/ajeassp.2010.73.82

REC, Real Estate Cadaster of the Czech Republic, Prague, (2020) [Online], Available: https://www.ikatastr.cz/#kde=50.13085,14.37327,18&info=50.13122,14.3732, [Accessed: 26 Apr., 2020] (in Czech)

Stránský, D. (2013), “Naturally close management of rainwater on building land and its consequences for spatial planning” (In Czech), project CZ.2.17/3.1.00/34101, [Online], Available: http://cvut.mapovyportal.cz/OPPA_Stransky.pdf, [Accessed: 06 Feb., 2019]

Stránský, D., Kabelková, I., Vítek, J., Suchánek, M. (2008), “The concept of rainwater management in the Czech Republic: Current state“ (In Czech), In: *Hospodaření s dešťovou vodou*, Brno, [Online], Available:: http://www.jvprojektvh.cz/photo/sekce/file/12008-03-11_JVPVH_2.pdf, [Accessed: 10 Oct., 2019]

Vickers, A. (2001), “*Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms*“, Amherst, Water Plow Press, ISBN-10:1931579091

Vítek, J., Suchánek, M., Finfrlová, P. (2010), “*Analysis of rainwater management potential in Hradec Králové“* (In Czech), *In: Sborník přednášek z V. ročníku semináře Hospodaření s dešťovými vodami ve městech a obcích,* ARDEC, Brno, 16 Mar. 2010, ISBN 978-80-86020-67-9

Vodni filtry.cz (2020), “*Automatic sand filter*”, (In Czech), [Online], Available: https://www.filtry-vodni.cz/katalog/filtry/samoridici-filtry/piskove-filtry/168175.html, [Accessed: 26 Apr., 2020]

TRENDS AND CHALLENGES IN THE BOVINE MEAT AND DAIRY SECTORS IN WALLONIA

Philippe Burny[1], Vincent Calay[2], Pierre Rondia[3], Jean-Luc Guyot[4], François Claisse[5], Rafael Ritondo[6] and Eric Froidmont[7]

[1, 3, 7] Walloon Agricultural Research Center, Gembloux, Belgium
[2, 4, 5, 6] Walloon Institute for Evaluation, Foresight Studies and Statistics, Namur, Belgium

[1]p.burny@cra.wallonie.be, [2]v.calay@iweps.be, [3]p.rondia@cra.wallonie.be, [4]jl.guyot@iweps.be, [5]f.claisse@iweps.be, [6]rri@iweps.be, [7]e.froidmont@cra.wallonie.be

Annotation: The paper shows the great importance and the evolution of the cattle breeding sector in Wallonia, which seems to decline (number of heads and number of cattle breeders) and is faced to economic problems. In addition, the challenges for the future are identified: population growth, changes in consumption patterns, new societal expectations, new structures of the food chain, emergence of different types of crises, and the Common Agricultural Policy for the period 2021-2027. To be more resilient in the future, the cattle breeding farm should be more diversified and autonomous, relying on the forage produced on farm and having more direct links with the consumers/citizens. This paper presents the results of the first step of a foresight research project dealing with the possible futures of cattle breeding in Wallonia. In the following steps, it will define contrasted scenarios for the year 2040.

Key words: Cattle breeding, milk, bovine meat, foresight study, Wallonia

JEL classification: Q18

1. Introduction

Dairy production and cattle breeding are very important in Walloon agriculture: in 2018, the production of milk and dairy products and the production of bovine meat represented as much as 44.7 % of the total value of agricultural production. However, the implementation of the Common Agricultural Policy (CAP) deeply transformed the bovine sector during the last decades. Today and tomorrow, it must face many challenges. As a consequence, the features of the future milk and bovine meat sectors in Wallonia are unclear and uncertain. So, the objectives of the paper are to describe and analyse the evolution of the bovine productions economy in Wallonia, to try to explain the most important changes, and to identify and discuss the challenges which will determine its future.

2. Materials and Methods

The analysis is firstly based on the available statistical data, dealing with the Walloon agriculture and the cattle in particular, coming from the annual agricultural general census, from the federal Ministry of Economics, the Direction for Agricultural Economics Analysis (DAEA) of the Ministry of the Walloon Region, and the Farm Accounting Data Network (FADN).

Secondly, a literature review is made concerning the future of agriculture and cattle breeding in Wallonia. Due to the problems observed in this field during the last years and to the market and policy uncertainty, such studies are more numerous today.

Thirdly, the main challenges to which agriculture and cattle breeding are faced are identified through a literature review.

Finally, an exploratory workshop was organized with stakeholders of the regional bovine sector (actors and experts) in order to get their analysis of the situation and their opinion on the main factors which influence the dairy and bovine meat sectors and will determine their future (Nymba et al., 2018).

This paper presents the main results of the first step (Godet, 2017) of a foresight research project entitled "To build the futures of cattle breeding (milk and meat) in Wallonia".

3. Results and Discussion

3.1. Main features and trends of cattle breeding in Wallonia

The number of cattle heads in Wallonia reached 1,532,000 in 1990 and began to decrease sharply in the years 2000, going down from 1,483,000 in 2000 to 1,289,000 in 2010 and 1,114,000 in 2018 (a decline of 30 % in a quarter of a century). Meantime, the mean size of the herd increased from 66 to 139 heads. The number of farmers raising dairy cows decreased very sharply: from 13,381 in 1990 to 3,417 in 2018 (a decline of three quarters).

After the implementation of dairy quotas in 1984, the dairy farmers turned to meat cattle, shifting from the Holstein to the Belgian White-Blue breed. So, the number of meat cattle breeders increased up to 10,800 in 2000, but sharply declined since then, reaching the number of 5,482 in 2018 (a decline of one half since 2000).

The low and more and more variable income of cattle breeders, largely depending on public support, both for meat and milk, is one of the reasons of this decline, coupled with the difficulties to find a successor when farms become larger and require heavy investment.

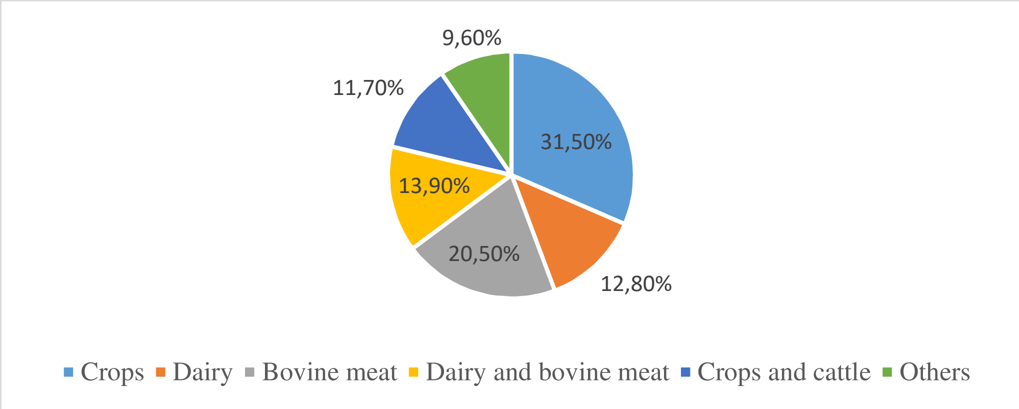
Table 1. Income (€) per working unit according to farm specialization (2016-2018)

Specialization	2016	2017	2018	Mean
Dairy	6391	29791	23482	19888
Bovine meat	7714	345	6208	4756
Dairy and bovine meat	9439	17366	15115	13974
Crops and dairy	4867	24930	16897	15565
Crops and bovine meat	4352	5883	8950	6395

Source: DAEA, 2020

Farms are highly specialized. In Wallonia, 20.5 % of the farms are specialized in bovine meat in 2016, and 12.8 % in dairy production, 13.9 % being specialized in both bovine meat and milk (DAEA, 2020). Two races became largely dominant: the Holstein in the dairy sector and the Belgian White-Blue in the bovine meat sector (Buron, Bouquiaux and Marsin, 2015). During the last decades, the Belgian White-Blue was selected for the production of meat and reaches very high yield of meat per carcass, most of the slaughtered animals being qualifies as "S" in the European classification. In the dairy sector, the yield increased considerably and reaches 6,748 liters per cow in 2018 (DAEA, 2020).

Figure 1. Farm specialization in Wallonia (2016)



Source: DAEA, 2020

In Wallonia, the permanent pastures represented 43 % of the Utilized Agricultural Area in 2018 (DAEA, 2020). However, cattle breeding largely depends on animal feed bought on the market (of which an important share is imported from non EU countries, like soybean meal or linseed meal). In 2018, bought animal feed represented 52 % of operational costs in the dairy sector, and 47 % of all operational costs in the bovine meat sector, while on farm forage counted for only 5 % and 7 %, respectively.

3.2 The challenges faced by the cattle breeding sector

Several studies have been recently made in Wallonia, dealing with the possible futures for the bovine meat and dairy sector, such as: Commission filière laitière (2019), Commission Viande bovine (2019), Dogot et al. (2006), La Spina (2016, 2017), Petel, Antier and Baret (2019a, 2019b, 2019c, 2019d), Réseau wallon de Développement rural (2014), Riera, Antier and Baret (2019), Vanwindekens (2015). Most of these studies have their own vision of the future and examine the way to reach the hoped solutions and their possible consequences. However, they discuss the constraints of the studied sectors and propose some means and measures which could give the dairy and bovine meat sectors some solutions to solve their problems and opportunities for the future.

From a broader point of view, other studies identify the main factors which will influence agriculture – and cattle breeding – in the next decades.

The main challenges can be identified as follows:

1) Demographic aspects

   The world population is still increasing quickly. It could reach 11.2 billion inhabitants in 2100, an increase of 50 % compared to today's situation (FAO, 2009). However, this increase will be very different from one to another part of the world. In developed countries, the increase will be very reduced, while it will be much higher in Africa. The phenomenon of urbanization will strengthen and the mean income will increase. In such conditions, the demand for agricultural products, including animal products, will significantly increase.

2) Consumption patterns

Consumption patterns are changing significantly. In developed countries, the consumption is declining regularly due to several reasons.

In Belgium, the apparent consumption of bovine meat declined from 14 kg per capita in 2010 to 11 kg per capita in 2018 (Statbel, 2020), while in the past bovine meat was considered as the best meat and was regularly consumed by all categories of the population. Pork and poultry are now serious competitors for bovine meat. The categories of bovine meat are also different from the past: people eat less often at home and mixed meat is more consumed today, while higher quality and more expensive pieces are less cooked. The specific quality products are more successful: organic food, origin-labelled products, "fair trade" and "fair price" products…

The reduction of meat consumption can lead to what is called "flexitarism", when people eat meat only some days of the week and are vegetarians during the other days. Going further, vegetarians, sometimes according to religious prescriptions, do not eat meat but consume animal products like milk or honey. At the extreme point, some people do not consume animal products at all ("veganism").

3) New societal expectations

Today, consumers and citizens, at least in developed countries, have new expectations regarding food, agriculture and food chain operators. These expectations influence not only the products themselves, but also the way they are produced and relations between consumers and economic actors. Among the new citizens' expectations can be cited:

- Ethics (some people think that we should not raise and kill animal; animal welfare (Delanoue and Roguet, 2015))
- Human health concerns (according to nutritionists, the consumption of too high quantities of meat and fat could lead to health problems)
- The public awareness about the deterioration of the environment (cattle breeding can contribute to water and air pollution and global warming)
- Quality and taste concerns (organoleptic characteristics of the food products)
- Social aspects

  Consumers are more interested to know more about the producers of their food, their way of life, their values, their expectations. They want to inform them directly about the characteristics of the products they wish to buy. Sometimes, they want to negotiate the prices directly. Some consumers are even interested in establishing real personal contacts with the producers.

- Agroecosystemic services

  The role of agriculture is not limited to food production. Agricultural activities are also supposed today to provide different kinds of extra-services: to preserve the environment, to maintain and support biodiversity, to fight against climatic changes by stocking carbon, to protect the countryside landscapes, to prevent soil erosion…but also, from a social point of view, to preserve the traditional "peasant way of life" and to protect the cultural heritage of the countryside (Duru et al., 2017; Hervieu, 2002; Neumeister et al., 2018; Ryschawy et al., 2015).

4) New structure of the food chain

   The farmers are setting up new producers' associations, like cooperatives in order to reduce production costs and get a stronger position vis-à-vis the agricultural inputs sellers and the buyers of their products. They are also more and more engaged in specific quality food chain organization within which they are able to share the added value with the other stakeholders (processors, wholesalers, retailers…).

   More and more farmers are involved in direct sales (on the farm, on public open markets, to restaurants, to supermarkets…) of their own products but also, more and more often, of the products they process and/or pack themselves on the farm (cheese, yoghurt, pieces of meat, flour…).

   Local products are more and more popular. Consumers organize purchasing cooperatives. As distances between producers and consumers are reduced, the impacts of transportation on the environment will be limited. In addition, to buy local products means to support local economic activities in a world generally open to a wild competition.

5) Crises

   Agricultural activities are faced to political, economic, trade, sanitary, climatic…crises. During the last years, agricultural trade has been disturbed by the political rivalry between the United States, China and Russia for the world leadership, leading among others to trade conflicts (higher tariffs on US/China exchanges, the Russian ban on agricultural products) to which the EU does not escape (higher tariffs to export some products to the US, for example). Sanitary crises appear regularly, even about the human population (Covid-19), having negative impacts on production, trade and consumption of agricultural products.

   International trade agreements signed by the EU have sometimes negative impacts on the European agriculture, especially the cattle breeding sector (agreement with the MERCOSUR and import of bovine meat from South America, for example).

   Usually faced to climatic phenomena like droughts and floods, agriculture is now and will be in the future impacted by climate changes, which, among others, will affect the forage availability for cattle.

6) Agricultural policy

   In Europe, the Common Agricultural Policy, which in the past registered successes but also failures, will have to support farmers to face many challenges. However, as the economic situation is troublesome due to the pandemia of coronavirus and as many other priorities already emerged before, the EU budget for the period 2021-2027 will be uneasy to define as a whole and for the CAP in particular. It is clear, nevertheless, that the environmental and climatic issues will play an even more important role than ever.

In such conditions, what could be the future for the cattle breeding sector in Wallonia? Perhaps, in order to be more resilient, the cattle breeding farm will be more diversified, including extra-agricultural activities and income. Farms combining polyculture and cattle breeding, with strong links between animal and vegetal products, buying less inputs, being more autonomous, relying more on permanent pastures and local forages, practicing the principles of circular economy and complementarity, selling more directly to the consumers, will be more resilient to ever changing conditions. However, it is probable that two types of agriculture will persist in the future: one which will produce all by managing the available resources according to the agroecological practices, and another one which will be "intensively sustainable" and will produce while respecting the resources but optimizing the use of inputs. More generally, natural resources will be preserved in order not to impact negatively the future generations. Nevertheless, the equilibrium between both types of agriculture is still to be defined.

4. Conclusion

The dairy and bovine meat sectors in Wallonia were deeply transformed during the last decades, adapting to the rules of the Common Agricultural Policy, with positive and negative consequences. However, the challenges for the future are numerous and some are threatening, especially in the bovine meat sector. Undoubtedly, the production, processing and distribution systems will have to be revised again in order to correspond to the new expectations of the citizens in general, who are only consumers but also take into account many other aspects than the economic ones.

In the further steps of the foresight research, workshops with farmers, actors and experts will be organized in order to determine the key variables of the cattle breeding system in Wallonia and to define contrasted scenarios for the year 2040.

Acknowledgements

The authors thank the actors and experts who participated in an exploratory workshop for their significant contribution.

References

Buron, M. H., Bouquiaux, J. M. and Marsin, J. M. (2015), *"Blanc-Bleu Belge, Blonde d'Aquitaine, Charolaise, Limousine, les quatre races viandeuses les plus répandues en Wallonie*", SPW Editions Bilans et perspectives, Service public de Wallonie Editions, Namur

Commission filière laitière (2019), "*Plan de développement stratégique 2019-2030*", Service opérationnel du Collège des Producteurs. Namur, [Online], Available: https://filagri.be/wp-content/uploads/sites/2/2019/10/Plan_strategique_bovinslait_juin2019.pdf, [Accessed: 10 March, 2020]

Commission Viande bovine (2019), "*Plan de développement stratégique à l'horizon 2030*", Service opérationnel du Collège des Producteurs. Namur, [Online], Available: https://filagri.be/wp-content/uploads/sites/2/2019/10/CdP_Plan-de-d%C3%A9veloppement_-viande-bovine_Provisoire_23042019-1.pdf, [Accessed: 10 March, 2020]

Delanoue, E. and Roguet, C. (2015), "Acceptabilité sociale de l'élevage en France: recensement et analyse des principales controverses à partir des regards croisés de différents acteurs", *INRAE Productions Animales,* vol. 28, no. 1, pp. 39 - 50. ISSN 2273-7766, DOI 10.20870/productions-animales.2015.28.1.3009

Direction de l'Analyse économique agricole (2020), "*Evolution de l'économie agricole et horticole de la Wallonie*", Service public de Wallonie. Namur, 2020, [Online], Available:

https://agriculture.wallonie.be/documents/20182/43924/RAPPORT+2020+EVOLUTION+DE+L+ECONOMIE+AGRICOLE+ET+HORTICOLE+DE+LA+WALLONIE/e525b7be-3109-4573-a04a-05ea750b9853, [Accessed: 12 March, 2020]

Dogot, T., Joveneau, A., Carton, J. and Delaunoy, C. (2006), "*Etude sur le positionnement des agriculteurs wallons dans la ruralité de demain et sur l'articulation de leurs rôles aux attentes de la société*", Cellule d'Analyse et de Prospective en matière de Ruralité. Faculté universitaire des Sciences agronomiques, Gembloux, [Online], Available: http://www.capru.be/publications, [Accessed: 10 March, 2020]

Duru, M., Donnars, C., Ryschawi, J., Therond, O. and Dumont, B. (2017), "La « grange »: un cadre conceptuel pour appréhender les bouquets de services rendus par l'élevage dans les territoires", *INRAE Productions Animales,* vol. 30, no. 4, pp. 273-284. ISSN 2273-7766

FAO, How to feed the world in 2050. Rome, 2009, [Online], Available: http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf, [Accessed: 11 March, 2020]

Godet, M. (2007), "*Manuel de prospective stratégique"*, Tome 2: L'art et la méthode, 3rd edition, Paris: Dunod. ISBN 978-2-10-053162-2

Hervieu, B. (2002), "La multifonctionnalité de l'agriculture: genèse et fondements d'une nouvelle approche conceptuelle de l'activité agricole", *Cahiers Agriculures,* vol. 11, no. 6, pp. 415 - 419. ISSN 1166-7699, E-ISSN 1777-5949

La Spina, S. (2016) "*Pistes d'avenir pour le secteur laitier wallon*", Nature & Progrès Belgique. Namur, [Online], Available: https://natproconsommateurs.files.wordpress.com/2016/01/9-rapport-lait-final.pdf, [Accessed: 10 March, 2020]

La Spina, S. (2017), "*Quelles races bovines pour relever les nouveaux défis de notre agriculture? Potentiel des races mixtes*", Nature & Progrès Belgique. Namur, [Online], Available: https://natproconsommateurs.files.wordpress.com/2016/01/11-races-bovines.pdf, [Accessed: 12 March, 2020]

Neumeister, D., Perrot, C., Dockes, A. C., Pineau, C. and Fourdin, S. (2018), "Comment l'élevage répond aux enjeux de durabilité à l'échelle d'un territoire? Etude de 10 cas concrets en Europe", *Rencontres Recherches Ruminants,* vol. 24, pp. 520-525

Nyumba, T., Wilson, K., Derrick, C. and Mukherjee, N. (2018), "The use of focus group discussion methodology: insights from two decades of application in conservation", *Methods in Ecology and Evolution*, British Ecological Society, vol. 9, pp. 20-32, ISSN 2041-210X, DOI 10.1111/2041-210X.12860

Petel, T., Antier, C. and Baret, Ph. 2019a), "*Etat des lieux et scénarios à l'horizon 2050 de la filière lait en Région wallonne*", Université Catholique de Louvain. Louvain-la-Neuve, [Online], Available: https://scenagri.be/wp-content/uploads/2019/03/UCLouvain_Filiere_Lait_Rapport_v190130.pdf, [Accessed: 12 March, 2020]

Petel, T., Antier, C. and Baret, Ph. (2019b), "*Etat des lieux et scénarios à l'horizon 2050 de la filière viande bovine en Région wallonne*", Université Catholique de Louvain. Louvain-la-Neuve, [Online], Available: https://scenagri.be/wp-content/uploads/2019/03/UCLouvain_Filiere_Viande_Rapport_190130.pdf, [Accessed: 12 March, 2020]

Petel, T., Antier, C. and Baret, Ph. (2019c), "Un passage vers des systèmes d'élevage à moindre utilisation d'intrants est-il possible? Composantes du verrouillage, leviers et mesures opérationnelles pour la filière laitière en Région wallonne", Université Catholique de Louvain. Louvain-la-Neuve

Petel, T., Antier, C. and Baret, Ph. (2019d), "Un passage vers des systèmes d'élevage à moindre utilisation d'intrants est-il possible? Composantes du verrouillage, leviers et mesures opérationnelles pour la filière viande bovine en Région wallonne", Université Catholique de Louvain. Louvain-la-Neuve

Réseau wallon de Développement rural (2014), "Les territoires ruraux wallons en 2040", Exercice prospectif, Carnet du réseau n° 3., [Online], Available: https://www.reseau-pwdr.be/sites/default/files/370787_140203_carnet_n3_territoires_ruraux_wallons_2040_prospective.pdf, [Accessed: 11 March, 2020]

Riera, A., Antier, C. and Baret, Ph. (2019), "*Study on livestock scenarios for Belgium in 2050*", Université Catholique de Louvain. Louvain-la-Neuve, http://www.agripressworld.com/_STUDIOEMMA_UPLOADS/downloads/Study_Livestock_Belgium_v190204.pdf, [Accessed: 12 March, 2020]

Ryschawy, J., Tichit, M., Bertrand, S., Allaire, G., Plantureux, S., Aznar, O., Perrot, C., Guinot, C., Josien, E., Lasseur J., Aubert, C., Tchakerian, E. and Disenhaus, C. (2015), "Comment évaluer les services rendus par l'élevage? Une première approche méthodologique sur le cas de la France", *INRAE Productions Animales,* vol. 28, no. 1, pp. 23-38. ISSN 2273-7766, DOI 10.20870/productions-animales.2015.28.1.3008

Vanwindekens, F. (2015), "L'exploitation laitière wallonne de demain", Carrefour des Productions animals, Gembloux Agro-Bio Tech et Centre wallon de Recherches agronomiques. Gembloux

TECHNOLOGICAL PROGRESS, WEATHER EFFECTS AND SUSTAINABILITY IN CZECH CEREAL PRODUCTION

Lukáš Čechura[1], Pavlína Hálová[2] and Jiří Mach[3]

[1, 2, 3] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]cechura@pef.czu.cz, [2]halova@pef.czu.cz, [3]mach@pef.czu.cz

Annotation: The paper deals with the analysis of technological progress, weather effects and sustainability in Czech cereal production. The analysis is based on fitted the stochastic yield function using fixed effects model and panel data of cereal production in individual regions of the Czech Republic in the years 1961 - 2018. The results indicate high sensitivity of cereal yield to the ratio of output and input price indices, considerable high positive technological progress and significant structural and agronomical changes in years 1973 and 1993. Moreover, the results revealed significant impact of weather as well as the impact of climate change. Finally, the results suggest the adaptation and mitigation measures must be introduced for achieving sustainable cereal production in the Czech Republic.

Key words: cereal, technological progress, yield function, fixed effects model, panel data

JEL classification: D21, D22, D24, B23

1. Introduction

The impact of weather has been intensively studied in the past year. Robertson et al. (2007) shows that impact of precipitation on the yield variance in the USA. He found that the models depend on the input data, when the simulation of regional yield is scarcely degraded, in terms of correlation and root-mean-square error. Chen et al. (2013) investigated the effects of the inter-annual variability and trends in temperature, solar radiation and precipitation during 1961–2003 on wheat and maize yields in a double cropping system at Beijing and Zhengzhou in the North China Plain (NCP), and examined the relative contributions of each climate variable in isolation. The Agricultural Production Systems Simulator (APSIM) was used to simulate crop yields using the ensemble of generated climate scenarios. The results showed that the warming trend during the study period did not have significant impact on wheat yield potential at both sites, and only had significant negative impact on maize yield potential at Beijing. Lobell et al. (2007) studied the relationship between crop yield and three climatic variables (minimum temperature, maximum temperature, and precipitation) for 12 major Californian crops: wine grapes, lettuce, almonds, strawberries, table grapes, hay, oranges, cotton, tomatoes, walnuts, avocados, and pistachios in the period 1980–2003. The months and climatic variables of greatest importance to each crop were used to develop regressions relating yield to climatic conditions. For most crops, fairly simple equations using only 2–3 variables explained more than two-thirds of observed yield variance. The types of variables and months identified suggest that relatively poorly understood processes such as crop infection, pollination, and dormancy may be important mechanisms by which climate influences crop yield. Yield-climate relationships can provide a foundation for forecasting crop production within a year and for projecting the impact of future climate changes.

De Wit et al. (2005) explored the effect of uncertainty in precipitation and radiation on crop simulation results at local (50 × 50 km grids) and regional scale (NUTS1 regions) and on the crop yield forecasts for Germany and France. Two experiments were carried out where crop yields for winter-wheat and grain maize were simulated using the crop growth monitoring system (CGMS) for the year 2000 with different precipitation and radiation inputs. The first experiment used precipitation and radiation inputs interpolated from weather stations while the second experiment used accurate precipitation and radiation inputs derived from the European Land Data Assimilation System (ELDAS). The differences between the simulated water-limited yields of the two experiments demonstrated that uncertainty in precipitation and radiation translates into a considerable uncertainty in crop yield at the level of 50 × 50 km grids. This uncertainty strongly decreases when simulation results are spatially aggregated to NUTS1 regions. European Statistical Office (EUROSTAT) yield statistics and CGMS model output for grain maize over the period 1990–1999 were used to develop yield forecasting equations for France and Germany. These equations were applied to the simulation results of both experiments. They concluded that uncertainty in radiation and precipitation in CGMS has little influence on the CGMS yield forecast at national level.

In the Czech agricultural context Hálová et al. (2015) studied the provision of a wide range of public goods, such as farmland biodiversity, water quality and availability, soil functionality, air quality, climate stability, resilience to flooding etc. Čechura et al. (2015) analyzed the total factor productivity (TFP) in agriculture in the situation of climate change. They concluded that some effects are systemic, i.e., they influence all sectors, but authors also identified idiosyncratic factors, especially in animal production.

Predicting the potential effects of climate change on crop yields requires a model of how crops respond to weather. As predictions from different models often disagree, understanding the sources of this divergence is central to building a more robust picture of climate change's likely impacts. A common approach is to use statistical models trained on historical yields and some simplified measurements of weather, such as growing season average temperature and precipitation. Although the general strengths and weaknesses of statistical models are widely understood, there has been little systematic evaluation of their performance relative to other methods. Lobell and Burke (2010) used a perfect model approach to examine the ability of statistical models to predict yield responses to changes in mean temperature and precipitation, as simulated by a process-based crop model. The Crop Environment Resource Synthesis (CERES) - Maize model was first used to simulate historical maize yield variability at nearly 200 sites in Sub-Saharan Africa, as well as the impacts of hypothetical future scenarios of 2°C warming and 20% precipitation reduction. Statistical models of three types (time series, panel, and cross-sectional models) were then trained on the simulated historical variability and used to predict the responses to the future climate changes. The agreement between the process-based and statistical models' predictions was then assessed as a measure of how well statistical models can capture crop responses to warming or precipitation changes. The performance of statistical models differed by climate variable and spatial scale, with time-series statistical models ably reproducing site-specific yield response to precipitation change, but performing less well for temperature responses. In contrast, statistical models that relied on information from multiple sites, namely panel and cross-sectional models, were better at predicting responses to temperature change than precipitation change. The models based on multiple sites were also much less sensitive to the length of historical period used for training. For all three statistical approaches, the performance improved when individual sites were first aggregated to country-level averages. Results suggest that statistical models, as compared to CERES-Maize, represent a useful if imperfect tool for projecting future yield responses, with their usefulness higher at broader spatial scales. It is also at these broader scales that climate projections are most available and reliable, and therefore statistical models are likely to continue to play an important role in anticipating future impacts of climate change.

This paper aims to fill the gap in empirical literature on the assessment of environmental dimension of agricultural production in Central Europe as well as the impact of climate change on cereal production in this region.

2. Materials and Methods

The estimate of the yield function is based on panel data representing the average cereal yields in individual regions of the Czech Republic for the period 1961 – 2018. Exploiting the properties of long panel dataset, i.e. small N and large T, it uses fixed effects model estimator. In particular, when N is small and T large than Pesaran (2015) shows that there is no difference between the employments of fixed or random effects model estimator, i.e. we do not need to test for the model specification in this case

This study follows Just and Pope (1979) stochastic production function specification:

$$y = f(X) + h(X)^{\frac{1}{2}}\varepsilon, \tag{1}$$

where $h(X)^{\frac{1}{2}}$ is a function of regressors in X. The advantage of the Just and Pope specification (1) over a standard approach, i.e. without $h(X)^{\frac{1}{2}}$, is twofold: (i) considering the risk of production and assuming the risk aversion then the risk effect is incorrectly estimated; (ii) the presence of heteroscedasticity makes it not, in general, possible to run hypothesis testing about the importance of regressors and it may decrease the efficiency of model estimate (Just and Pope, 1979).

The estimation procedure of (1) can be divided into three steps. The first step uses OLS and ***y*** is regressed on ***X***. In the second step the squared residual from the first step are estimated on ***X*** using OLS. Finally, in the third step we run the regression on ***X*** and squared root of the predictions from the second step.

The cereals yield function captures the impact of economic factors, technological progress, weather variables and climate change. In particular, the matrix ***X*** contains following variables:

- ***P_index_ratio*** - is a ratio of price output index over price input index.
- **Time vector** as a proxy for technological change – ***t*** and ***t_2***.
- **Dummy variables** to distinguish important changes in cereal production and rotation systems (based on the expert survey) – ***D_1*** – represents period 1961 - 1973; ***D_2*** – 1974 - 1993; and ***D_3*** – 1994 - 2004.
- **Average monthly temperatures** – from April to July – ***TM4***,…,***TM7***.
- **Average monthly precipitation** – from April to July – ***SM4***,…, ***SM7***.
- **Climate change variables** – average monthly temperatures and precipitation in combination with time vector – ***lT4_t***,…***lT7_t***, ***lS4_t***,…, ***lS7_t***.

All variables except for time vector and dummy variables were logarithmically transformed. Then, the variables (except for dummy variables) were normalized by their mean.

The econometric estimates were conducted in the econometric SW GRETL.

3. Results and Discussion

Table 1 presents the parameter estimate of the yield function. The results are consistent with economic as well as agronomical expectations. Moreover, it shows good statistical properties. In particular, majority of parameters are statistically significant even at 1 % significance level. The model is also characterized by high explanatory power. R2 suggests that almost 90 % of yield variability is explained by the variability of regressors.

Estimated parameters can be interpreted as elasticity when evaluated on the sample mean. In other word, the particular explanatory variable shows the percentage change in yield if it changes by 1 % evaluated on the sample mean. In this respect, the most sensitive reaction of cereal yield, 1.97%, was estimated for ***P_index_ratio***. The sign of the reaction suggests the important role of inputs in cereal yield, e.g. the higher is the use of fertilizer and pesticides the lower is the price ratio and the higher is the cereal yield. Then, we estimated positive technological progress. However, this positive technological change is slightly decelerating over time. The contribution of technological progress to the yield increase accounts on average for 0.23 % per year. That is, the results suggest that the technological change has played an import in cereal yield in studied period.

The dummy variables show that the structural changes and agronomical changes that occurred approximately in 1973 and 1993 play additional important role in cereals yield.

Table 1. Results of fixed-effects model for the dependent variable of yield of cereals

	Coefficient	**Std. Error**	**t-ratio**	**p-value**	
Const.	10.5005	0.522151	20.11	<0.0001	***
P_index_ratio	−1.96655	0.366539	−5.365	<0.0001	***
t	0.236457	0.0242662	9.744	<0.0001	***
t_2	0.000675363	0.000140614	4.803	<0.0001	***
D1	0.519444	0.194811	2.666	0.0078	***
D2	0.501326	0.188035	2.666	0.0078	***
D3	−0.0442143	0.0966970	−0.4572	0.6476	
TM4	−0.0183223	0.0108438	−1.690	0.0915	*
TM5	−0.0825139	0.0124316	−6.637	<0.0001	***
TM6	−0.141636	0.0142157	−9.963	<0.0001	***
TM7	−0.0986200	0.0118082	−8.352	<0.0001	***
SM4	0.00211633	0.000758078	2.792	0.0054	***
SM5	−0.000633272	0.000495653	−1.278	0.2018	
SM6	−0.00266315	0.000487744	−5.460	<0.0001	***
SM7	−0.00307510	0.000378354	−8.128	<0.0001	***
lT4_t	0.00657157	0.0156055	0.4211	0.6738	
lT5_t	−0.0188411	0.0289369	−0.6511	0.5152	
lT6_t	0.0270682	0.00564229	4.797	<0.0001	***
lT7_t	−0.109852	0.0334495	−3.284	0.0011	***
lS4_t	0.00216958	0.00170596	1.272	0.2039	
lS5_t	0.00228684	0.00238813	0.9576	0.3386	
lS6_t	−0.00470541	0.00223419	−2.106	0.0355	**
lS7_t	0.00460265	0.00195044	2.360	0.0185	**

*Source: own calculationα = 0.01 *** α = 0.05 ** α = 0.1**

Table 2. Results of statistic and econometric model verification

Mean dependent var	4.027902	S.D. dependent var	1.100704
Sum squared resid	98.72814	S.E. of regression	0.363304
LSDV R-squared	0.895927	Within R-squared	0.883813
LSDV F(35, 748)	183.9789	P-value(F)	0.000000
Log-likelihood	−300.2085	Akaike criterion	672.4171
Schwarz criterion	840.3358	Hannan-Quinn	736.9853
rho	0.137421	Durbin-Watson	1.688438

Source: own calculations

The effects of high temperatures of ***TM4 - TM7*** in the spring months, when cereals grow intensively, branch off and form an ear, are statistically significant and negative, evaluating on the sample mean of particular temperatures This suggests higher occurrence of damaging temperatures when the month temperatures are higher than long term averages. On the contrary, the precipitation in April SM4 has a positive and significant effect. Their lack in this period is a key issue for future returns. This problem threatens especially the fertile areas of South Moravia. In May and June, the effects of SM6 and SM7 change, and it is clear that a large amount of precipitation reduces yields. While rainfall in April has a positive effect on spike formation, higher rainfall in June and July may reduce yields due to potential susceptibility to mould, lodging and possible germination at harvest.

The effect of climate change on cereals yield is estimated by the changes of the temperatures and precipitation effects over time on cereals yield represented by variables ***lT4_t,….lS7_t***. The overall test for the significance of climate change includes the null hypothesis that the parameters on variables ***lT4_t,….lS7_***t are equal to zero. Since we can reject the null hypotheses with high probability (F(8, 748) = 13.9252, p-value 5.73879e-019) we can conclude that the climate change has a significant effect on cereal production in the Czech Republic. In particular, we found that the effects of June and July temperatures as well as June and July precipitations have been changing over time. As far as the temperatures are concerned, increasing temperatures in June have positive impact on yield but higher temperatures in July indicate the opposite effect. In the case of precipitations, the results suggest that the decreasing trend in precipitations in June and July has negative impact in June but positive in July. However, these effects cannot be taken as compensatory since damages in June can be hardly fully recovered in July.

In addition, we found large differences between the Czech regions. That is, the significant differences among estimated fixed effects show that there are considerable high differences in yield productivity among the regions.

4. Conclusion

The aim of this paper was to estimate the stochastic yield function on panel data of cereal yields in individual regions of the Czech Republic in the period 1961 - 2018. The function was estimated by the method of fixed effects, which demonstrated a statistically significant effect of most included explanatory variables. The ratio of output and input price indices is the most sensitive and inversely proportional, which confirms the economic behaviour of producers of a key agri-food commodity. The aim of the study was to investigate the influence of technological changes, which are brought by R&D expenditure in agriculture, but also reactions to changes in natural conditions or eating habits of the population. When modelling cereal production, we would make a serious specification error if we neglected the effect of weather, which is included here as a temperature variable and the total precipitation in the spring months variable, together with the effect of a combination of these phenomena and technological progress. Here it is evident that above-average temperatures in these months have a negative effect on yields in contrast to above-average precipitations in the early spring. Finally, the results suggest that the adaptation and mitigation measures must be introduced for reaching sustainable cereal production in the Czech Republic.

Climate change, dry and warm springs, which have become a reality in recent years, place high demands on agro-technical interventions in the cultivation of cereals, but require a comprehensive solution of research tasks dealing with the breeding of new, more resilient species. Research into chemical-based growth promoters that enable the plant to better withstand water stress is also a challenge for researchers. The evidences suggest that all agro-economic measures in the field of crop production should aim at sustainment and eventually increasing the productivity of agricultural crops, which are scientific and technological progress and changing climate.

Acknowledgements
The results are the part of the solution of project No. QK1920398 „Duality in Czech Agriculture: Advantage or Disadvantage for New Generation Agriculture?“, supported by the Ministry of Agriculture of the Czech Republic, program ZEMĚ.

References

Čechura, L., Kroupová, Z. and Rudinskaya, T. (2015), "Factors determining TFP changes in Czech agriculture", *Agric. Econ. – Czech*, vol. 61, no. 12, pp. 543 - 551, ISSN 0139-570X, DOI 10.17221/14/2015-AGRICECON

Chen, C., Baethgen, W. E. and Robertson, A. (2013), "Contributions of individual variation in temperature, solar radiation and precipitation to crop yield in the North China Plain, 1961–2003", *Climatic Change,* no. 116, pp. 767 – 788, DOI 10.1007/s10584-012-0509-2

De Wit A. J. W., Boogaard H. L. and van Diepen, C.A. (2005), "Spatial resolution of precipitation and radiation: The effect on regional crop yield forecasts", *Agricultural and Forest Meteorology,* vol. 135, no. 1–4, pp. 156 - 168, DOI 10.1016/j.agrformet.2005.11.012

Hálová, P., Žáková Kroupová, Z., Havlíková, M., Čechura, L. and Malý, M. (2015), "Provision of Public Goods in Czech Agriculture", *Proceedings of the 24th International Scientific Conference Agrarian Perspectives - Global Agribusiness and the Rural Economy,* Prague, pp. 145 -158, ISBN 978-80-213-2581-4

Just, R. and Pope, R. (1979), "Production Function Estimation and Related Risk Considerations", *American Journal of Agricultural Economics,* vol. 61, no. 2, pp. 276 - 84, DOI 10.2307/1239732

Lobell, D. B. and Burke, M. B. (2010), "On the use of statistical models to predict crop yield responses to climate change", *Agricultural and Forest Meteorology,* vol. 150, no. 11, pp. 1443 - 1452, DOI 10.1016/j.agrformet.2010.07.008

Lobell, D. B., Cahill, K. N. and Field, C. B. (2007), "Historical effects of temperature and precipitation on California crop yields", *Climatic Change,* vol. 81, pp. 187 - 203, DOI 10.1007/s10584-006-9141-3

Pesaran M. H. (2015), Time series and panel data econometrics, Oxford University Press. ISBN: 9780198736912

Robertson, A. W., Ines, A. V. M., Hansen, J. W. (2007) Downscaling of Seasonal Precipitation for Crop Simulation. *Journal of Applied Meteorology and Climatology* 46, pp. 677 – 693. https://doi.org/10.1175/JAM2495.1

POLICY AND MEDIA INFLUENCE OVER FOOD SYSTEMS IN RUSSIA: AN ANALYSIS OF SOCIAL IMPLICATIONS

Tatiana Demkina[1] and Artan Qineti[2]

[1, 2] Department of Economic policy, Slovak University of Agriculture in Nitra, Slovakia

[1]dlp14@list.ru, [2]artan.qineti@uniag.sk

Annotation: In the 21st century, *food security* is one of the most discussed topics in scientific and political circles. Meanwhile, during the last decades, social media stimulate an explanation of the debates around food security issues among civil society. Farmers together with other interest groups attempt influencing decisions of policymakers and changing the global food system. In Europe in 1993, for instance, Via *Campesina* was one of the first farmers´ movements, which supported the framework of *food sovereignty*, and opposed activities of companies controlling the global food market. However, the concept of *food sovereignty* has not been used in academia in Russia. Furthermore, the local media used to replace *food sovereignty* with the concept of *national food security*, representing both of them as synonyms. Currently the *Food Security Doctrine* is the programme supported on a governmental level with a focus on resolving food affordability and availability issues in Russia by 2020.

This academic paper aims at highlighting the respondents' attitudes on the implemented Food Security Doctrine from three Russian regions – the Altai, Primorsky, and Krasnodar krais and underlining vital changes occurred in food nutrition after 2014. Furthermore, the research contains analysis of attitudes on the limited access to food stuff after embargo implementation in 2014 and, as a result, mechanisms of change in food systems. In Russia both in rural and urban areas people produce some basic food stuffs (incl. fruits, vegetables, poultry, and pork meat, etc.). According to the quantitative analysis of the survey, most of the respondents supply relatives and neighbors with products and employment opportunities, producing diverse agricultural products. Those adaptation practices to the current food security situation indicate household as a producer in the food system chain. The Chi-square ($\chi 2$) Test of Contingencies was implemented to access weather region and related adaptation practices. The paper includes prospective motives of the households to produce diverse food and analytical implications of the media and policy influence on social attitudes.

Key words: *Food Security Doctrine in Russia, media, adaptation practices.*

JEL classification: Q18

1. Introduction

Mr. Dmitry Medvedev (President of the Russian federation in 2008-2012) first approved the Food Security Doctrine of the Russian Federation in 2010 and proposed the development plan for the period until 2020. Content of the Doctrine covered the number of goals, such as physical and financial affordability, as well as the quality of food, and self-sufficiency of country in food products.

Political movements in 2014 (administrative annexation of Crimea in the Russian territory, political conflict between Ukraine and the Russian Federation, and food embargo implemented as a result of sanctions) led to the socio-political struggle between the Russian Federation and the European Union. However, the following negative factors for the political and trade relationships built up a favorable climate for the development of food security in Russia.

The strategy of further development of agriculture in Russia was proposed by large-scale stakeholders and approved by political players, without assumptions of the individuals and households. It was often the case that opinions of small producers, such as small-scale farmers and local agricultural enterprises were not taken into consideration and not published in research findings and social media. On the other side, the Russian social media is publishing summit discussions and public speeches of the agricultural

companies' leaders that represent positive consequences of the embargo and future perspectives in the agricultural sector of Russia[2]. The question remains, whether the Russian population has the same attitudes concerning the implemented agricultural policy, as it is represented in the media space.
This research study will represent how the situation of food accessibility and availability has been changed after the introduced sanctions in 2014 and the current preferences of consumers varied between domestic and imported products. The objective is to observe the social practices of respondents' adaptation to the limited accessibility of food products and ways of its legitimation.

Theoretical Background and Propositions

The food security context in Russia can be characterized from several perspectives. On the one hand, there is a negative dynamic regarding the number of fundamental indicators of food security statement in Russia. Firstly, the quality of several food commodities (i.e. cheeses[3]) is sufficient in comparison to the European one; secondly, the economic accessibility of products decreased because of the constantly growing prices during 2014-2016. Those events led to the significant devaluation of the population income represented by weak nominal growth and a significant drop in real consumption.

Social media publications present the importance of self-sufficiency and the necessity of domestic product development in the agricultural sector. The government regards small stakeholders as non-effective, as a result, small-scale farmers do not receive enough federal support in the framework of the Food Security Doctrine, though the contribution of such producers is significant: 93% of potatoes, 80% of vegetables, 51% of milk, and 54% of meat from the total GDP (FSSS, 2013). As a result, in the post-soviet countries (Russia, Kazakhstan, and Ukraine, etc.) the term *food sovereignty* used to be defined in a different way (Visser et al., 2015). Until the present moment, the term was not applied in Russia, moreover, the media is used to replace the food sovereignty with the term national food security, representing both of them as synonyms.

There is an accurate type of food sovereignty in Russia because of unorganized formation, which could formulate the decision-making discourses and coordinate actions. Just the government had the legislation to create this type of organization (Visser et al., 2015). However, certain steps and some ideas of food sovereignty without negotiation are widespread among the population based on a "from the down to the upper" model (Visser et al., 2015). These practices in the notion of "quiet food sovereignty", based on the concept of "quiet sustainability" (Smith and Jehlička, 2013).

Measurements according to the food sovereignty in Russia are reduced. Ecological and economic benefits of the Russian small and middle farmers are high, as they are producing the biggest share of national food products and the recent years' harvest of potatoes, for instance, was higher than in commercial Britain and American companies (Ries, 2009).

Besides, domestic and foreign policies influence the food security policy in Russia. The policy agency was not active in finding a way to enter the World Trade Organization (WTO). As a result, the decision-making process on the accession of Russia in WTO was long. However, when negotiation led to the positive decision, Russian farmers and producers of agricultural commodities were against it. The main argument was incapacity of the applied Food Security Doctrine in the WTO policy framework (Barsukova, 2013).

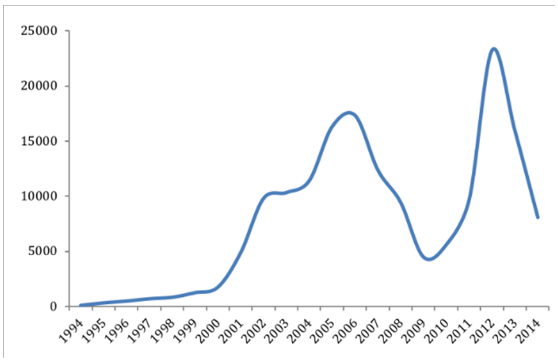
---

[2] Gromov A., Medvedev: The embargo in response to sanctions was useful for the Russian agribusiness, FAN. Retrieved from http://riafan.ru/430547-medvedev-embargo-v-otvet-na-sanktsii-okazalos-poleznyim-dlya-apk - rossii (May 23, 2016)
[3] Kalyukov E., Kruglikova M. About 80% of cheese in Russian stores proved as falsified, RBC. Retrieved from http://www.rbc.ru/business/01/10/2015/560d34ce9a79476b06409e09(May 23, 2016)

In 2000-2006, the Russian social media published many articles with discussions on the accession of Russia in the WTO (Barsukova and Korobkova, 2014). Russia entered the WTO on 22 August 2012, after what the term food security almost disappeared from the governmental disputes and was portrayed as a mistake of Mr. Dmitry Medvedev (Barsukova and Korobkova, 2014).

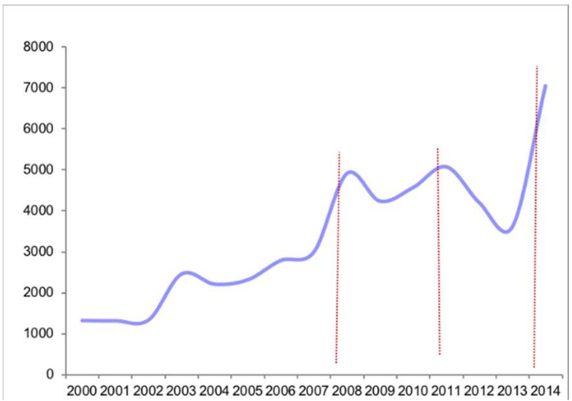
Articles about the WTO have been frequently published and media perceived it as a threat to the Food Security and independence of the country (Figure 1). In comparison, there was a decline in the media's attention to term food security itself (Figure 2).

Figure 1. Number of published articles by local media containing information on Russia's accession to the WTO



Source: Barsukova and Korobkova, 2014.

Figure 2. Number of published articles by local media containing information on Food Security



Source: Barsukova, 2016.

Therefore, according to the media publications, food security, and accession of Russia to the WTO as elements of liberal development are antagonistic. Political events (for ex., embargo) have made significant adjustments to the interpretation of food security and have given rise to a reaction in the form of a return to a sort of economic nationalism (Dufy, 2015; Barsukova, 2016). The image of the united people had to form the positive attitudes of the Russian population on the Food Security program. As a result, the Russian population expanded a mistrust of the global producers. Alternative food systems, such as direct marketing, farmer (weekends') markets, and self-production, became more popular, especially after debates about GMOs in 2014[4].

2. Materials and Methods

The paper is based on quantitative data analysis from the survey "Food Security and Social Trust" and aims at measuring media influence on the population attitudes about food security and at hypothesizing the impact of the current policy on the households' practices in Russia.

The research is based on survey data from the Altai, Krasnodar, and Primorskiy Krais. All federal subjects are of equal federal rights in the sense that they have equal representation – two delegates each in the Federation Council (upper house of the Federal Assembly). The terms "Krai" and "region" are used as synonyms in this article. The interviews were conducted by telephone during April-May 2015. A widespread pattern of regions' geographical allocation allowed to access and compare attitudes

[4] The government project on state regulation of genetic engineering activities has been submitted to the State Duma. Retrieved from http://www.garant.ru/news/605110/#ixzz5CwQnOss9

from the differently developed areas. Represented krais are located in 3 macro-regional parts of Russia: Siberia, European and Far-Eastern part respectively.

The main criteria for data selection was a response on the call, respondent's age (more than 18 years old, which has been defended by the voice of a respondent or by the question about the age), good connection and clear audibility, knowledge of Russian. Participants were between 18 and 92 years, living in urban and rural areas. The core aim was to collect data from ca. 600 conducted interviews from each of the regions. The total number of respondents was 1831.

Table 1. The frequency of responses distribution

Krai	Frequency	Percentage
Altai	571	31.2
Krasnodar	601	32.8
Primorsky	659	36
Total	**1831**	**100**

source: own processing

The collected interviews were analyzed using the methods of open and selective coding. The interviews were also translated from Russian to English and respondents remained anonymous because of the subject's sensitivity and data protection policy. The methods aimed to define the population motives towards the preference of domestic products. The answers were categorized into groups by the keywords. Furthermore, the adaptive practices towards the limited food accessibility lead to mutual support between relatives or neighbors. The analyzed answers represent how household producers from a rural area help urban population, and how social media and attitudes impact the development of self-efficient production and goods distribution. The Chi-square ($\chi 2$) Test of Contingencies was implemented to access weather two categorical (nominal) variables are related. That is, whether a group of category membership on one variable is influenced by (or contingent on) group membership on a second variable.

Research and clear vision of influencing factors on the population attitudes in Russia can promote the development of alternative food systems and policy, which will correspond to the current food security situation.

3. Results and Discussion

Adaptation of the Food Security Doctrine in Russia is one of the key measures against food insecurity. Doctrine determines the development direction of future policy. It is important to measure the percentage of the Russian population informed about the Food Security Doctrine. Significant criteria are the social impact on the formation of the policy processes, adaptation practices to sanctions and changes in foodstuffs. The last factor affected consumption preferences between domestic and imported products.

It is important to note that knowledge of the content does not influence the personal attitudes towards the necessity of the Food Security Doctrine implementation (Table 2).

Table 2. The connection between the number of informed respondents about the Food Security Doctrine content and their vision on the necessity of the Doctrine implementation

		Have you heard something or do not know the content of the Food Security Doctrine?				Total
		Yes	I have heard something	No	Difficult to answer	
In your opinion, is the Food Security Doctrine needed in Russia?	yes	152 (94.2%)	290 (96.2%)	135 (87.1%)	3 (60%)	580 (92.7%)
	no	4(2.5%)	8(2.6%)	3(18.8%)	1(20%)	16 (2.6%)
	difficult to answer	2(1.3%)	10(3.2%)	17(56.7%)	1(20%)	30 (4.8%)
	Total	**158**	**308**	**155**	**5**	**626**

source: own processing

The results of chi-square analysis ($\chi 2$ (1, N=626) = 27.95, with p = 0.00) are very significant statistically, with the null hypothesis rejected at the 0.05 level of significance. Although the association between knowledge of the content and attitude towards the Doctrine implementation considered as medium $\varphi = 2.1$. It indicates that respondents, who encourage the Doctrine entity, were roughly equally split between three regions. Even in the case when interviewees were not familiar with the content.

Another measure to ensure food security is a refusal of the foreign products import in favor of the domestic product consumption. Following the protectionist approach (Barsukova, 2016), a country's food security independence is determined as a part of its national interests. The interviewees were asked about their preferences of domestic products towards the imported ones (Table 3), as well as about their personal beliefs towards the implemented sanctions in 2014. The survey respondents believe that the food security doctrine is necessary, whilst relying on their internal feelings (Piechowski, 1981).

Table 3. Population preferences of the domestic and imported products in Altai, Krasnodar and Primorsky krais

		Altai krai	Krasnodar krai	Primorsky krai	Total
If two products are the same price and quality, but one is imported, and another is domestic, which one will you buy?	Domestic (Russian)	548(96.1%)	560(93.2%)	609 (92.4%)	1717 (93.8%)
	Imported (Foreign)	2 (0.4%)	9 (1.5%)	18 (2.7%)	29 (1.6%)
	Difficult to answer	20 (83.5%)	32 (5.3%)	33 (4.9%)	85 (4.6%)
Total		**570**	**601**	**660**	**1831**

source: own processing

The statistical estimation presents that the majority of the respondents (93.8%) from three regions would like to buy domestic products. Fewer people (1.6%) will prefer imported products to domestic one and the rest of the interviewees (4.6%) are in uncertainty.

The result of the chi-square test of contingencies was not statistically significant $p = 0.008$, with the null hypothesis discarded at the 0.05 level of significance. The $\chi 2(1, N=1831)$ statistic is calculated, it is 13.7. The association between region and preferences towards domestic products was high $\varphi = 0.61$, the proration of respondent preferences due to the region was not different.

According to the population attitudes, several motives aimed to reduce the imported products can be distinguished:

-health hazards associated with imported food, which can probably contain chemical components and GMO,

Key words in the recorded interview represents attitude towards imported food in Russia:

"... prohibit these products, because of the diseases,... these ***foreign chemical substances****."(Respondent woman, 79 year old)*

- to consume domestic products aimed to support the current policy in the country,

One of the recorded interviews demonstrates attitude towards imported food in Russia:

"..., it would be better if you will recommend ***to support*** *the economy of* ***your country****, not the foreign one ..." (Female respondent, 76 years old)*

-patriotic feelings.

Respondent: "I will buy a domestic one. I am a ***patriot,*** *I will buy domestic. Even if it is more expensive, I will still buy it." (Female respondent, 38 years old)*

Russian media often mentioned the topic GMO and quality of products during the last years. Published news on the open official Federal Services represents GMO from the negative site: "According to Rospotrebnadzor, the total share of unsatisfactory samples taken from imported products is increasing every month. The head of the department Anna Popova noted that this tendency in the decrease of the foreign food quality began a few years ago… " (Russian News Agency, 2015). Therefore, people believe in official statistics from federal institutions and responds, which rely on the critical assessment of the food quality coming from abroad.

The current embargo situation affected the economic accessibility of products by the rapid growth of the food prices in the late 2014 and 2015 years in Russia. In this period prices became on average 31.6% higher (Ria, 2015). For the number of retailers (Spar, Billa), dependent on import deliveries, it was difficult to find other suppliers in a short period time. The alternative solution was to increase food and non-food product prices. As a result, in 2016, the retail turnover rose by 2.8% (Borovikov, 2018). Therefore, due to the result of a Pearson's chi-square test of contingencies, the problem is not a ban on imports and lack of the products at the domestic market (Table 4), but whether the prices on both imported and domestic products are in principle capable for the households.

Table 4. Respondents attitudes towards the price regulations on basic foodstuffs implemented by the state

		The state should regulate prices only for a limited set of products	The state should not regulate food prices	difficult to answer	Total
Do you limit or do not your budget on foodstuffs, because of rising prices?	yes	1130 (69.8%)	92 (59.0%)	38 (67.9%)	1260 (68.8%)
	no	478 (29.5%)	63 (40.4%)	18 (32.1%)	559 (30.5%)
	difficult to answer	11 (0.7%)	1 (0.6%)	0	12 (0.7%)
	Total	**1619**	**156**	**56**	**1831**

source: own processing

The chi-square test presents that the dependence of the households limiting budget practices and lack of habitual foodstuffs on the Russian market is statistically not significant $\chi2$ (1, N=1831) =7.6, $p = 0.038$, $\varphi = 0.065$. Limitation of the spending on the food does not depend on the disappearance of the foodstuffs from the shops. Limitations of the budget did not relate to the limited availability of imported products.

According to the quantitative analyzes, the main reason for the increasing food prices was unfair retailers' behavior. The solution to this problematic situation can be implantation of price regulations on the governmental level (Table 4), especially for the basic foodstuffs (cereals, oils, meat and dairy products) converted, and aggregated by the calorie content of individual commodities (FAO, 2018). Due to the World Summit in 1974, Food Security is "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (UN, 1975). The insecurity associated with continuing, or structural poverty and low incomes in periods of intensified pressure caused by natural disasters, economic collapse or conflict. That corresponds to the economic situation in Russia in 2015.

Table 5. Respondents' adaptation practices towards the increasing food prices in Altai, Krasnodar and Primorsky krais

		Altai krai	Krasnodar krai	Primorsky krai	Total
Adaptation practices to the increasing prices for food	I will not do anything	76 (12.5%)	99 (16.2%)	79 (12.9%)	254 (13.9%)
	I will try to ensure me (my family) by food supplies	19 (3.1%)	52 (8.5%)	52 (8.5%)	123 (6.7%)
	I will limit myself even more in spending for food	171 (28.2%)	192 (31.4%)	172 (28.1%)	535 (29.2%)
	I will try to grow more products in my garden, on my plot	317 (**52.3%**)	241 (**39.4%**)	265 (**43.2%**)	823 (**44.9%**)
	Difficult to answer	23 (3.8%)	28 (4.6%)	45 (7.3%)	96 (5.2%)
	Total	**606**	**612**	**613**	**1831**

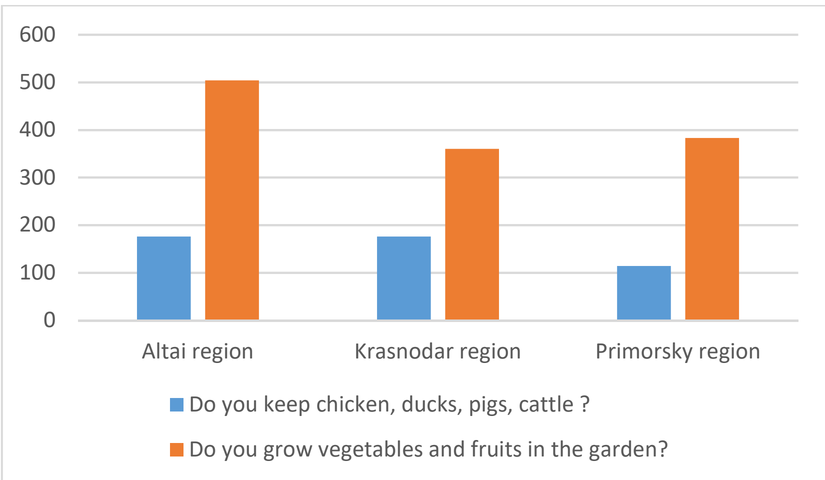
source: own processing

A Pearson's chi-square test of contingencies (with $\alpha=0.05$) is used to evaluate whether region related to the attitudes towards State regulation of basic foodstuffs prices. The variables are not related statistically, as a result, is not statistically significant $\chi 2$ (1, N=1831) = 8.3, p = 0.079; however, the majority of respondents who are limiting the spending on food have positive attitudes towards price regulations, $\varphi = 0.68$. The majority of respondents determine the State regulation like solution towards the rising prices and reduction of the spending on food.

Statistical approaches to vulnerability analysis attempt to identify the adaptation practices to the situation of the limited economic accessibility to foodstuffs in Russia and explain in which regions people are more vulnerable, and which future scenarios can be addressed. Adaptation occurs in response to, and in preparation for, multiple stressors that reconfigure access to resources required for the reply. The respondents had the multiple-choice question on the adaptation practices towards the increasing prices (Table 6). The results allow multiple stressors overtime after the implementation of the sanctions, by identifying how goods were obtained, constrained, and expended (Prowse and Scott, 2008).

According to the statistical analysis, if there will be a further increase in prices, the major number of respondents (45%) would try to grow more products in their garden, other people (29%) will limit food consumption and the rest (7%) will set up the strategic food reserves. The pensioners or pre-retirement (50-60 years old) persons are the main part of the rural population. Currently, agriculture faces the problem of labour shortage, even relatively small household plots (size varies from 20 to 40-50 acres) requires the involvement of additional workers and/ or agricultural machinery. These requirements are partly offset by the hiring of employees or getting help from neighbours and relatives. The payment is normally done by money or products. Moreover, this agreement balances the needs of some residents in work and the possibilities to satisfy the demand in labour. In this way, a network of labour relations established and regulated by the rural society independently, without the intervention of the state (Kultura, 2012).
According to the survey, the Russian population produce more fruits and vegetables on the private household plots. The highest number of respondents involved in the gardening is in Altai krai (83%), meanwhile less popular tendency to keep animals occurs in both Altai and Krasnodar krais (29%). In Primorsky krai gardening is a common practice (62.5%), but the practice keeping of animals is three times less (18.3%).

Figure 3. Number of respondents with household plot, represented by keeping animals and growing vegetables and fruits



source: own processing

Responses represent a variety of adaptation practices of the population to the situation of rising prices and limited affordability of food after applied sanctions. There is, therefore, the reasons to assert that there is a system of mutual support that exists parallel to the market one, autonomously from the currently implemented policy of food security in Russia. Owners of private plots do grow vegetables or fruits in the garden, holding chicken, ducks, cattle, cows, or pigs. By that they can support their household, friends, relatives, forming a "network of mutual support."

4. Conclusion

Food Security faces fundamental national problems in Russia and the food security Doctrine aims at solving them. The processes of the imposition of embargo on a number of imported foodstuffs in 2014 resulted in the limited economic access to sufficient and qualitative food, and as consequence, promoted the development of adaptation practices on the individual and household levels.

Due to the limited necessary liberal leverage of deterrence, the state used the Food Security concept as a legitimization political decision. The conceptualization and presentation of the Food Security and, in general, the explanation broadcast through the different media instruments, such as reports on national television and electronic newspapers. This strategy implemented concerning a particular country's political situation (Dyakova, 2003). The empirical analysis represents that respondents accurately capture and reproduce the same matrixes of de-problematization strategies that the media is using (Ibarra, Kitsuse, 2003). The particular case of the food embargo introduction allows interpreting food as a specific kind of political weapon.

The population's dissatisfaction with the increasing prices on foodstuffs leads to the changes in the diet values, as the consumer products are much lower in quality that can affect the vitamin and mineral levels. Respondents tend to blame the growth of the capitalistic market in the processes of the price increase. Therefore, the state remains out of the focus and does not contribute to the causes of the price changes.

Another important conclusion represents the adaptation strategies for the self-reliance of the population through the mutual support gained through social networks to ensure independence in terms of food availability and accessibility. However, the process of interaction between society and the state leads to isolation in discussion and problem-solving.

Food exchange between households and the muted discourse about rights are the important characteristics of the concept of "quiet food sovereignty" (Visser, 2015). The adaptive practices are formulated as "quiet" because their subjects "are more concerned with the role of the state and the quality of products than with the environmental impact of the food system as such." (Smith and Jehlička, 2013, 155). Mass support for the ideas proclaimed by the movement of *La Via Campesina* movement (La Via Campesina, 1996) was not observed. Moreover, the ideas of the movement are nearly not represented in the public discourse on population attitudes.

Notwithstanding the presence of variously available research results in the analysis of the food and nutrition security, the number of the research limitations was identified with a lack of data on nutrition status before the embargo and on the date, when the survey has been conducted. In this regard, further research and empirical data collection are required. The obtained results can be used in the context of studies of daily practices of the rural population in order to identify the possible influence on the development of food security in Russia.

References

Barsukova, S. (2013), "Milestones of agrarian policy in Russia in the 2000s", *Journal of World of Russia*, vol. 1, pp. 27 - 34

Barsukova, S. and Korobkova, A. (2014), "Russia in the WTO: a discussion in the Russian print media, *Journal of Social Sciences and Modernity*, vol. 5, pp. 44 - 58

Barsukova, S. and Dufi, K. (2015), "Food security: Russian concept", *J. Politiya*, vol. 3, no. 82, pp. 34 - 38

Borovikov, M. (2018), "*Development of the Russian FMCG market: growth rates and current trends*", J. Rusbase. [Online], Available: https://rb.ru/opinion/fmcg-tempy/ [Accessed: 20 May, 2020] (in Russian)

Dufy, C. (2015), "Redefining Business Values in Russia: The Boundaries of Globalisation and Patriotism in Contemporary Russian Industry", *J. Europe-Asia Studies*, vol. 67, pp. 84 -101

Dyakova, E. (2003), "Mass political communication in the theory of setting the agenda: from effect to process*", Political studies,* vol. 3., E-ISSN 1467-9248

FAO (2018), "*Low-Income Food-Deficit Countries (LIFDC)*", [Online], Available: http://www.fao.org/countryprofiles/lifdc/en/, https://rb.ru/opinion/fmcg-tempy/ [Accessed: 10 May, 2020]

FSSS (2013), "*Healthy food is the basis of public health*", [Online], Available: http://37.rospotrebnadzor.ru/document/2850/, https://rb.ru/opinion/fmcg-tempy/ [Accessed: 5 May, 2020]

Visser, O., Mamontova, N., Spoor, M. and Nikulin, A. (2015), "Quiet Food Sovereignty' as Food Sovereignty without a Movement? Insights from Post-socialist Russia", *J. Globalizations*, vol. 12, pp. 513 - 528

Kitsuse, J. and Ibarra, P. (2003), "Claims-making discourse and vernacular resources. Challenges and choices: constructionist perspectives on social problems, pp. 17-50

Kultura (2012), "*Treaty in the customary law of the modern village of Russia*", [Online], Available: https://www.culture.ru/materials/31319/dogovor-v-obychnom-prave-sovremennoi-derevni-rossii, [Accessed: 15 May, 2020]

La via Campesina (1996), "The right to produce and access to land. Voice of the Turtle". [Online], Available: http://www.voiceoftheturtle.org/library/viacampesina.php. [Accessed: 10 May, 2020]

Gudkov, L. (2015), "Structure and functions of Russian anti-Americanism: the mobilization phase of 2012 – 2015", *Bulletin of public opinion*, Data. Analysis. Discussions. Vol. 3, pp. 15 - 45

Ries, N. (2009), "Potato ontology. Surviving post-socialism in Russia", *Cultural Anthropology*, vo. 24, pp. 181–212. E-ISSN 1548-1360, DOI 10.1111/j.1548-1360.2009.01129.x

Ria News (2019), "*State Duma neglected the law project in the first reading about prohibition of GMO in Russia*", [Online], Available: [http://ria.ru/science /20150424/1060718919.html] [Accessed: 5 May, 2020], (in Russian)

Russian News Agency (2015), "*Russians choose their own products: foreign countries forgot* how to make normal products", [Online], Available: http://www.online-translator.com/Site.aspx?dirCode=ru-en&templateId=General&url=http://xn----ctbsbazhbctieai.ru-an.info/новости/россияне-выбирают-своё-за-рубежом-разучились-делать-нормальные-продукты/, [Accessed: 5 April, 2020] (in Russian)

Smith J. and Jehlicka P. (2013), "Quiet sustainability: Fertile lessons from Europe's Productive gardens", *Journal of Rural Studies*, Vol. 32, pp. 148-157. ISSN 0743-0167, DOI 10.1016/j.jrurstud.2013.05.002

Prowse, M. and Scott, L. (2008), "Assets and adaptation: an emerging debate", *IDS Bulletin-Institute of Development Studies*, vol. 39, pp. 42–52. E-ISSN 1759-5436

Piechowski, M. M. (1981), "The Logical and the Empirical Form of Feeling", *The Journal of Aesthetic Education*", vol. 15, no. 1, pp. 31-53. ISSN 0021-8510, E-ISSN 1543-7809, DOI 10.2307/3332208

THE EFFECTS OF CLIMATE CHANGE ON AGRICULTURAL SECTOR AND ECONOMIC GROWTH OF TURKEY

Eylül Güven[1], Maitah Mansoor[2], Jeta Sahatqija[3], Seth Nana Kwame Appiah-Kubi[4] and Mehmet Talha Aygün[5]

[1, 2, 3, 4, 5] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]guven@pef.czu.cz, [2]maitah@pef.czu.cz, [3]sahatqija@pef.czu.cz, [4]appiah-kubi@pef.czu.cz, [5]xaym001@studenti.czu.cz

Annotation: One of the most important components of a developing economy is the agricultural sector. It is possible to have an idea about the development level of the country by looking at the share of the agriculture in the Gross Domestic Product (GDP) of a country. In Turkey, from the beginning of 1920s to the end of 1960s approximately 45 % of GDP was obtained from agriculture, its share in GDP decreased to 26 % in 1980. In 2000, it decreased to 10.1 %. Throughout the process, this downward trend continued. The contribution of the agricultural sector to the economy, which was 9 % as of 2010 and decreased to 5.8 % by 2018. There are many reasons for this decrease, according to the Federation of Food and Drink Industry Associations of Turkey; "Climate change stands out as the biggest threat to agriculture and food production, despite the increase in food demand depending on the world population". The change in temperature and precipitation caused by climate change affect the agriculture sector by affecting both the quantity of product and the quality of the product. In this way, climate change also influences economic growth in countries. The aim of this study is to attempt to understand how climate change, which is one of the biggest factors affecting agriculture, has an impact on agriculture and indirectly on economic growth of Turkey. The statistical data for this study was retrieved mainly through Turkish Statistics Institution (TUIK). Collected data and information was analyzed by combining qualitative and quantitative approach methods. Findings reveal that climate change affects economic growth and agriculture negatively. Therefore, the policies to be implemented for reducing the negative effects of climate change can contribute significantly to both economic growth and the agricultural sector.

Key words: agricultural sector, effects of climate change, Turkey, economic growth

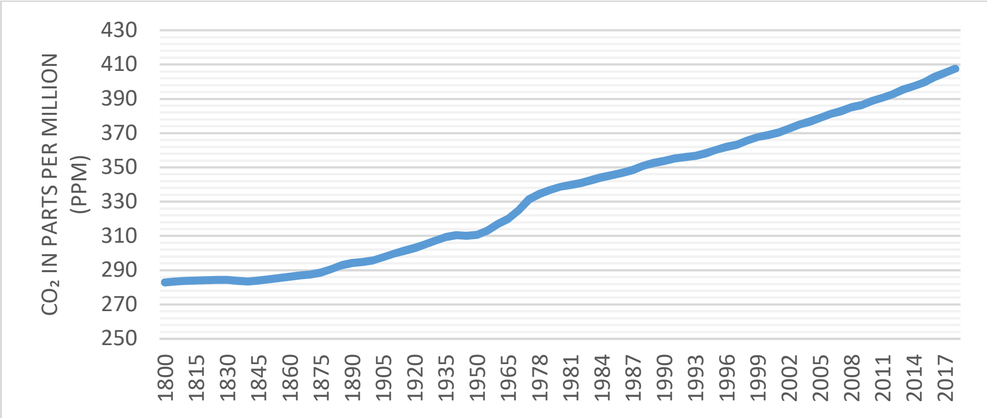
JEL classification: Q10, Q14, Q54, O13

1. Introduction

Increases in production and consumption, especially in the post-World War II period, brought up the increasing energy need. A number of environmental problems have emerged as a result of pressures caused by factors such as meeting these energy needs by using fossil fuel, unconsciously withdrawing raw materials from the environment, uncontrolled release of wastes to the environment as a result of consumption, increasing world population, rapid urbanization, deforestation and the use of chemical drugs in agriculture. And the climate change is biggest problem among environmental problems. Agriculture is considered most vulnerable to the climate change and the security of food is another issue that needs great concern.

Meeting these energy needs by using fossil fuel after the Industrial Revolution caused an increase in greenhouse gas emissions in the atmosphere. Measurements show that the concentration of carbon dioxide (CO_2), methane and nitrous oxide in the atmosphere has increased markedly as a result of human activities since 1750. CO_2 is the most important anthropogenic greenhouse gas. The CO_2 concentration in the atmosphere, which was 280 ppm (parts per million) before the Industrial Revolution, has increased to 379 ppm in 2005 (IPCC, 2007). And in 2011 the concentration of CO_2 has increased to 391 ppm and exceeded the natural range between 180 and 300 ppm (IPCC, 2013). The graph below shows the increase in CO_2 concentration in the atmosphere between 1800 and 2017.

Graph 1. Concentration of CO_2 (ppm) in the atmosphere between 1800 and 2017



Source: European Environment Agency, 2019

Climate change and global warming, which are associated with various factors such as temperature rise caused by high emissions of greenhouse gases, are an important threat to developed and developing countries. Significant reductions in greenhouse gas emissions from energy use, transportation and other sources, are important to avoid climate changes (Gomez-Zavaglia, Mejuto and Simal-Gandara, 2020). Floods, heat waves and storms that occur at regular intervals due to climate changes, has a negative impact on the agricultural production and livestock sector and harms the agricultural sector. Countries with these effects suffer great losses due to floods and storms. Farmers in underdeveloped countries, which could not improve their technology despite the world temperature increase in the last decade that changed the environmental ecosystem, use traditional breeding methods. Therefore, the failure to apply advanced agricultural methods to increase the output in these countries leaves the countries vulnerable to these losses. As a result, agricultural production decreases and the share of agriculture in the Gross Domestic Product (GDP) decreases (Khalid, Mahmood and Rukh, 2016). The climate change is projected to unfavorably distress to the agricultural outcome and countryside incomes. Therefore, precautions should be taken to reduce the problems in agricultural productivity (Chandio et al., 2020).

According to recent global evaluations, average surface temperatures have increased by around 0.6 °C over the past century. In the Sixth National Communication of Turkey report submitted to United Nations Framework Convention on Climate Change (UNFCCC) in 2016, it is stated that in western region of Turkey winter precipitation has decreased significantly in the last fifty years. On the other hand, autumn rains increased in the northern regions of Central Anatolia. Summer and spring rains did not show any trend. In the projections made for the future, an estimated decrease in total precipitation in Aegean and Mediterranean coast and increase throughout Turkey's Black Sea coast is expected. Summer temperatures in western cities of Turkey had increased in the last fifty years, winter temperatures in coastal areas generally showed a decrease. The average annual temperature increase of 2-3 °C is expected in Turkey until 2100, while summer temperatures in the western regions are expected to increase up to 6 °C. Turkey will be affected by the negative aspects of climate change such as the attenuation of water resources, drought and water stress increase, increase in forest fires, erosion, changes in agricultural productivity, ecological degradation, deaths due to heat waves and foodborne illness increase. It is also stated that Turkey is among the risk group countries (UNFCCC, 2016).

The effects of climate change on agriculture in Turkey have been a research issue since 2000s. There have been some empirical studies which were aiming of the past period effects of climate change in Turkey. In this study, we have been tried to understand how climate change has an impact on agriculture by examining data and other studies from previous years and to observe if it has an impact on economic growth of Turkey directly or indirectly.

2. Materials and Methods

The aim of this study was to examine the impacts of climate change on agriculture and on economic growth of Turkey. In order to understand the effects of climate change on Turkey's agriculture; area sown, production and yield of most produced four agricultural crops in Turkey were examined by using statistical data between 2000 and 2018. Those crops are wheat, barley, maize and chickpeas.

When the data of these agricultural crops was examined, it was observed that every year there was a fall in cultivation areas. According to the data of Turkish State Meteorological Service, precipitation in 2008, 2013 and 2017 was under average precipitation (Turkish State Meteorological Service 2020). When Figure 2 and Figure 3 were examined by taking area sown into consideration, it was found that there was a noticeable decrease in production and product yield in 2008. Also, there was a decrease in production and product yield in 2013 and 2017.

Table 2. Data of area sown, production and yield of wheat and barley between 2000-2018

Year	Wheat			Barley		
	Area sown (Decare)	Production (Tons)	Yield (Kg/Decare)	Area sown (Decare)	Production (Tons)	Yield (Kg/Decare)
2000	94 000 000	21 000 000	223	36 290 000	8 000 000	220
2001	93 500 000	19 000 000	203	36 400 000	7 500 000	206
2002	93 000 000	19 500 000	210	36 000 000	8 300 000	231
2003	93 000 000	21 000 000	226	36 000 000	9 000 000	250
2004	91 000 000	19 000 000	209	34 000 000	8 100 000	238
2005	92 500 000	21 500 000	232	36 500 000	9 500 000	260
2006	84 900 000	20 010 000	236	36 498 000	9 551 000	262
2007	80 900 000	17 782 000	220	29 500 000	5 923 000	201
2008	80 977 000	17 234 000	213	34 280 165	7 306 800	213
2009	81 000 000	20 600 000	254	30 100 000	7 300 000	243
2010	81 034 000	19 674 000	243	30 400 000	7 250 000	238
2011	80 960 000	21 800 000	269	28 688 331	7 600 000	265
2012	75 296 394	20 100 000	267	27 487 664	7 100 000	258
2013	79 192 084	19 000 000	240	27 872 973	6 300 000	226
2014	77 726 000	22 050 000	284	27 205 100	7 900 000	290
2015	78 668 874	22 600 000	287	27 835 830	8 000 000	287
2016	76 719 448	20 600 000	269	27 400 521	6 700 000	245
2017	72 992 701	20 000 000	274	26 119 403	7 000 000	268
2018	76 688 785	21 500 000	280	24 247 372	7 100 000	293

Source: Ministry of Agriculture and Forestry of Turkey, 2019

Table 3. Data of area sown, production and yield of maize and chickpeas between 2000-2018

Year	Maize			Chickpeas		
	Area sown (Decare)	**Production (Tons)**	**Yield (Kg/Decare)**	**Area sown (Decare)**	**Production (Tons)**	**Yield (Kg/Decare)**
2000	5 550 000	2 300 000	414	6 360 000	548 000	86
2001	5 500 000	2 200 000	400	6 450 000	535 000	83
2002	5 000 000	2 100 000	420	6 600 000	650 000	98
2003	5 450 000	3 000 000	550	6 060 000	620 000	102
2004	5 600 000	2 800 000	500	6 300 000	600 000	95
2005	6 000 000	4 200 000	700	5 578 000	600 000	108
2006	5 360 000	3 811 000	711	5 243 672	551 746	105
2007	5 950 000	4 274 000	718	5 051 654	518 026	103
2008	5 175 000	3 535 000	683	5 036 745	505 366	100
2009	5 920 000	4 250 000	718	4 559 344	562 564	123
2010	5 940 000	4 310 000	726	4 556 900	530 634	116
2011	5 890 000	4 200 000	713	4 464 129	487 477	109
2012	6 226 094	4 600 000	739	4 162 416	518 000	124
2013	6 586 450	5 950 000	894	3 885 175	450 000	116
2014	6 599 980	5 900 000	903	4 235 570	506 000	119
2015	6 881 699	6 400 000	930	3 593 042	460 000	128
2016	6 800 192	6 400 000	941	3 595 289	455 000	127
2017	5 919 003	5 700 000	923	5 144 159	630 000	122
2018	6 390 844	5 900 000	963	3 953 099	470 000	119

Source: Ministry of Agriculture and Forestry of Turkey, 2019

On the other hand, the changes in product yield caused by climate change and related ecological problems have adversely affected the agriculture sector economically. When the data shown in Figure 4 were examined, it was observed that the marketable value of agricultural products from past to present is getting lower than the production value of the agricultural products every year.

Table 4. Value of production and marketable of crop products in Turkey 2000-2019

Year	Crop Products			Year	Crop Products	
	Value of Production (TRY)	**Value of Marketable (TRY)**			**Value of Production (TRY)**	**Value of Marketable (TRY)**
2000	6 600 892 750	4 856 331 142		2010	28 464 470 262	22 108 721 336
2001	8 903 224 755	6 399 079 898		2011	35 708 465 221	27 875 672 874
2002	14 566 410 608	10 565 354 777		2012	33 158 241 882	25 512 087 590
2003	17 905 772 672	13 836 791 724		2013	39 124 023 862	30 093 338 087
2004	21 474 389 148	16 607 935 171		2014	42 170 007 141	32 938 000 192
2005	21 523 272 689	16 387 567 217		2015	49 519 631 343	38 213 189 415
2006	20 077 340 745	15 488 768 424		2016	47 985 465 088	37 582 476 309
2007	19 559 081 985	14 928 379 084		2017	56 119 498 611	44 071 923 191
2008	24 043 524 972	18 319 307 259		2018	62 215 074 201	49 109 670 090
2009	25 889 625 949	19 759 548 649		2019	77 550 084 250	60 943 897 945

Source: (TUIK) Turkish Statistical Institute, 2019

Due to falls of market value of agricultural products, decrease in quantity and the quality of the product, the share of the agriculture in the Gross Domestic Product of Turkey is decreasing every year. In Turkey, from the beginning of 1920s to the end of 1960s approximately 45 % of GDP was obtained from agriculture, its share in GDP decreased to 26 % in 1980. In 2000, it decreased to 10.1 %

(Yalcinkaya, Yalcinkaya and Cilbant, 2006). Throughout the process, this downward trend continued. The contribution of the agricultural sector to the economy, which was 9 % as of 2010 and decreased to 5.8 % by 2018 (TUIK, 2009).

Table 5. Annual GDP of Turkey and Share of Agriculture in GDP 2000-2018

Year	**Value (Thousand TRY)**	**Share (%)**
2000	17 205 761	10.1
2001	21 729 848	8.9
2002	36 901 720	10.3
2003	46 249 933	9.9
2004	54 365 145	9.4
2005	62 349 598	9.3
2006	64 415 593	8.2
2007	66 197 107	7.5
2008	74 451 345	7.5
2009	81 234 274	8.1
2010	104 703 635	9.0
2011	114 838 169	8.2
2012	121 692 893	7.8
2013	121 709 079	6.7
2014	134 724 745	6.6
2015	161 447 917	6.9
2016	161 304 618	6.2
2017	189 193 521	6.1
2018	216 666 387	5.8

Source: (TUIK) Turkish Statistical Institute, 2019

3. Results and Discussion

When the data obtained from the available statistics were interpreted, it was seen that the irregularity in the precipitation, which is one of the indicators of climate change and it causes the negative change in yield and quantity of products. These irregularities affect the agriculture sector economically. Therefore, the share of the agricultural sector in the country's GDP decreases.

It was seen that the low precipitation during 2008, 2013 and 2017 had negative impact on yield and quantity of products. Therefore, share of agriculture in GDP was decreased during those years. The share of agriculture in 2008 was not changed significantly but it decreased from 7.8 % to 6.7 % in 2013 and in 2017 from 6.2 % to 6.1 %.

Dumrul et al. (2017) studied the effects of climate change on Turkish agricultural sector for the period of 1961-2013 and found that agricultural gross domestic product was negatively affected by increase in temperature and decrease in precipitation and the same result was observed when we examined our data between 2000 and 2018.

Other studies in this area have been studied. According to the studies of Basoglu and Telatar (2013), 1-unit increase in annual precipitation change creates an increase of 0.06 unit in the share of agriculture sector in GDP. In addition, it was stated that 1-unit increase in annual temperature change causes 0.12 % decrease in the share of agriculture sector in GDP (Basoglu and Telatar, 2013).

Another research which is done by Dellal (2012); It was estimated that the productivity of the products will decrease throughout the country, the production quantity will decrease due to the decrease in yield, the product prices will increase, the producer welfare will increase by 8.3 % because of the increase in product prices, the consumer welfare will decrease by 1.7 % and the total welfare will decrease by 0.7 % (Dellal, 2012). According to Delince et al. (2015), at the global level, the climate change will cause a decrease in the yield between 2 % and 15 % by 2050 and this decrease will put pressure on global food prices, causing a price increase between 1.3 % and 56 % over the same period (Delince, Ciaian and Witzke, 2015).

4. Conclusion

The results suggest that climate change has negative impacts on the GDP of country. When the data obtained from the available statistics are interpreted, the contribution of agriculture in terms of Turkey's economy cannot be underestimated. However, the contribution of agriculture to GDP of Turkey is decreasing every year. The climate change is one of the reasons for this decrease. Because of irregularity in the precipitation, yield and quantity of products is constantly changing. And this change causes the indirect decrease in share of agriculture in GDP.

Findings reveal that climate change affects economic growth and agriculture negatively. Due to the low of precipitation, the inefficient product or the decrease in production has a serious effect on the market value of the agricultural product. Therefore, the policies to be implemented for reducing the negative effects of climate change can contribute significantly to both economic growth and the agricultural sector.

To improve our study, the effects of other criteria caused by climate change on agriculture and agriculture products can be studied. And it may give another perspective of negative effects of the climate change.

References

Basoglu, A. and Telatar, O. (2013), "The Impact of Climate Change: An Econometric Analysis on Agriculture", *Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü Sosyal Bilimler Dergisi*, vol. 3, no. 6, pp. 21-22, ISSN 2146-3727

Chandio, A. A., Jiang, Y., Rehman, A. and Rauf, A. (2020), "Short and Long-Run Impacts of Climate Change on Agriculture: An Empirical Evidence From China", *International Journal of Climate Change Strategies And Management*, vol. 12, no. 2, pp. 201-221, ISSN 1756-8692, DOI 10.1108/IJCCSM-05-2019-0026

Delince, J., Ciaian, P. and Witzke, H. P. (2015), "Economic Impacts of Climate Change on Agriculture: The Agmip Approach", *Journal of Applied Remote Sensing*, vol. 9, no. 1, ISSN 1931-3195, DOI 10.1117/1.JRS.9.097099

Dellal, I. (2012) "*Türkiye'de İklim Değişikliğinin Tarim Ve Gida Güvencesine Etkileri*", Türkiye'nin Birleşmiş Milletler İklim Değişikliği Çerçeve Sözleşmesi'ne İlişkin İkinci Ulusal Bildirimi Hazırlık Faaliyetlerinin Desteklenmesi Projesi (in Turkish)

Dumrul, Y. and Kilicarslan, Z. (2017), "Economic impacts of climate change on agriculture: Empirical evidence from ARDL approach for Turkey", *Journal of Business, Economics and Finance (JBEF)*, vol. 6, no. 4, pp. 336-347, ISSN 2146-7943, DOI 10.17261/Pressacademia.2017.766

Gomez-Zavaglia, A., Mejuto, J. C. and Simal-Gandara, J. (2020), "Mitigation of emerging implications of climate change on food production systems", *Food Research International*, vol. 134, ISSN 0963-9969, DOI 10.1016/j.foodres.2020.109256

Intergovernmental Panel on Climate Change (IPCC) (2007), "*A report of Working Group I of the Intergovernmental Panel on Climate Change "Summary for Policymakers""*, [Online], Available: https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-spm-1.pdf [Accessed: 01 April, 2020]

Intergovernmental Panel on Climate Change (IPCC) (2013), "*A report of Working Group I of the Intergovernmental Panel on Climate Change "Summary for Policymakers""*, [Online], Available: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_SPM_FINAL.pdf [Accessed: 01 April, 2020]

Khalid, A., Mahmood, F. and Rukh, G. (2016), "Impact of Climate Changes on Economic and Agricultural Value-Added Share in GDP", *Asian Management Research Journal*, vol. 7, no. 1, pp. 35-48

Turkish Statistical Institute (TUIK) (2009), Cari Fiyatlarla Tarimsal GSYH ve Tarimin Payi

Turkish State Meteorological Service (2020), Annual Precipitation in Turkey, [Online], Available: https://www.mgm.gov.tr/veridegerlendirme/yillik-toplam-yagis-verileri.aspx, [Accessed: 02 April, 2020]

United Nations Framework Convention on Climate Change (UNFCCC) (2016), Sixth National Communication of Turkey

Yalcinkaya, N., Yalcinkaya H. and Cilbant C. (2006) "Turkish Agriculture Policies Within the Framework of Arrangements for European Union and Effects on About the Future of Sector", *Yönetim ve Ekonomi,* vol. 13, no. 2, pp. 97-118

POSITIVE EFFECT OF CAPACITIES BUILDING PROGRAMS ON THE ADOPTION OF FARM CERTIFICATIONS IN PERU

Marcelo Herrera[1], Lety Gómez[2], Pedro Mateu[3] and Angie Higuchi[4]

[1, 2, 3, 4] Universidad del Pacífico, Peru

[1]m.herrerapostigo@alum.up.edu.pe, [2]lr.gomezd@alum.up.edu.pe, [3]pf.mateub@up.edu.pe, [4]a.higuchi@up.edu.pe

Annotation: Over the last decades, the demand of certificated agricultural products has been increasing around the world. However, in Peru, the proportion of certified farmers are still low. Capacities building programs (CBP), have been supported in order to promote participation of Peruvian farmers in the certification process. The objective of this study is demonstrating the positive effect of the capacities building programs (CBP) on the probability that Peruvian small and medium farmers would integrate an agricultural certification for their crops. Data from the Peruvian National Agricultural Survey of 2017 was used to find the relationship between attending a program of capacities building and the probability of having a certification. Two subsamples consisted on 25,440 observations were obtained in order to analyze the effect of the CPB on a certification adoption (organic agriculture for coffee and cocoa crops and GAP for banana and paddy rice respectively). A two-stage method was used based on the Propensity Matching Score technique. Outcomes of the study suggest that there is a positive and statistically significant relationship within the participation in these programs and the adoption of farm certifications. Results can help to define better public policies aimed to design an integrated system involving farm knowledge in order to help many agricultural families' wellbeing.

Key words: certification, capacities building programs, technical assistance, farmer training, Peru

JEL classification: Q13

1. Introduction

The European market increasingly demands more sustainable production practices and fairer food trade relations. Thus, the demand for healthy agricultural products with sustainable certifications have been increasing in recent years. This growth, initially fueled by the impact of the concern for safety and quality products on consumer habits, has spread around the world (Choque and Higuchi, 2019; Grunert, 2005). For example, in Europe, the per capita spending on organic food has doubled in the last decade and, currently this market has the highest organic market shares (FiBL, 2020). In this context, markets have begun to encourage the adoption of certifications, which are "guarantees" provided by authorized agencies that ensure certain quality standards (Andersen and Pazderka, 2003). And this has occurred for the main agro-export products of Peru, such as cocoa and coffee; as well as crops not so demanded by international markets, albeit with conditions that make the easy transition to certification possible, such as rice and banana. According to Gomez (2012), certifications are beneficial to farmers because they let producers access to more profitable markets and differentiation of their products. Moreover, they lead to rise their sales revenue, compensating the investment made to obtain it. However, in Perú, there are still many farmers who do not have any agricultural seal yet. In 2012, only1.1% of them claimed to have an organic certification (INEI, 2012). It is worth mentioning that agriculture is the sector with the lowest average income in the country.

Henson et al. (2011) and Tudela (2014) argue that there is a relationship between a farmer´s low participation in a certification process and the scarce availability of information. The latter is the reason why the use of technical assistance and training, which encompasses the concept of capacities building programs (CBP), have been supported in order to promote participation of Peruvian farmers in the certification process. On the one hand, these CBP enhance the little technical knowledge, which prevents farmers to enter to the main value chains (Jena, Chichaibelu, Stellmacher, and Grote, 2012). On the other hand, they also impact the updating information process and give incentives for the improvement of productivity techniques (Dunn, Sebstad, Batzdorff, and Parsons, 2006). Therefore, the objective of this study is demonstrating the positive effect of the capacities building programs (CBP) on the probability that Peruvian small and medium farmers would integrate an agricultural certification for their crops.

2. Materials and Methods

Data was based on the Peruvian National Agricultural Survey of 2017, published by the Peruvian National Institute of Statistics and Informatics (INEI in Spanish). It gathers information about the main agricultural, livestock and forest products, as well as the socio demographic characteristics of a sample of 29,610 Peruvian producers. As the focus of this study are the small and medium farmers, 25,440 observations that met the following criterions: According to INEI, small-scale farmers are identified mainly as the ones who have the lowest average income in the country, lack of educational resources, low use of family labor and also low allocation of their production to self-consumption. Differently, medium-sized farmers own more than 5 hectares and sale their production directly to local or regional markets.

It is necessary to clarify that this study is based on the premise that the training workshops have different effects on the certification. Thus, through a stratified sample design, two subsamples were obtained in order to analyze the effect of the capacities building programs on a certification adoption: 1) organic agriculture for coffee and cocoa crops and 2) good agricultural practices (GAP) for banana and paddy rice respectively. According to the National Service for Agri-Food Health and Quality of Peru, cocoa and coffee are an important part of the exportable supply of organic products, being Amazonas, Piura and San Martin within the five Peruvian regions with the highest number of organic producers in 2017 (SENASA, 2017). Thus, the first subsample considered farmers who work with an organic certification in cocoa and coffee from the three main regions above mentioned. Then, the second subsample was based on the efforts of institutions, such as the National Institute of Agrarian Innovation (INIA in Spanish), that have tried to spread improvements on agricultural production, especially in rice and banana crops. This has been generated in reaction to the increased international demand for this type of products, which, in turn, has motivated these crops in the north coast region, specifically Tumbes and Piura, where the best weather conditions were given (INIA, 2010).

In order to study the relationship between the capacities building programs and the probability of having an agricultural certification, a two-stage estimation process was followed using the Propensity Score Matching method. This method consists in finding the people who are most similar to the participants with regard to the relevant characteristics in the group of non-participants for the purpose of finding the effect of the program as the difference of the outcome variables between the treated and their respective partners (Caliendo & Kopeining, 2005).

In the first stage of the analysis, the probability of participation of each farmer was predicted through a *Probit* model for the two types of training, using the following specifications:

$$CB\_Org_i = \beta_0 + \beta_1 HC_i + \beta_2 AccCred_i + \beta_3 Asoc_i + \beta_4' X_i + \varepsilon_i \quad (1)$$

$$CB\_Gap_i = \beta_0 + \beta_1 HC_i + \beta_2 CredAcc_i + \beta_3 Asoc_i + \beta_4{}' X_i + \varepsilon_i \quad (2)$$

Table 1 shows the summary statistics of the variables included in equations (1) and (2).

Table 1. Summary statistics of variables

Variable	**Description**	**Total (n= 25440)**		
		Frecquency (Percent) 1	**0**	**Mean (S.D.)**
CB_Org_i	Dummy variable (1=the farmer participates in a capacities building program about organic productions; 0=does not participate)	1.46%	98.54%	-
CB_Gap_i	Dummy variable (1=the farmer participates in a capacities building program about good agricultural practices; 0 = does not participate)	8.37%	91.63%	-
HC_i	Number of travelling hours from the productive unit to the capital city (hours)	-	-	1.37 (1.856)
$CredAcc_i$	Have you applied for a loan in the last year? (1=yes, 0=no)	13.93%	86.07%	-
$Asoc_i$	Dummy variable (1=member of an association, 0=not a member)	7.17%	92.83%	-

Source: Own elaboration based on INEI, 2017

To guarantee the compliance of the Conditional Independence Condition (CI), which argues that participation in a program is not determined by unobserved variables, a common support is defined from the individual probabilities found on the previous stage (Caliendo & Kopeining, 2005). In this study, two techniques are used to evaluate the common support: common and trimming. The first one suggests eliminating observations below the minimum of one group and above the maximum of the other group, in order to have both distributions as similar as possible. The second technique uses a trimming process to define the common support region by the elimination of the 30% of the observations with the lowest density within the distributions (Smith and Todd, 2005).

In the second stage, after defining a common support based on the previously calculated probabilities, a probabilistic match between the treated group and the potential control group was performed in order to explore the relationship between attendance at capacities building programs and certifications. Furthermore, to ensure the robustness of the results, this method was tested using two forms of probabilistic matching: the nearest neighbor and the Gaussian Kernel. The first method consists in choosing an individual from the comparison group as a matching partner for a treated individual that is its closest in terms of propensity score. In the kernel matching method, all the observations treated are paired with a weighted average of all the control units. Likewise, the two techniques for the common support were used. Finally, a diagnosis of the matching quality was made through the standardized means difference (SMD) balance analysis, which consists in calculating the difference in means of each covariate between groups, divided by the standard deviation of the treated and control group. A value above 10% is a sign of imbalance between the groups (Zhang, Kim, Lonjon, & Zhu, 2019).

3. Results and Discussion

Relationship among CBP and organic certification

Table 2 presents results obtained in the initial stage, which predicts the individual probability of assistance in programs that involved the subsample of surveyed farmers whose crops were cocoa or coffee based on variables that affect their behavior according to empirical evidence.

Outcomes show that being a member of an association, the hours of distance between the productive unit and the capital, the proportion of production sold, and the use of compost are statistically significant and have a positive impact on the probability of attending a workshop on organic agriculture issues (Table 2). On the other hand, the use of fertilizers has a significant and negative effect on this probability. This result could be associated with the type of fertilizer commonly used by this class of farmers, which is presumed to be chemical.

Table 2. Effect of interest variables on the probability of attending a capacities building program on organic production.

VARIABLES	B (Standard errors)	P-Value
Credit Access	0.137	0.208
	(0.109)	
Association	1.505***	0.000
	(0.1000)	
Hours_distance	0.0562***	0.009
	(0.0214)	
Another_occu	-0.0600	0.557
	(0.102)	
Prop_prod_sold	0.631***	0.000
	(0.136)	
Total_plots	-1.98e-06	0.517
	(3.05e-06)	
Age	0.00153	0.674
	(0.00362)	
Sex	0.0675	0.619
	(0.136)	
Fertilizer	-0.237**	0.023
	(0.104)	
Compost	0.889***	0.000
	(0.104)	
Constant	-3.235***	0.000
	(0.271)	
Observations	4,118	

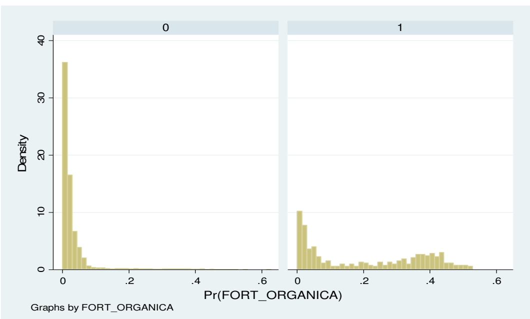
*** p<0.01, ** p<0.05, * p<0.1

Source: own elaboration based on INEI, 2017

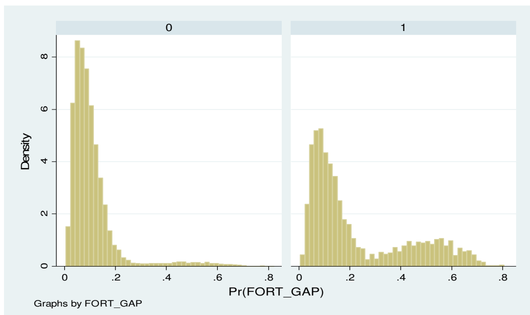
The next step analyzes the distribution of individual participation probabilities. Figure 1 shows that the treated and the potential control groups share almost the same probabilities of attending organic agriculture workshops in the range of low occurrence probabilities. This evidence partially corroborates the compliance of CI, which allows an unbiased matching estimator. Finally, the balance of compared groups was tested by the SMD analysis in order to verify the quality of the match (Zhang, Kim, Lonjon, & Zhu, 2019).

Figure 1: Probability distribution of the treatment and control groups

Capacities building in organic matters



Capacities building good agricultural practices



Source: Own elaboration based on National Institute of Statistics and Informatics of Peru.

In the second stage, the estimated impact of the attendance to the workshop with the nearest neighbor and trimming technique was 0.38 standard deviations, with a significant effect at 1% confidence. It implies that having attended capacity building programs on organic issues generate an increase on the probability of having a certification. Similarly, the estimated impact using kernel matching was 0.43 standard deviations. The results of SMD test confirms the quality of the pairing carried out because almost all the biases associated with the variables do not exceed 10% (Table 4). While the research of Henson et al. (2011) incorporated training (technical assistance) as a determinant of the farmer's decision to obtain the GlobalGAP certification, this study concluded that attending instructional programs (CBP) influence on the probability that farmers would integrate an organic certification.

Relationship among CBP and GAP certification

The results were analyzed within the subsample of surveyed farmers whose plantations were banana and paddy rice. Table 3 shows obtained in the first stage.

Table 3. Effect of interest variables on the probability of attending a capacities building program on good agricultural practices.

VARIABLES	B (Standard errors)	P-Value
Credit access	0.290***	0.000
	(0.0710)	
Association	1.160***	0.000
	(0.0730)	
Hours_distance	-0.00810	0.618
	(0.0162)	
Another_occupation	0.0614	0.354
	(0.0662)	
Prop_prod_sold	0.293***	0.001
	(0.0902)	
Total_plots	-9.07e-07	0.567
	(1.58e-06)	
Age	-0.00878***	0.000
	(0.00234)	
Sex	0.103	0.215
	(0.0827)	
Fertilizer	-0.329***	0.000
	(0.0736)	
Compost	0.551***	0.000
	(0.0679)	
Constant	-1.365***	0.000
	(0.166)	
Observations	3,842	

*** p<0.01, ** p<0.05, * p<0.1

Source: own processing based on INEI, 2017

Aftermaths show that access to credit, being part of an association, the proportion of production sold and the use of compost present positive and significant impact on the probability of participation, as in the previous case. On the other hand, use of fertilizers negatively affects the probability of attending these workshops (Table 3). Figure 1 also shows a probability distribution with similar behavior between the treated and the potential controls for good agricultural practices workshops. In the same way as the previous case, this relationship seems to be fulfilled only for low individual probabilities.

In the second stage, under a trimming support at 30%, the estimated impact of this training with the nearest neighbor technique was 0.07 standard deviations, with a significant effect at 1% of confidence. Similarly, the impact using kernel matching was 0.07 standard deviations. Finally, except for fertilizers, no variable has a bias above 10%. Therefore, it is possible to affirm the absence of an imbalance between the groups compared (Table 4).

Table 4. Results of Bias Test for the organic and good agricultural practices (GAP) groups

Variables	Credit access	Association	Hours_distance	Another_occupation	Prop_prod_sold	Total_plots	Age	Sex	Fertilizer	Compost
Organic	0.0	3.6	2.8	7.6	-4.2	7.6	6.2	-6.9	-16.8	-7.7
GAP	1.1	-1.9	2.4	3.1	1.5	4.0	1.6	-0.7	0.0	3.5

Source: own processing base on National Institute of Statistics and Informatics of Peru.

Outcomes indicate that the probability of participation has a positive contribution to the probability of being certified in both cases. Therefore, it will be necessary for the government to continue promoting agronomic knowledge programs for agricultural dependent families. In this way, farm certifications will boost international sales which are translated on the farmers‘ competitiveness as well as the quality life of their families.

To this end, the scope of technical assistance and training services that the Government, throught the Peruvian ministry of agriculture provides together with other institutions, mainly the National Service for Agrifood Health and Quality (SENASA) and INIA, should be expanded to provide tools that prepare farmers to enhance their low level of participation on getting a farm certification for their crops. In light of the results found in both cases, improving credits and loans for small and medium producers, for example, through low interest rates, is a way of dealing with the limited availability of the farmers‘ financial resources. In addition, the association among producers through an organization that promotes participatory methodologies and technical assistance should be supported, since it plays a vital role as a channel of access to this education type in order to perform better farm practices and get a certification. For example, work of the Rural Agrarian Development Program should be focused on improving associativity amid farmers in order to reduce educational transaction costs for these vulnerable groups. Similarly, offering means that allow farmers to allocate most of their production for sale should be considered to promote participation. Finally, it is also necessary to foster the participation of other institutions, without duplicating efforts, such as NGOs, given the positive results generated by supporting farmers in rural regions.

4. Conclusion

The purpose of the research was to evaluate the contribution of capacity building programs (CPB), that is, technical assistance and training, on the probability of Peruvian small and medium farmers to have a certification (organic or GAP). Therefore, a two-stage estimation process was carried out under the Propensity Score Matching scheme. The results about the programs on organic production suggest that access to credit, the hours of distance between the productive unit and the capital, the proportion of production sold, the use of compost and the association are some variables that present a positive participation on the probability of attending this type of capacity building programs. All of these are statistically significant except for the first variable. Also, the difference in the probability of having a quality certification between those who attended the organic agriculture capacity building programs and the control group was 0.408. On the other hand, regarding the programs on good agricultural practices, the results indicate that the access to credit, the use of compost and the association through an institution has a positive impact on the probability of attending this type of capacity building programs. In this case, the difference between the comparable groups was 0.109.

Finally, the Peruvian government by means of the Peruvian ministry of agriculture should enhance capacities building programs for the country's most vulnerable communities in order to reduce information asymmetries and support certification for improving the Peruvian farmers' economy. One to accomplish it is through implementing means that allow farmers to trade their production to the public. Similarly, regarding the outcomes of this study, projects like the Rural Agrarian Development Program should also focus on stimulating association between producers through the application of participatory experiences by means of institutions reducing transaction costs at the same time. Furthermore, improving credit access for small and medium farmers are essential to provide them with the necessary resources for investment in farm education and certification. For example, rural banks should offer loans with low interest rates conditioned on obtaining a farm certification in the near future.

References

Andersen, M., and Pazderka, C. (2003), "¿Es la certificación algo para mí? - Una guía práctica sobre por qué, cómo y con quién certificar productos agrícolas para la exportación", *Series de publicaciones RUTA*, Costa Rica, pp.1 – 21, ISBN 9968-866-30-X

Choque, I. and Higuchi A. (2019), "The motivational profile of quinoa consumers in modern metropolitan Lima, Peru", *Proceedings of Agrarian Perspectives XXVIII*, Prague, pp. 83 – 90, ISBN 978-80-213-2973-7

Caliendo, M. and Kopeining, S. (2005), *"Some practical guidance for the implementation of Propensity Score Matching",* German Institute for Economics Research, ISSN 1433-0210

Dunn, E. G., Sebstad, J., Batzdorff, L. and Parsons, H. (2006),*"Lessons Learned on MSE Upgrading in Value Chains",* microREPORT #71, Washington DC, [Online], Available: https://url2.cl/bYcs3, [Accessed: 23 Feb., 2020]

FiBL (2019), *"The World of Organic Agriculture Statistics and Emerging Trends 2020",* Switerland, Research Institute of Organic Agriculture, ISBN 978-3-03736-150-7 Available: http://www.organic-world.net/yearbook/yearbook-2020.html, [Accessed: 23 Apr., 2020]

Henson, S., Masakure, O. and Cranfield, J. (2011), "Do Fresh Produce Exporters in Sub-Saharan Africa Benefit from GlobalGAP Certification?", *World Development*, vol. 39, no. 3, pp. 375 - 386, ISSN 0305-750X, DOI 10.1016/j.worlddev.2010.06.012

Jena, P. R., Chichaibelu, B. B., Stellmacher, T. and Grote, U. (2012), "The impact of coffee certification on small-scale producers' livelihoods", *Agricultural Economics*, vol. 43, no. 4, pp. 429-440, E-ISSN 1574-0862, DOI 10.1111/j.1574-0862.2012.00594.x

INEI, IV Censo Nacional Agropecuario 2012, Base de Datos REDATAM, 2019, [Online], Available: http://censos.inei.gob.pe/Cenagro/redatam/, [Accessed: 29 Sep., 2019]

Smith, J. and Todd, P. (2005), "Does matching overcome LaLonde's critique of nonexperimental estimators?", Journal of Econometrics, vol. 125, pp. 305-353, ISSN: 0304-4076, DOI 10.1016/j.jeconom.2004.04.011

Tudela, J. W. (2014), "*Adopción de Tecnologías Orgánicas en Productores Cafetaleros del Perú: Identificación y caracterización*", Consorcio de Investigación Económica y Social, Puno, 2014, [Online], Available: https://n9.cl/4ygh, [Accessed: 23 Dec., 2019]

Ministerio de Agricultura y Riego (2019), Dirección de Seguimiento y Evalución de políticas, Informe de seguimiento al fortalecimiento de capacidades, [Online], Available: http://tiny.cc/o4iwnz, [Accessed: 23 Apr., 2020]

Zhang, Z., Kim, H. J., Lonjon, G. and Zhu, Y. (2019), "Balance diagnostics after propensity score matching", *Annals of Translational Medicine*, vol. 7, no. 1, pp. 16, ISSN 2305-5839, E- ISSN 2305-5847, DOI 10.21037/atm.2018.12.10

FARM VIABILITY PREDICTION IN AREAS FACING NATURAL CONSTRAINTS IN THE CZECH REPUBLIC

Tomáš Hlavsa[1], Renata Aulová[2], Zuzana Pacáková[3] and Zuzana Hloušková[4]

[1, 4] Institute of Agricultural Economics and Information, Mánesova 1453/75, 120 00 Prague 2

[2] Department of Economics, [3]Department of Statistics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]tom.hlavsa@gmail.com, [2]aulova@pef.czu.cz, [3]pacakova@pef.czu.cz, [4]hlouskova.zuzana@uzei.cz

Annotation: Farm sustainability is one of the important issues of Common Agricultural Policy (CAP) payments to farmers in mountain areas or in other areas facing natural or other specific constraints (ANC). Maintaining income levels, developing farm economies in rural areas, and encouraging competitive agricultural practices are the challenges facing the programming period for public policies. ANCs in the Czech Republic are characterized by a lower level of income compared to areas outside ANCs. The paper deals with assessment of economic viability and predictors of this viability of farms operating in Czech ANCs. Logistic regression and decision trees were developed to find factors that are of significant relation to economic viability. Lower viability can be seen in ANCs that show higher dependence upon current subsidies, including ANC payments, a higher share of unpaid labour, lower production and higher costs per one unit of production (cost factor). Cost factor and size group (ha UAA) were the most important factors among all ANC groups. Cost factor is in negative relation to economic viability; the farms with lowest UAA of ha are of lower economic viability, compared to large farms. Farm specialization seems not be an important factor in case of non-ANC farms. Relatively successful are Grazing livestock farms in ANC, on the other hand this group is highly dependent upon subsidies.

Key words: Farm Net Value Added, decision trees, logistic regression, prediction, viability

JEL classification: B41, C10, C30, Q14, Q18

1. Introduction

Farm sustainability is one of the important issues of Common Agricultural Policy (CAP) payments to farmers in mountain areas or in other areas facing natural or other specific constraints (ANC). The purpose of ANC payments is to provide compensation to farmers for the natural or specific disadvantages of farming in areas with natural or specific handicaps "by encouraging continued use of agricultural land and contributing to maintaining the countryside as well as to maintaining and promoting sustainable farming systems". The compensation payment shall ensure the economic viability of farms in the countryside, especially in mountain areas.

Assessment of sustainability at the farm-level covers a wide range of indicators. These are used for identifying and quantifying aspects of sustainability and are commonly aggregated into environmental, social and economic dimensions (Kuosmanen and Kuosmanen, 2013; Astier et al., 2012; Mayer, 2008; Schader et al., 2014; Hildeń, Jokinen and Aakkula, 2012). Mainly economic and social dimension demand consistent and robust indicators and methods (Finkbeiner et al., 2010). Economic dimension in sustainable concept assessment is usually focused on variety of performance indicators and the cost (manufacturing costs, life cycle costs) calculation (Schader et al., 2014; Finkbeiner et al., 2010; Meul et al., 2008). In this paper we have focused on economic viability framework as a complexed economic indicator in sustainability assessment at farm-level.

Economic viability has no universal definition. A study (O'Donoghue et al., 2016) compares different definitions of economic viability in previous literature. The crucial finding is a difference between the US and the European concepts of economic viability. Whereas the US and Canadian experts define viability in terms of meeting the income needs of the farm family, the European definitions understand viability as an opportunity cost measure. Economic viability is mainly measured by profitability, liquidity, stability and productivity (Latruffe et al., 2016). The first three categories have been frequently used in financial statement analyses (Gibson 2013). Research studies used the financial ratios as indicators of firm economic viability such as return on investment, debt to net income ratio, expense to income ratio, direct payments to producers and dependency, return to equity (Slavickiene and Savickiene, 2014b; Blazkova and Dvoulety, 2018), profitability of sales, profitability of assets, percentage coverage ratio (profit to interest charges) and debt to equity ratio (Koleda and Lace, 2010). One of the most significant problems of financial ratios is a purely accounting perspective which does not consider the opportunity cost of owning land, labour and capital. Authors suggest that viability assessments through financial indicators is rather financial viability than economic viability because it does not consider productivity and opportunity costs. Productivity is one of the most popular ways how to measure economic viability. Productivity is a measure of the ability of the factors of production to generate output (Latruffe et al., 2016), either as partial productivity of labour, land, capital (Slavickiene and Savickiene, 2014a; Ryan et al., 2016), total factor productivity (Davidova et al., 2005) or technical efficiency (Latruffe and Desjeux, 2016). When considering both family farms and legal entities together (typically in Czech ANCs), the productivity indicators are the best solution for calculating economic viability and sustainability, despite some bias in the evaluation of family farms (Spicka et al., 2019).

Farm size (Davidova et al., 2005; Slavickiene and Savickiene, 2014a), farm specialization (Ryan et al., 2016; Vrolijk et al., 2010) and farm systems are considered important factors affecting farm viability. The viability of farming varies substantially among farm systems. More viable are dairy farms, whereas farms with grazing livestock obtain worse results. The analysis by Balezentis and Novickyte (2018) revealed that general field cropping and horticultural Lithuanian family farms are characterized by relatively higher profitability and growth than other farm types.

Based on modified profit indicator, this paper aims to examine the selected predictors of economic viability of farms operating in areas facing natural constraints in the Czech Republic.

2. Materials and Methods

The objective of this article is to examine selected predictors of economic viability of farms operating Czech ANCs.

The main objective is fulfilled by way of the following sub-objectives: i) estimation of Modified Profit; ii) development of two predictive models – logistic regression and decision trees; iii) identification of important factors effecting prediction of Modified Profit

The data set we used was obtained from the FADN CZ database and Land Parcel Information System (LPIS) for the period 2011-2017. The FADN database provides internationally comparable data for assessing the income of agricultural holdings and the impacts of the Common Agricultural Policy (Vrolik et al., 2010; Andersen et al. 2007). From this point of view, it can be stated as a powerful tool for the evaluation of the economic viability of farms.

For the classification of individual farms according the methodology of ANC 2018, the Land Parcel Information System (LPIS) and the share of the utilized agricultural area (UAA) belonging to the ANC were used. Farms with more than 50% of the agricultural land situated outside the ANC (non-ANC) are marked as farms in favoured natural conditions. Mountain ANC (ANC-M) farms are those with more than 50% of the UAA in the mountain regions. Other than mountain ANCs (ANC-O) are represented by farms with more than 50% of the UAA in the ANC and less than 50% in a mountain ANC.

Economic prosperity by ANC farms was measured by the following indicators:

- Farm net value added (FNVA) per annual working unit (AWU)
- Modified profit

Farm Net Value Added is calculated as total production plus balance current subsidies and taxes minus total intermediate consumption and minus depreciation. FNVA represents remuneration to the fixed factors of production (work, land and capital), whether they be external or family factors. As a result, holdings can be compared irrespective of their family/non-family nature of the factors of production employed. FNVA should cover not only the paid wages of employees but also the expected income for an unpaid labour force including owners. Modified FNVA (MFVA) was used in the calculation of profit.

$$MFNVA = Farm\ net\ value\ added - Wages - Interest\ paid - Rent\ paid \qquad (1)$$

Subsequently, the reference average income per unpaid worker (Family Working Unit – FWU) was established. This income was used as the opportunity cost to farmer's unpaid labour and the modified profit was calculated. Expected income for unpaid labour is represented by costs at level of paid labour, which is available in the FADN. Paid labour cost was used to estimate the opportunity cost for FWU, and the level of modified profit was calculated according to the following formula:

$$Modified\ profit = Modified\ FNVA\ - FWU * average\ paid\ labour\ costs \qquad (2)$$

Based on (2) the authors classified the farms into two classes and created binary variable, which is used as the target variable in modelling process. A farm with Modified profit per Annual Working Unit (MP/AWU) > 0 is considered economically viable. MP/AWU <= 0 represents farms for which Modified profit does not cover opportunity costs of wages, and therefore is not considered economically viable.

Following variables were chosen as the explanatory predictors for classification of farms into the correct category of target variable (farms with MP/AWU > 0 and farms with MP/AWU <= 0): Cost factor, Indebtedness, share of Current subsidies on Farm Net Value Added (FNVA), Farm specialization and Size group (based on utilized agricultural area UAA).

Table 1. Variables used in predictive analysis

Variable	Description
Target variable	
Modified Profit/AWU	0: MP/AWU <=0; 1: MP/AWU<0
Explanatory variables	
Cost factor	Total costs/Total production (CZK/CZK)
Indebtedness	Long- and short-term liabilities/Total Assets (%)
Current subsidies/FNVA	Current subsidies/Farm Net Value Added (%)
Farm specialization	1: Grazing Livestock; 2: Milk; 3: Field crops; 4: Mixed
Size group	1: up to 300 hectares of utilized agricultural area; 2: 300-499; 3: 500-899; 4: 900-1799; 5: 1800-2499; 6: >=2500

Source: own elaboration

To understand and summarize the states of viability of farms, classification methods were used. Various prediction models are widely used to predict farm business failure, the first attempts can be dated to 1960's. Since the 1960s, financial ratios grouped in the multivariate credit scoring models experienced a boom (Altman, 1968). They measure the financial condition of the company using multidimensional analysis and predict the risk of business failure. Other authors (Deakin, 1972; Blum, 1974; Lin, 2009) have later introduced their prediction model based on multivariate discriminant analysis (MDA), while others have discussed the limits of MDA resulting especially from the data assumptions. Therefore, Ohlson (1980) has introduced a logistic regression prediction model. Logistic regression is still one of the most widely used business failure prediction method, used also as a reference method, when different prediction models are compared (Lin, 2009; Gepp and Kumar, 2015; Klepac and Hampel, 2017). In recent years, the business failure prediction models are often built upon modern datamining techniques, aiming to find a model without strict requirements on data matrix character. Among these methods, decision trees, are the most commonly used methods (Koyuncugil and Ozgulbas, 2012; Klepac and Hampel, 2017).

Logistic regression

Logistic regression is a regression model with binary dependent variable. It predicts the probability of an event occurring based on a set of variables, that can be both categorical as well as quantitative. The relation between probability an event occurs, that is P(Y=1), and the set of explanatory variables is given by following equation

$$\ln\left(\frac{P}{1-P}\right) = \beta_0 + \sum_i \beta_i x_i \qquad (3)$$

If the value of exp b is greater than 1, it indicates that as the predictor increases, the odds of the event occurring increase as well. Parameters of the logistic regression equation are estimated using maximum-likelihood estimation. The parameters were tested with a Wald test for joint significance. More crucial to the interpretation of logistic regression is the value of exp b, which indicates the change in odds (the probability of an event occurring divided by the probability of the event not occurring) corresponding to a unit change in the predictor. (Tufféry, 2011; Mzoughi, 2011).

Decision trees

Decision tree is structured as a sequence of simple questions. The answers to these questions determine what next question, if any, is posed. The result is a network of questions that forms a tree-like structure. There was employed Chi-Square Automatic Interaction Detector model (CHAID). It allows multiple splits on a variable. For classification of subjects according to binary variable Modified Profit, it relies on the Chi-square test to determine the best split at each step. First the continuous predictors were binned to create a set of categories, where each category is a subrange along the entire range of the variable. This binning operation permits CHAID to accept both categorical and continuous inputs. The categories of each variable are analyzed to determine which ones can be merged safely to reduce the number or categories. The algorithm searches for the split point with the smallest adjusted p-value of the Chi-Square test (Abbott, 2014; Tufféry, 2011). All analyses were carried out using IBM SPSS.

3. Results and Discussion

The results of main indicators by farm classification are summarized in Table 2. Generally higher labour intensity is associated with Milk production, which has the highest AWU/100 ha. A lower share of paid annual working unit (AWU) is evident in mountain ANC and in Grazing livestock farms, where about half of the AWU is unpaid. Mountain ANCs show a higher rate of Cost factor (total costs/total production), which is a risk factor for farm viability. The table also shows a lower FNVA/AWU in mountain and other than mountain areas and a lower FNVA/AWU in Grazing Livestock and Milk specialization. A high dependence on subsidies can be recognized in mountain ANCs especially, where the entire FNVA is covered by subsidies. The same may be concluded for the Grazing livestock specialization, where the share of operating subsidies to FNVA is approximately 138%. ANC payments play an important role in farms in mountain areas and Grazing livestock specialization, for which about one fifth of total operating subsidies is represented by ANC payments.

Table 2. Descriptive statistics of selected farm types

	ANC			**Farm specialization**			
	M	**O**	**Non**	**Grazing livestock**	**Milk**	**Field crops**	**Mixed**
Count	1 342	3 676	3 475	1 550	1 018	3 157	2 768
Average ha UAA per farm	187	223	254	139	289	193	347
Own land/ UAA (%)	28.70	19.40	19.29	32.70	17.45	21.93	16.03
AWU/100 ha	2.62	2.63	2.59	2.15	3.78	2.04	3.01
Paid AWU/ total AWU (%)	71.97	75.97	81.56	49.85	85.37	68.88	88.07
Indebtedness (%)	25.14	28.93	25.76	19.83	33.30	23.27	29.57
Cost factor	1.38	1.19	1.08	1.66	1.18	1.06	1.15
FNVA/AWU (CZK)	489 251	513 494	633 285	474 929	493 817	665 525	542 610
Current subsidies/FNVA (%)	107.41	78.86	56.57	138.30	72.78	59.45	64.77
ANC payments/Current subsidies (%)	19.25	8.02	0.54	18.33	10.02	1.25	5.11

Source: FADN CZ 2011-2017, own calculation

Note: FNVA=Farm Net Value Added; AWU=Annual Working Unit; Cost factor=Total costs/Total production

Various papers confirmed that the farm economy in less favoured areas (LFA; since 2018 ANCs) is different comparing to those outside (Lososova and Zdenek, 2013; Hlavsa et al., 2020). Due to different natural conditions (ANC types), predictive models were built separately for ANC-H, ANC-O and non-ANC.

Two predictive methods were examined to find factors that are of significant relation to economic viability. The first one, logistic regression, provided more general look at the factors in various ANC groups. The CHAID decision tree, on the other hand, makes it possible to study the relations more deeply, that is for subgroups based on size farm or farm specialization.

Table 3. Logistic regression results

	ANC – M			**ANC – O**			**Non – ANC**		
Variable	**B**	**S.E.**	**Exp(B)**	**B**	**S.E.**	**Exp(B)**	**B**	**S.E.**	**Exp(B)**
Cost factor	-0.62**	0.12	0.54	-0.91**	0.11	0.40	-1.56**	0.17	0.21
Indebtedness	0.66	0.43	1.94	0.47*	0.19	1.60	0.43*	0.21	1.53
Current subsidies	-0.04*	0.02	0.957	0.00	0.00	1.00	-0.02	0.01	0.98
Farm specialization									
1	1.03**	0.23	2.80	0.60**	0.14	1.82	-0.35	0.30	0.70
2	1.61**	0.24	4.98	-0.01	0.12	0.99	0.07	0.22	1.07
3	-0.10	0.47	0.90	0.59**	0.11	1.80	0.10	0.10	1.10
Size Group									
1	-3.05**	0.81	0.05	-3.03**	0.24	0.05	-3.49**	0.28	0.03
2	-0.49	0.86	0.61	-0.42	0.27	0.66	-1.12**	0.31	0.33
3	-0.02	0.82	0.99	-0.51*	0.25	0.60	-0.70*	0.30	0.50
4	-0.15	0.81	0.86	-0.31	0.24	0.73	-0.80**	0.29	0.45
5	0.44	0.92	1.56	0.15	0.28	1.17	-0.81*	0.32	0.45
Constant	1.98*	0.81	7.22	2.34**	0.26	10.41	3.93**	0.32	50.95

Source: FADN CZ 2011-2017, own calculation

*Note: * and ** denote significance at 5%, resp. 1% level*

In the group of mountain ANC (ANC-M) farms all but the Indebtedness variables were found significant predictors of economic viability. The higher the cost factor and the higher the Current subsidies, the lower the odds of economically viable farm. The Farm specialization was also found as a significant predictor. This categorical variable is of four categories, the last one (Mixed specialization) has been used as the reference category. Therefore, it can be assumed, that farms with specialization in Grazing livestock or Milk are of higher chance of being economically viable (Exp(b) = 2.80 and 4.98 resp.). Size group was found the most important factor in decision tree models; however, the results differ among the ANC groups. The Size group variable is of six categories, with the last one (above 2500 ha) used as the reference category in logistic regression model. There is a significant difference between the last and the first size category (up to 300 ha), while the farms in the first group are of lower economic viability compared to the largest farms.

Cost factor, Indebtedness, Farm specialization and Size group were found significant predictors in the group of other than mountain ANCs (ANC-O). Cost factor is of negative relation to economic viability (b = -0.91), while the Indebtedness is in positive relation to it. Farms with higher Indebtedness level have about 1.6 times higher chance of being economically viable

(Exp(b) = 1.60). For categorical variable Farm specialization, categories were compared to the reference one (Mixed). Farm with specialization in Grazing livestock and Field crops are of significantly higher economic viability, compared to the Mixed specialization (Exp(B) = 1.82, resp. Exp(B) = 1.80). On the other hand, farms with lower UAA size in ha, were often found less economically viable, compared to the group of farms with more than 2500 ha (Exp(b) = 0.05 for size group below 300 ha and Exp(b) = 0.60 for 500-900 ha size group).

In the group of non-ANC farms, only three factors were found statistically significant for economic viability prediction: Cost factor, Indebtedness and Size group. Cost factor is of negative impact (Exp(b) = 0.21, while the higher the Indebtedness of farms in this group, the higher the chance of being economically viable (Exp(b) = 1.53). For Size group indicator, all contrast to the last category (above 2500 ha) were found statistically significant. Farms with smaller UAA size were found less economically viable, with Exp(B) between 0.03 and 0.50.

Therefore, it can be assumed, that the Cost factor and Size group were the most important factors among all ANC groups. Cost factor is in negative relation to economic viability in all three groups. The group of farms with the lowest UAA size in ha is of lower economic viability in all ANC groups, compared to large farms. On the other hand, Farm specialization seems not to be an important factor in case of non-ANC farms.

Using decision trees (CHAID procedure), more detailed results for subgroups of farms can be found. Let put stress on ANC-M. Considering the predictor variables, Cost factor, Indebtedness, Current subsidies/FNVA, Farm specialization and Size group, we can see that the algorithm found a splitting point that perfectly distinguished the farms up to 300 ha from other size groups (Chi-Square = 436.9; $p<0.001$). In the smaller size group up to 300 ha, there is a higher share of farms with a negative value of Modified Profit. The second split of the farm group up to 300 ha is on Farm specialization (Chi-Square = 115.9; $p<0.001$), where better results show Milk farms. Following the results from first split, the group of farms with more than 300 ha were within the second split divided into three subgroups by Cost factor (Chi-Square = 56.95; $p<0.001$). The rules is: when Cost factor is equal to or less than 1.195, then Modified Profit > 0 is characterized, when Cost factor lies between 1.195 and 2.66, then raised proportion of threatened farms with Modified Profit <= 0, when Cost factor exceeds 2.66, then the proportion of these farms is raised even more.

Size group was the first splitting variable in ANC-O as well as in ANC-M. Three relative internally homogenous groups were created; up to 300 ha, 300-1800 ha and over 1800 ha (Chi-Square = 1141.251; $p<0.001$). Considering first group up to 300 ha, there was a largest share of farms with negative Modified Profit. The bigger the size group, the less farms with negative Modified Profit was recorded. When we have an insight in the smallest group up to 300 ha, the second split is on Indebtedness (Chi-square = 128.816; $p<0.001$), where the most threatened farms are those with higher Indebtedness. The other Size groups from first split (300-1800 ha and over 1800 ha) worked within second split with Cost factor (Chi-Square = 281.512; $p<0.001$ for 300-1800 ha and Chi-Square = 90.872; $p<0.001$ for farms over 1800 ha). More farms from both nodes with negative Modified Profit were recorded in groups with higher Cost factor.

Similarly, also in the group Non-ANC (comparing to ANC-O) the first splitting was created using Size group. Three groups were built: up to 300 ha, 300-2500 ha and over 2500 ha

(Chi-square = 1088.127; $p<0.001$). As the size group increases, the share of farms with negative Modified Profit increases as well. The second split in the group up to 300 ha was based on Current subsidies/FNVA (Chi-Square = 153.611; $p<0.001$). The higher the share of Current subsidies on Farm Net Value Added, the more farms with negative Modified Profit. For the remaining Size groups from the first split, Cost factor was found the most important in the second split (Chi-square = 494.558; $p<0.001$ for 300-2500 ha and Chi-Square = 41.931; $p<0.001$ for farms over 2500 ha). In both Size groups greater proportion of farms with negative Modified Profit was related to the higher Cost factor.

The results are in accordance with selected findings of Stolbova and Micova (2012) and Lososova and Zdenek (2013). First paper shows that large farms situated in less favoured areas (LFA; since 2018 ANC) are more successful than small farms. The second paper states that the extensive farms in mountain areas are even more successful, however, they are highly dependent upon support aid. Field crops are the least dependent upon subsidies, which is consistent with the results of Lososová and Zdeněk (2014). More intensive enterprises with higher labour inputs in the Milk specialization (3.78 AWU/100 ha) show a relatively favourable viability with a lower percentage of threatened enterprises compared to the other groups of specialization. This corresponds to conclusions of Vrolijk et al. (2010). Doucha, Štolbová and Lekešová (2012) analyzed the impact of agricultural policy on the economy of farms in Czech LFAs. A multi-criteria impact assessment shows that under the Czech conditions for support in LFAs, the economic situation of larger extensive farms, measured by the Farm Net Value Added per one Annual Working Unit, is very good, even in comparison with farms in the regions with the best natural conditions and out of LFAs. These findings are along with the results of this paper. Farms cultivating larger UAA showed on average higher economic viability, which corresponds to the conclusions of Davidova et al. (2005) or Slavickiene and Savickiene (2014a).

4. Conclusion

This article deals with the examination of selected predictors of economic viability of farms operation in Czech areas facing natural constraints. For assessment of viability, the authors used Modified Profit per Annual Working Unit which also considers opportunity costs on unpaid labour. Lower viability can be seen in ANCs that show higher dependence upon current subsidies, including ANC payments, a higher share of unpaid labour, lower production and higher costs per one unit of production (cost factor). Authors examined two predictive methods to find factors that are of significant relation to economic viability. A general look at the factors was performed through logistic regression, deeper study of various subgroups was made using decision trees. Cost factor and size group (ha UAA) were the most important factors among all ANC groups. Cost factor is in negative relation to economic viability; the farms with the lowest UAA of ha are of lower economic viability, compared to large farms. Farm specialization seems not be an important factor in case of non-ANC farms. Relatively successful are Grazing livestock farms in ANC, on the other hand this group is highly dependent on subsidies. It is evident that subsidies for smaller farms in ANCs, including ANC payments, represent a significant support and stabilizing element of income and support for viability. These results can be used to support the design of a new Common Agricultural Policy that emphasizes smaller farms with livestock production that are in ANCs.

Acknowledgements

Supported by Institute of Agriculture Economics and Information Prague, Czech Republic, Internal Research Grant No. 1297/2020.

References

Abbott, D. (2014), "*Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst*", USA, Indianapolis: John Wiley & Sons, Incorporated, 2014. ISBN 9781118727935

Altman, E. (1968), "Financial ratios, discriminant analysis and the prediction of corporate Bankruptcy", *Journal of Finance* (Sept.) 589-609

Andersen, E. et al. (2007), "Farm management indicators and farm typologies as a basis for assessments in a changing policy environment", *Journal of Environmental management*, No. 82: pp. 353–362

Astier, M., García-Barrios, L., Galván-Miyoshi, Y., González-Esquivel, C. E., Masera, O. R. (2012), "Assessing the sustainability of small farmer natural resource management systems. A critical analysis of the MESMIS program (1995-2010)", *Ecology and Society*, No. 17(3), pp. 263–288. https://doi.org/10.5751/ES-04910-170325

Balezentis T., Novickyte L. (2018), "Are Lithuanian family farms profitable and financially sustainable? Evidence using DuPont model, sustainable growth paradigm and index decomposition analysis", *Transformations in Business and Economics*, No. 17 (1): pp. 237-254

Blazkova I., Dvoulety O. (2018), "The causes of firm performance variation in the Czech food processing industry in the context of the outlier effect", *Management Research Review*, No. 41: pp. 968-986

Blum, M. (1974), "Failing Company Discriminant Analysis", *Journal of Accounting Research*, vol. 12. no.1, pp. 1-25

Davidova S., Gorton M., Ratinger T., Zawalinska K., Iraizoz B. (2005), "Farm productivity and profitability: a comparative analysis of selected new and existing EU member states", *Comparative Economic Studies*, no. 47: pp. 652–674

Deakin, E. (1972), "A Discriminant Analysis of Predictors of Business Failure", *Journal of Accounting Research*, vol.10, no. 1, pp. 167-179

Doucha T., Stolbova M., Lekesova M. (2012), "Assessment of support in the Czech Less Favoured Areas with special regards to cattle breeding", *European Countryside*, No. 3: pp. 179-191

Finkbeiner, M., Schau, E. M., Lehmann, A., Traverso, M. (2010), "Towards life cycle sustainability assessment", *Sustainability*, No. 2(10), pp. 3309 – 3322. https://doi.org/10.3390/su2103309

Gepp, A. Kumar, K. (2015), "Predicting Financial Distress: A Comparison of Survival Analysis and Decision Tree Techniques", *Procedia Computer Science*, no. 54, pp. 396 – 404

Gibson C.H. (2013), "*Financial statement analysis*". Cengage Learning, Andover.

Hildeń, M., Jokinen, P., Aakkula, J. (2012), "The sustainability of agriculture in a northern industrialized country - From controlling nature to rural development", *Sustainability*, 4(12), 3387–3403. https://doi.org/10.3390/su4123387

Hlavsa, T., Špička, J., Štolbová, M., Hloušková, Z. (2020), "Statistical analysis of economic viability of farms operating in Czech areas facing natural constraints", *Agricultural Economics – Czech*, vol. 66, in press

Klepac, V., Hampel, D. (2017), "Predicting financial distress of agriculture companies in EU", *Agricultural Economics – Czech*, vol. 63, no. 8, pp. 347 - 355

Koleda N., Lace N. (2010), "Dynamic factor analysis of financial viability of Latvian service sector companies", *Economics and Management*, no. 15: pp. 620-626

Koyncugil, A. S., Ozgulbas, N. (2012), "Financial early warning system model and data mining application for risk detection", *Expert Systems with Applications*, no. 39, pp. 6238 - 6253

Kuosmanen, N., Kuosmanen, T. (2013), "Consistent aggregation of generalized sustainable values from the firm level to sectoral, regional or industry levels", *Sustainability*, No. 5, pp. 1568-1576

Latruffe L., Desjeux Y. (2016), "Common agricultural policy support, technical efficiency and productivity change in French agriculture", *Review of Agricultural, Food and Environmental Studies*, No. 97: pp. 15–28

Latruffe L., Diazabakana A., Bockstaller C., Desjeux Y., Finn J., Kelly E., Ryan M., Uthes S. (2016), "Measurement of sustainability in agriculture: A review of indicators", *Studies in Agricultural Economics*, No. 118: pp. 123–130

Lin, T. - H. (2009), "Crossmodel study of corporate financial distress prediction in Taiwan: Multiple discriminant analysis, logit, probit and neural networks models", *Neurocomputing*, no. 72, pp. 3507 - 3516

Lososova J., Zdenek R. (2013), "Development of farms according to the LFA classification", *Agricultural Economics – Czech*, No. 59: pp. 551-562

Lososova J., Zdenek R. (2014), "Key Factors Affecting the Profitability of Farms in the Czech Republic", *Agris on-line Papers in Economics and Informatics*, No. 6 (1): pp. 21-36

Mayer, A. L. (2008), "Strengths and weaknesses of common sustainability indices for multidimensional systems", *Environment International,* No. 34: pp. 277-291. http://dx.doi.org/10.1016/j.envint.2007.09.004

Meul, M., Passel, S., Nevens, F., Dessein, J., Rogge, E., Mulier, A., Hauwermeiren, A., (2008), "MOTIFS: a monitoring tool for integrated farm sustainability", *Agron. Sustain. Dev.*, No. 28, pp. 321–332. https://doi.org/10.1051/agro:2008001

Mzoughi, N. (2011), "Farmers adoption of integrated crop protection and organic farming: Do moral and social concerns matter?", *Ecological Economics,* No. 70, pp. 1536-1545. https://doi.org/10.1016/j.ecolecon.2011.03.016

O'Donoghue C., Devisme S., Ryan M., Conneely R., Gillespie P., Vrolijk H. (2016), "Farm economic sustainability in the European Union: A pilot study", *Studies in Agricultural Economics*, No. 118: pp. 163–171

Ohlson, J. (1980), “Financial Ratios and the Probabilistic Prediction of Bankruptcy”, *Journal of Accounting Research*, vol. 18, no. 1, pp. 109-131

Ryan M., Hennessy T., Buckley C., Dillon E.J., Donnellan T., Hanrahan K., Moran B. (2016), “Developing farm-level sustainability indicators for Ireland using the Teagasc National Farm Survey”, *Irish Journal of Agricultural and Food Research*, No. 55: pp. 112–125

Schader, C., Grenz, J., Meier, M. S., Stolze, M. (2014), “Scope and precision of sustainability assessment approaches to food systems”, *Ecology and Society*, No. 19(3), 42. https://doi.org/10.5751/ES-06866-190342

Slavickiene A., Savickiene J. (2014a), “Comparable analysis of farm viability assessment methodologies”, *European Scientific Journal*, No. 10: pp. 130–150

Slavickiene A., Savickiene J. (2014b), “The evaluation of small and medium farms’ economic Viability in the new EU countries”, *Economy & Business Journal*, No. 8: pp. 843–855

Spicka J., Hlavsa T., Soukupova K., Stolbova M. (2019), “Approaches to estimation the farm-level economic viability and sustainability in agriculture: A literature review”, *Agricultural Economics – Czech*, No. 65: pp. 289-297

Stolbova M., Micova M. (2012), “The farm size in the less-favoured areas and the economy of support spending on public goods production in the case of the Czech Republic”, *Agricultural Economics – Czech*, No. 58: pp. 482-494

Tufféry, S. (2011), “*Data Mining and Statistics for Decision Making*“. UK, West Sussex: Wiley. ISBN 978-0-470-68829-8.

Vrolijk H.C.J., de Bont C.J.A.M., Blokland P.W., Soboh R.A.M.E. (2010), “Farm viability in the European Union: Assessment of the impact of changes in farm payments”, LEI Wageningen UR, Den Haag

TRENDS IN FOOD RETAILING – OPPORTUNITIES FOR LOCAL AGRICULTURAL PRODUCTION

Michal Chocholoušek[1], Lucie Vokáčová[2], Jan Huml[3] and Tereza Šímová[4]

[1, 2, 3, 4] Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]chocholousek@pef.czu.cz, [2]vokacova@pef.czu.cz, [3]huml@pef.czu.cz, [4]simovat@pef.czu.cz

Annotation: Secondary data analysis are used for current trends and prognoses of future food retailing. Value chain of food within major distribution channel (agricultural producer, processor, retailer) in The CR is based on 2018 FADN data (agricultural producer), Panorama of the Manufacturing Industry 2018 (producer) and published major retailers' annual reports (specifically their P&Ls). Selected indicator applied is added value margin (calculated as "added value/revenues"), representing, in a simple way, share of value added by company to procured inputs on company revenues. 37% of additional gross margin increase potential for agricultural producer, in general, is in shortening particular distribution channel in The CR. Interconnection of on-line and off-line environment, together with changing preferences of customer (decline of branding importance, local production, freshness, quality preferences, customers experience, waste management emphasizing via on-line and off-line environment interconnection, for e.g. augmented reality, using artificial intelligence and proper marketing instruments are defining potential for local producers to differentiate their products and acquire additional margin.

Key words: Retail, Value Chain, Product Differentiation, Distribution Channel, Local Production

JEL classification: M31, Q13

1. Introduction

Food retailing is one of the most innovative sectors within the food chain. Innovations affect cost of supply reduction, higher customer satisfaction, and higher control over the supply (Dawson, 2010). Nowadays food retailing is more fragmented and diverse, consequently creating new opportunities for alternative initiatives (Guptill and Wilkins, 2002). Consumers are expecting alternative and innovative products. Number of consumers focus on the product they regard as healthful, real, natural, original, and authentic (Grunert, 2017; Mac Clay and Feeney, 2019). Consumers require food origin, procurement, production ethics norms and quality standards application information (Grunert, 2017).

Traditional food supply chains are complex, stretch across the world, and include many stakeholders (Hearnshaw and Wilson, 2013). Long complex food chains represent a "black box", which makes it almost impossible to find out where the food comes from (Migliore, Schifani and Cembalo, 2015). In the traditional supply chain, farmers create input into the food supply chain, which determines the quality of the whole process (Grunert, 2017). But the position of farmers is anonymous and easily interchangeable. Low profit of farmers is one of the issues in traditional food supply chains (Cucagna and Goldsmith, 2018).

This fact causes, farmers are looking for potential to increase revenues and profit preoccupying preferable position in the value chain. One of the options is product differentiation development (Hughes, 2014; Alvarez et al., 2018). Chocholoušek and Huml (2019) defined product differentiation as "capability to reach higher profitability than other competitors in the same industry/conditions, without external support/subsidies". Product differentiation leads to sell the product for a higher price than competitors (Chocholoušek and Huml, 2019). Another option, leading to farmers position improvement is sustainable food value chain (Connell, Smithers and Joseph, 2008; Migliore, Schifani and Cembalo, 2015; Olafsdottir et al., 2018). Food value chains develop business alliances, based on collaboration. All actors aim to gain competitive advantages within particular food value chains (Grunert, 2017; EC, 2018). FAO (2014) in the definition of the sustainable food value chain emphasizes the importance of coordinated value-adding activities in each part of the food chain. In the short food supply chains, consumer knows exactly food origin. Transparency and sustainability, reducing food waste became core areas for the food chain (Grunert, 2017; Profeta and Hamm, 2019; Borsellino, Schimmenti and El Bilali, 2020). Consequently, shortening the length of food supply chain represent fastening production delivery to final consumer potential for agri-food producers (Balcarová, 2019). Shortening the food supply chain, especially for small and medium-sized agricultural productions, develops potential for margin increase (Grunert, 2017). King et. al. (2010) states that the revenue of farmers is in short food supply chains equal or up to seven times higher than in the long food chains. Also, the interaction between consumers and farmers have a sense of community - the food is used to create identity and feeling of belonging (Grunert, 2017; Pícha, Navrátil and Švec, 2018; De Bernardi, Bertello, Venuti, Foscolo, 2020). Consumers buy local food also because they consider local food to be healthier, fresher, tastier, and protect the environment (Haas et al., 2013). Pícha, Navrátil and Švec (2018) highlight that the local product is based on tradition, origin of materials, and habits of production and consumption. Consumers consider local products to be higher quality than the national and regional branded products (Pícha, Navrátil and Švec, 2018; Stoklasa and Starzyczna, 2017).

Consumers recently require fair price, convenience, quality and variety of products (Sides and Swaminathan, 2020). Consumers using emotions when shopping (KPMG, 2019) and they are capable to pay a premium price for convenience (Sides and Swaminathan, 2020). Consumers also relying more on word of mouth and community communication (KPMG, 2019). Then retailers look for more diverse and sophisticated markets - an opportunity for local agricultural production. According to KMPG (2019), retailers should use buyers/consumers data to deep retail. Deep retail will cause hyper-personalization, which means that retailers will know what consumer need before the consumer realize. With this knowledge, retailers can cooperate with local farmers and deliver local food into the household (Sides and Swaminathan, 2020).

Paper's objective is to define gross margin potential, capable to be transferred to the agricultural producer from remaining parts of the distribution channel, if approached successfully. Summarize current trends and prognoses of future food retailing, state key opportunities for the local agricultural producer in The CR aiming to acquire defined gross margin potential.

2. Materials and Methods

Current trends and prognoses of future food retailing are based on available secondary data analysis and synthesis.

Value chain of food within major distribution channel (agricultural producer, processor, retailer) in The CR is based on 2018 FADN data, representing 1538 holdings (agricultural producer), Panorama of the Manufacturing Industry 2018 (producer) and published selected major retailers' annual reports (specifically P&Ls). Selected indicator applied is added value margin (AVM) (calculated as "added value/revenues"), representing, in a simple way, share of value added by company to procured inputs on company revenues.

Presented value chain analysis delivers qualitative overview (not representative but robust enough for general overview) of particular value chain, aiming to define potential for agricultural producer gross margin increase.

3. Results and Discussion

Value chain analysis

Table 1 describes distribution of AVM in different production focus areas. The spread is from-1% to 29%. This indicator is not affected by state subsidies, i.e. despite negative value, farms may generate positive earnings. The whole industry average is 24%.

Table 1. AVM – Agricultural producers

Production focus areas	Field Crops	Horti-culture	Vine	Permanent crops	Milk	Grazing Live-stock	Pig and poultry farming	Mixed	**Total**
AVM 2018	23%	25%	28%	34%	29%	-1%	11%	27%	**24%**

Source: own research, 2020 based on FADN, 2018

Table 2 describes distribution of AVM in different food processing areas. The spread is from -7% to 35%. The whole industry average is 22%.

Table 2. AVM – Processors

AVM	2014	2015	2016	2017	2018
10.1 Processing and preserving of meat and production of meat products	15%	16%	15%	16%	17%
10.2 Processing and preserving of fish, crustaceans and mollusks	16%	18%	16%	20%	20%
10.3 Processing and preserving of fruit and vegetables	21%	21%	21%	22%	22%
10.4 Manufacture of vegetable and animal oils and fats	7%	5%	6%	4%	7%
10.5 Manufacture of dairy products	12%	13%	16%	15%	14%
10.6 Manufacture of grain mill products, starches and starch products	15%	16%	17%	17%	16%
10.7 Manufacture of bakery products and confectionery	32%	33%	34%	35%	35%
10.8 Manufacture of other food products	21%	21%	23%	23%	22%
11 Manufacture of beverages	30%	31%	31%	32%	31%
Total	**20%**	**21%**	**22%**	**22%**	**22%**

Source: MIT,2020

Table 3 describes distribution of AVM in different food processing areas. The spread is from -4% to 18%. The whole industry average is 15%.

Table 3. AVM – Retailers

	Kauf-land	Lidl	Albert	Tesco	Penny	Makro	Billa	Globus	Jip	Coop	**Total**
AVM	15%	18%	14%	18%	13%	10%	14%	14%	4%	18%	**15%**

Source: MJ, 2020

Table 4 describes distribution of added value within value chain of examined distribution channel. Processors are adding highest absolute value added of AVM (in financial units). Recently, those are usually developing product differentiation, bearing its costs and benefiting from “good job done”. Nevertheless, within processors there is high spread of AVM (Table 2), leading by beverage and bakery products and confectionery producers. Similar situation could be monitored in Table 3, where spread of AVM is from 4% to 18%.

Table 4. AVM – Retailers

	value added margin per distribution chain link	financial units of revenues per distribution chain link	financial units of margin per distribution chain link	% of gross margin to acquire for agricultural producer when shortening distribution channel
input into value chain		50,4	50,4	
agricultural producer	24%	66,3	15,9	22%
processor	22%	85,0	18,7	15%
retail	15%	100,0	15,0	

Source: own research, 2020

Current trends and prognoses of future food retailing

Recent retail industry changes are driven by, sophisticated technology activation, augmented reality (AR), artificial intelligence (AI), accompanied with customer data-based offer and purchases via social networks. According to IGD[5], future retail is based on functional on-line and off-line environment interconnection, capability to deliver customer experience and above standard services (qualified personnel included), within social responsibility context. Trends, predicted by market research agencies and supported by consulting companies and retail professionals[6], could be summarized as follows (ZaP, 2018; KPMG, 2019, Ipsos, 2019; Sides and Swaminathan, 2020): on-line and digitalization, food origin and quality, product offer and personalization, customer experience, social responsibility.

Increasing share of on-line shopping is a major trend in retail, accompanied with intensifying interconnection of e-commerce and social networks. At the other hand, it can be monitored, originally digital brands are building "stone-stores". On-line and off-line market interweaving has potential for shopping convenience improvement. AR or AI are instruments to overcome edge between digital and physical reality. It leads to purchase simplicity increase, purchasing platforms development, omnichannel solution development and delivery process fastening. On-line and off-line environment interconnection transfers into marketing communication specific tools development. An illustrative example in agri-food chain is Blockchain technology (connecting devices and enhancing the scope of the "Internet of Things" /IoT/ economy), effective for example in the fight against fraud and counterfeiting, food security and the redistribution of value along the supply chain. It can improve communication and information flow (accuracy and speed) between players in the chain (EC, 2018; Scuderi, Foti, and Timpanaro, 2019).

Of course, as with many other technologies, "financial motives" will determinate AR's (not only) survival (Loijens and Grunert 2017).

Product differentiation and premium products is logical step to fulfill "financial motives". It has been already proven, affluent customers targeting pays off (as well as price sensitive customers targeting). Birth certificate, traceability, interconnected with augmented reality (for e.g. customer shots cell phone on product bar-code and see product origin, way of processing, timing of delivery), etc., has potential for product differentiation, which can overweight, in particularly in food business, producer or seller branding. Now, more traditional agribusiness sectors are embracing market segmentation and product differentiation practices (Huges, 2014). Based on Mac Clay and Feeney study (2019) the consumer in the agri-food

[5] IGD (The Institute of Grocery Distribution) is a research and training charity in sector of the food and consumer goods industry.
[6] Nielsen, GfK, Ipsos, KPMG, Deloitte, PwC, Flop, Lidl

sector has focused on products with higher added value and more specific characteristics in terms of quality, traceability and labeling.

Another product differentiation basement potential is in local food origin. Research, Lizbetinova (2017) declares, local origin can strengthen local producer position on the market. Local products are perceived as of higher quality (Pícha, Navrátil a Švec, 2018) and local customers incline to pay higher price for them (Profeta and Hamm, 2019). Local production support can even cause negative perception of foreign products (related to ethnocentrism) Stoklasa a Starzyczna (2017).

Sustainability and social responsibility reflect using spare technologies, waste management, unwrapped or zero-waste stores, support of local communities, etc. Customers are more interested in product affection on health and environment (Mac Clay and Feeney, 2019). Concerning complexity of agri-food chains, activated solution shall help to reach target of food delivery, environment sustainability and economic growth, starting from agricultural systems to food distribution complexity reduction (Borsellino, V., Schimmenti, E. and El Bilali, 2020).

4. Conclusion

Additional gross margin potential to be acquired by farmers via shortening particular distribution channel in The CR is 37%. Interconnection of on-line and off-line environment, together with changing preferences of customer (decline of branding importance, local production, freshness, quality preferences, customers experience emphasizing via augmented reality, using artificial intelligence and proper marketing instruments are defining potential for local producers to differentiate their products and acquire additional margin.

Local production of quality food (not only), with effective (likely shortened) supply chain, interconnecting on-line and off-line environment (AI, AR, customers experience and interaction, omni-channel, etc.) has robust potential for market success in close future.

Acknowledgements

This article was created with the support of the Internal Grant Agency (IGA) of FEM CULS in Prague, registration no. 2019B0006 – Attributes of alternative business models management in food production.

References

Alvarez, A., García-Cornejo, B., Pérez-Méndez, J. A. and Roibás, D. (2018), "The profitability of value-added products in dairy farm diversification initiatives", *Spanish Journal of Agricultural Research*, vol. 16, no. 2, pp. 1 - 8. E-ISSN 2171-9292, DOI 10.5424/sjar/2018162-11813

Balcarová, T. (2019), "The Attribute of Local Products in the Context of Real Knowledge of Purchased Products", *Proceedings - of the 28th International Scientific Conference Agrarian Perspectives XXVIII "Business Scale in Relation to Economics"*, Prague, pp. 14–20. ISBN 9788021329737

Borsellino, V., Schimmenti, E. and El Bilali, H. (2020), "Agri-Food Markets towards Sustainable Patterns", *Sustainability*, vol. 12, no. 6, ISSN 2071-1050, DOI 10.3390/su12062193

Connell, D. J., Smithers, J. and Joseph, A. (2008), "Farmers' markets and the good 'food' value chain: A preliminary study", *Local Environment*, vol. 13, no. 3, pp. 169 - 185. ISSN 1354-9839 E-ISSN 1469-6711, DOI 10.1080/13549830701669096

Cucagna, M. E. and Goldsmith, P. D. (2018), "Value adding in the agri-food value chain", *International Food and Agribusiness Management Review*, vol. 21, no. 3, pp. 293 - 316, ISSN 1559-2448, DOI 10.22434/IFAMR2017.0051

Dawson, J. (2010), "Changes in food retailing and their implications for new product development. Consumer-Driven Innovation in Food and Personal Care Products", Woodhead Publishing Limited, ISBN 9781845695675

EC, European Commission (2018), "Farmer position in value chains, CAP Objective 3 – Improve imbalances in the food chain", [Online], Available: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/key_policies/documents/cap-specific-objectives-brief-3-farmer-position-in-value-chains_en.pdf / [Accessed: 26 Apr. 2020]

FADN, Farms Account Data Network CZ, Liaison Agency CZ - 2018, [Online], Available: http://www.fadn.cz/ [Accessed: 26 Apr. 2020]

FAO, Food and Agriculture Organization of the United Nations (2014), "*Developing sustainable food value chains*, *Guiding principles*", Control, Rome, ISBN 9789251084816.

Grunert, K. G. (Ed.) (2017), *"Consumer trends and new product opportunities in the food sector",* Wageningen, Wageningen Academic Publishers, ISBN 9789086868520

Guptill, A. and Wilkins, J. L. (2002), "Buying into the food system: Trends in food retailing in the US and implications for local foods", *Agriculture and Human Values*, vol. 19, no. 1, pp. 39 - 51, ISSN 15728366, DOI 10.1023/A:1015024827047

Hearnshaw, E. J. S. and Wilson, M. M. J. (2013), "A complex network approach to supply chain network theory", *International Journal of Operations and Production Management*, vol. 33, no. 4, pp. 442 - 469, ISSN 0144-3577, DOI 10.1108/01443571311307343

King, R. P. (2010), "*Comparing the Structure, Size, and Performance of Local and Mainstream Food Supply Chains)*", U.S. Department of Agriculture, Economic Research Service (ERS report summary), ISBN 9781437935233

Hughes, D. (2014), "European Food Marketing: Adding Value in Mature Food Markets through Market Segmentation and Product Differentiation", *EuroChoices*, vol. 13, no. 2, pp. 20 - 26, ISSN 1478-0917, DOI 10.1111/1746-692X.12058

Chocholoušek, M. and Huml, J. (2019), "Farmers business scale relation with product differentiation in the Czech Republic", *Proceedings of the Agrarian perspectives XXVIII. – Business Scale in Relation to Economics*, Prague, pp. 75 - 81, ISBN 9788021329737

Ipsos, Ipsos - Global Market Research and Public Opinion Specialist (2019), "*Retail Trends In 2019 To Watch Out For*", United Kingdom, [Online], Available: https://www.ipsos-retailperformance.com/en/insights/retail-trends-2019-watch/, [Accessed: 23 March, 2020]

KPMG, KPMG International Cooperative (2019), "Retail Trends 2019: Global Consumer & Retail", [Online], Available: https://assets.kpmg/content/dam/kpmg/xx/pdf/2019/02/global-retail-trends-2019-web.pdf, [Accessed: 23 March 2020]

Loijens, L. W. S. and Grunert, K. (2017), “Chalenges of augmented reality in the food sector”, In: *Augmented reality for food marketers and consumers*, Waginingen, Waginingen Academic Publishers, pp. 87 - 95, ISBN 978-90-8686-842-1

Lizbetinova, L. (2017), “Clusters of Czech Consumers with Focus On Domestic Brands”, *Proceedings of the 29th International-Business-Information-Management-Association Conference*, Vienna, pp. 1703 - 1718, ISBN 978-0-9860419-7-6

Mac Clay, P. and Feeney, R. (2019), “Analyzing agribusiness value chains: a literature review”, *International Food and Agribusiness Management Review*, vol. 22, no. 1, pp. 31 - 46, ISSN 1559-2448, DOI 10.22434/IFAMR2018.0089

Migliore, G., Schifani, G. and Cembalo, L. (2015), “Opening the black box of food quality in the short supply chain: Effects of conventions of quality on consumer choice”, *Food Quality and Preference,* vol. 39, pp. 141 - 146, ISSN 0950-3293, DOI 10.1016/j.foodqual.2014.07.006

MIT, Ministry of Industry and Trade of the Czech Republic (2020), “Panorama of the manufacturing industry of the Czech Republic, [Online], Available: https://www.mpo.cz/en/panorama-interactive-table.html, [Accessed: 20 Apr., 2020]

MJ, Ministry of Justice of Czech Republic (2020), “Veřejný rejstřík a Sbírka listin” (Public Register and Collection of Documents), [Online], Available: https://or.justice.cz/ias/ui/rejstrik, [Accessed: 20 Apr., 2020]

Olafsdottir, A. H., Gudbrandsdottir, I., Sverdrup, H. U., Bogason, S. G., Olafsdottir, G. and Stefansson, G. (2018), “System dynamics modelling and system analysis applied in complex research projects – The case of VALUMICS”, *International Journal on Food System Dynamics*, vol. 9, no. 5, pp. 409 - 418, ISSN 1869 6945, DOI 10.18461/ijfsd.v9i5.953

Pícha, K., Navrátil, J. and Švec, R. (2018), “Preference to Local Food vs. Preference to ‘National’ and Regional Food”, *Journal of Food Products Marketing,* Routledge, vol. 24, no. 2, pp. 125 - 145, ISSN 15404102, DOI 10.1080/10454446.2016.1266549

Profeta, A. and Hamm, U. (2019), “Consumers’ expectations and willingness-to-pay for local animal products produced with local feed”, *International Journal of Food Science and Technology,* vol. 54, no. 3, pp. 651 - 659. E-ISSN 1365-2621. DOI 10.1111/ijfs.13933

Scuderi, A., Foti, V. and Timpanaro, G. (2019), “The supply chain value of pod and pgi food products through the application of Blockchain”, *Calitatea, Quality-Access to Success*, vol. 20, no. S2, pp. 580 - 587. [Online], Available: http://ezproxy.techlib.cz/login?url=https://search-proquest-com.ezproxy.techlib.cz/docview/2198417566?accountid=119841 [Accessed: 23 March, 2020]

Sides, R. and Swaminathan, N. (2020), “2020 retail industry outlook. Convenience as a promise”, [Online], Available: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consumer-business/us-retail-industry-outlook-2020-final-100720.pdf, [Accessed: 23 March, 2020]

Stoklasa, M. and. Starzyczna, H. (2017), “Consumer ethnocentrism of Moravian-Silesian region: comparison of CETSCALE research 2013/17”, *Proceedings of the 20th International Colloquium on Regional Sciences,* Brno, pp. 590 - 597, ISBN 978-80-210-8587-9

ZaP (2018), “*Zboží & Prodej, Anketa: Jaké trendy budou vládnout retailu*?” [Online], Available: https://www.zboziaprodej.cz/2018/01/17/anketa-jake-trendy-budou-vladnout-retailu-ptali-se-obchodniku-i-odborniku/, [Accessed: 23 March, 2020]

ESTIMATION OF THE OUTPUT GAP IN CZECH AGRICULTURE

Jakub Ječmínek

Department of Trade and Accounting, Faculty of Economics and Management, CULS Prague, Czech Republic

jecminek@pef.czu.cz

Annotation: Potential output represents maximum sustainable level of output that the economy can produce. Although output gap is usually measured for the whole economy, we are able to break down the economy and estimate output gap for any given sector (we focus on Czech agriculture exclusively). We followed methodology of Czech National Bank (Hájek and Bezděk, 2010) and Plašil (2011): the former focuses on Cobb-Douglas production function and Hodrick-Prescott filter for detrending of total-factor productivity. The latter is maximum entropy bootstrapping technique which is particularly useful because beside point estimate we are able to get confidence intervals as well. The results show that total-factor productivity is steadily increasing in Czech agriculture. Actual output is also steadily increasing since 2010 mainly due to higher capital stock. We conclude that potential output is ranging between 56 to 76 billion CZK and as of 2018 actual output is around its potential. If the actual output surpasses its potential over a long period of time, it may raise some issues such as growth in consumer prices of agricultural products and other related effects.

Key words: Output gap, agriculture, Hodrick-Prescott, potential output, GDP

JEL classification: Q10

1. Introduction

As defined by Samuelson and Nordhaus (2010) potential output represents maximum sustainable level of output that the economy can produce. If we subtract actual GDP from its potential, then we are given output gap which represents the loss of efficiency. The goal of the government is to minimize business cycles swings (measured by actual GDP) and to operate to its potential as much as possible. Output gap is usually interpreted as unused potential of the economy. Main factors driving the actual output (GDP) are consumption, international trade, and investments. Other factors might arise as a results of the country specific environment, such as tax policy. Tax policy significantly effects foreign direct investments (Moravec and Kukalová, 2014), which is important shifter of the actual GDP and aggressive tax planning, which causes shifting the money abroad and tax competition (Ječmínek, Moravec and Kukalová, 2020).

The output gap is periodically estimated by several national institutions mainly for understanding the Czech macroeconomic business cycle and therefore accurate economic stabilization policy. There are multiple methods for output gap measurement (Brandner, Diebalek and Schuberth (1998) summarize traditional approaches). The methods used for estimating potential output in OECD are the center of the work of Giorno et al. (1995). Hájek and Bezděk (2000) estimated potential output and output gap for Czech Republic over time period from 1991-2001. Other estimates for Czech Republic are provided by Schneider and Krejdl (2000) and Plašil (2011). Hájková and Hurník (2007) were testing if Cobb-Douglas production function is suitable for Czech Republic environment. Output gap as an indicator of inflation was the objective of Kloudová (2013).

Although output gap is usually measured for the whole economy, we are able to estimate output gap for any given sector of economy. Those results are particularly interesting for better understanding of which sectors of economy are underperforming. Information about the long-term trend of agriculture productivity in Australia are provided in the work of Sheng et al. (2017). Fuglie et al. (2017) in their article review the current debate on whether U.S. agricultural productivity growth is slowing. Other authors focus on agricultural productivity, such as Tekin and Evcim (2011).

Krejčí (2013) analyzed potential output and fixed capital using system dynamics methodology for NACE 1 (agriculture, forestry, and fishing) in Czech Republic. Krejčí (2013) covered time period from 1995 to 2010. However, these results do not cover post-crisis development and further output gap analysis.

The objective of the paper is to estimate the output gap and corresponding confidence intervals for Czech agriculture and potentially examine key that are driving the potential output upwards.

2. Materials and Methods

The first methodology we followed is used by Czech National Bank (see Hájek and Bezděk, 2000). Firstly, we compute total-factor productivity using Cobb-Douglas production function and then perform Hodrick-Prescott filter (see Hodrick and Prescott, 1980) for detrending total-factor productivity. Later is discussed a maximum entropy bootstrapping technique which enables us to get confidence intervals as well as point estimate.

We start with generally defined Cobb-Douglas production function written as

$$Y_t = {L_t}^{\alpha} {K_t}^{1-\alpha}, \qquad (1)$$

where *Y* is actual output in the time period *t*, *L* is labour force in a time period *t*, *K* is capital stock in a time period *t* and parameter *α* is output elasticity. Adding total-factor productivity (*A*) to the equation enables us to capture technological progress. The equation 1 is therefore expressed as

$$Y_t = {L_t}^{\alpha} {K_t}^{(1-\alpha)} A_t. \qquad (2)$$

The data are obtained from macroeconomic accounts of Czech Statistical Office. Since actual output[7], total labour force and capital stock are published, we can obtain total-factor productivity from equation 2 simply as

$$A_t = \frac{Y_t}{{L_t}^{\alpha} {K_t}^{(1-\alpha)}}. \qquad (3)$$

We computed total-factor productivity as described in equation 3 for the whole time series and subsequently applied Hodrick-Prescott filter which enables us to separate trend and cyclical component from raw data.

There are, however, two parameters that had to be arbitrarily chosen, such as parameter *α* and Hodrick-Prescott multiplier λ[8]. Hájek and Bezděk (2000) state that empirical literature suggests $\lambda=100$ for yearly time series data and $\lambda=1600$ for quarterly time series. We estimated

[7] Note that we use GVA (*Gross Value Added*) as an actual output for agriculture.

[8] Multiplier λ is smoothing parameter of Hodrick-Prescott filter which adjusts the trend to short-term fluctuations. For $\lambda=0$ remains smoothed vector of values unchanged.

parameter α as a ratio of total compensation of employees in Czech agriculture to GVA (Gross Value Added). Throughout the time period from 1993 to 2018[9] the average ratio was 46.1% ($\alpha=0.461$).

Potential output (Y^*) is then given by equation 2, where we substitute employment, capital stock and trend component of total-factor productivity. We obtain output gap simply as

$$output\ gap\ (in\ \%) = \frac{Y - Y^*}{Y^*} \cdot 100. \qquad \textbf{(4)}$$

Applying Hodrick-Prescott filter on raw data is the most common way of obtaining potential output. However, we get only point estimate and without confidence intervals, the results may be misleading. One of the methods to get confidence intervals is based on the work of Plašil (2011) who proposed using maximum entropy bootstrapping technique (as described in Vinod, 2004 and 2006).

Maximum entropy bootstrap is described in Vinod (2013) as *"computer intensive tool for statistical inference and is particularly suited for complicated problems where traditional (asymptotic) confidence intervals tend to be too wide, difficult to construct and unreliable […]"*. Full description of the algorithm is out of scope of this article; however, the reader may find complete seven steps algorithm in Vinod and López-de-Lacalle (2009). The bootstrapping technique was performed on total-factor productivity rather than on actual output for comparison with previous methodology. All computations were performed in the R statistical environment.

3. Results and Discussion

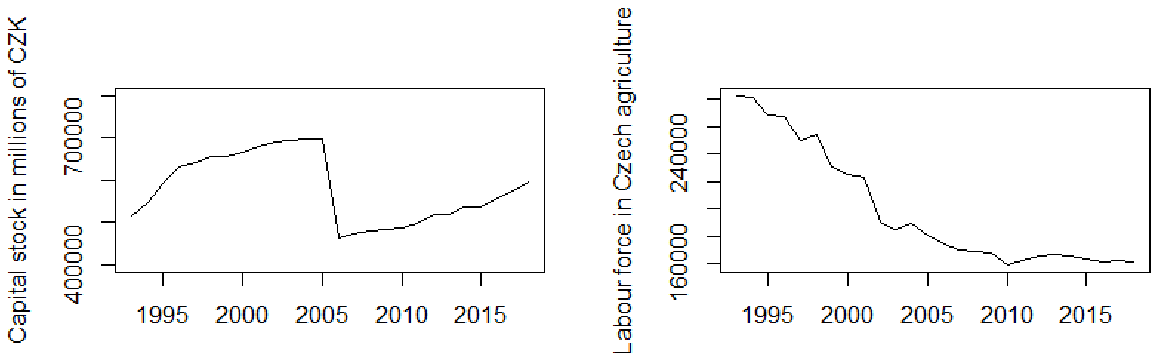
According to data from Czech Statistical Office, gross value added of Czech agriculture is 2.89% of total gross value added. The magnitude of output gap in Czech agriculture is therefore not significant for the whole economy but is important for maximum efficiency, international competitiveness, and resource utilization.

Figure 1 displays total labour force and capital stock in Czech agriculture over time period from 1993 to 2018. Total capital stock in Czech agriculture was rising constantly from 1993 up to 2005. In 2005 total capital stock fell from nearly 700 billion CZK up to 460 billion. However, capital stock started to rise again, and total capital stock was around 600 billion in 2018.

Labour force is steadily declining throughout the whole time series. The number of people employed in agriculture (including forestry and fishing) was 283 thousand in 1993, 166 thousand in 2014 and 161 thousand in 2018. It is well-documented phenomenon that as countries develop the share of the people working in agriculture decline. However, Czech agriculture is facing aging of agricultural population (Boháčková and Hrabánková, 2011) which may cause future long-term shortage of agricultural workforce.

[9] We have collected the data for the longest time period available.

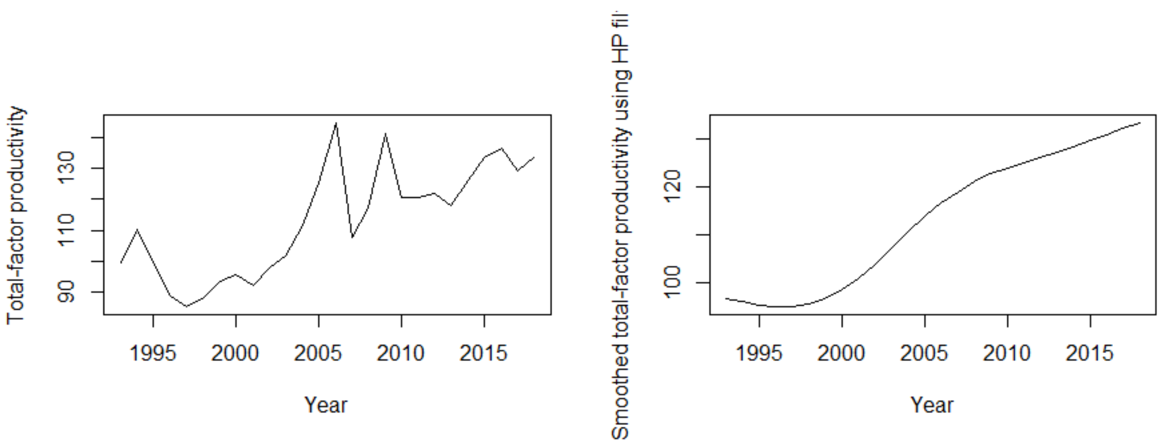
Figure 1. Time series of labour and capital stock



Source: Database of National Accounts - Czech Statistical Office, own computation in R statistics

As described in section 2, total-factor productivity was measured as a residual (see equation 3). Empirical total-factor productivity is graphed in figure 2, together with trend component smoothed using Hodrick-Prescott filter.

Figure 2. Total factor productivity - empirical and smoothed

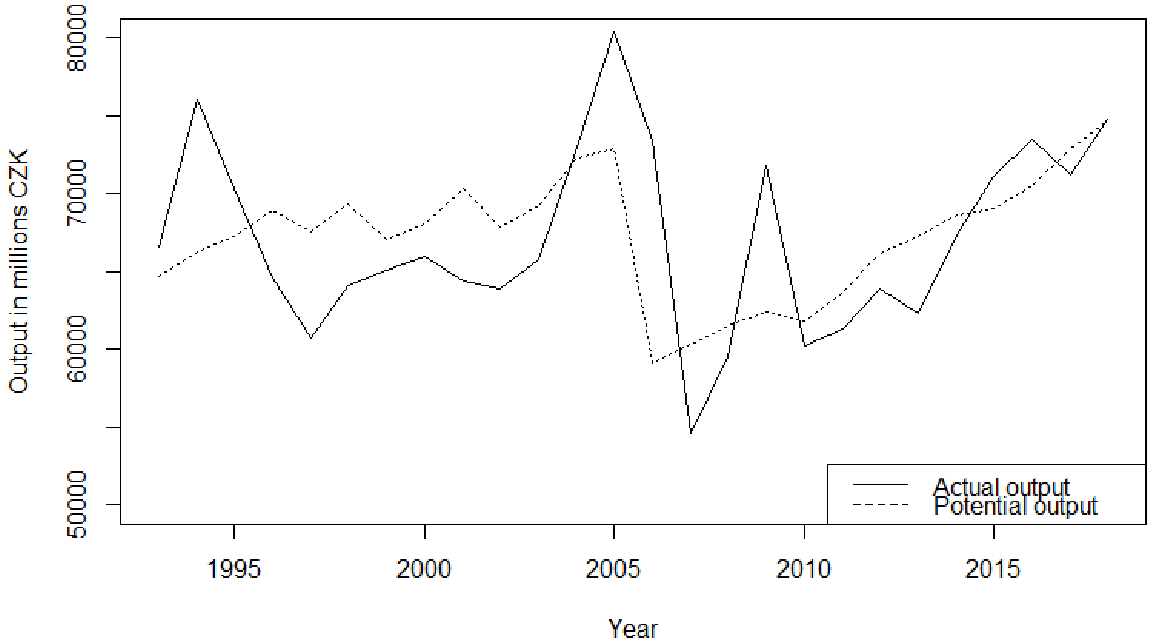


Source: Database of National Accounts - Czech Statistical Office, own computation in R statistics

As illustrated in figure 2, smoothed total-factor productivity is increasing. These results are on par with Hájek and Bezděk (2000) where total-factor productivity for the whole economy is also increasing. These results differ from Čechura (2012) who explored technical efficiency and total-factor productivity using Fixed Management model. Čechura (2012) state that total-factor productivity in total agriculture is decreasing since 2005 and is a result of various components, such as technical change, management, and scale effect. However, methodologies are not compatible for further analysis of the results.

Trend component of total-factor productivity was substituted back into the equation 2. Figure 3 illustrates mutual trajectories of actual and potential output in agriculture of Czech Republic from 1993-2018. Actual output oscillates between 50 and 80 billion CZK with a peak in 2005 (mainly due to total capital stock). Between the years 1996-2003 and 2010-2014 Czech agriculture experienced output gap raging up to 10% in 1997.

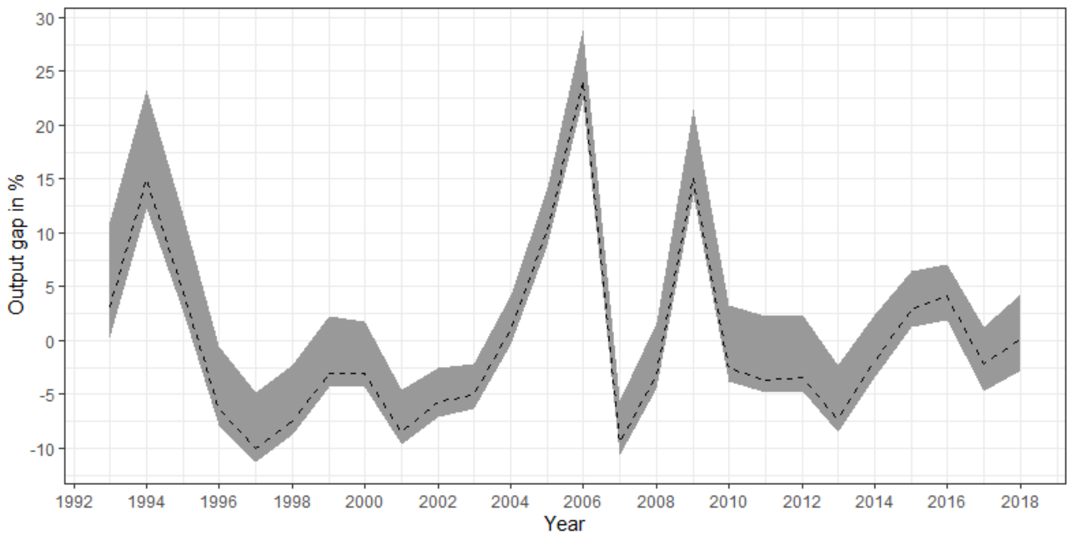
Figure 3. Trajectory of actual and potential output in Czech agriculture



Source: Database of National Accounts - Czech Statistical Office, own computation in R statistics

As described in previous chapter, point estimate without proper confidence intervals may be misleading. To obtain confidence intervals, we performed maximum entropy bootstrapping technique as proposed in Plašil (2011) using *meboot* package in R. Figure 4 shows point estimate as well as 90% confidence intervals of the output gap in Czech agriculture.

Figure 4. Point estimate and confidence intervals of the output gap in Czech agriculture



Source: Database of National Accounts - Czech Statistical Office, own computation in R statistics

Confidence intervals generally indicate the level of precision of the estimate (as shown in figure 4 as a shaded regions). We would like to emphasize that confidence intervals are crucial part of the analysis because we are able to deduct the level of variability and reliability of the estimate. For instance, the point estimate in 2010 was indicating output gap -2.57%, however confidence intervals are ranging from -3.95% to 1.72% so we cannot effectively conclude neither positive nor negative output gap. Moreover, the variance of the interval must be respected as well.

The findings suggest volatile tendency of the potential output and output gap with no particular trend. We can see a sharp drop in potential and actual output between the years 2005-2007 as a subsequent effect of decreasing capital stock and labour force. Recent years are less turbulent for Czech agriculture because output gap is relatively stable around zero. The swings in potential and actual output are also connected to agriculture specific factors (water and rainfall, temperature, diseases, etc.).

4. Conclusion

This paper dealt with potential output and corresponding output gap in Czech agriculture over the time period from 1993 to 2018. We present beside traditional point estimate also confidence intervals which were computed using maximum entropy bootstrapping technique as proposed in Plašil (2011).

We estimated that potential output for the time from 1993 to 2018 is fluctuating between 56 to 76 billion CZK. Actual and potential output experienced sharp drop between the years 2005-2007 mainly due to decreasing total capital stock in Czech agriculture (capital stock dropped from nearly 700 billion CZK in 2005 to 464 billion CZK in 2006). Recent years are relatively less turbulent for Czech agriculture with output gap ranging around zero.

Future research will be oriented on the factors that are affecting output gap and compare the results from Czech agriculture to other sectors of the economy.

Acknowledgements

This paper is a partial result of the research project No. 2019B0010 - Czech Social System Fraud Rate Estimation and System Optimization Proposals, supported by the Internal Grant Agency (IGA) of Faculty of Economics and Management, CULS Prague.

References

Boháčková, I. and Hrabánková, M. (2011), "Stárnutí zemědělské populace a generační výměna v členských zemích EU", *Acta Universitatis Bohemiae Meridionales*, The Scientific Journal for Economics, Management and Trade, vol. 14, no. 2, pp. 45-52. ISSN 1212-3285

Brandner, P., Diebalek, L. and Schuberth, H. (1998), "*Structural Budget Deficits and Sustainability of Fiscal Positions in the European Union*", Oesterreichische Nationalbank, Working Paper 26 [Online], Available: https://econpapers.repec.org/paper/onboenbwp/26.htm, [Accessed: 10 Mar. 2020]

Čechura, L. (2012), "Technical efficiency and total factor productivity in Czech agriculture", *Agricultural Economics*, vol. 58, no. 4, pp. 147-156

Fuglie, K., Clancy, M., Heisey, P. and MacDonald, J. (2017), " Research, Productivity, and Output Growth in U.S. Agriculture", *Journal of Agriculture and Applied Economics*, vol. 49, no. 4, pp. 514-554, DOI 10.1017/aae.2017.13

Giorno, C., Richardson, P., Roseveare, D. and van den Noord, P. (1995), "*Estimating Potential Output, Output Gaps and Structural Budget Balances*", OECD Economics Department Working Papers, No. 152, OECD Publishing, Paris, DOI 10.1787/533876774515

Hájek, M. and Bezděk, V. (2000), "*Odhad potenciálního produktu a produkční mezery v ČR*", Praha, Česká národní banka [Online], Available: https://www.cnb.cz/export/sites/cnb/en/economic-research/.galleries/research_publications/mp_wp/download/vp26hajekbezdek.pdf, [Accessed: 15 Mar. 2020]

Hájková, D. and Hurník, J. (2007), "Cobb-Douglas Production Function: The Case of a Converting Economy", *Czech Journal of Economics and Finance*, vol. 57, no. 9-10, pp. 465-476, ISSN 0015-1920

Hodrick, R. J. and Prescott, E. C. (1980), "*Post-war U.S. Business Cycles: An Empirical Investigation, Working Paper*", Carnegie Mellon University

Ječmínek, J., Moravec, L. and Kukalová, G. (2020), "Vliv agresivního daňového plánování na inkaso daně z příjmů právnických osob", *Politická ekonomie*, vol. 68, no. 1, pp. 3-17. ISSN 0032-3233, DOI 10.18267/j.polek.1264

Kloudová, D. (2013), "Produkční mezera jako indikátor inflace – případ pro českou ekonomiku", *Politická ekonomie*, vol. 61, no. 5, pp. 639-652. ISSN 0032-3233, DOI 10.18267/j.polek.921

Krejčí, I. (2013), "*Dynamika fixního kapitálu*", Czech University of Life Sciences in Prague.

Moravec, L. and Kukalová, G. (2014), "Investments Allocation Tax Factors in Pre-crisis Time", *Proceedings of the 11th International Scientific Conference on European Financial Systems 2014*, Lednice, pp. 396-402

Plašil, M. (2011), "Potenciální produkt, mezera výstupu a míra nejistoty spojená s jejich určením při použití Hodrick-Prescottova filtru", *Politická ekonomie*, vol. 59, no. 4, pp. 490-507

Samuelson, P. A. and Nordhaus W. D. (2010), "*Economics*", Boston, McGraw-Hill Irwin, ISBN 978-0-07-351129-0

Schneider, O. and Krejdl, A. (2000), "Strukturální schodky veřejných rozpočtů v ČR", *Finance a úvěr*, vol. 50, no. 3, pp. 161-174, ISSN 0015-1920

Sheng, Y., Jackson, T., Zhao, S. and Zhang, D. (2017), "Measuring Output, Input and Total Factor Productivity in Australian Agriculture: an Industry-Level Analysis", *Review of Income and Wealth*, vol. 63, pp. S169-S193, DOI 10.1111/roiw.12250

Vinod, H. D. (2004), "Ranking Mutual Funds Using Unconventional Utility Theory and Stochastic Dominance", *Journal of Empirical Finance*, vol. 11, no. 3, pp. 353–377

Vinod, H. D. (2006), "Maximum Entropy Ensembles for Time Series Inference in Economics", *Journal of Asian Economics*, vol. 17, no. 6, pp. 955–978

Vinod, H. D. and López-De-Lacalle. (2009), "Maximum Entropy Bootstrap for Time Series: The meboot", *Journal of Statistical Software*, vol. 29, no. 5, pp. 1–19

Vinod, H. D. (2013), "Maximum Entropy Bootstrap Algorithm Enhancements", *SSRN Electronic Journal*. DOI 10.2139/ssrn.2285041

DIGITALIZATION ANALYSIS OF RURAL AREAS AS THE BASIS FOR SUSTAINABLE ECONOMIC DEVELOPMENT

Mariya Vyacheslavovna Kagirova

Russian State Agrarian University - Moscow Timiryazev Academy, Institute of Economics and Management of AIC, Department of Statistics and Econometrics, Russia

kagirovamary@gmail.com

Annotation: The article is devoted to the development a methodology for a comprehensive analysis of processes and prospects in agriculture due to global digitalization. The object of the study is the regions of the Russian Federation, as well as the countries of the world, with the aim of conducting a comparative analysis of the digitalization rates in a territorial context. Cross-sectional data were used, including indicators of information, social and economic development of regions, indicators of the use of digital technologies in rural and urban areas; time series of indicators of the use of digital technologies in Russia and other countries in the period 2000 - 2018. To identify the degree of differentiation of regions, the following methods were used: statistical groupings, cluster analysis, calculation of rank correlation coefficients. For the analysis of changes in agriculture over a long period, methods of comparing parallel series, alignment of the time series using the least squares method were used. Based on the application of statistical methods, trends are identified in the level of the main indicators of the digital economy infrastructure in terms of personal computer availability, the use of the global Internet and the availability of websites for organizations. Regional differences in the conditions for the formation and degree of functioning of the digital economy are identified, groups of regions with low and the high level of development of the infrastructure of the digital economy of agriculture, the implementation of digital transactions and the availability of content are formed. The need for a territorial differentiated approach to determining priority areas for using funds for the development of information and communication technologies in accordance with the identified structural elements of the system is established

Key words: digital economy, sustainability, information technologies, agriculture, differentiation

JEL classification: Q10; C21; C22; F63

1. Introduction

The relevance of the chosen research topic is due to the acute problem of rural areas in Europe and Russia, which are at risk of degradation and extinction due to depopulation (natural and migratory), disparity in the conditions of market relations, the dependence of production on climate change. According to estimates by Anokhina M. (Anokhina, 2020), the uneven development of the agrarian complex is expressed by a lag of 30% of producers lagging behind, in some constituent entities of the Russian Federation the share of depopulated villages exceeded 20%). As a result, in most countries, modern rural policies do not meet current rural development requirements. In addition, market and social changes have a strong influence on how agricultural producers conduct their business. Climate change, the need to ensure food security of the country and the requirements of the market for organic production in conditions of environmental degradation increase the responsibility of farmers for the conservation of natural resources, as noted in the work of Ulman, M. and Šimek, P. (Ulman et al, 2020) Thus, it imposes an additional burden on producers, but also builds confidence in the need to increase labor productivity through the use of innovative technologies, since ensuring food independence and increasing export potential in modern conditions, given the requirements of a modern consumer and the need of conservation of resource potential, is not possible without application innovative tools based on the use of digital technologies, which is also confirmed by the results in the works of Forero-Cantor (Forero-Cantor, Ribal and Sanjuán, 2020). Thus, state policy should be aimed at supporting agricultural producers in the transition to digital technologies, creation of new jobs, which in general is the basis for sustainable development of rural areas.

The solution to this problem involves the transition of the socio-economic organization of the village to a qualitatively new level, ensuring the conservation of the rural population, improving living conditions, and the production of high-quality products based on expanded production. The digital economy creates the conditions for the efficient production of material goods, predetermines progress in all areas of the national economy. Moreover, the increase in value added is associated with an increase in labor productivity through the use of advanced technologies by highly qualified employees, i.e. the formation of a new technological base in various types of economic activity is associated with training and advanced training of employees (Csordás, 2020). In the context of the global digital transformation of the economy, requiring end-to-end automation of all major production and economic processes (Petrov, 2018), as a necessary condition for ensuring the country's competitiveness in the world market, the development of rural areas is at risk due to the features that are the object of submitted study.

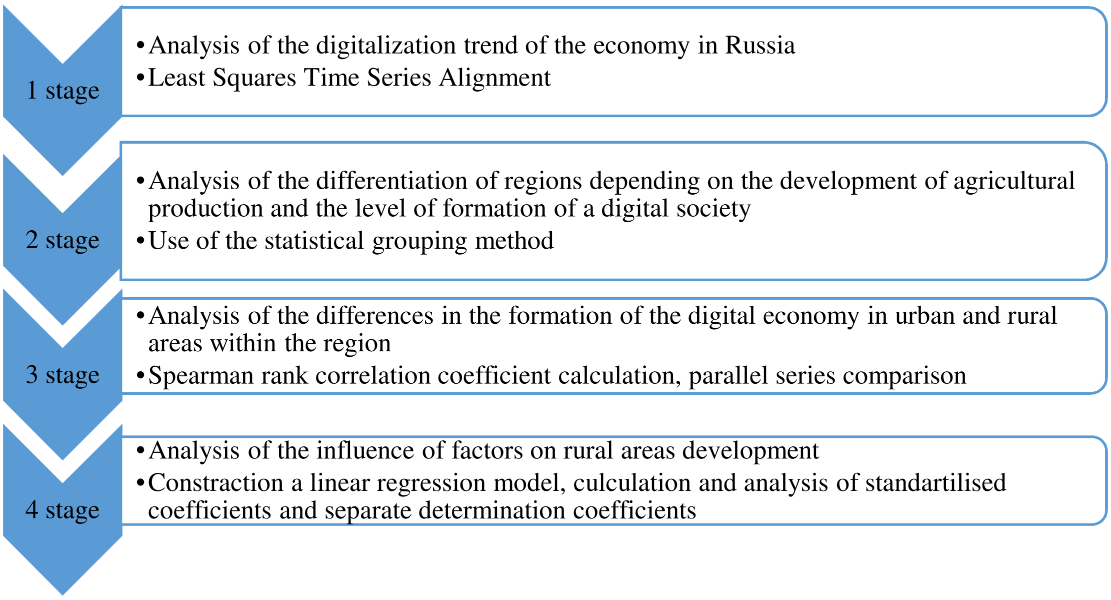
The agrarian sector of the country's economy is represented by a system of the following elements: large and medium agricultural organizations, small and micro enterprises, peasant (farmers), households; interconnected by various production and marketing relationships. This leads to a high degree of differentiation in the rate of adaptation to changing external economic conditions, as noted in the article (Curtiss et al., 2018). Categories of produces have different resource potential, the basis of which is made up of workers of different qualification characteristics and level of education, the ability to acquire skills in the digital field, involving the accumulation, processing, structuring and analysis of Big Data. Also, the categories of farms differ in the level of profitability of production, i.e. material resources for the transition to production using innovative digital technologies. Many scholars note the historical conditionality and economic need to preserve all elements with differentiation of the structure by territory and type of product in order to ensure sustainable development of rural areas (Zinchenko, 2016, Blinova, Vyalshina, 2019). All this necessitates a differentiated approach to regional policy development. Many researchers focus on measuring regional differences in the provision of population, producers of various kinds of resources. Thus, Forero-Cantor G. in his work (Forero-Cantor, Ribal, and Sanjuán, 2020) food security, notes that it is necessary to distinguish between the concepts of simply “resource availability” and “stability”, which implies protection from the effects of various risks (economic and climatic), suggests differentiating territories according to this criterion with the goal of building state policy. We also offer the same approach to the development of government support measures aimed at developing a digitalization base for the economy. We believe that it is necessary to distinguish between urban and rural areas with different levels of development of information technology, take into account that the main task at the moment is the creation of a common information society as the basis of the digital economy. Thus, the accelerated digitalization processes of precisely lagging areas will lead to the development of rural areas.

2. Materials and Methods

The object of the study is the regions of the Russian Federation, as well as the countries of the world, with the aim of conducting a comparative analysis of the digitalization rates in a territorial context. Cross-sectional data were used, including indicators of information, social and economic development of regions, indicators of the use of digital technologies in rural and urban areas; time series of indicators of the use of digital technologies in Russia and other countries in the period 2000 - 2018.

To identify the degree of differentiation of regions, the following methods were used: statistical groupings, regression analysis, calculation of rank correlation coefficients. For the analysis of changes in agriculture over a long period, methods of comparing parallel series, alignment of the time series using the least squares method were used.

Figure 1.Scheme of a statistical analysis of the impact of digitalization on the level of rural development



Source: Constructed by the author

To determine the regions that concentrate production on agricultural products, the grouping method was used. As a grouping characteristic, we used the indicator “Share of Gross Agricultural Value Added in the Gross Regional Product”. Three groups of regions were identified: I - 0.1-3.0%, II - 3.1-10.0%, III - above 10%. The groups are characterized by a set of indicators: i) indicators of the use of information technology; ii) regional development indicators.

In order to study the uniformity of the development of the use of digital technologies in urban and rural areas in the Russian regions by the main indicators characterizing the use of information technologies (share of resident population): “Personal computers in households”, “Mobile Internet in households”, “Broadband Internet in households”, “Internet users”, “Go online every day”, “Use the Internet from mobile devices”, “Shop online”, “Receive electronic government services”; arithmetic average calculated for urban and rural areas. According to the obtained indicator, the Spearman rank correlation coefficient was determined for two series:

$$p = 1 - 6\frac{\sum d^2}{n^3 - n} \quad (1)$$

In order to identify the impact of information technology as a factor on the development of rural territories, we have distinguished a group of regions with a rural population share of over 25% (there were 48 such regions), we consider the rest urban once. A linear multiple regression model was constructed for this sample (the specification of the model is based on the analytical method, each of the proposed factors has an added effect in the formation of the level of the effective attribute, while not being a prerequisite for its existence).

$$\boldsymbol{y_i = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + \varepsilon} \quad (2)$$

The main indicator characterizing the development of rural territories is the gross regional product per capita of the rural population, this indicator will be a response variable (y) in the regression model. The following indicators were used as factors:

x_1 - investment in fixed assets in agriculture per 100 hectares of farmland, th. rub. This is an indicator characterizing investments in the development of agricultural production, as the basis for providing employment and a source of income for the rural population (production factor);

x_2 - environmental costs per 100 hectares of farmland, th. rub. This indicator characterizes the provision of environmental protection and restoration (ecological factor);

x_3 - gross agricultural added value per capita, th. rub. Labor productivity in agriculture on the one hand and income level on the other (social factor);

x_4 - costs of information and communication technologies per 1 employee in agricultural production, th. rub. Factor of information (digital) development of the region.

To assess the influence of factors on the development of rural areas, an analysis of communication indicators was carried out; net regression coefficients of the resulting model; Comparative analysis of β-coefficients and separate determination coefficients (d_i^2).

$$\boldsymbol{\beta_i = b_i \frac{\sigma_x}{\sigma_y}} \quad (3)$$

where $\boldsymbol{b_i}$ - net regression coefficient, $\boldsymbol{\sigma_x}$ – standard deviation of the explanatory variable i, $\boldsymbol{\sigma_y}$ - standard deviation of the response variable y

$$\boldsymbol{d_i^2 = \beta_i r_{x_i y}} \quad (4)$$

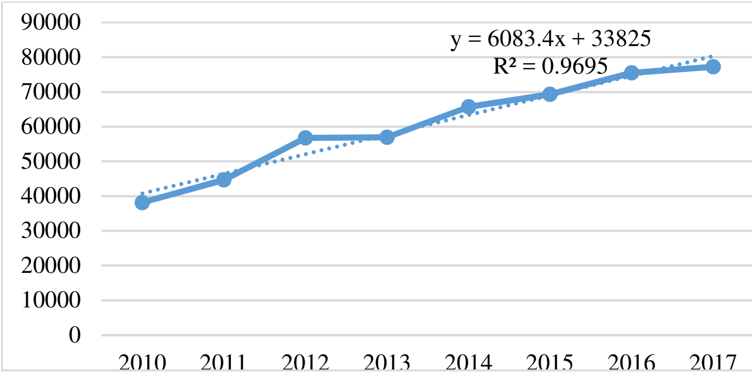
where $\boldsymbol{\beta_i}$ - β-coefficient, $\boldsymbol{r_{x_i y}}$ – linear correlation coefficient for the explanatory variable i and response variable y.

3. Results and Discussion

Despite the fact that since 2010, the costs of ICT development in Russia have been growing (Figure 2) annually by an average of 6 billion rubles, Russia is significantly lagging behind in the processes of digital transformation of the economy. According to the data published by the Research Institute of Higher School of Economics (Abdrakhmanova et al.) In 2017-2018, the Russian Federation ranks 45th in the ICT Development Index, 35th in the E-Government

Development Index and 10th in the Global Cybersecurity Index. In general, with an average level of 0.54 in the EU, the International Digital Economy and Society Index, in Russia this indicator amounted to 0.47. The low level of development of digital technologies in various types of economic activity leads to a lag in economic development from developed countries. Russia ranks 45th in the Global Innovation Index, 38th in the Global Competitiveness Index, and 43rd in the Drivers of Production Index.

Figure 2. Domestic expenditures on research and development in the priority area "Information and telecommunication systems" at constant prices, mln. rub.



Source: Constructed by the author on the base of HSE data

It should be noted that only by ensuring the uniform territorial development of the information society and digital transformations in all countries we can talk about the formation of a global digital economy, the same applies to the types of economic activity in building a digital economy in the country. It is worth noting that according to the main indicator at the moment characterizing the level of development of the digital economy in the country, the share of GVA of "digital" activities in the country's GDP, Russia from 2010 to 2016 moved from 17th place in the group of G20 countries (1.9%) up to 16th place (2.8%)

Russia's lagging behind economically developed countries is largely due not only to the later start of formation of the digital economy, but to the unevenness of processes across territories and activities. Agriculture is especially noticeably behind the industries, which is also reflected in the provision of rural areas information technology. So, in 2018, in 30 regions of Russia, the share of gross value added of agriculture, hunting and forestry in gross regional product was higher than 10%, in 15 regions - above 15%, which are characterized by low rates of development of information technologies (Table 1).

Table 1. Characterization of differences in the use of information technologies and factors by groups of regions of the Russian Federation in 2017

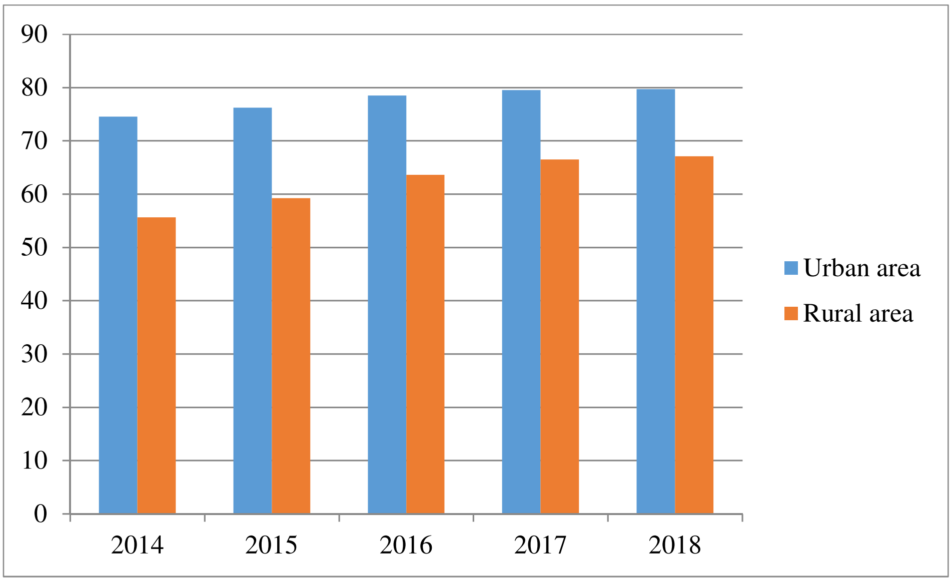
Indicator	Groups of regions by share of GVA of agriculture, hunting and forestry in GRP, %			Average
	0,1-3,0	**3,1-10,0**	**above 10,0**	
Share of GVA of agriculture, hunting and forestry in GRP, %	1.7	6.3	16.2	9.3
Use of PCs in organizations, %	94.1	92.5	92.0	92.5
Use of global networks in organizations, %	91.5	89.7	89.3	89.8
Organizations with a WEB site, %	46.9	46.2	46.7	46.5
Number of PCs per 100 employees	48.4	47.4	44.5	46.4
Organizations that use electronic data exchange between their and external information systems, %	61.4	63.6	61.8	62.6
GRP per capita, th. rub.	850	342	256	387
Investments in fixed assets per capita, th. rub.	212	86	72	103
Per capita cash income, rub. per month	42011	25717	22944	27139

Source: Constructed by the author on the base of Federal State Statistical Services, 2017

The data in the table indicate that the lack of material resources for the formation of a digital economy in regions with a high share of agricultural producers in the region's income generation (with a target level of 100%, the main indicators range from 44.5 to 92%) is due to low incomes of the population (by 45 , 4% lower than in group I, and make up 84.5% of the average level), low level of investment in fixed assets (66% lower than in group I), the overall level of regional development is lower in the third group then on average by 69.1%. Note that the above indicators illustrate the need for a differentiated approach to subsidizing the development of the information society in a territorial context, special attention should be paid to rural territories in terms of providing the material base for the use of digital technologies.

The need to pay special attention to the technological development not only of the region as a whole, but separately to rural areas, is proved by the results of the analysis of the relationship between the level of digital technology in urban and rural areas. Spearman's rank correlation coefficient calculated by the integrated indicator of using digital technologies, according to 2017 data, was 0.582. It indicates that even with high rates of overall development of digitalization in the region, rural areas can lag significantly behind urban areas. The analysis of the differences between urban and rural areas for individual indicators of the use of ICT showed a convergence, which is associated with the implementation of state support measures aimed at the development of agriculture and rural areas. So, according to the indicator characterizing the possibility of using digital technologies - the presence of households with Internet access (Figure 3), the difference between urban and rural areas in 2014 was 19.8 pp. by 2017 decreased to 15.7 percentage points due to higher growth rates of this indicator for households in rural areas. The same applies to access to the Internet 18.9 pp. and 13.0 p.p., respectively.

Figure 3. Households with Internet access by type of area (% of the total number of households)



Source: Constructed by the author on the base of HSE data

Thus, the policy of digital transformation of the economy should be based on the goal of achieving uniform development in the context of territories and types of economic activity. It will ensure the realization of the potential of the digital economy in increasing labor productivity and improving the quality of life of the population in urban and rural areas, its alignment and sustainable development of rural territories.

To identify the degree of influence of factors of various nature on the development of rural territories, an econometric modeling was carried out, as a result, a multiple regression model of the following form was obtained:

$$\tilde{y}_i = 105.452 + 0.020x_1 + 0.036x_2 + 0.561x_3 + 15.270x_4 \quad \textbf{(5)}$$

(25.9;0.00)* (0.005;0.05) (0.01;0.01) (0.26;0.03) (2.04;0.00)

* there are standard errors and significance level of parameters in brackets

This equation is generally reliable with a probability of 0.99 (significance level 0.000), each of the parameters is also reliable with a significance level of 0.05. Thus, it is possible to draw objective conclusions based on this model. The multiple correlation coefficient R = 0.94 indicates a close relationship between GRP per capita and the factors included in the equation, while the factors account for 88% of the variation in GRP (R2 = 0.88). The value of the net regression coefficients shows that with an increase in investments in fixed assets in agriculture per 100 hectares of farmland by 1 thousand rubles, GRP per capita of the rural population will increase by 20 rubles; with an increase in environmental costs by 100 hectares of farmland by 1 thousand rubles, GRP per capita will increase by 36 rubles; a change in labor productivity and income in agriculture (GVA of agriculture per capita) by 1 thousand rubles will lead to a change in the resulted indicator by 561.4 rubles; a change in ICT costs by 1 thousand rubles will result in to significant changes by 15270.2 rubles.

Table 2. Coefficients calculated using the regression model

Indicator	x_1	x_2	x_3	x_4
Elasticity Coefficient	0.017	0.041	0.159	0.445
β-coefficient	0.029	0.262	0.148	0.668
Separate Determination Coefficient	0.012	0.217	0.041	0.604

Source: Constructed by the author

A comparison of the coefficients (Table 2) allows us to see that the factor of the informational development of society currently has the most significant effect on the change in GRP per capita. So, a change in ICT costs of 1% will lead to a change in GRP of 0.45%, this factor also explains 60.4% of the variation of the resulted indicator. This confirms the effectiveness of investments in ICT development in rural areas to ensure their intensive sustainable development.

The need to develop a separate set of measures aimed at providing a platform for the use of digital technologies in rural areas, the creation of an accessible information and communication infrastructure, the introduction of satellite communications technologies, was noted in the framework of the forum "Social development of rural areas - the basis of territorial development of the Russian Federation" of the Committee of the Federation Council on Agricultural food policy and environmental management (Issues of Digital Transformation). The corresponding program was developed and adopted by the Ministry of Agriculture of the Russian Federation (Departmental project "Digital Agriculture") and provides for the achievement of targets on the main indicators of the development of the information society in rural areas by 2024. Thus, the territorial leveling tendencies and the further development of the foundations of the digital economy formation will continue during the implementation of the activities of this Project.

4. Conclusion

In the framework of the presented work, the today's position of the Russian Federation in the development of the digital economy at the world level was studied. It has been established that the increasing annual costs of using innovative information and communication technologies do not have significant impact. This suggests that there is a need to consider the distribution of digitalization processes in the territories. The study revealed a high degree of differentiation in the size of digitalization by Russian regions, including the fact that regions that are more specialized in agricultural production have low rates of digital technology due to the lack of an appropriate resource base. It has been established that the general high development of the region does not always entail the development of rural territories, and urban territories are ahead of rural territories in the development of the information society. The need to ensure the sustainable development of rural areas requires a more accelerated pace of digitalization compared with urban areas in order to ensure the convergence of labor productivity and, consequently, production profitability and improving the quality of life of the population. The lag in the development of one element (rural areas) leads to a decrease in the competitiveness indicators of the entire system (the country as a whole). Thus, state support should be aimed at providing rural support and improving the skills of agricultural workers in the use of digital technologies as a driving force for sustainable rural development.

A positive example of the effective investment of funds aimed at the development of digital technologies and the sustainable development of rural areas is the Krasnodar Region. In this region there is a high proportion of the rural population (45%) and the total increase in the rural population in 2018 amounted to 0.14% (unlike other rural areas, where the population is reduced annually due to both natural loss and due to migration), GRP per capita in rural areas in this region is higher than in the Southern Federal District by 21.8%. In the Krasnodar Region, ICT costs are equal to the average for the previously selected regions, while in the region 189 agricultural organizations use elements of precise farming (differentiated tillage by electronic maps, application of active substances using drones, tracking the status of crops involving drones, etc.), 41 agroholdings use precise animal husbandry (automatic climate control in farms, monitoring the condition of animals, robotics of the milking process, etc.). This led to a higher level of labor productivity and agricultural income by 14% than the sample average.

Of particular interest in this research topic is the study of labor productivity in various types of activities and on average across territories, its changes with the increasing use of digital technologies. However, at present, this information is difficult to access for researchers..

References

Afonina, V. (2018), "*The impact of digitalization on the development of the agricultural sector*", MSH, No 3, URL: https://cyberleninka.ru/article/n/vliyanie-tsifrovizatsii-na-razvitie-agrarnogo-sektora-ekonomiki

Anokhina, M. (2020), “Parameters of the strategy for managing the economic growth of agricultural production in Russia.” *Agric. Econ. – Czech*, 66: 140–148. https://doi.org/10.17221/255/2019-AGRICECON

Blinova, T. and Vyalshina, A. (2019), "Employment in Enterprises of Different Size in Rural Russia: Socio – Demographic Features", *Proceedings - of the 28th International Scientific Conference Agrarian Perspectives XXVIII. Business Scale in Relation to Economics*, pp. 21-28, ISBN 978-80-213-2973-7; ISSN 2464-4781 (Online)

Csordás, A. (2020), “Diversifying Effect of Digital Competence", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 3-13. ISSN 1804-1930. DOI 10.7160/aol.2020.120101

Curtiss, J, Gagalyuk, T., Epshtein, D. and Unay-Gailhard, I. (2018), “Russian Farm Economic Resilience in the Context of Structural Adjustments: the Case of the Northwest Region and the 2008 Economic Crisis”, *Proceedings - of the 28th International Scientific Conference Agrarian perspectives XXVII. Food safety – food security Proceedings of the 27th international scientific conference*, Prague, Czech Republic, pp. 28-35, ISBN 978-80-213-2890-7; ISSN 2464-4781 (Online)

Departmental project "Digital Agriculture", URL: http://mcx.ru/upload/iblock/900/900863fae06c026826a9ee43e124d058.pdf

Digital Economy Indicators in the Russian Federation: 2018 : Data Book / G. Abdrakhmanova, K. Vishnevskiy, G. Volkova, L. Gokhberg et al.; National Research University Higher School of Economics. – Moscow: HSE, 2018.

Digital Economy of the Russian Federation, URL: http://government.ru/rugovclassifier/614/events/

Forero-Cantor G. and Ribal J., Sanjuán N. (2020), “Measuring regional differences in food security from access and stability dimensions: A methodological proposal based on elasticities.” *Agric. Econ. – Czech*, 66: 112–119. https://doi.org/10.17221/97/2019-AGRICECON

Issues of Digital Transformation of Rural Areas Considered in the Federation Council, URL::http://council.gov.ru/events/news/94291/

Petrov, A. (2018), "Digitalization of the Economy: Problems, Challenges, Risks" *Trade policy*, No3 (15). URL: https://cyberleninka.ru/article/n/tsifrovizatsiya-ekonomiki-problemy-vyzovy-riski

Ulman, M., Šimek, P., Masner, J., Kogut, P., Löytty, T., Crehan, P., Charvát, K., Oliva, A., Bergheim, S. R., Kalaš, M., Kolokol, D. and Sabbatini, T. (2020), “Towards Future Oriented Collaborative Policy Development for Rural Areas and People", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 111-124. ISSN 1804-1930. DOI 10.7160/aol.2020.120110

Zinchenko, A. (2016), "Methodological Issues of Economic and Statistical Analysis of Agriculture", *Methodological support for conducting scientific research on the economic problems of the development of the agricultural sector of Russia, Collective monograph*, Moscow, pp. 129-158

SEGMENTATION OF 3D POINT CLOUDS DATA TO ANALYZE ENVIRONMENTAL ADAPTATIONS IN SORGHUM

Serkan Kartal[1], Jan Masner[2], Pavel Šimek[3], Michal Stočes[4], Vojtěch Novák[5], Jana Kholová[6] and Sunita Choudhary[7]

[1, 2, 3, 4, 5] Department of Information Technologies, Faculty of Economics and Management, CULS Prague, Czech Republic
[6, 7] International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Hyderabad- 5023204, Telangana, India

[1]kartal@pef.czu.cz, [2]masner@pef.czu.cz, [3]simek@pef.czu.cz [4]stoces@pef.czu.cz, [5]novakvojtech@pef.czu.cz, [6]J.Kholova@cgiar.org, [7]S.Choudhary@cgiar.org

Annotation: Climate change and varied precipitation patterns are threatening the sustainability of food production in India. Our challenge is to develop novel technologies that allow crop production to be observed or analyzed in the face of declining water availability. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is one of the leading institutes that pave the way for further progress in this area by using up-to-date technologies. The imaging platform they use produces the opportunity for analyzing critical features for drought adaptation and harnesses crop genetics for the breeding of improved varieties. This study introduces the software tool which facilitates the analysis of the 3D point clouds data collected by the ICRISAT. Thanks to the software tool developed, the 3D crop data segments from the tray, soil and the noise data. When the outputs are examined in detail, it is clearly seen that the separation process has been carried out successfully. Thus, the first step to produce more consistent data analysis results by using state of art machine learning algorithms has been fulfilled.

Key words: Sustainability, drought, data segmentation, data analysis

JEL classification: C61

1. Introduction

In this study, the development of the first step to process the data obtained from the imaging platform is explained. Imaging platform, shown in the Figure 1, scans the sorghums from above continuously and save the data in 3D point clouds format. Since the developments of the canopy are strongly influenced by the environmental factors, system has been constructed in which sorghums are grown at a density that reflects the field conditions (Welcker et al., 2007; Tardieu and Tuberosa, 2010; Welcker et al., 2011). The platform has been set outdoors and each data has a time stamp that allows it to be monitored depending on environmental conditions. In addition, the platform is able to collect data at a fairly high frequency (at least once per day), in order to prepare a dataset suitable for detailed analysis.

Figure 1. Phenotyping platform.

Source: authors

Studies in literature reveal importance of the technologies developed in order to increase food production in the agriculture (Helfer et al., 2019). The usability tests that need to be done to be able to use these technologies more efficiently and effectively have been examined in different studies (Novak et al., 2011). However, technologies developed to observe the effects of irrigation systems on the food production are still not at the desired level. Zaman et al. (2011) present that water availability during the grain filling period is critical for crop production (Zaman et al., 2011). Traits related to the development of crops are tightly associated to plant water use and to the combination of how large and quickly they develop (Kholová et al., 2014). In another study, Vadez et al. (2011) explain the effects of the plant water use pattern on development of the plant leaf area depending on the leaf's growth rate (Vadez et al., 2013). However, so far, only a few groups in the world are equipped to investigate plant sensitivity, genetic markers affecting canopy growth, and their interaction with environmental factors (Vadez et al., 2015). Therefore, understanding these canopy growth components and their interactions with the environment is crucial for the process of developing sorghums resistant to environmental factors. In accordance with this purpose, this platform has been constructed to collect enough evidence pointing towards importance of canopy-related traits for water use and water-use efficiency. In addition, if appropriate machine learning algorithms are selected, there is a wide range to derive more information from collected data. However, in order to use these algorithms, the existing data must be pre-processed. In other words, crop data should be segmented from soil and tray data.

2. Materials and Methods

The necessary segmentation process was carried out by filtering operations based on mathematical calculations. Nevertheless, standard programming languages do not have the ability to read, write and manipulate 3D data easily. Hence, one of the most popular 3D data manipulation libraries, Point Cloud Library (PCL), was used to perform these operations (Rusu & Cousins, 2011). Since the library is written in C ++ programming language, the rest of the project was developed in C ++ using the Visual Studio 2017 development environment.

The PCL contains many state-of-the art algorithms including segmentation, filtering, model fitting, feature estimation and registration. These algorithms can be used to filter noisy data, segment relevant parts of a scene, extract key points and compute descriptors to recognize objects, create surfaces from point clouds and visualize them. Furthermore, as the library has

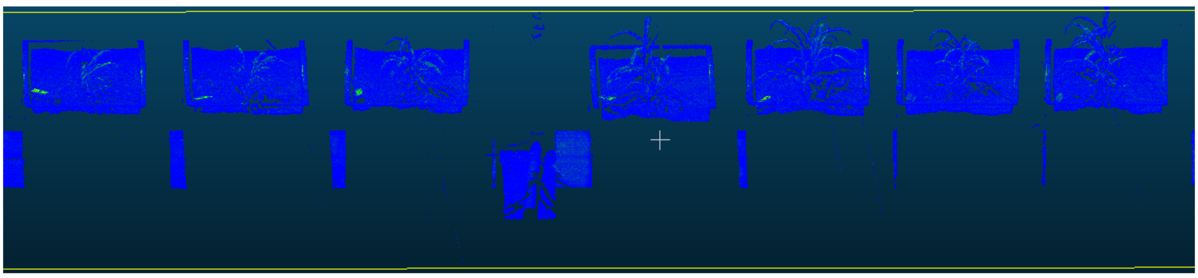
Berkeley Software Distribution (BSD) license, it can be used free of charge for commercial and scientific studies. In order to use the library, the necessary files were uploaded into VS development environment, and the necessary connections were completed.

Nguyen and Le (2013) have surveyed variety of segmentation methods and categorized them into five classes: edge-based methods, region-based methods, attributes-based methods, model-based methods and graph-based methods. Advantages and disadvantages of all methods have been examined in detail. According to this study, edge-based methods are fast, but they have accuracy problems and are very sensitive to noisy data. Attributes-based methods rely on the definition of neighborhood and the density of the point cloud. Graph based methods are illustrated as robust but time consuming when dealing with huge amount of input points. On the other hand, advantages of the region growing and model-based methods have been emphasized at the end of the study. Based on this study and the literature, these two proposed methods were employed and the acquired results were compared with the results of the mathematical segmentation process we developed.

Region-based and model-based methods require threshold values to be set for the cluster membership criterion before starting segmentation operation. While small threshold values separate the clusters very precisely and form a large number of clusters containing few points, the large threshold value forms a small number of clusters containing large number of points. Thus, if the threshold value is selected too small, some soil data will remain outside of the soil cluster and cannot be completely separated from the plant data. On the other hand, if the threshold value is selected too big, then some plant points might be included in the soil cluster and causes loss of information. In this study, the smoothness values are chosen to be big enough that both algorithms can provide the same precision as the mathematical model.

Data files created during the scanning process of sorghums are saved in Polygon File Format (PLY- Also known as the Stanford Triangle Format). The ply files produced by our laser scanner are a kind of points cloud data file where the scanned data is stored as points. A point data unit consists of only x, y, z coordinate information and the intensity value. Intensity value can be considered as a simple color information. However, when the data files obtained are colored according to the intensity value, the image given in Figure 2 appears.

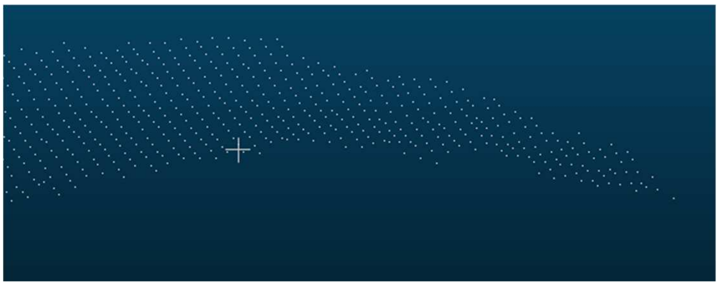
Figure 2. View of a sample scan file.



Source: own data processing

It is obviously seen that the intensity value does not make a significant difference on data. Hence, data segmentation process has been performed depending on the coordinate values. In order to better understand the data format, a zoomed view of the points on a leaf are given in Figure 3.

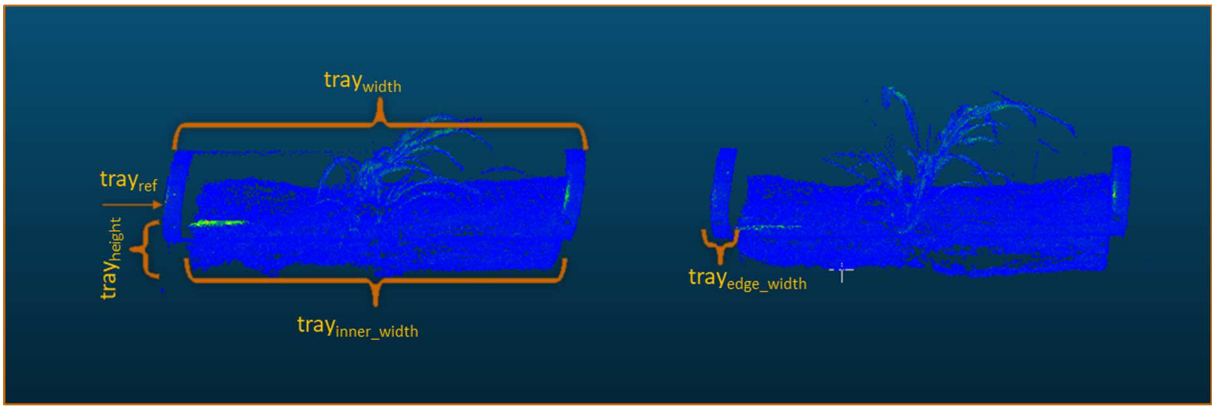
Figure 3. Zoomed view of the points on a leaf.



Source: own data processing

The proposed segmentation algorithm separates the data according to the mathematically calculated limit values. The algorithm consists of two steps: the first is to separate the trays from each other, and the second is to separate the sorghums from the tray and soil data. To be able to separate tray, firstly, trays must be detected. Before the algorithm starts working, a reference point indicating the height (z) value of the trays needs to be entered as a parameter ($tray_{ref}$). In order to explain how the algorithm works, all fixed values used in calculations are labeled with a specific name. Accordingly, $tray_{width}$ and $tray_{height}$ labels show the width and height values of the trays, respectively. All the labeled constant values are illustrated on the Figure 4.

Figure 4. The first two trays of the data, after the bottom part segmentation process. Additional info given on the image illustrates the constant values used during the segmentation process.



Source: own elaboration based on data

Firstly, points having lower z values than ($tray_{ref}$ - $tray_{height}$) are filtered, and the result given in Figure 4 is achieved. Then, the algorithm starts at z = $tray_{ref}$ and y = 0 coordinate and moves in the y direction to search for the first tray. If the searched y and z coordinate has more than 100 points carrying different x coordinate values, this means that the first tray has been reached. Once the tray is found, the tray object is cut along the y coordinate depending on the $tray_{width}$ and separated from the others. The same process is repeated until all trays are separated from each other.

Secondly, the sorghum must be separated from the tray and soil data. To be sure that the algorithm produces good results when sorghums are small, the sorghum(s) data must be precisely separated from the soil and tray data. The tray edge width ($tray_{edge\_width}$) and inner area width ($tray_{inner\_width}$) of the tray are given in Figure 4. According to these values, the sorghum and soil data are separated from the tray data. Lastly, it is required to separate the sorghum from the soil. For this process, the z coordinate value where the sorghum and crop data will be separated must be calculated. Initially, the points inside the tray (having smaller z coordinate value than $tray_{ref}$) has been taken. Then, their average z value calculated and labeled as separation point. Since the soil data in the tray is much more than the sorghum data, the calculated average value is close to the average of the pure soil data.

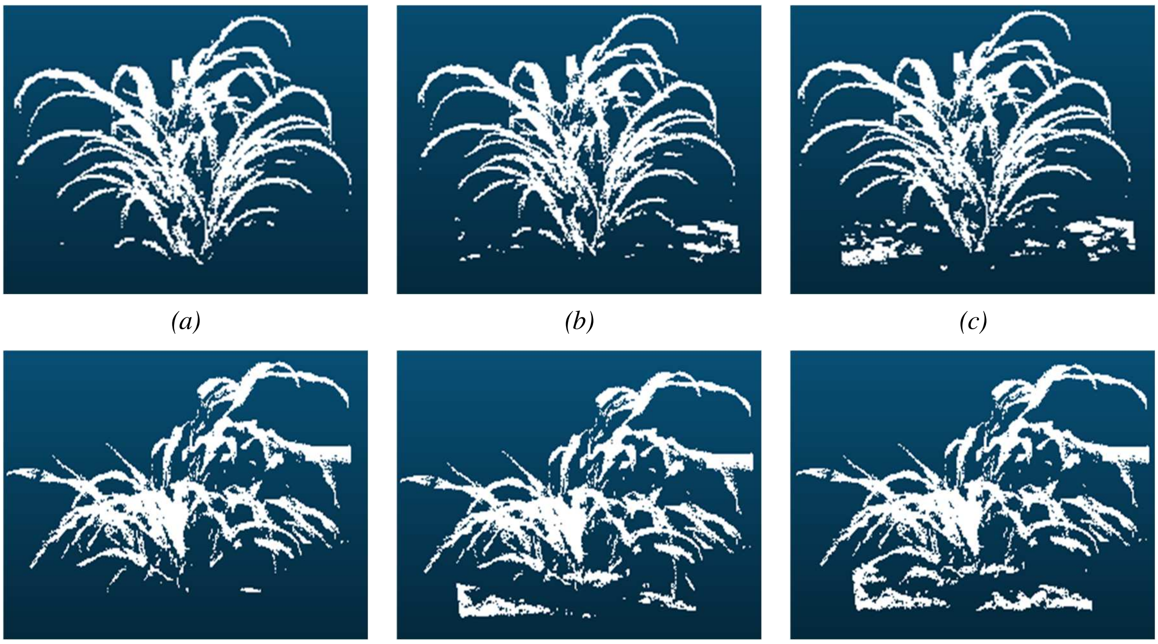
The biggest problem at this stage is that the soil data does not have a flat surface. To overcome this problem and separate sorghum data from soil data as much as possible, the separation point is updated by adding a small amount of fixed value. Finally, sorghum and soil data are separated from each other according to this separation point.

However, if the soil surface is too rough, then some small soil data can be interfered into the sorghum data. Since these data will be in very small pieces, they can be completely cleaned with the statistical data filtering algorithm planned to be used in the next step.

3. Results and Discussion

In order to evaluate the study results, the algorithms have been tested on the existing data set. The expected result is that the algorithm works successfully and segments correctly crop data from tray and soil data. Results of the proposed algorithm are compared with the results of two state of art point cloud segmentation algorithms and the original data set. The segmented crops data and the remaining data have been colored differently so as to evaluate results easily. Results of the proposed algorithm, region-based algorithm and model-based algorithm for two samples are given in Figure 5, respectively.

Figure 5. Segmentation result of proposed algorithm (a, d), region-based algorithm (b, e) and model-based algorithm (c, f) for two samples.



(a) *(b)* *(c)*

(d) *(e)* *(f)*

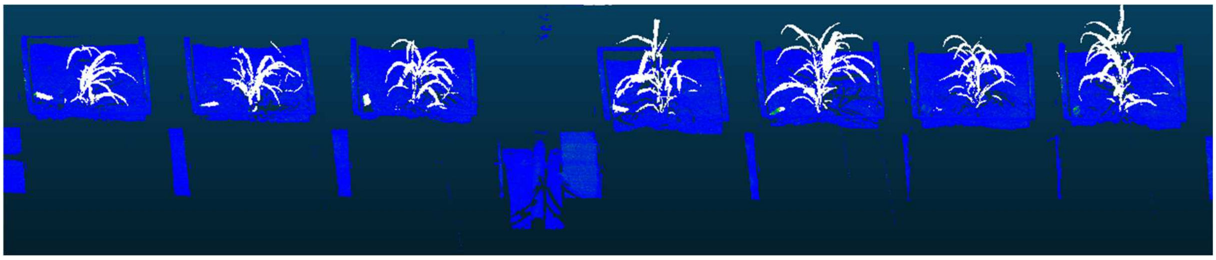
Source: own data processing

When the results are examined in detail, it is seen that some soil data still remains in the plant point cluster after region-based and model-based algorithms have been applied. Although it is possible to clean small soil clusters by data cleaning operations, the same is not possible for large clusters. On the other hand, the results of the mathematical segmentation process show that soil data is more properly separated from plant data. The final version of the segmented data by using mathematical segmentation algorithm and their comparisons with the original data are shown in Figure 6-7, respectively.

Figure 6. Result of a segmentation process for a complete scan file.

Source: own data processing

Figure 7. A comparative view of the segmentation process for a complete scan file.



Source: own data processing

The results demonstrate that the proposed algorithm works effectively on all test images. In some trays, it is seen that the barcodes used to label sorghums are located on the inner area of the tray. Since the barcodes are higher than the soil, they are mixed with the sorghum data during the separation process. However, since these are small pieces that are relatively far away from sorghum, it is possible to easily detect and clean them with the noise cleaning algorithms in the next step. As a result, when the results are examined in general, it can be clearly observed that the algorithm segments the test data with a high success rate.

By completing this segmentation step, the most suitable data set that will be used to obtain the most accurate results in the later step of the project has been prepared. In the next step, it is planned to develop a software tool to estimate the number of the sorghum in environment, the number of leaves in each plant and leaf size by using supervised and unsupervised machine learning algorithms (Tchapmi et al., 2017; Xie et al., 2019). Thus, operations that require a lot of labor work can be carried out quickly and easily with the prepared software tool.

4. Conclusion

In this project it is aimed to improve the drought-resistant sorghums by measuring the reactions of sorghums to the environment factors. However, gathering some information such as number of sorghums and number of leaves may require a lot of labor work. In order to speed up these processes, a data analyzing software developed with appropriate machine learning algorithms is required. However, in order to achieve a good result from these algorithms, the data must be cleaned and converted into the appropriate format explained.

In this study, it is aimed to prepare a suitable data set for the next steps of the project by separating the sorghum data from the tray and soil data. The proposed algorithm employed on existing data set and the results are compared with two state of art point cloud segmentation algorithms. When the results obtained from the segmentation process are examined, it is clearly seen that the proposed algorithm produces successful results. Thus, the suitable data set for the data analyzing algorithms to be applied in the next step has been prepared.

Acknowledgements

This research was carried out under the project: "Supporting the development of international mobility of research staff at CULS Prague", reg. no. CZ.02.2.69/0.0/0.0/16_027/0008366.

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019MEZ0006 – "Analysis of 3D point cloud models of crops for high throughput phenotyping and genetic mapping for canopy size and structure components".

References

Helfer, G. A., Barbosa, J. L. V., Martini, B. G., dos Santos, R. B. and da Costa, A. B. (2019), "Ubiquitous computing in precision agriculture: a systematic review", *AGRIS On-line Papers in Economics and Informatics*, vol. 11, no. 4, pp. 3-13, DOI 10.7160/aol.2019.110401

Kholová, J., Murugesan, T., Kaliamoorthy, S., Malayee, S., Baddam, R., Hammer, G. L. and Vadez, V. (2014), "Modelling the effect of plant water use traits on yield and stay-green expression in sorghum", *Functional Plant Biology*, vol. 41, no. 11, 1019-1034, DOI 10.1071/FP13355

Nguyen, A. and Le, B. (2013), "3D point cloud segmentation: A survey. In 2013 6th IEEE conference on robotics", *Automation and Mechatronics* (RAM), pp. 225-230

Novák, J. Š., Masner, J., Vaněk, J., Šimek, P. and Hennyeyová, K. (2019), "User Experience and Usability in Agriculture-Selected Aspects for Design Systems", *Agris On-Line Papers in Economics & Informatics*, vol. 11, no. 4, pp. 75-83, DOI 10.7160/aol.2019.110407

Rusu, R. B. and Cousins, S. (2011, May), "3d is here: Point cloud library (pcl)", *In 2011 IEEE International Conference on Robotics and Automation*, pp. 1-4, IEEE, DOI 10.1109/ICRA.2011.5980567

Tardieu, F. and Tuberosa, R. (2010), "Dissection and modelling of abiotic stress tolerance in plants", *Current opinion in plant biology*, vol. 13, no. 2, pp. 206-212, DOI 10.1016/j.pbi.2009.12.012

Tchapmi, L., Choy, C., Armeni, I., Gwak, J. and Savarese, S. (2017, October), "Segcloud: Semantic segmentation of 3d point clouds", *In 2017 international conference on 3D vision (3DV)*, pp. 537-547, IEEE, DOI 10.1109/3DV.2017.00067

Welcker, C., Boussuge, B., Bencivenni, C., Ribaut, J. M. and Tardieu, F. (2007), "Are source and sink strengths genetically linked in maize plants subjected to water deficit? A QTL study of the responses of leaf growth and of anthesis-silking interval to water deficit", *Journal of Experimental Botany*, vol. 58, no. 2, pp. 339-349, DOI 10.1093/jxb/erl227

Welcker, C., Sadok, W., Dignat, G., Renault, M., Salvi, S., Charcosset, A. and Tardieu, F. (2011), "A common genetic determinism for sensitivities to soil water deficit and evaporative demand: meta-analysis of quantitative trait loci and introgression lines of maize", *Plant Physiology*, vol. 157, no. 2, pp. 718-729, DOI 10.1104/pp.111.176479

Xie, Y., Tian, J. and Zhu, X. X. (2019), "*A review of point cloud semantic segmentation*", arXiv preprint arXiv:1908.08854

Vadez, V., Kholova, J., Zaman-Allah, M. and Belko, N. (2013), "Water: the most important 'molecular' component of water stress tolerance research", *Functional Plant Biology*, vol. 40, no. 12, pp. 1310-1322, DOI: 10.1071/FP13149

Vadez, V., Kholová, J., Hummel, G., Zhokhavets, U., Gupta, S. K. and Hash, C. T. (2015), "LeasyScan: a novel concept combining 3D imaging and lysimetry for high-throughput phenotyping of traits controlling plant water budget", *Journal of Experimental Botany*, vol. 66, no. 18, pp. 5581-5593, DOI 10.1093/jxb/erv251

Zaman-Allah, M., Jenkinson, D. M. and Vadez, V. (2011), "A conservative pattern of water use, rather than deep or profuse rooting, is critical for the terminal drought tolerance of chickpea", *Journal of Experimental Botany*, vol. 62, no. 12, 4239-4252, DOI 10.1093/jxb/err139

COMPARATIVE ADVANTAGES AND COMPLEMENTARITY OF AGRI-FOOD TRADE BETWEEN THE EU AND RUSSIA

Sergey Victorovich Kiselev[1], Roman Anatolievich Romashkin[2] and Anastasiya Pavlovna Soldatova[3]

[1, 3] Faculty of Economics, Lomonosov Moscow State Universit, Russia
[2] Eurasian Center for Food Security, Lomonosov Moscow State University, Russia

[1]servikis@yandex.ru, [2]romromash@gmail.com, [3]soldatova-n99@yandex.ru

Annotation: The European Union and Russia are traditional trading partners. They have intensive ties in agri-food sphere as well. Since Russian food embargo imposition, some changes in trade patterns have happened. The paper analyses major trends in comparative advantages for selected products and complementarity of agri-food trade between the EU and Russia taking into account possible influences of embargo. The analysis is based on data of International Trade Center, Russian statistics and USDA information as well. The paper describes the results of the calculations of major indices and indicators of comparative advantages and complementarity. At the same time, changes in total factor and labor productivity were analyzed as the most important determinants of competitiveness. In addition, the influence of exchange rate trends on Russian export and import of agri-food products has been estimated. The paper demonstrates that even under conditions of Russian food embargo and import substitution policy the European Union continues to maintain the high potential for agri-food export to Russia.

Key words: agri-food trade, comparative advantages, complementarity, competitiveness, embargo

JEL classification: Q17, Q18

1. Introduction

This paper aims to estimate the comparative advantages and complementarity of agri-food trade between the European Union and the Russian Federation, taking into account the competitiveness and the existence of Russian food embargo.

After the imposition of food embargo in 2014, Russia has strengthened import substitution processes. In general, the negative balance of Russian agri-food trade has been significantly improved. At the same time, food imports from the European Union declined. The reduction in imports from the EU was partially offset by other countries' exports that were not under to Russian sanctions. Besides, since 2018 the Russian government has aimed to increase the value of agri-food export in a short period (including high value added products), develop an export-oriented commodity distribution infrastructure, and facilitate access of agricultural goods to targeted markets. In this regard, it is of interest to study changes in basic factors in trade between such major partners as the EU and Russia in the context of the food embargo and the Russian policy of import substitution and export promotion. As a result, it will also allow us to assess what might happen in case the food embargo is lifted.

One of the influencing factors is level of trade complementarity between the two trading partners. Assessment of changes in complementarity allows to understand how the export profile of one country corresponds to the import profile of another. Such approach was used in relation to Chinese trade (Huo and Lu, 2014; Chunyan and Chunjie, 2015). Research on perspectives of the Russian agricultural exports in terms of comparative advantage with the use of Balassa, Lafay and some other indices was made by Benesova et al. (2017).

However, it should be emphasized that a sufficiently detailed analysis of the complementarity of trade between the EU and the Russian Federation has not been conducted yet.

In our opinion, it is worth to supplement such analyses with a study of competitiveness from the side of production factors. In particular, it is important to evaluate various indices in connections with trends in Total Factor Productivity (TFP), labor productivity, and the exchange rate of currencies. As for productivity as such, there are quite a lot of researches on this aspect. For example, Total Factor Productivity issues were studied by many American and other scientists (Rada et al., 2017).

2. Materials and Methods

Trade analysis is based on ITC Trade Map data, as well as Russian statistics. The analysis of the dynamics of Total Factor Productivity is based on data from the USDA and Eurostat.
One of the indices is Trade Complementarity Index (TCI). This is an indicator of how well the structure of one country imports matches to structure another country exports.

$$TCI = 100(1 - \sum(\frac{|m_{ik} - x_{ij}|}{2})), \quad \textbf{(1)}$$

where: x_{ij} is the share of good i in global exports of country j and m_{ik} is the share of good i in all imports of country k.

The index ranges from 0 (no goods are exported by one country or imported by the other) to 100 (export and import shares exactly match).

The analysis of comparative advantages in trade is based on the coefficient of the Revealed Comparative Advantage of B. Balassa (RCA) for goods from Russia and the EU (Balassa, 1977). The indicator represents the following ratio:

$$RCA = \frac{x_i/X}{x_{wi}/X_w}, \quad \textbf{(2)}$$

where: x_i – export of product i from a certain country, X – total export volume of the country taken, x_i – world export of product i, X – total world export volume.

RCA shows the ratio of the share of the product group (or certain product) in the country's export volumes to the share of the product group (or certain product) in world exports. This coefficient characterizes the country's competitiveness in world markets based on the value of exported products.

Given the fact that RCA has some limitations (does not account for the distortions in trade caused by subsidies, tariff and non-tariff barriers; does not take into account intra-industry import) analysis of competitiveness of Russian agricultural sector and EU is supplemented by the calculations of the Index of Lafay (Lafay, 1992), which is based on calculating comparative advantages based on net exports.

$$LFI = 100\left(\frac{x_{ij}-m_{ij}}{x_{ij}+m_{ij}} - \frac{\sum_{j=1}^{N}(x_{ij}-m_{ij})}{\sum_{j=1}^{N}(x_{ij}+m_{ij})}\right)\frac{x_{ij}+m_{ij}}{\sum_{j=1}^{N}(x_{ij}+m_{ij})}, \quad \textbf{(3)}$$

where: N – total number of traded goods; x_{ij}, m_{ij} – export and import of goods j by country i, respectively.

Besides, we use the Export Competitiveness Index (XCI):

$$XCI = \frac{x_{it}/X_{it}}{m_{kj}/M_{kt}}, \tag{4}$$

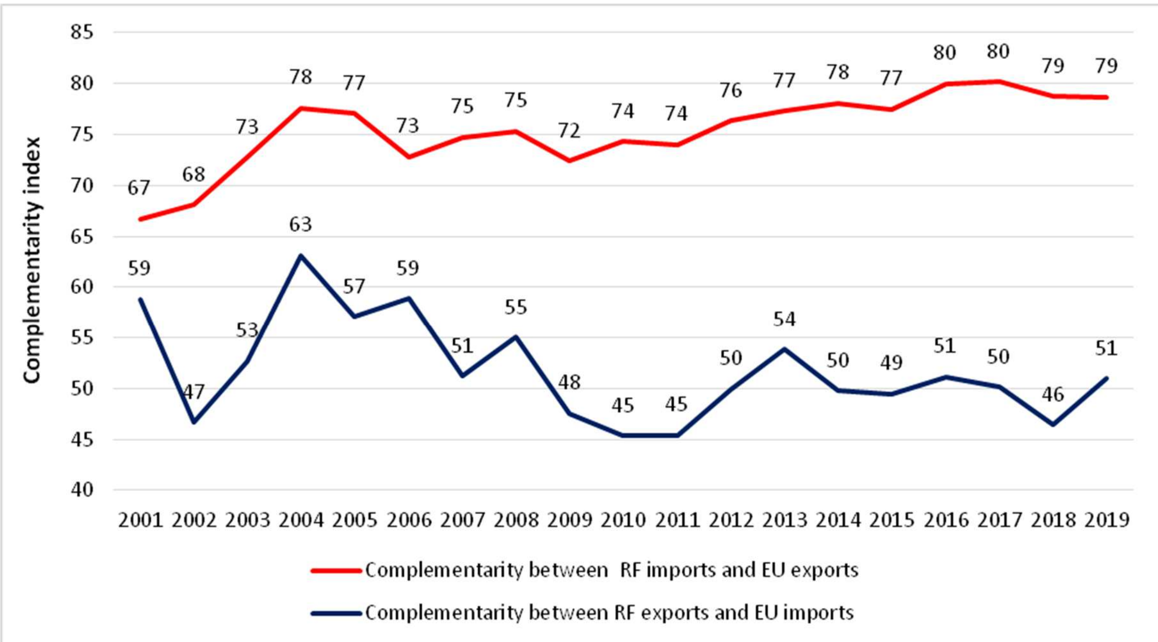
where: x_{ij} – export of product j of country i; X_{it} — total export of country i; m_{kj} — import of product j in market k; M_{kt} — total import in market k.

3. Results and Discussion

Russia and the EU have close trade ties. This refers to many products, including agri-food. Generally, export from Russia is rather small. In 2013 it is accounted for only 0.4% of total European agri-food imports, increasing to 0.45% in 2018. As for the Russian Federation, export-import relations with the EU are still of great importance. Thus, in 2013 and 2018 the shares of export to the EU in all export of Russian agri-food products were 14.4 and 11.2%, respectively. In Russian agri-food import, European goods accounted for 35.2 and 24.6% in 2013 and 2018. As a result of the food embargo, the value of mutual export and import decreased for Russia, but remained quite significant. Regarding particular goods, it should be emphasized that supply of many import products has ceased (cheese, meat, dairy products, fruit, etc.). At the same time import of some products (chocolate, wine, food preparations, preparations for animal feeding, etc.) have retained and even increased.

In terms of complementarity, TCI remains high for the EU (Figure 1). As a result of the Russian food embargo, it fell slightly in 2015, but then increased and afterwards remained at a high level. This indicator, therefore, demonstrates high potential of export of agri-food products from the EU to Russia. The embargo had only a minor impact on the index at the beginning. As for the Russian Federation, the complementarity index is lower than that of the EU, ranging from 46 to 51%. In this regard, we can conclude that Russia does not have great prospects for increasing its exports to the European Union from this point of view. Conversely, with the lifting of sanctions by Russia, the potential for increasing European exports is high.

Figure 1. Agri-food trade complementarity indices between the EU and the RF, 2001-2019, %



Source: Calculations on the base of ITC Trade Map, 2020

The analysis of complementarity of trade should be supplemented with a study of the comparative advantages and competitiveness of Russian and European products. Thus, it is of interest to make an assessment basing on Export Competitiveness Index (XCI), Revealed Comparative Advantage Index (RCA), and the Lafay comparative advantage index (LFI). In terms of comparative advantage, it is well known that the most competitive are Russian grains and oilseeds, vegetable oil (Ishchukova and Smutka, 2013; Benesova et al., 2017). However, it is essential to know how these comparative advantages change over time. In particular, whether the embargo and import substitution policies have affected Russia's agri-food products in terms of their comparative advantage and competitiveness. For this purpose, we analyzed products that once had a comparative advantage over others, products for which import substitution was significant (poultry meat and meat of swine), as well as products that are not competitive (bovine meat) (Table 1).

Table 1. Trends of comparative advantages and competitiveness of selected products in Russia

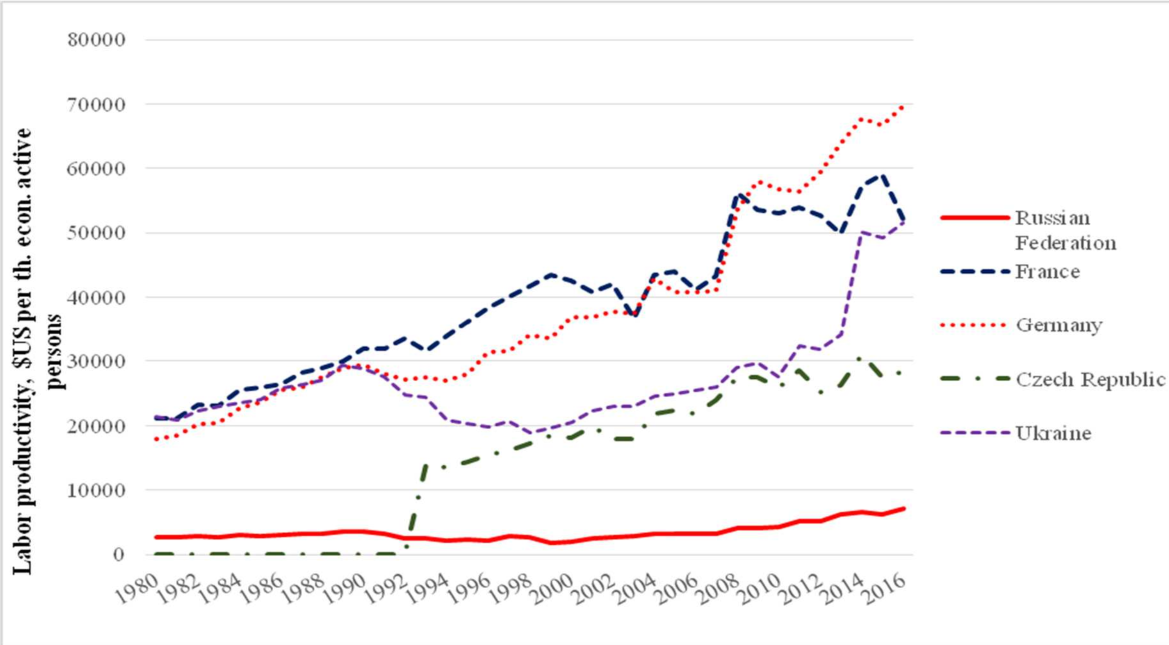
HS Product code	Products	XCI		RCA		LFI	
		2013	**2018**	**2013**	**2018**	**2013**	**2018**
1001	Wheat	296.9	760.3	3.314	9.189	0.0238	0.0945
1206	Sunflower seeds	0.206	0.040	1.019	0.464	-0.0029	-0.0093
1512	Sunflower Oil	9.243	1.175	5.844	5.909	0.0465	0.0003
0203	Meat of swine	close to 0	close to 0	close to 0	0.086	-0.0227	close to 0
0207	Poultry meat	close to 0	close to 0	0.037	0.296	-0.0313	close to 0
0202	Bovine meat	close to 0	close to 0	close to 0	0.025	-0.0213	close to 0

Source: Calculations on the base of ITC Trade Map, 2020

Trends in the indicators show that there have been no significant changes in the comparative advantage and competitiveness of major Russian agricultural products. Traditional agri-food products of Russian agriculture – wheat, sunflower seeds, sunflower oil – remain competitive. However, while there have been visible improvements in competitiveness of wheat production, export opportunities of sunflower seeds and oil have declined. This requires additional analysis, although it is possible to assume increased competition from other countries, particularly Ukraine.

The performance in the production of poultry meat, meat of swine and bovine meat has improved somewhat. This indicated certain success of import substitution policy and implementation of state-supported investment programs in these industries. However, there is no turning point yet, and we cannot expect a significant increase in these exports in the near future. This is also consistent with the comparative analysis of changes in labor productivity in the Russian Federation and the European Union (Figure 2).

Figure 2. Trends of agricultural labor productivity in the RF and some countries of the EU, 2005-2016 ($US per th. econ. active persons)

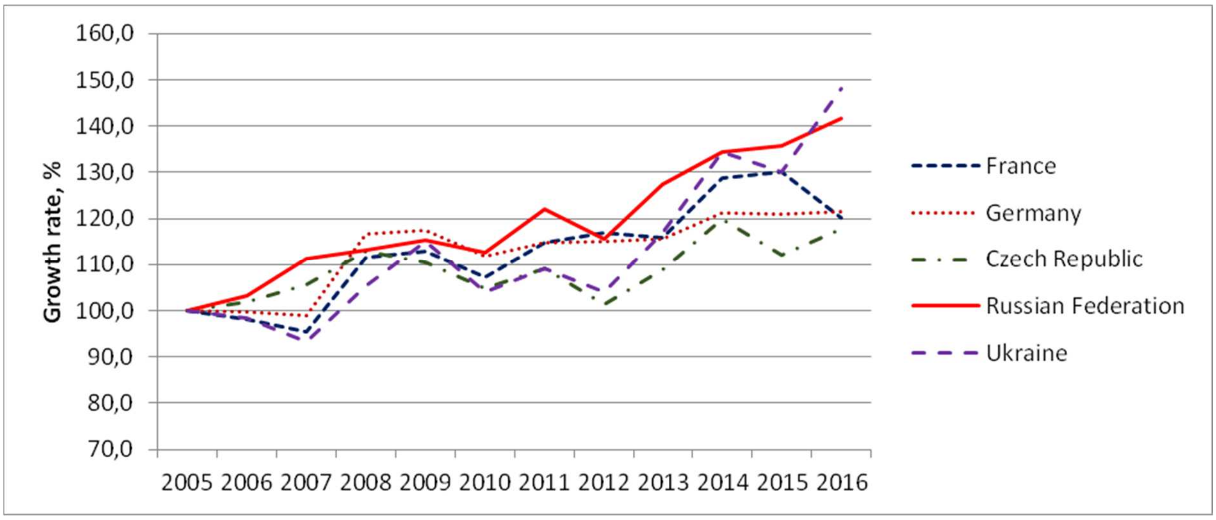


Source: Calculations on the base of USDA data

As can be seen from figure 2, the growth of agricultural labor productivity and its overall level is significantly higher in European countries. This is a fundamental factor that determines the competitiveness of EU agri-food products. It should be stated that the dynamics and level of labor productivity in the Russian Federation is far behind the leading European countries and Ukraine as well.

However, growth of agricultural Total Factor Productivity in the Russian Federation is more dynamic in comparison to European countries, slightly lagging behind Ukraine (Figure 3). However, this indicator does not reveal real level of competitiveness, showing only relative changes. As shown, Russia's TFP increases faster in comparison to the leading European countries. However, this growth still does not compensate for the lag in the level of labor productivity.

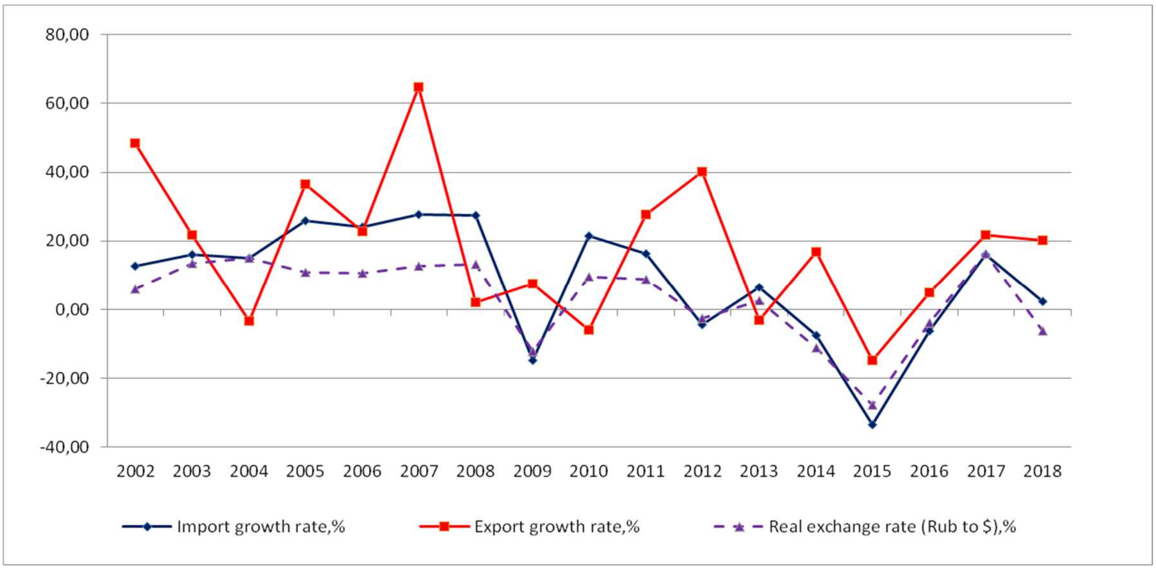
Figure 3. Trends of Agricultural Total Factor Productivity in the RF and some countries of the EU, 2005-2016, %



Source: Calculations on the base of USDA data

Another factor that affects competitiveness of Russian agri-food trade is the exchange rate (Figure 4).

Figure 4. Trends of exchange rate (Rub.to $), agri-food export and import, 2004-2018



Source: Calculations on the base of statistics of Federal State Statistic Service of Russia and CBR

The influence of exchange rate on Russian import was highlighted by Kiselev et al. (2016). The dynamics of the exchange rate, export and import of agri-food products demonstrate their close relationships. Regression analysis shows that changes in exchange rate determine agri-food import dynamics by 89%. Thus, food embargo influenced on the decrease of agri-food import was rather modest. And changes in imports and exchange rates are co-directional. Import of agri-food products is so sensitive that their changes almost always exceed the changes in exchange rates. Export is significantly less dependent on the exchange rate. Its impact determines only 12% changes in export. Although in the period from 2014 to 2018, this influence increases to 61%. Generally, we can conclude that in case of ruble devaluation, there most probably will be no significant growth in exports, including export to the European Union.

4. Conclusion

In spite of food embargo, compliance of EU export profile to Russia's agri-food import structure continues to grow. Actually, no influence on agri-food trade complementarity from the Russian food embargo. It is supported by comparative advantages of the EU in agri-food trade with the Russian Federation. The fundamental factor of such situation is high level of labor productivity in the EU. For example, in Russia labor productivity 5 times less than in Germany. In current conditions the elimination of embargo will restore the volumes of main exported European products in Russian market. However, TFP trends demonstrate the competitiveness in Russia is growing faster than in selected European countries.

The import substitution and export promotion policy in Russia has not changed a lot the competitiveness of major exported agri-food products. Product spectrum of Russian export goods should be the same. The performance in the production of poultry meat, meat of swine and bovine meat has improved to some extent. This indicated certain success of import substitution policy and implementation of state-supported investment programs in these industries.

One of the most important factor for Russian agri-food import is exchange rate. Import is so sensitive that its percentage changes almost always exceed the changes in exchange rates. There is no significant influence of percentage changes in exchanges rates on Russian agri-food export.

Acknowledgements

This research was conducted at Lomonosov Moscow State University and financially supported by the Russian Foundation for Basic Research (Grant No 20-010-00639 A).

References

Balassa, B. (1977), "Revealed Comparative Advantage Revisited: An Analysis of Relative Export Shares of the Industrial Countries, 1953-1971", *Manchester School of Economic and Social Studies*, 1977, Vol. 45(4), pp. 327-344, ISSN 1465-9957, DOI 10.1111/j.1467-9957.1977.tb00701.x

Benesova, I., Maitah, M., Smutka, L., Tomsik, K. and Ishchukova, N. (2017), "Perspectives of the Russian agricultural exports in terms of comparative advantage", *Agricultural Economics – Czech,* vol. 63, no. 7, pp. 318-330, DOI 10.17221/344/2015-AGRICECON

CBR, Central Bank of Russia, The main derivatives of the dynamics of the ruble exchange rate, [Online], Available: http://www.cbr.ru, [Accessed: 15 Apr. 2020]

Chunyan, Y. and Chunjie, Q. (2015), "Research on the Complementarity and Comparative Advantages of Agricultural Product Trade between China and CEE Countries", *Journal of Service Science and Management*, 8, pp. 201-208, DOI 10.4236/jssm.2015.82022

Federal State Statistic Service of Russia, Foreign Trade, [Online], Available: https://www.gks.ru/folder/11193, [Accessed: 21 Apr. 2020]

Huo, W. and Lu, X. (2014), "Research on the Competitiveness and Complementarity between China and Members of the Shanghai Cooperation Organization: An Empirical Study Based on RCA, GL, ES and TI Indexes", *Journal of Southwest University for Nationalities (Humanities and Social Sciences)*, vol. 3, pp. 110-115

Ishchukova, N. and Smutka, L. (2013), "Revealed comparative advantage of Russian agricultural exports", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*", vol. 61, no. 4, pp. 941-952, DOI 10.11118/actaun201361040941

ITC Trade Map, International Trade Center, Trade statistics for international business development, [Online], Available: http://www.trademap.org, [Accessed: 15 Apr. 2020]

Kiselev, S., Strokov, A., Zhorova, M. and Belugin, A. (2016), "The Impact of Food Trade Restrictions on the Russian Agriculture" *Proceedings of the Agrarian Perspectives XXV*, Prague, pp. 147-154, ISBN 978-80-213-2655-2

Lafay, G. (1992), "The Measurement of Revealed Comparative Advantages" in Dagenais, M. and Muet, P. (eds.), *International Trade Modeling*, Chapman and Hill, London, 1992, pp.209-234, ISBN 10: 0412450003 / 0-412-45000-3, DOI:10.1007/978-1-4757-2150-8_10

Rada, N., Liefert, W. and Liefert, O. (2017), "Productivity Growth and the Revival of Russian Agriculture", ERR-228, U.S. Department of Agriculture, Economic Research Service, 2017 [Online], Available: https://www.ers.usda.gov/webdocs/publications/83285/err-228.pdf?v=0, [Accessed: 22 Apr. 2020]

USDA, United States Department of Agriculture, International Agricultural Productivity, [Online], Available: https://www.ers.usda.gov/data-products/international-agricultural-productivity/, [Accessed: 21 Apr. 2020]

GENERATION Y.1 AND ITS RELATION TO THE PURCHASE OF DOMESTIC AND/OR FOREIGN FRUIT AND VEGETABLE

Jana Kozáková[1] and Mária Urbánová[2]

[1,] Faculty of Economics and Management Department of Management, [2]Department of Economics, Slovak University of Agriculture in Nitra, Slovakia

[1]kozakova@uniag.sk, [2]urbanovam@uniag.sk

Annotation: Generation Y.1 is described as the generation, which have large access to information what makes them more confident with their preferences while buying products. Generation Y.1 is slowly starting its career and many young people from this generation are in the life phase of forming their own households, which is also connected with the creation of shopping and eating habits. Article examines the impact of selected factors on the preferences and perceptions of economical educated members of generation Y.1 when buying fruit and vegetable. Selected question from a questionnaire were tested, compared and significances were further described to get the applicable results. The chosen statistical Kruskal-Wallis test showed a several significances between variables. There was a significant difference of local grower preferences with the consumption of fruit and vegetable and with the preferences of origin of consumed fruit and vegetable. According to seasonal sources there was a difference between the preferences of origin and local growers. Lastly, according to off seasonal sources, significant factors were consumption of fruit and vegetable and preferences of origin grown. The only variable, which was significant according to all of the examined factors, was preferences of origin grown, which makes it the most important factor for the Generation Y.1 in relation to purchase the fruit and vegetable.

Key words: fruit, vegetable, factors of consumption, generation Y.1, Slovakia

JEL classification: D12, I12, Q13, Q21

1. Introduction

Consumption of fruit and vegetable is typical for humans worldwide. In the past, before technological revolution and access to various transport possibilities people were focused on local sources. Nowadays, the possibility to buy exotic fruit and vegetable in every supermarket it is widely proclaimed and used. In addition, the price of these products is often very accessible despite additional transport and storage costs their price has to include. Foreign producers, often have a comparative advantage in the production of fruit and vegetables, which we are able to produce ourselves. Common fresh products, which are also grown by our farmers and sold directly on farms or in local markets, are available at supermarkets at a lower price. These products are purchased from abroad and despite their price include transport and storage costs, it is still lower compared with local products. There are several reasons which caused this paradox (e.g. different state support for farmers, different labor or material costs…) and also several impacts (e.g. lover quality of products, shorter durability, possible ethical issues related to their production. Current diets are detrimental to both human and planetary health and shifting towards more balanced, predominantly plant-based diets is seen as crucial to improving both. Low fruit and vegetable consumption is itself a major nutritional problem (Mason-D'Croz, 2019). Fruits and vegetables are important components of a healthy diet. Reduced fruit and vegetable consumption is linked to poor health and increased risk of non-communicable diseases (NCDs). An estimated 3.9 million deaths worldwide were attributable to inadequate fruit and vegetable consumption in 2017 (WHO, 2020). A meta-analysis of cohort studies following 469,551 participants found that a higher intake of fruits and vegetables is associated with a reduced risk of death from cardiovascular disease, with an average reduction in risk of 4% for each additional serving per day of fruit and vegetables (Wang, et al., 2014). Generation Y.1 are consumers, who have great access to information, which makes them surer of themselves when making purchases. As buyers, they defend their choices, they look for real benefits in products, they discuss and think about what they are proposing, they value sincere and direct speech, they save in the face of possible economic instability. Regarding the consumption of fresh foods, they have a problem with food waste (balance between the amount purchased and the amount consumed). For these reasons, they are looking for fresh foods easy to manipulate and practical at the time of consumption (AECOC, 2017). One of the most specific features of Generation Y is that they grew up with technology and rely on it to perform their jobs better. The Generation Y cohort is also referred to as Millennials, the Internet generation and/or the Net generation. (Thompson, 2017). Most of generation Y members are already working, however some are still studying and will join the workforce in the short future. Although they are partly supported by their parents, they value their independency. They are optimistic towards their own careers as well as the environment (Jorg, 2017). Gen Y's are more likely to respond to the elements of ethics and compliance programs that include social interaction and provision of support (e.g., helplines, mechanisms for seeking advice, training). (ERC, 2013). Because of major differences in the stages of lives they currently experience, it is useful to split this generation into Gen Y.1 and Gen Y.2. (Kasasa, 2019). About 1.5 million farms in the EU manage fruit orchards (including nut orchards) that covered 3.4 million hectares in 2017. A further 2.2 million hectares of fresh vegetables were cultivated in the EU by about 0.8 million farms (Eurostat, 2019). In Slovakia, fruit was harvested in 2018 on 4400 hectares. In case of vegetable it was 6140 hectares, which means 10 540 hectares of fresh products together. The same year we produced 50 860 tons of fruit and 106 390 tons of vegetable. (Eurostat, 2020). Despite this production, we are still depending on import of fruit and vegetable. We import about 100 000 tons of fruit from temperate zone and substantial part of this quantity is made up of apples with the biggest imports from Poland and Hungary. Imports of vegetables exceeded exports by EUR 182.5 billion. We have a negative trade balance for processed vegetables of almost 46 billion EUR. The difference between exports and imports for vegetables alone is 228 billion. EUR. The situation is not more favorable for fruits. Here, the negative balance is 235 billion EUR and 41 billion EUR for processed fruit, which is of total 276 billion EUR (Huba, 2019) Although local, seasonal and farm-to-table are watchwords for many consumers, globalization has triumphed in the produce aisle (Karp, 2018). Locally grown food creates important economic opportunities, provides health benefits and helps to reduce environmental impact, brings the community together and gives people the opportunity to make a difference. Supporting community economics and building relationships with local food producers is incredibly important, as is protecting the environment (ARROWQUIP, 2017). Another health benefit to buying locally grown is that you are getting produce at its peak state. Local farms can allow their fruits and vegetables to ripen longer or even fully ripen, which also adds to nutrition (Bishop, 2019). Changing shopping behaviors may be particularly difficult with low-income populations who often have restricted budgets. Prior studies have found that introducing promotional materials in a store was not associated with making produce purchases (Gittelsohn, 2010)

2. Materials and Methods

The impact of selected factors on the preferences and perceptions of generation Y.1 is examined when buying fruit and vegetable. The questionnaire survey conducted by Google Forms was used. Respondents were 150 graduates of Slovak University of Agriculture in Nitra born between 1990 - 2000 (Generation Y.1) selected by stratified random sampling. There is no pre-assumption of the certain view preferences of respondents, due to the fact that research is made especially on respondents with economical oriented study programs-not strongly connected to agriculture, while the students are from all over Slovakia. The rate of return was 99% and after data adjusting (Munk, et al., 2013) the sample was narrowed to 146 respondents graduate at least the first degree of university study.

Table 1. Design of questionnaire

No.	Topic	Question	Options
Q1	Consummation of fruit and vegetable (F&V)	Consumption of fruit and vegetable.	1- I consume fruit and vegetables; 2- I consume only fruit; 3- I consume only vegetable; 4- I consume no fruit and no vegetable
Q2	Preferences of origin grown	I prefer fruit and vegetables grown:	1-In Slovakia, 2-Abroad, 3-I don't care about the origin
Q3	Seasonal sources	From what source are most seasonal fruit and vegetable you consume?	1-Grown at home, 2- Purchased from local growers (from the market or directly from the grower), 3 - Purchased in a supermarket
Q4	Off seasonal sources	From what source is most off seasonal fruit and vegetable you consume?	1-Grown at home, 2- Purchased from local growers (from the market or directly from the grower), 3 - Purchased in a supermarket
Q5	Preferences of local growers	Would you like to buy fruit and vegetable from local growers for any price?	1-Yes, 2-I prefer local growers only with better price, 3-No
Q6	Perception of quality of Slovak F & V	What do you think about the quality of Slovak fruit and vegetables compared to foreign ones?	1-Slovak has higher quality than foreign, 2-Slovak has the same quality than foreign, 3-Slovak has less quality than foreign

Source: own design

Statistical analysis

Population size is represented by 2500 graduates of economic oriented study programs who fits to Generation X. With 95 % of probability that our sample accurately reflects the attitudes of the population and 8 % margin of error, sample of 146 can be considered as representative. Statistical analysis was processed by using a statistical addition to excel - XL stat.

Our data suited for the Kruskal-Wallis test with the assumptions:

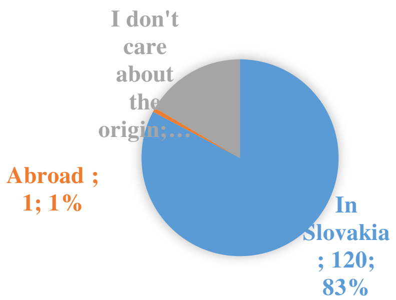
- H_0: The samples come from the same population and that there is no difference between samples.
- H_a: The samples do not come from the same population, so there is a difference between samples.

Computed p-value lower than the significance level alpha=0.05, indicates to reject the null hypothesis H_0, and accept the alternative hypothesis Ha. For the factors detected as significant by Kruskal-Wallis test, mean and other descriptivism's were included to clarify the results. For indication of autocorrelation the Durbin – Watson test was used (Abrahamse and Louter, 1971).

3. Results and Discussion

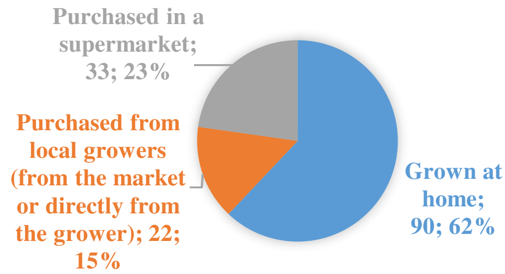
The sample consist of 111 women (77%) and 34 man (23%) which corresponds to the gender composition of addressed graduates. The majority (94%) of respondents do not have special food preferences, 3 % stated gluten-free and/or lactose-free nutrition and 3% were vegetarians. Only 2 respondents consume only fruit and 1 only vegetable. Majority of them prefer fruit and vegetable produced in Slovakia (120), only one prefer foreign production and 24 do not care about the origin of fruit and vegetable they are buying. Since only question Q1 was considered as significant in further statistical analysis, all other mentioned sorting questions were excluded from analysis. Generation Y.1 is defined as responsible and their decisions use to base on previous seeking of relevant information. These characteristics are confirmed also by our sample, since the majority of respondents (83 %) prefer fruit and vegetable grown in Slovakia. Remarkably, 16 % of them do not care about the origin and only 1% of them prefer foreign products (Figure 1). Source of purchased fruit and vegetable is one of the crucial factors in this research. In Slovakia, the availability of fresh fruit and vegetable has seasonal character. Of course, there are some possibilities to consume older stored products (e.g. potatoes, tomatoes, carrot…) or buying from local growers with greenhouse cultivation and winter production capacity. However, we do not consider these options as primarily due to the quantity of imported fruit and vegetables from abroad. In respect of this, we asked respondents separately for consumption of seasonal and off-seasonal sources of fruit and vegetable.

Figure 1. Preferences of origin (grown)



Source: calculations based on own research

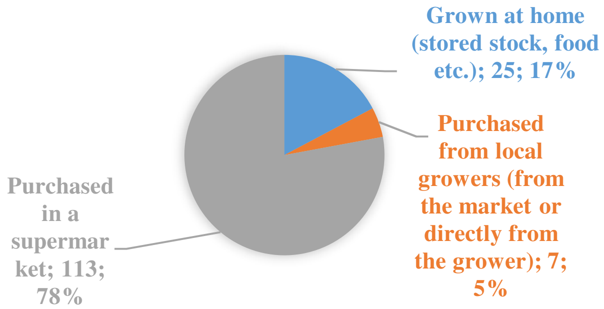
Figure 2. Seasonal sources of fruit and vegetable



Source: calculations based on own research

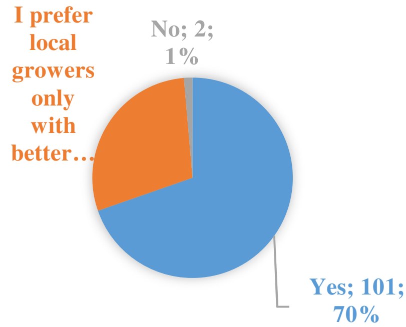
Examined Y.1 generation consumers stated that during season they consume mainly fruit and vegetable produced in Slovakia. 15% of respondents purchase seasonal F&V from local growers and 62 % are consuming home grown fruit and vegetable. Only 23% buy this fresh production during season in supermarket (Figure 2).

Figure 3. Off-seasonal sources of fruit and vegetable



Source: calculations based on own research

Figure 4. Preferences of local growers



Source: calculations based on own research

As expected, off-seasonal situation is quite different. Only 17% of them are still consuming mainly own grown F&V, since their expiration is limited due to storage possibilities. The same reason caused that additional 5 % are buying from local growers/markets. The majority 78 % are buying off seasonal fresh fruit and vegetable in supermarket (Figure 3). Despite general price sensitivity of typical consumer, the demand on products with the direct impact on consumer's health and well-being is usually not as elastic as when buying other products. Regarding this, we asked respondents if they would like to buy F&V from local growers for any price. Their answers in 70 % confirmed that price is not the crucial factor for them. Only 1 % stated the opposite and additional 29 % would prefer local growers only with better price (Figure 4). Willingness to pay more for local production is connected with the expectations of its quality. Considering this, we included question about the quality of Slovak F&V compared to foreign ones. It is not a surprise that 75 % of respondents think, that Slovak production of F&V is of higher quality compared to foreign one. Only 4 % stated that Slovak production has less quality and 21 % think that Slovak and foreign production has the same quality. From the Kruskal-Wallis p-values (Table 1) of lower than 0, 05, we can conclude that there are several significances between the examined variables. According to preferences of local growers there was a high significance with consumption of F&V, when most of those who prefer local growers even with a higher price also consume both fruit and vegetable.

Table 1. P-values of Kruskal – Wallis tests

Variable\Test	According to Pref. of local growers	According to Seasonal sources	According to Off seasonal sources
Consumption of fruit and vegetable (F&V)	**<0.001**	0.554	**0.043**
Preferences of origin grown	**0.002**	**0.013**	**0.040**
Preferences of local growers	---	**0.010**	0.611
Perception of quality of Slovak F&V	0.184	0.064	0.171

Source: calculations based on own research

Table 2. Preferences of local growers

Variable	Observations	Minimum	Maximum	Mean
Consumption of F&V | 1	101	1.000	2.000	1.020
Consumption of F&V | 2	42	1.000	1.000	1.000
Consumption of F&V | 3	2	1.000	4.000	2.500
Preferences of origin grown | 1	101	1.000	3.000	1.198
Preferences of origin grown | 2	42	1.000	3.000	1.643
Preferences of origin grown | 3	2	1.000	3.000	2.000

Source: calculations based on own research

Table 3. According to Seasonal sources

Variable	Observations	Minimum	Maximum	Mean
Preferences of origin grown | 1	90	1.000	3.000	1.289
Preferences of origin grown | 2	22	1.000	3.000	1.091
Preferences of origin grown | 3	33	1.000	3.000	1.636
Preferences of local growers | 1	90	1.000	3.000	1.256
Preferences of local growers | 2	22	1.000	2.000	1.227
Preferences of local growers | 3	33	1.000	3.000	1.545

Source: calculations based on own research

Table 4. Off - seasonal sources

Variable	Observations	Minimum	Maximum	Mean
Consumption of F/V | 1	25	1,000	4,000	1,120
Consumption of F/V | 2	7	1,000	2,000	1,143
Consumption of F/V | 3	113	1,000	2,000	1,009
Preferences of origin grown | 1	25	1,000	1,000	1,000
Preferences of origin grown | 2	7	1,000	3,000	1,286
Preferences of origin grown | 3	113	1,000	3,000	1,416

Source: calculations based on own research

Just 2 consumers that don’t prefer local growers eat either fruit or vegetable (Table 2). A preference of origin grown was also a significant factor, while most of local preference consumers (101) prefer products grown in Slovakia (1, 19) - what is obvious. Those, who prefer local growers only with better price (42), prefer mostly abroad grown F&V (1, 64). According to seasonal sources preference of two factors turned out as significant (table 3). Most of those who consume seasonal fruit and vegetable grown at home prefer them grown in Slovakia and prefer local growers. Those who purchase seasonal products in a supermarket (33) prefer abroad grown fruit and vegetable (1, 63) and only prefer local growers with better price (1, 54). Also 2 significances can be seen according to off seasonal sources. Similar as for the seasonal ones, the preference of origin is significant and most of the respondents buy their off seasonal F&V in supermarkets (113) and at the same time prefer Slovakian grown products (1, 4).

4. Conclusion

Each country's millennials are different, but because of globalization, social media, the spreading of Western culture and the speed of change, members of generation Y.1 worldwide are more similar to one another than to older generations within their nations (Time, 2013). As consumers they are more responsible as older generations, they are digitally experienced, they can use information and they react on trends. Currently, one of the biggest trends in consumption behavior is focusing of healthy, fresh and local alternatives. Our survey based on the fact, that this trend is modern especially among young educated individuals who can be considered as Generation Y.1 and that healthy food marketing in the retail environment can be an important driver of F&V purchases (Sutton et al., 2019). The developed questionnaire survey was made with respondents of 150 SPU graduates of economical oriented study programs. Six questions were chosen for further statistical analysis. After the hypotheses were set, tests were performed for the verification of them. Outcomes of Kruskal – Wallis tests confirmed statistically significant differences between several variables. There is a statistically significant difference between preferences of local growers and consumption of fruit and vegetable and between preferences of local growers and preferences of origin of consumed fruit and vegetable. This test also confirmed difference between preferences of examined consumers about seasonal sources of fruit and vegetable they are consuming and preferences of origin of these fresh products, which was confirmed also by difference between preferences of the examined consumers about seasonal sources of fruit and vegetable they are consuming and their preferences of local growers. In case of preferences of examined consumers according to off-seasonal sources of fruit and vegetable they are consuming, it has a relationship with references of origin grown and also consumption of fruit and vegetable. Indeed, the only variable, which was significant according to all of the examined factors, was preferences of origin grown, which makes it the most important factor for the Generation Y.1 in relation to purchase the F&V.

Acknowledgements
The paper is part of the project KEGA 005SPU-4/2019 "Theory and Practice of the International Management and Entrepreneurship in the Multicultural Environment" conducted at the Department of Management at the Faculty of Economics and Management, SUA in Nitra.

References

Abrahamse, A. P. J. and Louter, A. S. (1971), "On a new, test for autocorrelation in least squares regression", *Biometrika,* vol. 58, no. 1, pp. 53-60, DOI 10.1093/biomet/58.1.53

AECOC, 2017, Consumption of fruits and vegetables in millennials. Planasa, 2017. Based on AECOC SHOPPERWIEV research 2017, [Online], Available: https://www.aecoc.es/servicios/estudios/shopperview-perfil-comprador/, [Accessed: 12 Feb. 2020]

ARROWQUIP, Top Benefits of Buying Locally Grown Food. Animal Science. 6.4.2017. [Online], Available: https://arrowquip.com/blog/animal-science/top-benefits-buying-locally-grown-food, [Accessed: 09 Feb. 2020]

Bishop, T. (2019), "*Health Benefits of Eating Local Produce*", Down to Earth. Organic and Natural. [Online], Available: https://www.downtoearth.org/environment/localhawaii/health-benefits-eating-local-produce, [Accessed: 18 May. 2019]

Eurostat, Where do we grow our fruit and vegetables? Product Eurostat News, 2019. [Online], Available: https://ec.europa.eu/eurostat/en/web/products-eurostat-news/-/DDN-20191003-1, [Accessed: 24 Feb. 2020]

Eurostat, Agriculture DATASET. [Online], Available: https://appsso.eurosta t.ec.europa.eu/nui/show.do?dataset=apro_cpsh1&lang=en, [Accessed: 09 Feb. 2020]

Gittelsohn, J., Vijayadeva, V., Davison, N., Ramirez, V., Cheung, L. W., Murphy, S. and Novotny, R. (2010), "A food store intervention trial improves caregiver psychosocial factors and children's dietary intake in Hawaii", *Obesity,* vol. 18, no.1, pp. 84-S90. DOI 10.1038/oby.2009.436

Huba, J. (2019), "*Saldo v ovocí a zelenine je 500 miliónov eur. Pestovatelia to chcú zmenit*". Poľnoinfo. [Online], Available: https://polnoinfo.sk/saldo-v-ovoci-a-zelenine-je-500-milionov-eur-pestovatelia-to-chcu-zmenit/, [Accessed: 16 Jan. 2020]

Jason-D'Croz, D., Bogard, J. R., Sulser, T. B., Cenacchi, N., Dunston, S., Herrero, M. and Wiebe, K. (2019), "Gaps between fruit and vegetable production, demand, and recommended consumption at global and national levels: an integrated modelling study", *The Lancet Planetary Health*, vol. 3, no. 7, pp. e318-e329, DOI 10.1016/S2542-5196 (19)30095-6

Karp, D. (2018), "Most of America's Fruit Is Now Imported. Is That a Bad Thing?", *The New York Times*. 13. 03. 2018. [Online], Available: https://www.nytimes.com/2018/03/13/dining/fruit-vegetables-imports.html, [Accessed: 23 Feb. 2020]

Kasasa, (2019), "Boomers, Gen X, Gen Y, and Gen Z Explained". Search. [Online], Available: https://www.kasasa.com/articles/generations/gen-x-gen-y-gen-z., [Accessed: 07 Mar. 2020]

Munk, M., Drlik, M., Kapusta, J. and Munkova, D. (2013), "Methodology design for data preparation in the process of discovering patterns of web users' behavior". *Applied Mathematics & Information Sciences*, vol. *7*, pp. 27-36, DOI 10.12785/amis/071L05

Sutton, K., Caldwell, J., Yoshida, S., Thompson, J. and Kuo, T. (2019), "Healthy food marketing and purchases of fruits and vegetables in large grocery stores", *Preventive medicine reports*, vol. *14*, no. 100861, DOI 10.1016/j.pmedr.2019.100861

Thompson, C. A. (2017), "Leading a Multigenerational Workforce in the Public Sector". [Online], Available: https://www.aecoc.es/servicios/estudios/shopperview-perfilomprador/https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=5026&context=dissertations, [Accessed: 20 Mar. 2020]

Time, Millennials: The Me Me Me Generation, May 20, 2013 [Online], Available: https://time.com/247/millennials-the-me-me-me-generation/, [Accessed: 09 Feb. 2020]

Wang X., Ouyang Y., Liu J., Zhu M., Zhao G., Bao W. and Hu F.B, (2014), "*Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies*", *BMJ 2014*, Jul 29; 349: pp. 4490. DOI 10.1136/bmj.g4490

WHO, World Health Organization (2020), Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases. E-Library of Evidence for Nutrition Actions (eLENA), 2020. [Online], Available: https://www.who.int/elena/titles/fruit_vegetables_ncds, [Accessed: 09 Feb. 2020]

COINTEGRATION ANALYSIS OF PRODUCERS' MILK PRICES IN RUSSIAN REGIONS AFTER THE IMPORT BAN

Mikhail Krivko[1] and Luboš Smutka[2]

[1, 2] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]krivko@pef.czu.cz, [2]smutka@pef.czu.cz

Annotation: Paper attempts to analyze the impact of Russian import ban on separate regions of Russia, i.e. federal districts, from perspective of producers' milk prices cointegration between different federal districts of the country. Federal districts of Russian Federation differ in terms of production volume means; however null hypothesis of equal mean cannot be rejected for producers' prices during the period of 2010-2018. Influence of changes in prices among regions are evaluated using Granger-causality approach and Phillips' Z-alpha test. Main findings suggest that regional milk markets have become less integrated in terms of producer prices, with 16 long-term interdependences between milk prices in different regions has been eliminated and replaced by 2 (between Central and Siberian Federal Districts). Changes in milk producer prices in Far Eastern Federal District has become less associated with prices in other federal districts. The number of Granger causality relationships has increased after the import ban, with two federal districts (Ural and Volga) increased causality relationship on all other regions. Import ban has led to increase in price integration of regional markets of milk, while there is an evidence of structural break presence.

Key words: Russian Federation, import ban, cointegration analysis, milk prices.

JEL classification: Q13, Q17, Q18.

1. Introduction

Developments in Russian milk industry are tightly connected with the topic of import ban, that was introduced by Russian Government. In August 2014 Russian Federation replied to European Union's sanctions with so-called Russian embargo, which represents import ban on the several European agricultural products, including meat, fish, cheese, milk, fresh fish, vegetables and fruits produced in the countries, which joined EU restrictive measures to Russia. Import ban relates to the goods originated in United States, European Union, Norway, Canada and Australia.

Regarding domestic effects of import ban, some authors point out that the results vary across sub-sectors, with increases in production of pork and decreases among dairy, beef and fish producers (Wengle, 2016).

Liefert et al. (2019) attribute the changes in imports (average annual meat import was 40% lower in 2014-2016 compared to 2011-2013) to import ban, while changes in exports were partially caused by production-enhancing favorable weather (grain exports were 50% higher in 2014-2016 then 2011-2013). As per Boulanger et al. (2016), modelling the sanctions' situation using common general equilibrium (CGE) approach has shown, that import ban should result in 5.7% decrease of milk price in Finland and 3.2% decrease of milk price in Lithuania, while price on Russian domestic market should increase by 6.1%. Authors also anticipated increases of import of dairy products from Belarus and New Zealand by 202 million EUR for each country as a result of supplier substitution. This finding is also supported by Venkuviene and Masteikiene (2015), who suggest that the dairy sector, followed by the meat sector, in Central and Eastern Europe (CEE) are the sectors most suffered from the Russian import ban. Czech Republic, Slovakia, Poland and Hungary (Visegrad Group) had experienced milk price drop and decreasing competitiveness due to Russian embargo, while elimination of milk quotas and cheap import products also played a significant role (Zdráhal et al., 2016, Nagy and Jámbor, 2019, Zdráhal et al., 2018). Fedoseeva and Herrmann (2019) argue, that despite the fact that Russian import ban has affected German exports, there are several other important events with relatively higher impact for Germany, such as EU-wide pork ban imposed by Russia in the beginning of 2014.

Banse et al. (2019) assessed several trade policy scenarios and has suggested, that possible removal of Russian import ban will affect Russian agricultural production only to a limited extent, while there will be no effect on the EU. At the same time, depending on how competitive Russian farmers become, creation of free trade area from Lisbon to Vladivostok would benefit farmers in the EU more than farmers in Russia. Authors used general equilibrium model MAGNET (Woltjer et al., 2014) to estimate several trade policy scenarios for the period of 2017-2030, and the results suggest slight decrease of dairy production in Russia (-0.8% by year 2030) and increase of dairy imports by 23%. Removal of import ban would lead to 3% decrease in dairy production, which authors attribute to increased competition with high quality imports of previously banned products.

Some of the researchers also point out to the decrease in revealed comparative advantage of EU exports to Russian Federation, especially in terms of meat, milk, cheese, apples and vegetables (Kašt'aková et al.,2018). Tleubayev et al (2018) have studied the changes on Russian dairy market on the example of cheese products and have found evidence of increased integration of regional markets, as well as higher speed of price adjustment.

As Russian Federation consists of different regions, that vary on the level of agricultural production and prices, it is important to understand the regional structure of the cost of self-sufficiency, as well as the direction of import ban impact. As mentioned by Tleubayev et al. (2018), regional milk markets in Russia did not show complete integration in the period before Russian import ban. If Russian milk market is considered homogeneous, some of the conclusions made based on these assumptions might lead to incorrect implications.

This paper attempts to provide an analysis of interdependencies between regional price pairs in connection to the changes on regional markets induced by Russian import ban of 2014. Dependency of prices in different territories has important policy implications, especially for countries with heterogenic regional economic structure. Regions of Russian Federation differ in terms of milk production and milk prices, therefore any conclusion made for the country as a whole might not necessarily hold true for each and every of the regions. The aim of the paper is to identify changes in milk prices cointegration between federal districts of Russian Federation before and after introduction of Russian import ban in August 2014.

Research question is formulated as follows: what are the changes in milk price integration between federal districts of Russia after the import ban of 2014?

2. Materials and Methods

Current research employs publicly available monthly data on milk production volumes and producers' prices of milk originated from Russian Statistical Service (Rosstat). Data covers period of 2010-2018 for the cointegration analysis. Time periods of the data has been chosen due to the availability of consistent time series applicable for the needs of the research, which is one of the important features of statistical data on Russian Federation.

The question of interdependencies between time series of milk prices in individual regions of Russian Federation should be addressed. In terms of current analysis, Augmented Dickey-Fuller test (ADF test, Dickey and Fuller (1979), Said and Dickey (1984)) and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS test, Kwiatkowski et al. (1992)) were used for detection of unit roots, Phillips Z_α test for cointegration and Granger causality test for detection of causality between pairs of variables.

Granger causality test (Granger, 1969) helps to determine whether past values of independent variable is statistically useful in describing values of dependent variable, together with past values of dependent variable. Thus, this test does not show real causality, but rather whether adding lags of independent variable improves the regression. It tests in one direction, therefore two-direction test might be more useful to reveal whether feedback is present in the underlying data-generation process.

Granger causality test states the null hypothesis of no causality, i.e. $x_j(t)$ does not Granger cause $x_i(t)$, by employing two models, restricted and non-restricted models:

$$x_i(t) = \alpha_1 x_i(t-1) + c_1 + u_1(t) \quad \textbf{(1)}$$

$$x_i(t) = \alpha_2 x_i(t-1) + \beta_2 x_j(t-1) + c_2 + u_2(t) \quad \textbf{(2)}$$

Using the mentioned models (1) and (2), the null hypothesis can be formulated as:

$$H_0\colon \beta_2 = 0 \quad \textbf{(3)}$$

The presence of feedback relationship can be tested by swapping $x_i(t)$ and $x_j(t)$ in the models (1) and (2) accordingly.

The presence of cointegration relationships between pairs of prices among all Federal Districts is tested by Phillips Z_α test. This test (Phillips and Ouliaris, 1990, Phillips, 1987) is a cointegration test based on residuals, which employs the linear regression of specified form to calculate Z_α statistic. The null hypothesis of no cointegration is rejected if the computed value of Z_α statistic is smaller than the appropriate critical value, as described in Phillips and Ouliaris (1990).

3. Results and Discussion

Russian Federation can be considered as a country with significant regional differences in terms of milk industry. There are several dimensions to this fact, including geographical and historical reasons. In terms of geographical dimension, Russian Federation is the biggest country in the world, covering the area of more than 17 million square kilometres, 16.3 million of which is rural land area, but only 13% of which is agricultural land. Thus, it is relatively difficult to consider Russian Federation as a homogeneous economy, because unlike many other countries, differences in prices and production volumes between regions of Russia might differ more than between different countries of the world.

Milk prices have shown higher speed of increase since 2014, but what are the connections between separate regions in terms of price change? This mutual interdependence of prices in Russian regions can be tested by employing tools of cointegration analysis. Phillips' Z_α test of cointegration for the period 2000-2014 shows 16 cointegration relationships between prices time series among Russian regions (Table 1).

Table 1. Phillips' Z_α test results for cointegrated price pairs before 2014. Source: ("AP figure" Font)

№	Price pair	F statistic	F critical	p-value
1	Central Federal District - Southern Federal District	-29.0047	-28.3218	<0.01
2	Central Federal District - Volga Federal District	-59.0262	-28.3218	<0.01
3	North-Western Federal District - Siberian Federal District	-29.5493	-28.3218	<0.01
4	North-Western Federal District - Far-Eastern Federal District	-37.5179	-28.3218	<0.01
5	Southern Federal District - Central Federal District	-28.8629	-28.3218	<0.01
6	Southern Federal District - Volga Federal District	-49.3392	-28.3218	<0.01
7	Southern Federal District - Ural Federal District	-37.9384	-28.3218	<0.01
8	Volga Federal District - Central Federal District	-59.2174	-28.3218	<0.01
9	Volga Federal District - Southern Federal District	-49.8084	-28.3218	<0.01
10	Volga Federal District - Ural Federal District	-37.8005	-28.3218	<0.01
11	Siberian Federal District - North-Western Federal District	-29.7246	-28.3218	<0.01
12	Siberian Federal District - Far-Eastern Federal District	-36.4482	-28.3218	<0.01
13	Ural Federal District - Southern Federal District	-38.0502	-28.3218	<0.01
14	Ural Federal District - Volga Federal District	-37.495	-28.3218	<0.01
15	Far-Eastern Federal District - North-Western Federal District	-40.8411	-28.3218	<0.01
16	Far-Eastern Federal District - Siberian Federal District	-39.5786	-28.3218	<0.01

Source: Rosstat, 2019, own calculations.

Cointegration implies log-run dependence, and as can be seen from the results of Phillips' Z_α test prices in all federal districts had dependences to prices to at least two other regions. However, after 2014 only one of the cointegration relationships remains, which is the cointegration between Central Federal District and Siberian Federal District (Table 2).

Table 2. Phillips' Z_α test results for cointegrated price pairs after 2014

№	Price pair	F statistic	F critical	p-value
1	Central Federal District - Siberian Federal District	-29.4607	-28.3218	<0.01
2	Siberian Federal District - Central Federal District	-32.263	-28.3218	<0.01

Source: Rosstat, 2019, own calculations.

As can be seen on the results of cointegration analysis, regional milk markets have become less integrated in terms of price dependences between federal districts. At the same time, cointegration relationship between Central and Siberian federal districts, which is the only one cointegration relationship after 2014, was not observed before. This finding implies, that there is a statistically significant long-term equilibrium between prices in Central and Siberian federal districts, which was not observed before 2014 and might be one of the effects of Russian import ban. It also suggests, that introduction of import ban has destroyed the long-term equilibriums in other regional price pairs. At the same time, as analysis after 2014 has included observations from August 2014 to December 2018 (52 monthly observations), it suggests that this period of time was not enough for these long-term equilibriums to return to its prior state. This fact also suggests the presence of structural break, which can be assessed by the procedure introduced by Kejriwal and Perron (2010).

However, cointegration analysis as per Phillips' Z_α test does not show whether prices in one region have an influence on prices in another region, i.e. direction of the influence. Granger causality test can help to reveal whether addition of past values of milk prices in i region can help in explaining prices in *j* region, therefore suggesting direction of influence. In terms of current analysis, Granger causality is considered as a measure of influence of prices in one region on prices in another.

Prices in Central Federal District and in Volga Federal District had influence on prices in all other regions of Russia before the import ban in August 2014.

Five feedback relationships have been revealed (Table 3): CFD and VFD; NWFD and SIBFD; NWFD and UFD; SFD and VFD; UFD and VFD. If the period before the ban is restricted to 52 observations (the same length of the period as from August 2014 till December 2018), then no feedbacks are present, and number of Granger-causality relationships decrease from 30 to 13 (Table 4).

Table 3. Granger causality test results for price pairs before 2014

	Dependent variables								
Independent variables	CFD	FEFD	NCFD	NWFD	SFD	SIBFD	UFD	VFD	Grand Total
CFD	-	1	1	1	1	1	1	1	7
FEFD	0	-	0	0	0	0	0	0	0
NCFD	0	0	-	0	0	0	0	0	0
NWFD	0	1	0	-	0	1	1	0	3
SFD	0	1	1	1	-	1	1	1	6
SIBFD	0	1	0	1	0	-	0	0	2
UFD	0	1	1	1	0	1	-	1	5
VFD	1	1	1	1	1	1	1	-	7
Grand Total	1	6	4	5	2	5	4	3	30

Source: Rosstat, 2019, own calculations.
Note: (1 means Granger-cause, 0 means no Granger-cause).

It is important to mention, that prices in Far Eastern federal district had been influenced by prices in all other federal districts (except North-Caucasian) in the period before 2014. This fact can be considered as an evidence of price integration. Prices in North-Western and Siberian districts had the same structure of influence: prices were influenced by all other districts, except Far Eastern and North-Caucasian, which are the districts with least milk production capacity, and might be considered as most excluded from supply chains in other districts. Surprisingly, prices in Central district had been influenced only by prices in Volga federal district and did not experience influence from other federal districts. Swap of dependent and independent variables shows, that Central, Volga and Southern federal districts are the region, which changes in prices Granger-cause changes in prices in all other federal districts.

Robustness of these results has been tested by restricting time period to the same number of observations, as for the period after import ban (52 observations, April, 2010-August, 2014). Results of the Granger-causality tests for this case are shown on Table 4.

Table 4. Granger causality test results for price pairs, period April, 2010 – August, 2014

	Dependent variable								
Independent variables	CFD	FEFD	NCFD	NWFD	SFD	SIBFD	UFD	VFD	Grand Total
CFD		0	1	1	0	1	0	0	3
FEFD	0		0	0	0	0	0	0	0
NCFD	0	0		0	0	0	0	0	0
NWFD	0	0	1		0	1	0	0	2
SFD	0	0	1	1		1	0	0	3
SIBFD	0	0	0	0	0		0	0	0
UFD	0	0	1	0	0	1		0	2
VFD	0	0	1	0	0	1	1		3
Grand Total	0	0	5	2	0	5	1	0	13

Source: Rosstat, 2019, own calculations.
Note: (1 means Granger-cause, 0 means no Granger-cause).

At the same time, restriction of observations to the period of April, 2010-August, 2014 shows, that already in this period many of previously strong Granger-causes does not hold. However, Central, Volga and Southern Federal Districts remain the most influential in terms of Granger-causality of price changes. This result has shown consistency after the changes of method setup, therefore might be considered robust. Another robust result can be found in case of Siberian Federal District, as it still has 5 variables which Granger-cause changes in milk prices in this region.

Table 5. Granger causality test results for price pairs before 2014

	Dependent variables								
Independent variables	CFD	FEFD	NCFD	NWFD	SFD	SIBFD	UFD	VFD	Grand Total
CFD	-	0	1	1	0	1	0	0	3
FEFD	0	-	0	0	0	0	0	0	0
NCFD	0	0	-	1	0	1	0	0	2
NWFD	0	0	0	-	0	0	0	0	0
SFD	1	1	1	1	-	1	0	0	5
SIBFD	0	0	0	1	0	-	0	0	1
UFD	1	1	1	1	1	1	-	0	6
VFD	1	0	1	1	1	1	1	-	6
Grand Total	3	2	4	6	2	5	1	0	23

Source: Rosstat, 2019, own calculations.
Note: (1 means Granger-cause, 0 means no Granger-cause).

As can be seen on the Table 5, Ural Federal District have enhanced its position in terms of price influence on Southern Federal District, while prices in Volga Federal District have lost their influence on Far-Eastern Federal District. Prices in Ural Federal District does not Granger-cause prices in Volga Federal District, while the opposite holds true. Interestingly, changes of milk price in Central Federal District did Granger-cause in 3 other federal districts, however Ural and Volga Federal Districts have increased the number of Granger-causes twice, from 3 to 6.

Results of Phillips' Z_α test prices suggest decrease in the level of integration between federal districts. Regional markets of milk have become less integrated, which comes into controversy with findings of other authors, for example in relation to prices of cheese (Tleubayev et al., 2018). However, several features of the present analysis differ from the referenced research of Tleubayev et al. Firstly, current paper focuses on prices and production of milk, while authors of the referenced paper investigated changes of cheese market. Cheese is a product with higher added value, while milk on most of the markets (including Russian Federation) is a commoditized product. Range of cheese products is large, while milk is usually represented by 4 or 5 different types based on fat content. Secondly, analysis in the referenced paper was conducted on the data of several specific regions of Russia (39 price pairs), while analysis in current paper is done for all federal districts of Russia, which represents higher level of aggregation but broader overview of regional differences at the same time.

As Kharin (2015) has shown, there is an important feature of vertical price transmission on Russian diary market, when during the period of 2002-2014 retail prices seemed to had influence on farm gate prices, while the opposite influence was rejected after testing. In another paper on the matter of price transmission on the Russian dairy market, Kharin (2019) has investigated spatial (horizontal) price transmission in four Russian Federal Districts (Central Federal District, Volga Federal District, Northwestern Federal District and Southern Federal District) using Hansen-Seo technique to identify threshold effects in cointegration relationships of price pairs. It helped to reveal long-run relationship via threshold vector error correction model (TVECM) for all the price pairs in scope of the research. Current paper employs Granger-causality tests in order to show the price cointegration from a different angle.

It is interesting to compare the results of Kharin (2019) with the results of current research. First of all, it is important to consider, that author has performed analysis for 4 federal districts, while current research offers cointegration analysis of all federal districts in Russia. In current research, cointegration has been proved by the means of Phillips' Z_α test for the price pair Central Federal District – Siberian Federal District, while this price pair was not included in the referenced paper. Author also highlights remarkable place of Central Federal District among other regions of Russian Federation: together with Volga Federal District, these are the regions with highest raw milk production and population. This observation is also supported by the results of current research, as Central Federal District is the only region for which price integration with other region remains after the import ban.

In the contrast, results of Granger-causality test suggest that Central Federal District has stable part of its influence in terms of milk prices on other regions of Russia before and after the import ban. At the same time, Ural Federal District and Volga Federal District have achieved influence on more other federal districts in the period after the import ban, then it was before. This fact might be considered together with results of Kharin (2019), where the author also suggests price leadership of Volga Federal District within Volga-Central price pair, due to higher milk production and per capita consumption in the region.

4. Conclusion

The results of current research have shown several features of producers' prices of milk in federal districts of Russian Federation.

Results of cointegration analysis have shown several important changes after 2014. Sixteen cointegration relationships between price pairs in federal districts have been replaced by only two. All regions have lost the integration, but to different extent. The most stable region is Central Federal District, as it has maintained cointegration of prices with Siberian Federal District. Extinction of such relationships can be attributed to import ban of 2014, as milk was one of the products in scope of the ban.

Another effect of import ban can be observed in changes of Granger-causality of prices. Ural Federal District and Volga Federal District have increased their influence on prices in other regions, which goes in line with results of other researchers (Kharin, 2019, Tleubayev et al., 2016).

Overall, cointegration analysis has brought additional perspective to the discussion of Russian import ban effect on agricultural sector of Russian Federation. Due to significant differences in cointegration before and after 2014, there is an evidence of structural break in regional cointegration of milk prices. Further research in the field of milk price cointegration in Russia after the import ban can include analysis of cointegration in individual regions, which forms federal districts. Such analysis may provide more detailed view on the topic, as well as reveal several features that are overlooked on more aggregated level.

Acknowledgements

This paper is a partial result of the research project No. 2020A0015 - Price changes on agrifood markets in post-Soviet countries under Russian import ban and sanctions, supported by the Internal Grant Agency (IGA) of Faculty of Economics and Management, CULS Prague.

References

Banse, M., Duric, I., Götz, L., and Laquai, V. (2019), "From the Russian food import ban to free trade from Lisbon to Vladivostok – will farmers benefit?", *Journal of International Studies*, 12(4), 20-31. DOI:10.14254/2071-8330.2019/12-4/2, ISSN: 2306-3483

Boulanger, P., Dudu, H., Ferrari, E. and Philippidis, G. (2016), "Russian Roulette at the Trade Table: A Specific Factors CGE Analysis of an Agri-food Import Ban", *Journal of International Studies*, Volume 12, Issue 2, pp. 82-98, DOI 10.14254/2071-8330.2019/12-2/5, ISSN: 20718330

Dickey, D. and Fuller, W. (1979), "Distribution of the Estimators for Autoregressive Time Series With a Unit Root", *Journal of the American Statistical Association*, Volume 74, №366, pp. 427-431. DOI:10.2307/2286348, ISSN: 0162-1459

Fedoseeva S and Herrmann R. (2019), "The price of sanctions: An empirical analysis of German export losses due to the Russian agricultural ban", *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 1–15, DOI 10.1111/cjag.12194, ISSN: 1744-7976

Granger, C. (1969), “Investigating Causal Relations by Econometric Models and Cross-spectral Methods”, *Econometrica*, Volume 37, Issue 3, pp. 424-438, DOI 10.2307/1912791, ISSN: 1468-0262

Hertel, T. W. (2007), (ed.) Global Trade Analysis: Modelling and Applications, (Cambridge: Cambridge University Press)

Kašt’aková, E., Baumgartner, B. and Žatko, M. (2018), “The impact of the Russian embargo on its agri-food trade with the EU: Analysis by selected indicators”, *International Journal of Agricultural Management*, Volume 7, issue 4 , pp. 256–271. DOI 10.17323/1996-7845-2018-04-12, ISSN: 2047-3710

Kejriwal, M. and Perron, P. (2010), “Testing for Multiple Structural Changes in Cointegrated Regression Models”, *Journal of Business & Economic Statistics*, Volume 28, Issue 4, pp. 503-522, DOI: 10.1198/jbes.2009.07220, ISSN: 1537-2707

Kharin, S. (2015), “Vertical price transmission along the diary supply chain in Russia”, *Studies in Agricultural Economics*, Volume 117, Issue 2, pp. 80-85, DOI 10.7896/j.1517, ISSN: 1418-2106

Kharin, S. (2019), “Horizontal price transmission on the Russian dairy market: nonlinear approach”, *Agris on-line Papers in Economics and Informatics*, Volume XI, Number 3, pp. 45-54, DOI: 10.7160/aol.2019.110305, ISSN: 1804-1930

Krivko, M., Smutka, L. and Strielkowski, W. (2019), “Food security and trade via lenses of sanctions”, J*ournal of Security and Sustainability*, Issues, Volume 8, Issue 4, pp. 815-826, DOI 10.9770/jssi.2019.8.4(22), ISSN: 2029-7017

Kwiatkowski, D., Phillips, P. C. B. , Schmidt, P. and Shin, Y. (1992), “Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?”, *Journal of Econometrics*, Volume 54, Issues 1–3, pp. 159-178, DOI 10.1016/0304-4076(92)90104-Y, ISSN 0304-4076

Liefert, W. M., Liefert, O., Seeley, R., and Lee, T. (2019), “The effect of Russia’s economic crisis and import ban on its agricultural and food sector”, *Journal of Eurasian Studies*, Volume 10, Issue 2, pp. 119–135, DOI 10.1177/1879366519840185, ISSN: 1879-3665

Nagy, J. and Jámbor, Z. (2019), “Competitiveness in Dairy Trade – the Case of EU and the Visegrad Group Countries”, *AGRIS on-line Papers in Economics and Informatics*, Volume 11, Number 4, pp. 61-74, DOI 10.7160/aol.2019.110406, ISSN 1804-1930

OECD, Producer and Consumer Support Estimates Database [online], [accessed on 30-01-2019]. Available on WWW: http://www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

Phillips, P. (1987), “Time Series Regression With a Unit Root”, *Econometrica*, Volume 55, Issue 2, pp. 277-301, DOI 10.2307/1913237, ISSN: 1468-0262

Phillips, P., Ouliaris, S. (1990), “Asymptotic Properties of Residual Based Tests for Cointegration”, *Econometrica*, Volume 58, Issue 1, pp. 165-193, DOI 10.2307/2938339, ISSN: 1468-0262

Rosstat, Federal State Statistics Service, Russian Federation, https://fedstat.ru/, Accessed: March, 15, 2019

Said, S. E. and Dickey, D. A. (1984), “Testing for unit roots in autoregressive-moving average models of unknown orderů, *Biometrika*, Volume 71, Issue 3, pp. 599–607, DOI 10.1093/biomet/71.3.599, ISSN: 0006-3444

Tleubayev, A., Jamali Jaghdani, J., Götz, L. and Svanidze, M. (2018), ”*The effects of trade policy on domestic dairy market: the case of Russian food import ban on regional cheese market integration in Russia*”, Conference Paper/Presentation, International Association of Agricultural Economists (IAAE), 2018 Conference, July 28-August 2, 2018, Vancouver, British Columbia

Venkuviene, V. and Masteikiene, R. (2015), “The impact of Russian Federation economic embargo on the Central and Eastern European countries business environments”, *Procedia Economics and Finance*, Volume 26, pp. 1095-1101, DOI 10.1016/S2212-5671(15)00935-1, ISSN: 2212-5671

Wengle, S. (2016), “The domestic effects of the Russian food embargo”, *Demokratizatsiya*, Volume 24, Issue 3, Summer 2016, Pages 281-289

Zdráhal, I., Chmelíková, G. and Blažková, I. (2018), “Sector-Wide and Country-Specific Drivers of Firm Performance in the Visegrad Group Dairy Industry”, *AGRIS on-line Papers in Economics and Informatics*, Volume 10, Number 4, pp. 89-100. DOI 10.7160/aol.2018.100410, ISSN 1804-1930

Zdráhal, I., Chmelíková, G., Blažková, I. and Bečvářová, V. (2016), “*Differences in the Performance of the Dairy Industries within the Visegrad Group Countries*”, The International Scientific Conference INPROFORUM 2016, November 3-4, 2016, České Budějovice, pp. 132-136

LENDING RATE AND LOAN PORTFOLIO OF SELECTED AGRICULTURAL DEVELOPMENT BANKS IN GHANA

Sandra Boatemaa Kutin[1], Seth Nana Kwame Appiah-Kubi[2], Karel Malec[3], Maitah Mansoor[4], Orhan Zaganjori[5], Jeta Sahatqija[6] and Denim Umeshkumar Anajwala[7]

[1] Department of Humanities, [2, 3, 4, 5, 6, 7] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]sbkutin@st.ug.edu.gh, [2]appiah-kubi@pef.czu.cz, [3]maleck@pef.czu.cz, [4]maitah@pef.czu.cz, [5]zaganjori@pef.czu.cz, [6] sahatqija@pef.czu.cz, [7]denimanajwala91@gmail.com

Annotation: The objective of this study was to examine the effects of lending interest rates on the loan portfolio of Agriculture Development Banks in Ghana. This study was largely quantitative research. The study population was drawn from Agriculture Development Banks currently listed on the Ghana Stock Exchange. Since the number of banks is so large, a census was employed to select ten (10) banks as targeted in the study. Data was collected from annual reports of the seven banks for the 7 years between 2009 and 2016. Panel data techniques were employed to analyze the data. The findings from the analysis showed that there is a negative significant effect of lending rate on the loan portfolio of the listed Agriculture Development banks in the country. The major recommendation was that great efforts should be made by banks' management to manage their operational cost, which will reduce the lending rate and consequently reduce non-performing loans and increase portfolio size.

Key words: Agriculture, interest rates, loan portfolio, panel data, Agriculture Development bank

JEL classification: C1, M2, O1

1. Introduction

Lending practices in the world have existed since the period of the Industrial Revolution and was meant for commercial and production activities (Reinhart & Rogoff, 2011). This brought about the need for large capital investment with an upturn in the financial requirement of many companies and turn into banks for financial assistance. Lending represents one of the main services that Agriculture banks perform. It is how banks fulfill their financial intermediation function: that is to exchange funds between surplus and deficit economic units. In the process of carrying out this primary task, banks have found themselves performing several functions which include; the mobilization of savings and money transfer services (Alhassan, et.al, 2013). According to Garr (2013), banks are traditionally in the business of collecting deposits from customers and making out loans to various economic agents such as individuals, businesses, organizations and the government to help them undertake viable investments and developmental initiatives that will help in the socio-economic development of the country. Banks lend for various maturity periods, ranging from short term, medium term, to the long term.

As much as the operations of banks are risky due to the ability of loan default, banks still give out loans with the motivation of interest gains. Crowley (2007), the lending rate is money a borrower pays for the use of the money they borrow from a lender/financial institution or fee paid on borrowed assets. According to Cobbinah (2011), the rate of interest is the price at which the rate of purchasing power can be shifted from the future into the present- borrowed today with a promise to pay it back with interest in the future. Interest is not a single lump sum but an ongoing stream of payment. He defined interest rate as the price of money or the "percent of the premium paid on money at one date in terms of money to be in hand one year later". Therefore, interest on loans is the price the lender charges the borrower for using the borrowed funds. The lending rate has an impact on the loan portfolios of Agriculture Development banks. Although all banks in Ghana set their lending interest rates based on the policy rate given by the Bank of Ghana (BoG), the lending rate determined by the Agriculture Development banks may differ from bank to bank. Therefore, it is very important to know the effect of lending interest rates on the loan portfolio of banks since it could help in controlling and influencing the size and quality of loans banks give out and for that matter their riskiness. Knowledge of these effects can help in economic development in their area of the control of loans advanced by universal banks to their economic agents. However, according to Yebaoh-Mensah (2015) with the proliferation of banks into the economy coupled with their economic activities on the Ghana Stock Exchange (GSE), the relationship between bank's interest rate and their profitability is too general in scope, making it very blur to really single out the effect of interest rates on the loan portfolio of banks in Ghana. It is from this that the study seeks to investigate the effect of lending rates on the loan portfolio of agriculture development banks in Ghana, over a period of eight years (2009 -2016). To wholly address the overall goal of the study, the following specific objectives have been coined to 1) To describe the factors that determine interest rates in Ghana. 2)To examine the effects of lending rate on the loan portfolio size of ADBs in Ghana. 3)To examine the effects of lending rate on the loan portfolio quality of ADBs in Ghana. To achieve the above stated objectives, the following hypothesis were tested: H0: Lending rates has no statistically significant effect on the loan portfolio of listed Agriculture Development banks in Ghana. H1: Lending rates has a statistically significant effect on the loan portfolio size of listed Agriculture Development banks in Ghana. H2: Lending rates has a statistically significant effect on the loan portfolio of listed Agriculture Development banks in Ghana The Materials and Methods section of this paper describes how the secondary research was conducted as well as the model specification. Results and Discussion section presents the results obtained and discussion and comparison of the results of own research with similar studies in the context of the issue are conducted

2. Materials and Methods

The study employed a quantitative approach with a panel research design in nature. The study samples ten (10) Agriculture Development banks listed on the Ghana Stock Exchange (GSE). A Purposive sampling was adopted to select listed Agriculture Development banks on the GSE will Financial statements from 2009 to 2016. The panel analysis approach was also employed by the researcher to assess the effects of lending rates on the loan portfolio of ADB banks in Ghana. According to Balgati (2013), panel data gives more informative data, more variability, more degrees of freedom and more efficiency. Since the panel data relate to firms (banks) over time, there is bound to be heterogeneity in these units. Following the standard linear specification for a panel regression model, the researcher used the model specified below:

$$Y_{it} = \beta_0 + \beta' X_{it} + \varepsilon_{it} \tag{1}$$

Where Y_{it} is the dependent variable of bank i in time t, with $i = 1 \dots N$(Number of observations) and $t = 1 \dots T$(Time periods), $X_{it}$is a vector of the explanatory variables for bank i in time t, then $\beta 0$ is constant, and β' are co-efficient which represent the slope of the variables, and ε_{it} is the error term.

Following Saunders & Cornett (2006), and Saba et al., (2012), the researcher then specified the functional form of the model as follow:

$$NPL_{it} = \beta_0 + \beta_1 LR_{it} + \beta_2 DP_{it} + \beta_3 CA_{it} + \beta_4 AG_{it} + \beta_5 BS_{it} + \beta_6 ME_{it} + \varepsilon_{it} \quad \textbf{(2)}$$

$$PFS_{it} = \beta_0 + \beta_1 LR_{it} + \beta_2 DP_{it} + \beta_3 CA_{it} + \beta_4 AG_{it} + \beta_5 BS_{it} + \beta_6 ME_{it} + \varepsilon_{it} \quad \textbf{(3)}$$

From the equations above, $NPL_{it}$and,PFS_{it} are the dependent variables of bank *i* in time *t*, with *i*= 1 …N(Number of observations) and *t* = 1 … T (Time periods).LR_{it} is the independent variables for bank i in time *t*, whiles $DP_{it}, CA_{it}, AG_{it}, BS_{it}, ME_{it}$are the controlled variables, then $\beta_1 - \beta_6$ are the co-efficient which represents the slope of the variables, and ε_{it} is the error term to control hetroscedescity.

Where:*LR*: Lending Rate, β_0: the regression constant, *NPL*: Non Performing Loans, *PFS*: Portfolio Size, *DP:* Deposit levels of bank, CA*:* Bank's Capital, *AG:* Age of bank, *BS:* Bank Size, *OPE*: Operational Cost Efficiency.

3. Results and Discussion

Based on the two models developed because of the dependent variables being portfolio quality (non- performing loans) and portfolio size using random effect Generalized Least Square (GLS) regression as our estimator. For the first objective which states, to assess the effect of lending rate on the loan portfolio quality of banks in Ghana with its hypothesis, H_0: Lending rate has no statistically significant effect on the loan portfolio quality of listed banks in Ghana. The researchers found that the study supported the alternative hypothesis; thus, lending rate has a positive significant effect on the loan portfolio quality. We therefore reject the null hypothesis and conclude that lending rates has a significant effect on loan portfolio quality. Our second hypothesis which was H_1: Lending rates has a statistically significant effect on the loan portfolio size of listed Agriculture Development banks in Ghana. Our results revealed that; lending interest rate has a negative significant impact on the loan portfolio size. We reject the null hypothesis and conclude that lending rates has a significant effect on portfolio size. With respect to our third research which was to examine the effect of lending rate on loan portfolio quality, we found out that lending rate has a significant impact on the loan portfolio quality. When there is 1 percent increase in lending rates of the banks, these banks will experience 34.24 percent increase in non-performing loans of the banks and thus decrease portfolio quality. This is attributed to the fact that most banks in Ghana face the problem of adverse selection when granting loans forgetting that high lending rate only attract only risky borrowers. Therefore, when the interest is high, only those who can repay the loan will accept the credit facility. However, because of the issue of adverse selection they lend to risky borrowers who have less capacity to honor their loan repayment and this contribute to the high loan default in the country. The result is in support to other findings such as Ongweso (2005) whose study found out a positive effect between interest and non-performing loan, an increase in interest rate leads to an increase in non-performing loans, a test of significance however revealed a weak relationship between the two. Deposit had a positive statistically significant (5%) effect on loan default. Empirically, this implies that 1 percent increase in deposit leads to 1.16 percent increase in loan defaults because as banks collect more deposit from surplus units, they intend to give out more loans as it is their major source of revenue. The empirical results were consistent with the study's expectation, which stated there is a positive relationship between deposit and loan default by Olokoyo (2011) and Biekpe (2011).

In addition, from the result of effect of lending rate on portfolio size, lending interest rate has a significant negative impact on the loan portfolio size. In other words, 1 percent increase in lending rates of the banks leads to 1.34 percent decrease in portfolio size of the banks. Contrary to the above findings, Olokoyo (2011) found that there was insignificant but positive relationship between loan portfolio size and interest rate (bank lending rate). However, in support of the researcher's findings, Ladime et.al (2013) found a negative relationship between loan portfolio size and interest rate (bank lending rate).

Furthermore, from the results below on portfolio size, deposit from customers has a significant positive impact on the loan portfolio size. In other words, 1 percent increase in customers deposits of the banks leads to 1.15 percent increase in portfolio size of the banks. This is because as banks can mobilise more funds from surplus customers, they will then have more to lend to the deficit units. The finding supports the view of Olokoyo (2011) and Ladime et.al (2013). Moreover, from the same result, Bank capital has a significant positive impact on the loan portfolio Size. In other words, 1 percent increase in banks capital leads to 0.09 percent increase in portfolio size of the banks. This means that banks with higher capital base are able to give out huge loans all other things being equal.

Lastly, operational cost efficiency has a significant positive impact on the loan portfolio Size. In other words, 1 percent increase in operational cost efficiency leads to 0.09 percent increase in portfolio size of the banks. This means that if banks are more cautious about how to minimize their cost, it will eat up into their mobilized fund to reduce the amount of loans to be given out.

Table 1. Effect of Lending Rate on Portfolio Quality

	Coef.	Robust Std. Err.	Z	P>|z|
LR	34.2357	10.76382	3.18	0.001
DP	1.158794	0.4770716	2.43	0.015
CA	1.437922	22.17469	0.06	0.948
AG	-.0132108	43.14552	-0.00	1.000
BS	0.7834506	0.606283	1.29	0.196
OPE	-42.79157	77.63551	-0.55	0.582
_cons	-16.46038	3.975271	-4.14	0.000
rho | 0.9533145	*Prob>chi2= 0.000*	*R-sqd = 0.5694*	*Num. of obs = 76*	

Source: Authors' own calculation (2020)

Table 2.Effect of Lending Rate on Portfolio Size

	Coef.	Robust Std. Err.	Z	P>|z|
LR	-1.341652	0.4672482	-2.87	0.004
DP	0.1709535	0.0701598	2.44	0.015
CA	0.9266726	0.5432595	1.71	0.088
AG	-0.9189858	0.9393784	-0.98	0.328
BS	0.0917326	0.4777894	0.19	0.848
OPE	21.21203	3.938382	5.39	0.000
_cons	5.882999	0.9572267	6.15	0.000
rho | 0 .99491035	Prob>chi2= 0.000	R-sqd = 0.7932	Num. of obs = 76	

Source: Authors' own calculation (2020)

Table 3. Multicolliniarity Statistics

Variable	VIF	Tolerance (1/VIF)
LR	1.11	0.900004
DP	1.04	0.957850
CA	1.02	0.976265
AG	3.24	0.308330
BS	2.34	0.427655
OPE	2.19	0.457659
Mean VIF	1.82	

Source: Authors' own calculation (2020)

4. Conclusion

Our study was carried out to examine the effect of the bank's lending rate on the loan portfolio of Agriculture Development banks listed on the GSE in Ghana. Specifically, it sought to; describe the factors that determine interest rates in Ghana; examine the effects of lending rate on the loan portfolio size of banks in Ghana and examine the effects of lending rate on the loan portfolio quality of banks in Ghana. The empirical results for the first model showed that; Bank's lending rate, which is the main predator variable, has a positive significant effect on portfolio quality with deposit as the only control variable having a positive statistically significant effect at 1 percent (0.01) and 5 percent (0.05) significance level respectively. The empirical results for the second model showed that; lending rate and operational cost efficiency were found to be statistically significant at 1 percent significance level whiles, deposits from customers and bank capital were statistically significant at 5 percent and 10 percent levels respectively. Moreover, the Lending interest rate had a positive with on loan portfolio (Non-performing loans and portfolio size). The direction of the sign of the variable of interest corroborated with the study's expectation. The empirical results indicated that an increase in any of this variable would cause an increase in both the portfolio quality and portfolio size of ADBs financially. The lending rate has a positive effect on the loan portfolio, and this can be attributed to an increase in lending rates. An increase in lending rate will attract few customers who are highly risky to default, this will force the banks to invest their excess funds in another avenue other than granting huge loans, and this will result in reducing the portfolio size of the Agriculture development banks. Operational cost efficiency has a positive effect on portfolio size. Therefore, we conclude that operational Cost efficiency has a significant effect on loan portfolio size. Besides, deposit and capital had a significant effect on portfolio size. The results of the regression revealed that all significant variables were at 1 percent, 5 percent, and 10 percent significance levels respectively in both models.

Based on the above findings, the following recommendations are made. Firstly, agriculture development banks are to find the best ways (such as reducing their interest rate for customers) of managing their operational cost in order to reduce their lending rates. Secondly, the study recommends that agriculture development banks in Ghana should assess their clients and charge lending rates accordingly. Ineffective lending interest rate policies reduces their portfolio size. The study also recommends that these banks should apply stringent regulations on lending rates charged to regulate their lending interest rates and enhance periodic/regular credit risk monitoring of their loan portfolios to reduce the level of loans performance.

References

Alhassan, A. L., Owusu, B. F., and Asamoah, M. E. (2013), "Does Asset Quality Persist on Bank Lending Behavior? Empirical Evidence from Ghana", *Global Journal of Management and Business Research*, vol 13, no.1, pp. 21-30. https://journalofbusiness.org/index.php/GJMBR/article/view/975

Baltagi, B.H. and Liu, L. (2013), "Estimation and prediction in the random effects model with AR (p) remainder disturbances", *International Journal of Forecasting***,** vol. *29,* no. 1, pp.100-107. DOI 10.1016/j.ijforecast.2012.07.001

Biekpe, N. (2011), "The competitiveness of commercial banks in Ghana". *African development review*, vol. 23, no.1, pp.75-87. DOI 10.1111/j.1467-8268.2010.00273.x

Cobbinah, N. E. (2011), "*The Impact of Bank of Ghana Policy Rate on Commercial Bank Lending Rate: The Study of Barclays Bank Ghana*" Kwame Nkrumah University of Science and Technology (Doctoral dissertation), pp. 5-19. http://hdl.handle.net/123456789/4887

Crowley, J. (2007), "*Interest Rate Spreads in English-Speaking Africa*" International Monetary Fund Working Paper, Geneva, 2007, [Online], Available: https://books.google.dk/books?hl=en&lr=&id=jnSpBWfXgaAC&oi=fnd&pg=PA3&dq [Accessed: 03 Feb, 2020]

Foss, D., Norden, L., and Weber, M. (2010), "Loan growth and riskiness of banks", *Journal of Banking and Finance*, vol. 34, no.12, pp. 2929-2940. DOI 10.1016/j.jbankfin.2010.06.007

Garr, D. K. (2013), "Banking Sector Development in Ghana for the Period 1989 to 2010". *Research Journal of Finance and Accounting*, vol. 4, no.16, pp. 32-37. doi=10.1.1.820.5388&rep=rep1&type=pdf

Ladime, J., Sarpong Kumankuma, E., and Osei, K. A (2013), "Determinants of bank lending behavior in Ghana". *Journal of Economics and Sustainable Development*, vol 4, no.17, pp.42 - 48. ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)

Olokoyo, F. O. (2011), "Determinants of Commercial Banks' Lending Behavior in Nigeria", *International Journal of Financial Research*, 2(1): 2. ISSN 1923-4031 (online) / 1923-4023 (print)

Ongweso, B. A. (2005), "The relationship between interest rate and non-performing loans in Commercial Banks in Kenya". U.O. N MBA Project, Nairobi, 2005, [Online], Available: http://erepository.uonbi.ac.ke/bitstream/handle/11295/78382/Munialo [Accessed: 15 Jan, 2020]

Pallant, J.F. and Tennant, A., (2007), "An introduction to the Rasch measurement model: an example using the Hospital Anxiety and Depression Scale (HADS)". *British Journal of Clinical Psychology*, vol.46, no.1, pp.1-18. DOI 10.1348/014466506X96931

Reinhart, C. M., and Rogoff, K. S. (2011), "From financial crash to debt crisis". *American Economic Review*, vol.*101*, no.5, pp.1676-1706. DOI 10.1257/aer.101.5.1676

Saba, I., Kouser, R. and Azeem, M. (2012), "Determinants of Nonperforming Loans: Case of US Banking Sector", *The Romanian Economic Journal*, vol. 1, no. 1, pp44-51. DOI articole/2014-06-27/2682/15

Yeboah-Mensah, E. (2015), "*Determinants of Loan Portfolio Size of Universal Banks in Ghana*" (Doctoral dissertation) University of Ghana, pp. 25-40 http://197.255.68.203/handle/123456789/8598

VALUE-ADDED CONTENT OF AGRI-FOOD PRODUCTION IN THE CZECH REPUBLIC: DECOMPOSITION ANALYSIS IN DYNAMICS

Elena Kuzmenko

Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

kuzmenko@pef.czu.cz

Annotation: The present paper provides the decomposition analysis of selected agri-food global value chains aiming to demarcate domestic value added (VA) components from foreign ones in final domestic product. This approach is illustrated by the example of the Czech Republic. The analysis encompasses final product of A01, A03 and C10-12 industries according to the WIOD classification, at the two-digit ISIC rev.4 level, covering virtually an entire Czech agri-food sector. The conducted analysis helped to shed the light on a degree of the selected country dependence on international fragmentation of production processes and revealed the dynamics of both domestic and foreign VA components in final products of mentioned economic sectors for the period from 2000 to 2014, the latest available data in WIOD. One of the important results of this research is that it has uncovered tangible, in some cases even dramatic, changes in proportions of domestic VA components pointing either to a specific shift in a country's production policy priorities or to a forced change in the country's specialization in international agri-food production processes.

Key words: WIOD, Agri-food production, the Czech Republic, Value added, Leontief inverse.

JEL classification: C67, O13, Q17

1. Introduction

Recent years a lot of debates have been taken place in scientific literature regarding possible ways to ensure sustainable development of agri-chain at its different levels (Lebacq, T. et al, 2013; Bosc, P-M. et al, 2017). Within the framework of CAP main emphasis in the EU is gradually shifts towards ecological aspects (Vlontzos, G. et al 2017) and simultaneously in direction of encouraging the reduction of farms number together with enlargement of their average size (Piecuch, J. and Paluch, L., 2018), supporting improvement of farm technical equipment (Barath, L. and Ferto, I., 2016; Rizov, M. et al, 2013), an increase in the exports of agricultural commodities, intensification of organic production, restructuring the markets for agricultural products and services (Benešová, I. et al, 2016, Čechura, L. et al, 2014) along with improvement of living conditions of rural population (Piecuch, J. and Paluch, L., 2018). On the one hand a unified agricultural policy (CAP) has been existing within the EU for a number of years, on the other - there is an apparent difference in social, economic and environmental conditions of individual EU states (Basovníková, M., 2014). In this regard, it becomes interesting to uncover the very dynamics of factual state of affairs in the domestic agri-food sector and to reveal its developmental trend. In the present analysis we will mainly focus on the composition of final domestic product in terms of its value added components. Thus, the goal of this research is to demarcate value-added portions, domestic vs. foreign ones, in final products of A01, A03 and C10-12 Czech industries (Crop and animal production, hunting and related service activities; Fishing and aquaculture; Manufacture of food products, beverages and tobacco products respectively). Using the Leontief's approach and the World Input-Output data upon the global agri-food value chains we will analyze the value-added content of final demand for Czech products. The methodology employed in this paper is close to ones suggested by Johnson and Noguera (2012), Koopman et al (2014) and Dietzenbacher et al (2013). To estimate a value-added (VA) portion of a particular country in a selected global value chain (GVC), it is necessary to trace the stream of intermediates through all industries and countries involved into this value chain. The World Input-Output Database (WIOD) has been designed namely for such kind of analyses (Timmer et al. 2014; Dietzenbacher et al. 2013). The present analysis will be solely based on data retrieved from the WIOD.

2. Materials and Methods

Prior to analyzing Czech final product in terms of its international value-added content, key terminology, methods and data that will be used in the present research are worth clarifying. A global value chain of a final product (GVC) is understood here in line with Marcel P. Timmer et al (2014) as the "value added of all activities that are directly and indirectly needed to produce it. This global value chain is identified by the country-industry where the *last stage of production* takes place before delivery to the final user". A final product is called final since it is consumed, unlike intermediate one that is used in a production process further. Consumption is understood here in a wider meaning to incorporate both private and public consumption along with investment (Timmer et al, 2014).

The WIOD provides detailed information on national production activities and international trade data (between regions, not within) covering 43 countries, including all 27 countries of the European Union, 16 other major economies (Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Norway, Russia, South Korea, Switzerland, Taiwan, Turkey, United Kingdom and the United States) and the "rest of the World" group of countries (RoW) to have the information about final output complete. However, namely these 43 countries represent more than 85 percent of world GDP. World Input-Output tables (WIOT) are constructed to represent how much of each of 56 products is produced and used by each of 56 industries, covering the overall economy, including agriculture, mining, construction, utilities, 14 manufacturing industries, and 17 services industries. The tables have been constructed by combining national input-output tables with bilateral international trade data, following the conventions of the System of National Accounts (Miller and Blair, 2009; Timmer et al, 2014). First release of WIOD was in spring 2012, revisions in fall 2013 and the second, last, release in 2016 representing data as of 2014.

A number of studies (e.g. Marcel P. Timmer et al, 2014; Ali-Yrkkö, Rouvinen, Seppälä, and Ylä-Anttila, 2011; Dedrick, Kramer, and Linden, 2010) suggest that developed economies, delivering capital and high-skilled labor, have grasped most of the value, whilst developing ones, contributing low-skilled activities, add eventually little value. For better understanding the proportion and development of a particular country's VA component in a domestic final product we demarcate domestic value-added components from foreign ones. To achieve this aim the following steps will be done:

i. Data upon Czech product of A01, A03 and C10-12 demanded all over the World will be extracted from the World Input-Output Tables (WIOT): Figure 1 represents a schematic outline of the WIOT.

Figure 1. Schematic outline of a WIOT

			Use by country-industries									Final use by countries			Total use
			Country 1			…	Country M					Country 1	…	Country M	
			Industry 1	…	Industry N	…	Industry 1	…	Industry N				…		
Supply from country-industries	Country 1	Industry 1													
		…													
		Industry N													
	……														
	Country M	Industry 1													
		…													
		Industry N													
Value added by labour and capital															
Gross output															

Source: Timmer, M. et al (2015).

ii. Using a decomposition technique based on the Leontief's methodology (in line with Timmer (2014, 2015)), we will trace the value added by different countries that is directly and indirectly needed for production of selected industries final product in a selected country:

$$\boldsymbol{K} = \boldsymbol{F}(\boldsymbol{I} - \boldsymbol{B})^{-1}\boldsymbol{C} \tag{1}$$

where $\boldsymbol{C}$ – is a matrix of consumption levels (i.e. all final demand, including investment demand); $\boldsymbol{K}$ – is a matrix of the value added by all factors that are involved in any stage of the production of $\boldsymbol{C}$; $\boldsymbol{B}$ – is a matrix with intermediate input coefficients describing how much intermediates are needed to produce a unit of output in a given industry; $\boldsymbol{I}$ – is the identity matrix; $(\boldsymbol{I} - \boldsymbol{B})^{-1}$ – is the Leontief inverse which represents the gross output values generated in all stages of the production process of one unit of consumption; $\boldsymbol{F}$ – is a diagonal matrix of value added to gross output ratios in all industries in all countries (in line with Koopman et al. (2014), it is a VA measure that includes net taxes on intermediate inputs as well as international trade margins).

iii. The domestic VA portion in final domestic product will be traced and estimated:

According to Timmer (2015), the domestic contribution to the output value of a particular consumption good is traced by appropriately chosen the final demand vector $\boldsymbol{C}$ in equation (1). When $\boldsymbol{C}$ refers to the consumption of products delivered solely by Czech industries (according to WIOD definition), then this decomposition provides the value added by all labour and capital that was needed in any stage of production of these products. Following the accounting framework proposed by Timmer et al (2015) WIOT, as displayed in Figure 1, can be rearranged the way that GVCs will be represented by columns, each of them are for each final product. All final products will be represented by the country-industry-of-completion, where cells of each column (industries delivering intermediate inputs) show the origin of the value added, which could be both foreign and domestic.

iv. Top countries in terms of their VA-portions in Czech final product will be identified along with the dynamics of their contribution to the Czech agri-food production.

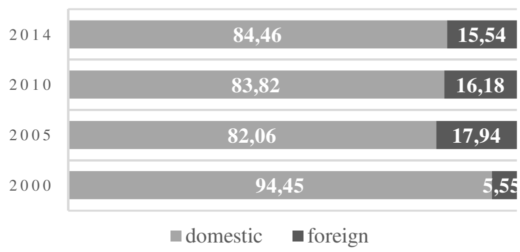
Using Timmer's et al (2015) approach based on Leontief's decomposition technique we will focus on the global value chains of Czech final products, namely the value-added content of final demand for Czech products. The foreign value-added portion can serve as a certain metrics of international fragmentation of domestic production processes (Feenstra and Hanson, 1999). Analyzing the production fragmentation we can get insight to the degree of a selected country dependence on contributions of other countries in production process of final domestic product. The analysis will be done for the period from 2000 to 2014.

3. Results and Discussion

The conducted analysis for the period from 2000 to 2014 enabled to clearly delimit domestic VA components in final domestic product from foreign ones. Considering C10-12 industries and its' structure of VA components in final product, the highest VA (in % to *total* VA) turned out to belong to the following countries (except for the Czech Republic itself): as per 2014, to Slovakia – 13.37 %, Germany – 7.34 %, Italy – 5.21 %, Poland – 3.99 %, Hungary – 2.40 %, while at the beginning of the analyzed period, in 2000, the contribution was different and in a slightly different composition of countries: Slovakia – 4.37 %, Germany – 1.74 %, ROW – 1.47 %, Poland – 0.93 %, Russia – 0.49 %. More information about decomposition of VA in C10-12 provided below in Table 3, where the VA by top 5 countries constitute in different years from 63.29 % to 73.02 % to *total foreign* VA in a corresponding year. Please, note that values in Tables "b" are recalculated to be expressed in % to total *foreign* VA component in a particular year. Detailed information upon other selected for the analysis sectors A01 and A03 is given in Table 1 and Table 2 correspondingly. Because of the limited extent, only selected results of the research are presented here, extended results can be provided upon request.

Table 1. Value-added components in Czech final product of A01 sector:
a) in % to total VA; b) Top 5 countries with highest VA, in % to total foreign VA.

a)



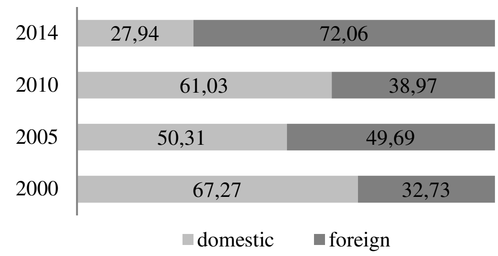
b)

	2000		2005		2010		2014
DEU	35.58	**SVK**	39.19	**SVK**	52.23	**SVK**	41.18
AUT	11.78	**DEU**	19.86	**DEU**	10.09	**RUS**	10.19
SVK	9.29	**HUN**	10.39	**POL**	6.70	**DEU**	9.68
POL	7.78	**POL**	8.17	**ROU**	5.55	**POL**	8.69
NLD	4.54	**AUT**	3.56	**HUN**	5.24	**ROW**	6.73

*Note: * - "top" countries in terms of the size of their VA in final Czech product.*
Source: Own calculation. Data were retrieved from WIOD.

Table 2. Value-added components in Czech final product of A03 sector:
a) in % to total VA; b) Top 5 countries with highest VA, in % to total foreign VA.

a)



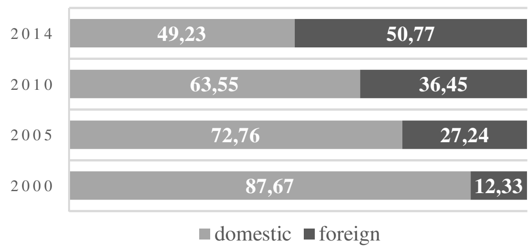
b)

	2000		2005		2010		2014
FRA	23,57	**DEU**	34,29	**DEU**	20,88	**DEU**	20,86
DEU	16,63	**ROW**	13,60	**SVK**	18,32	**HUN**	13,51
SVK	12,35	**SVK**	13,02	**ROW**	17,41	**BGR**	13,49
BEL	10,20	**FRA**	12,34	**HUN**	9,31	**ROW**	12,12
ROW	9,16	**AUT**	6,97	**AUT**	8,72	**ROU**	11,62

*Note: * - "top" countries in terms of the size of their VA in final Czech product.*
Source: Own calculation. Data were retrieved from WIOD.

Table 3. Value-added components in Czech final product of C10-12 sector:
a) in % to total VA; b) Top 5 countries with highest VA, in % to total foreign VA.

a)



b)

2000		2005		2010		2014	
SVK	35,40	SVK	33,58	SVK	25,84	SVK	26,33
DEU	14,12	DEU	17,47	DEU	15,13	DEU	14,46
ROW	11,94	POL	6,57	ITA	9,85	ITA	10,27
POL	7,56	ROW	6,31	POL	7,28	POL	7,86
RUS	3,99	HUN	5,35	HUN	5,62	HUN	4,73

*Note: * - "top" countries in terms of the size of their VA in final Czech product.*
Source: Own calculation. Data were retrieved from WIOD.

The provided above values revealed that Czech VA component in final domestic (Czech) product of A03 industries had declined over the analyzed period most dramatically, i.e. from 44.87% in 2000 to 9.63% in 2000, that is more than 4 times (see Table 2)! Czech VA portion in final domestic product of A01 sector had declined as well, but fortunately to a much lower extent, from 94.45 % in 2000 to 84.46 % in 2014 (see Table 1). Domestic VA portion in final product of C10-12 industries had also exhibited a very pronounced decline from 87.67 % in 2000 and 49.23 % as per 2014 (see Table 3). Similar results were shown in the study of Ševčíková (2003) still in the beginning of 2000th, i.e. the period when the process of globalization or more intensive fragmentation of production processes involving a growing number of countries had started. It is a widely accepted fact, that liberalization policies have fundamentally changed the economic and institutional contexts in which agricultural producers work (Bosc et al, 2017). Sojkova and Stehlíková (2005) supposed that "there is a requirement to perceive the tendency towards the downgrading the status of agriculture in national economies of the EU countries", though taking into account "the differences in the importance of agriculture mainly in the countries that are the new EU members". Bórawski et al (2018) also registered a declining VA of the food industry in the years 2011-2015, but only in the Czech Republic (-6.9 %), the Netherlands (-2.1 %) and Spain (-3.5 %). The matter is that, higher product differentiation and value adding over time has significantly changed the price spread between the farm value of products and the retail value (Cucagna and Goldsmith, 2016). Ehpstejn et al (2018) emphasize the idea that resilience of the agricultural organizations is closely connected with integration processes. In this context, GVCs help to realize the essence of shifts in production and trade, interdependency among economies and comprehend to what degree competitiveness of export is linked to effective allocation of cost and accessibility of final producers and consumers abroad.

4. Conclusion

The results of conducted analysis indicate that domestic VA in Czech final product had visibly declined in all agri-food sectors (see Tables 1-3). This fact may be indicative of a gradual shift of the Czech Republic in GVCs from one specialization to another. The question is - whether this shift had been a result of focused actions or a forced change in production priorities in the context of new institutional and economic circumstances when adapting to them? At the same time, if we take a look at agri-food production itself, a declining domestic VA may (not necessarily must) signalize about increasing dependence on foreign partners and eventually decreasing self-reliance in terms of maintaining national food security. All these aspects are worth studying and conducting further in-depth analysis. Answering these questions is above the scope of this paper, but surely deserves further attention. Other possible topics for future research may consist in conducting similar analyses with regard to other EU countries in order to explore the dynamics of Czech (or any other selected country's) VA portion already in their final products. This investigation may help to identify the direction of shift in intra-EU fragmentation of production processes. The results of such analyses may shed the light on competitiveness issues of domestic producers representing respective industries on other EU markets. Obviously, the beginning of the XXI century was characterized by formation a new paradigm of international trade in which countries specialize more on specific targets and functions of doing business rather than on mere production of certain goods. The unfolding situation gave rise to new opportunities, new risks and new challenges for all participants of GVCs. Another expansion of the present analysis may be realized via uncovering the factor content of global value chain of Czech agri-food products: to conduct such an analysis, one can sum over value added by all labor and similarly for capital, revealing thus what is the value added by capital and labor separately.

Acknowledgements
The research results are part of the project QK1920398 "Duality in Czech Agriculture: Advantage or Disadvantage for New Generation Agriculture?" within the Program of Applied Research "ZEMĚ" of the Ministry of Agriculture for 2017-2025 funded by the Ministry of Agriculture of the Czech Republic, NAZV.

References

Ali-Yrkkö, J., Rouvinen, P., Seppälä, T. and Ylä-Anttila, P. (2011), "Who Captures Value in Global Supply Chains? Case Nokia N95 Smartphone", *Journal of Industry Competition and Trade*, vol. 11, pp. 263–278, DOI 10.1007/s10842-011-0107-4

Barath, L. and Ferto, I. (2016), "Productivity and Convergence in European Agriculture", *Journal of Agricultural Economics*, vol. 68, no.1, pp.1–9, DOI 10.1111/1477-9552.12157

Basovníková, M. (2014), "Performance of Agricultural Enterprises With Specialization Livestock Production After Year 2013 in the Context of CAP Development Scenarios", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 62, no. 129, pp. 1251–1256, DOI 10.11118/actaun201462061251. pp. 1251-1256

Benešová, I., Novotná, Z., Šánová, P. and Laputková, A. (2016), "Economic Comparison of Agricultural Sector of Eurasian Countries – Is There Any Potential for Development Through Economic Cooperation?", *AGRIS on-line Papers in Economics and Informatics*, vol. 8, no. 2, pp. 19–31, ISSN 1804-1930, DOI 10.7160/aol.2016.080202

Bórawski, P., Żuchowski, I. and Dunn, J. W. (2018), "The economic situation of the food industry in EU countries", *Economic Science for Rural Development Conference Proceedings,* vol. 48, pp. 222−231, DOI 10.22616/ESRD.2018.139, ISBN 978-9984-48-294-1

Bosc P.M., Rafflegeau S., David-Benz H., Lemeilleur S., Moustier P. and Peyre M. (2017), "Collective Action in Agri-Chains", *Biénabe E., Rival A., Loeillet D. (eds) Sustainable Development and Tropical Agri-chains,* Springer, Dordrecht: Springer, pp. 71–81, ISBN 978-94-024-1015-0, DOI 10.1007/978-94-024-1016-7_6

Cucagna, M. and Goldsmith, P. (2016), “Value adding in the agri-food value chain”, *The International Food and Agribusiness Management Review*, vol. 21, no. 3, pp. 293–316, DOI 10.22434/IFAMR2017.0051

Čechura, L., Grau, A., Hockmann, H., Žaková Kroupová, Z. and Levkovych, I. (2014), “Total Factor Productivity in European Agricultural Production“, DOI 10.13140/RG.2.1.3856.9367

Dedrick, J., Kraemer, K. and Linden, G. (2010), “Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs”, *Industrial and Corporate Change*, vol. 19, pp. 81–116, DOI 10.2139/ssrn.1125024

Dietzenbacher, E., Lenzen, M., Los, B., Guan, D., Lahr, M. Sancho, F., Suh, S. and Yang, C. (2013), “Input-Output Analysis: The Next 25 Years”, *Economic Systems Research*, vol. 25, pp. 369–389, DOI 10.1080/09535314.2013.846902

Ehpstejn, D. B., Curtiss, J., Gagalyuk, T. and Unay-Gailkhard, I. (2018), “Resilience of the agricultural organizations and the factors and integration processes influencing it (on the data of Northwest of Russia)”, *Agribusiness Sector: Economics, Management*, ISSN 0235-2443

Johnson, R. and Noguera, G. (2012), “Accounting for intermediates: Production sharing and trade in value added”, *Journal of International Economics*, vol. 86, no. 2, pp. 224–236, DOI 10.1016/j.jinteco.2011.10.003

Koopman, R. Zhi W. and Shang-Jin, W. (2014), “Tracing Value-Added and Double Counting in Gross Exports”, *American Economic Review*, vol. 104, no. 2, pp. 459–94, DOI 10.1257/aer.104.2.459

Lebacq, T., Baret, P. and Stilmant, D. (2013), “Sustainability indicators for livestock farming”. A review, *Agronomy for Sustainable Development*, vol. 33, pp. 311–327, DOI 10.1007/s13593-012-0121-x

Piecuch, J. and Paluch, L. (2018), “The evolution of the agricultural sector in Central and East European countries after 12 years of membership in the EU on the example of Poland”, *Proceedings of the 19th International Scientific Conference "Economic Science for Rural Development*, pp. 238–248, DOI 10.22616/ESRD.2018.028, ISBN 978-9984-48-292-7

Rizov, M., Pokrivcak, J. and Ciaian, P. (2013), “CAP Subsidies and Productivity of the EU Farms”, *Journal of Agricultural Economics*, vol. 64, pp. 537–557, DOI 10.1111/1477-9552.12030

Sojkova, Z. and Stehlíková, B. (2005), “Comparative analysis of the economic role of agriculture in the EU countries Komparatívna analýza ekonomického postavenia poľnohospodárstva v krajinách Európskej únie”, *Agricultural Economics (Zemědělská ekonomika)*, vol. 50, no. 8, pp. 369–375, DOI 10.17221/5219-AGRICECON

Ševčíková, M. (2003), “Comparison of the value added development in the agricultural and food sectors and the efficiency of its creation”, *Agricultural Economics (Zemědělská ekonomika*), vol. 49, no. 1, pp. 22–29, DOI 10.17221/5260-AGRICECON

Timmer, M., Dietzenbacher, E., Los, B., Stehrer, R. and Gaaitzen J. de Vries (2015), “An Illustrated User Guide to the World Input-Output Database: The Case of Global Automotive Production”, *Review of International Economics*, vol. 23, no. 3, pp. 575–605, DOI 10.1111/roie.12178

Timmer, M.P., Erumban, A.A., Los, B., Stehrer, R. and Gaaitzen J. de Vries (2014), "Slicing Up Global Value Chains", *Journal of Economic Perspectives*, vol. 28, no. 2, pp. 99–118, DOI 10.1257/jep.28.2.99

Vlontzos, G., Niavis, S. and Pardalos, P. (2017), "Testing for Environmental Kuznets Curve in the EU Agricultural Sector through an Eco-(in) Efficiency Index", *Energies,* vol. 10, no.12, DOI 10.3390/en10121992

WIOD, World Input Output Database, World Input Output Tables for 2000 – 2014, Release 2016, [Online], Available: http://www.wiod.org/database/wiots16, [Accessed: 25 Jan. 2020]

TRADITION IN REGIONAL DIMENSION (THE CASE OF FISH TRADITION IN CZECHIA)

Michal Lošťák

Department of Humanities, Faculty of Economics and Management, CULS Prague, Czech Republic

lostak@pef.czu.cz

Annotation: The paper explores traditions as regionally constructed. It shows what is considered as the tradition in term of fishing in Czechia in regional dimension. The findings are important for regional or rural development. As such traditions are jiond with development. The research used questionnaire survey distributed among representative quota sample of the Czech population (n=1006 respondents). The quantitative data were underpinned by the findings from interviews with crucial stakeholders in fishing sector. The data suggest the main tradition in term of fishing in Czechia is Christmas carp. However, there is not equal understanding of this tradition among the NUTS3 regions in Czechia. Although the difference is not statistically significant, 90 % of respondents in NUTS3 regions of Pardubický kraj, Hradecký kraj, Praha and Jihočeský kraj highlighted this tradition as strong or very strong, while in the case of Ústecky kraj it was only about 60 % of respondents who considered Christmas carp as a tradition. These polarization reflect regional inequalities. The research findings, however, also indicate that the preservation of the Christmas carp as being the tradition is not easy (e.g. processing the carp for the dish is time demanding and difficult compared convenient fish food). Also this aspect has its regional dimension and ehoces regional differentiations. As such traditions are influenced by regional disparities)

Key words: traditions, development, time, space, rural, regional, fishery

JEL classification: A14, Q22

1. Introduction

This paper explores the role of traditions in rural or regional development. Such a research focus might look as being not too ambitious for an academic paper. Both traditions and rural or regional developments are well addressed in academic literature in term of their quantity. For instance, more than 1,000 papers in Web of Science database in subject area of sociology have the term "tradition" in their title, and more than 150 of business subject area papers operate in their title with the word "tradition". More than thousand papers in the subject area of economics is titled with the wording "regional development". More than 600 papers are published with the tittle including "rural development" in subject area economics and about 270 in subject area sociology. If looking at such quantitative dimension, a right question sounds what kind of the novelty does this particular paper contribute to the body of existing literature? An answer is easy. It is framing the traditions in regional or rural context in the way which will bring traditions and rural development together because there are almost no such papers directly addressing both traditions and rural or regional development (only about 100 papers address these terms together under "rural development" and "tradition" wording). The paper wants to suggest that territorial dimension is the "staple" putting traditions and development together.

The reason why both concepts are mostly considered separately is farmed by their context. The concept of traditions seems to contradict the issue of development. While traditions echo stability because they support social order through its extension of the past to the present (Kabele 1998), connotations of development are significant for change considered as intentional intervention of people into events (Kabele 1998). Utilizing Giddens' structuration theory (1984) with its emphasis on practices produced and reproduced in time and space, this paper recognizes the fact that both traditions and development have their temporal dimension. In the case of traditions time is not evolving, time is cycled. Development results into evolving time which is not cycled (Sorokin, Merton, 1937). Simply speaking, traditions are a sort of "frozen time", while development is "flying time" creating contemporary runway world (Giddnes 2000)". Traditions make events to be always the same – they assist to reproduce the society, while development differentiates events towards various novelties (innovations) – it assists to change the society. While development is coined by the modernity under the idea of progress, traditions, by their nature, oppose the belief in progress (Giddnes 2000).

Temporal dimension is obvious in both development and traditions. What is missing yet, it is their spatial dimension. Spatial dimension is embedded neither in the concept of tradition or development. It must be added separately with other words (e.g. regional traditions or rural development). However, this paper wants to highlight that spatial dimension (in our case related to region or the countryside) is presented in traditions or development. Referring to the time by their nature both tradition and development lose their essence without spatial context. The investigation of how spatial context of tradition and related development is presented, it is the goal of this paper. As a case illustrating this issue the case of Czech fishery will be utilised. The paper wants to explore how traditions are regionally constructed and with consequences for development. This objective necessitates finding find out what is considered as the tradition in term of fishing in Czechia. The findings might be beneficial for various activities related to Czech fishing sector and rural or regional development.

The text utilizes ideas of Berger and Luckman (1996) about social construction of reality. The traditions do not exist per-se but they are socially constructed. It means they really exist only as the outcome of the institutionalization of our activities. The activities are always conducted in time and space. It brings us back to spatial and temporal dimensions of traditions and development.

2. Materials and Methods

The research used triangulation (Giddnes 1989) of quantitative and qualitative approaches in social science research. Questionnaire survey, as quantitative approach in this case, was conducted among representative quota sample of the Czech population (n=1006 respondents). The data collection was implemented by specialised agency through computer assistant telephone interview. The questionnaire was developed by the team involved in the project funded by the Czech Ministry of Culture named "Cultural traditions of Czech fishing in the light of its utilization in tourism and landscape architecture". The quantitative data were underpinned by the findings from interviews with crucial stakeholders in fishing sector. Interviews echo qualitative approach in social science research. The interviews were conducted with almost 90 stakeholders involved in fishery industries and related areas (e.g. education, gastronomy, environmental protection). They operated in 6 fishing regions of Czechia (out of 18 such regions). These regions were Blatensko region, Vodňany region and Třeboňsko region (all three regions are parts of NUTS 3 region Jihočeský kraj), Hodonínsko region (part of NUTS3 Jihomoravský kraj), Lázně Bohdaneč region and Litomyšl region (both are parts of NUTS3 Pardubický kraj) and in Chlumec nad Cidlinou region (part of NUTS 3 Hradecký kraj). These six regions are the most prominent territories in term of fishing (they are important not only form the point of fish production but also in term of fishing history, fish gastronomy, location of vocational fishing schools, attractions related to fishing for leisure time or fishing related environmental protection). The stakeholders in these regions provided their views in the form of semi-structured interviews (the same questions depending on the role of the interviewed stakeholder in the fish sector). Their answers were recorded and are shared by the research team.

3. Results and Discussion

The stakeholders mostly consider as the main tradition in the area of fishing the fish harvesting and its relations related to fish production. Some of them perceived as the tradition the ritual of fisherman's initiation. There were presented also some other traditions related to fishing (e.g. the ponds in landscape, fishing contests, fish food) but they were pronounced in very few interviews depending on who were interviewed stakeholders. What is important, geographical region does not differentiate the views through which the stakeholders consider the traditions. The factor that differentiates their views is the experience with the fishing and social position hold by the people (who they are). That means, if geographical space does not differentiate a sort of social space does so. Such understanding of a social space is coined by P. Bourideu (1998) in his terms of social field and related habitus. Social positions forming social space in the form of social field are joined with habitus representing certain set of activities (fishing industry, education in fishery, environmental protection) and goods (ponds, forestry, fishing factories, food). Therefore, different traditions also echo different activities of people involved. The activities reflect their position in the social field. It will also impact their attitudes to possibilities of development. Those considering the tradition in fish harvesting see this activity as the main contribution of fishery to rural development which should be supported. Therefore there is the link between their conceptualization of traditions (influenced by their social field and related habitus/activities) and the orientation of development in the geographical territory they operate. Such outcome also suggest the development is not independent on people, it is constructed by their activities reflecting certain social positions. Therefore, positioning of people in social space who are involved in development influences the course of such development.

If considering the views without reference to social space but in reference to geographical space (NUTS 3, for instance), the results of the investigation alter. The respondents of representative questionnaire survey had the opportunity to select more possibilities from various traditions and using four points Likkert scale they evaluated how much they consider suggested items as traditions (very strong tradition, strong tradition, weak tradition, no tradition). The Czech people consider as the most important tradition (in term very strong and strong) related to fishery the Christmas (87 % of respondents). For the foreigners, not being familiar with the Czech context, it might be the revolting finding but for the Czechs it will be obvious. Czech fishing sectors is a sort of neglected sector in terms of production and employment but achieving its highly important significance during a short period before Christmas. It is because of the consumption of the carp as festive Christmas dinner. Such carp is often sold and slaughtered directly from the vats on the streets which is a peculiarity for the foreigners. If the Czechs consume in average less than 6 kg of fish meat (including sea fish which is about 4 – 4.5 kg) per capita a year (CZSO, 2020), about 80 % of domestic fish consumption is done during Christmas. Therefore, the only significant link of the Czech population to the fishery is Christmas and it is the reason why the strongest fish-related tradition is Christmas, since Christmas is not questionable tradition. As such, it enables to anchor the fish as the tradition as well. The carp consumption for Christmas is not long lasting practice because it started in the 19th century and the Christmas carp dish the Czech consider as the tradition (deep fried carp) stared to dominate Christmas dinner during 20th century (Šimša 2017). Since the main tradition of fishery is Christmas, also related activities with Christmas score high in how strong tradition are they. The carp dishes were mentioned as the important tradition by 81 %. This percentage is similar to 80 % of respondents linking the tradition with fish harvest. Once the fishes are harvested, people (72 % of the respondents) also see as the tradition the direct sale of the fishes from ponds (not through the shops). The tradition named Christmas carp (cluster Christmas - carp dish - fish harvest – direct fish sale) is constructed by the respondents as the most prominent and the strongest Czech fish tradition. It was also confirmed by factor analysis when Christmas, carp dish and fish harvest were extracted as one factor of fish tradition in Czechia. The item of direct sale is added into the cluster as being linked with the three other variables in narration of stakeholders.

However, such the strength of Christmas carp tradition differs among NUTS 3 regions as table 1 indicates.

Table 1. Regional differences in perceiving the strength of fish traditions clustered as Christmas carp

Fish tradition	Czech NUTS 3 regions													
Christmas carp cluster	PHA	SCK	JCK	PZK	KVK	ULK	LBK	KHK	PBK	KVS	JHK	OLK	ZLK	MSK
Christmas	93	92	92	80	82	63	83	88	98	81	88	87	86	87
Fish harvest	81	87	88	67	64	57	66	89	90	83	83	87	76	80
Carp dish	85	84	92	69	68	58	71	87	88	81	80	92	86	75
Direct fish sale	70	84	86	56	61	47	61	74	88	73	64	84	65	77

Source: Authors‘ calculation of representative questionnaire survey results

Note: the numbers are the percentages of respondents (n = 1006) who consider named traditions as strong and very strong. NUTS 3 regions are PHA: Praha; SCK: Středočeský kraj; JCK: Jihočeský kraj; PZK: Plzeňský kraj; KVK: Karlovarský kraj; ULK: Ústecký kraj, LBK: Liberecký kraj; KHK: Královéhradecký kraj; PBK: Pardubický kraj; KVS: Kraj Vysočina; JMK: Jihomoravský kraj; OLK: Olomoucký kraj, ZLK: Zlínský kraj; MSK: Moravskoslezský kraj.

The fish related traditions clustered under the Christmas carp are the strongest in the regions where we conducted the interviews with the important stakeholder (with the exception of Jihomoravský kraj). They are NUTS 3 regions Pardubický kraj, Jihočeský kraj and Hradecký kraj. Respondents in other NUTS 3 regions of Středočeský kraj and Olomoucký kraj also inclined to this tradition. The other side of the spectrum is Ústecký kraj. The views of people as for Christmas carp tradition in NUTS 3 Ústecký kraj score by far the lowest in their inclination towards this tradition. Ústecký kraj is together with Moravskoslezský kraj one of regions with unfavourable economic, social and environmental conditions of their development which accelerates regional disparities (Vláda ČR, 2013). It indicates there might be a link between traditions and development. The link does not mean directly that unfavourable conditions for development equals lowering the strength of the traditions because both Moravskoslezský kraj and Ústecký kraj are considered as Czech NUTS 3 regions with unfavourable conditions for their development but the viewing the Christmas carp traditions among dwellers in these regions differentiates. The reason is that Moravskoslezský kraj is the region with much higher proportion of the fish ponds than Ústecký kraj. Ústecky kraj is one of two Czech NUTS 3 regions (with Zlínský kraj) where there is no fishery business operating the ponds with the size above 100 ha (2C analytics, 2016). Therefore, the link between the traditions and development is regionally constructed by the context in which the traditions are viewed. If there is not any background for such a context (like the presence of fishery industry in Moravskoslezský kraj) any attempt to "import" fish tradition into the region without such background fails.

Another cluster of fish related traditions (which was also extracted through factor analysis) supports the findings discussed in previous paragraph. This cluster is also generally considered as stronger tradition and is related to the environment. For almost 60 % of Czechs the traditions of Czech fishery also means the outlook of the landscape (so called historical landscape), and for 64 % of the Czechs the fishery is related to retaining the water in the landscape. The contribution of fishery to biodiversity stands for strong or very strong tradition for 47 % Czechs. Table 2 demonstrates regional differences in these views.

Table 2. Regional differences in perceiving the strength of fish traditions clustered as environmental issues.

Fish tradition	Czech NUTS 3 regions													
Environmental cluster	PHA	SCK	JCK	PZK	KVK	ULK	LBK	KHK	PBK	KVS	JHK	OLK	ZLK	MSK
Landscape outlook	51	72	82	49	57	44	59	66	71	56	50	64	60	61
Maintaining water	62	65	75	51	54	47	70	69	80	60	58	69	71	62
Supporting biodiversity	34	57	54	38	36	33	43	63	49	23	40	61	64	49

Source: Authors' calculation of representative questionnaire survey results

Note: the numbers are the percentages of respondents (n = 1006) who consider named traditions as strong and very strong. NUTS 3 regions are PHA: Praha; SCK: Středočeský kraj; JCK: Jihočeský kraj; PZK: Plzeňský kraj; KVK: Karlovarský kraj; ULK: Ústecký kraj, LBK: Liberecký kraj; KHK: Královéhradecký kraj; PBK: Pardubický kraj; KVS: Kraj Vysočina; JMK: Jihomoravský kraj; OLK: Olomoucký kraj, ZLK: Zlínský kraj; MSK: Moravskoslezský kraj.

The regional differences in viewing in the fish tradition related to environmental issues (environmental cluster) is more or less similar like in Christmas carp cluster. The strongest is this tradition of fishery perceived in NUTS 3 regions Pardubický kraj, Jihočeský kraj and Hradecký kraj (regions we conducted the interviews with stakeholder as the most important regions with fishery related activities). Respondents in other NUTS 3 regions of Středočeský kraj, Olomoucký kraj and Zlínský kraj (this NUTS 3 region was not listed among those with the strongest Christmas carp tradition) also inclined to this tradition more than other regions. The opposite side of the spectrum is again Ústecký kraj. This NUTS 3 regions, however, does not lag behind other NUTS 3 regions, such as Plzeňský kraj or Karlovarský kraj, in the perception of environmental tradition of fishery when the difference was in the case of Christmas carp tradition much higher between Ústecký kraj and other NUTS 3 regions.

The similarity in regional differences presented in various clusters of fish tradition (clusters were extracted by factor analysis) suggests strong regional dimension of traditions. This dimension is underpinned by the socio-economic and environmental context echoing previous development of the region. That is why the traditions if linked with development echo some elements of path-dependency (David, 2000), namely the fact that previous development reflects also regional context (e.g. in the case of this research the existence of the ponds in the region significantly influences the construction of the tradition of fishery).

4. Conclusion

The text demonstrated that traditions and development have not only their temporal dimension but also are mutually joined when people construct the spatial dimension of the traditions. Although both development and tradition intrinsically refer to time, the spatial dimension Is inherently embedded in both. Spatial dimension is influenced by the historical development of the territory but is also impacted by the social space of the people (people with certain position construct the traditions reflecting their position). Therefore the traditions echo the not only geographical space but also social space. It is the space (being it natural space or social space) which manifests temporal dimension of the traditions. This is important for rural development and working with traditions in rural development projects.

Acknowledgements

The paper was written with the support of the grant of Ministry of Culture named "Cultural traditions of Czech fishing in the light of its utilization in tourism and landscape architecture" (Kulturní tradice českého rybářství ve světle jejího využití v cestovních ruchu a krajinotvorbě DG18P02OVV057). The text does not echo the views of the ministry.

References

2C analytics. (2016), "*Marketingová studie odvětví akvakultury.*" [Online], Available: http://eagri.cz/public/web/file/484960/Marketingova_studie_odvetvi_akvakultury_final_1.pdf [Accessed: 20 Apr. 2020]

Berger, P.L. and Luckman, T. (1996), *"Social Construction of Reality (A Treatise in Sociology of Knowledge)"*, Anchor Books, ISBN 0-385-05898-5

Bourdieu. P. (1998), *"Teorie jednání (translated from French Raisons pratiques, Sur la théorie de l'action by V. Dvořáková)"*, Praha, Karolinum, ISBN: 80-7184-518-3

CZSO, Czech Statistical Office/, Spotřeba potravin 2018, Prague, 2019, [Online], Available: https://www.czso.cz/csu/czso/spotreba-potravin-2018, [Accessed: 20 Apr. 2020]

David, P. (2000), "*Path dependence, its critics and the quest for 'historical economics'*". [Online], Available: http://www-siepr.stanford.edu/workp/swp00011.pdf, [Accessed: 25 Apr. 2020]

Giddnes, A. (1984), *"The Constitution of Society (Outline of the Theory of Structuration)."* Berkley and Los Angeles, University of California Press, ISBN 0-520-05292-7

Giddnes, A. (1989), *"Sociology",* Cambridge, Polity Press, ISBN 978-07-456-0546-6

Giddens, A. (2000), *"Runaway World (How Globalization Is reshaping Our Lives)."* New York, Routlege, ISBN: 0-415-92719-6

Kabele, J. (1998), *"Přerody (Principy sociálního konstruování)"*, Praha, Karolinum, ISBN: 80-7184-359-8

Sorokin, P.A. and Merton R.K. (1937), "Social Time: Methodological and Functional Analysis", *The American Journal of Sociology,* vol. 42, no 5, pp. 615-629

Šimša, M. (2017), "Kapr se definitivně rozšířil až za komunismu, říká etnolog Šimša," Lidovky.cz. [Online], Available: https://www.lidovky.cz/domov/salat-a-kapr-se-rozsirily-za-komunismu-rika-etnolog-martin-simsa.A171222_210232_lide_mber [Accessed: 15 Apr. 2020]

Vláda ČR, (2013). Příloha č. 1b k Usnesení vlády ze dne 25 září 2013 č. 732 (Usnesení vlády ČR 732/2013). [Online], Available: https://apps.odok.cz/djv-agenda?date=2013-09-25 [Accessed: 20 Apr. 2020]

APPROACHES TO MEASURING THE IMPACT OF DROUGHT AND CLIMATE CHANGE ON CROP YIELDS

Jiří Mach[1], Pavla Hošková[2] and Josef Slaboch[3]

[1, 3] Department of Economics, [2] Department of Statistics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]mach@pef.czu.cz, [2]hoskova@pef.czu.cz, [3]jslaboch@pef.czu.cz

Annotation: The aim of the paper is to compare different approaches to determining the magnitude of changes in the dependence of yields of main crops on inputs influenced by climate change (such as precipitation amount), but also on other inputs into crop production. The research used data on annual precipitation, annual inputs of individual types of fertilizers and yields of selected crops, in a time series from 1961 - 2019. Regression and correlation analyses were used. We searched for the strength of dependence using Pearson correlation coefficient and stepwise analysis, by which the main variables were selected. The results show that the dependence of hectare yields of wheat, potatoes and rapeseed on rainfall over the whole time series is rather inconclusive; the total annual precipitation even negatively correlates with wheat yield. The dependence on nitrogen inputs was significant, but it is also influenced by precipitation. On the other hand, in the first period (1961 - 1990) there is a smaller residual variance than in the period after 1990, which is confirmed by multiple determination indices for all inputs. For further investigation, the authors will use other variables such as soil moisture or water permeability.

Key words: precipitation, crop yield, fertilizers, nitrogen, winter wheat, stepwise analysis, correlation

JEL classification: Q10, Q24, Q54

1. Introduction

Currently, scientists worldwide are trying to clarify the impact of climate change on agricultural production. It turns out that these changes bring considerable extremes in course of the weather. In the Czech Republic (CR), we have been dealing mainly with droughts in recent years. Nevertheless, as data on rainfall for the almost last 60 years suggest, in the new millennium there was both an extreme in terms of the lowest average annual total precipitation (505 mm in 2003) and the opposite extreme of 868 mm in 2010 (according to the Czech Hydrometeorological Institute – CHMI). As for example Chloupek et al. (2004) mention, the average temperature increased significantly during the last 50 years, on average by 0.021°C each year, but in the last 10 years by 0.087°C each year. These climate changes were favourable for the most of the commonly grown crops (wheat, barley, oil-seed rape, sugar beet, rye, maize and legumes), since the crops gave higher yields in warmer years that were accompanied by more hours of sunshine. The consumption rate of nutrients in the Czech Republic increased by 2.91 kg/ha annually from 1918 to 2000, one kilogram of nutrients (N+P+K) increased yields of cereals by 6.7–10.1 kg/ha of grain, rape by 5.2 and root crops by 26.1 – 37.8. They also report that the efficiency of applied nutrients was higher in years with average precipitation than in years with over-average precipitation, and much higher than in dry years. Trnka et al. (2012) examined the changes in the yield stability of winter wheat and spring barley over the past 140 years and changes in the weather–yield relationships. The study area was located in the CR within eight districts for which yield data were collected for the years 1869–1913 and 1961–2007. During the early period, drier conditions had very small negative or even slightly positive effects on yields, whereas at the end of the 20th century, the May and June drought became a factor that explained a considerable proportion of the yield variability. Numerous studies also suggest that changes in precipitation rates have less impact on crop yields than changes (increases) in temperature (Akumaga et al., 2018, Xiao et al., 2008 and Verón et al. 2015). Tao et al. (2015) used simple and explicit methods, as well as improved datasets for climate, crop phenology and yields, to address the association between variability in crop yields and climate anomalies in China from 1980 to 2008. They found that the simultaneous occurrence of high temperatures, low precipitation and high solar radiation was unfavourable for wheat, maize and soybean productivity. This was because of droughts induced by warming or an increase in solar radiation. Webber et al. (2015) simulated water limited and nitrogen–water limited yields across the EU-27 to 2050 for six key crops to assess how important consideration of nitrogen limitation is in climate impact studies for European cropping systems. Their results suggest that inclusion of nitrogen limitation hardly changed crop yield response to climate for the spring-sown crops considered (grain maize, potato, and sugar beet). However, for winter-sown crops (winter barley, winter rape and winter wheat), simulated impacts to 2050 were more negative when nitrogen limitation was considered, especially with high levels of water stress. Future nitrogen using rates are likely to decrease due to climate change for spring-sown crops, largely in parallel with their yields. These results imply that climate change impact studies for winter-sown crops should consider N-fertilization.

2. Materials and Methods

The paper used data from the period 1961 - 2019. Within these 59 years, these values were assessed: annual precipitation totals for the Czech Republic (in mm), total annual average nutrient intake N, P, K (in kg per hectare) and yields per hectare of selected crops (winter wheat, winter oil-seed rape and potatoes – in tons) in the Czech Republic. Aggregate data for all nutrients – "total fertilizer" - were also used. To express the effect of climate change, the data were also divided into 2 periods - until 1990 (1961 - 1990) and after this period, i.e. the remaining 29 years (1991 - 2019).

When monitoring the relationships between different characters, statistical methods from the field of regression and correlation analysis are most often used. The main task of regression analysis is to capture the course of dependence between variables using the regression function. The basic model of regression dependence expresses any value of the dependent variable Y as $y' = f(x_i) + e_i$, where e_i are residual deviations that can be interpreted as a consequence of random influences, including possible imperfections of the selected function. If a certain type of regression function is selected, it is necessary to determine the specific parameters of this function so that the selected regression function best captures the actually observed values. The least squares method is most often used to determine the parameters, and it is based on the requirement that the sum of the squares of errors e_i is minimal:

$$\sum_{i=1}^{n} e_i^2 = \sum_{i=1}^{n} (y_i - y_i')^2 = \min \qquad \textbf{(1)}$$

Regression functions can contain only two variables (dependent and independent), then it is a simple model, or more variables (mostly independent), then it is a multiple model. In the case of multiple regression functions, the problem of so-called multicollinearity can be encountered, where there can be a strong linear interdependence between the explanatory variables of the regression model. This situation may arise e.g. for the reason that some of the explanatory variables are unnecessary because it can be replaced by a linear function of some or all of the other variables. Multicollinearity is considered detrimental because it increases the variance of estimates, affects individual t-tests in which some (or even all) regression coefficients prove to be statistically insignificant. In general, multicollinearity is identified when one of the correlation coefficients in the correlation matrix exceeds 0.75. One possible way to remove multicollinearity is to use methods that look for the best subset of explanatory variables. These methods include the so-called stepwise regression, which monitors at each step what would happen if the explanatory variables were selected for the regression function in a different order. The resulting model then represents the "optimal" subset of explanatory variables, provided that the shape of the model is correct, no significant explanatory variable has been neglected, the degree of multicollinearity is tolerable, and the data are good.

3. Results and Discussion

For selected crops (winter wheat, winter rape and potatoes), the effect of precipitation and fertilizer inputs (independent variables) on total hectare yield (dependent variable) was investigated. At the beginning, it is necessary to note that the influence of precipitation on nutrient intake is evident and was proved especially for nitrogen and all selected crops. The results for wheat, which is the most important of the mentioned crops, will be analysed in more detail. A simple description of the input variables is given in Table 1.

Table 1. Simple statistical characteristics of inputs

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Total annual precipitation	59	669.98	86.31	39529	505.0	868.0
Nitrogen	59	75.03	23.23	4427	20.8	107.3
Phosphorus	59	36.58	23.72	2158	12.4	85.9
Potassium	59	41.89	33.16	2472	7.2	99.5
Total fertilizers	59	153.50	65.83	9057	70.5	272.6

Source: own processing based on data from the CHMI and the Czech Statistical Office (CZSO).

For the entire period (59 years) was first performed simple regression and correlation - dependent variable was the yield per hectare, independent variable individual indicators (inputs). The greatest strength of the dependence was found for the independent variable “nitrogen”, which can explain 55.6% of the variance of the dependent variable hectare yield of wheat (the strength of the dependence can be assessed as medium). On the contrary, the weakest strength of the dependence is for the “precipitation” variable, whose share in the variability of the yield per hectare is only 1.19% (it can be assessed as a very weak dependence). The model describing the dependence of the wheat yield per hectare only on precipitation is statistically insignificant, as well as for “total fertilizers” and for “phosphorus” (see Table 2).

Table 2. Wheat - simple regression model results (1961 – 2019)

Independent variable	Index of determination R^2	Index of correlation R	p-value	Significant regression model
Total fertilizers	0.0013	-0.03595	0.7869	no
Nitrogen	0.5560	0.74565	<.0001	yes
Phosphorus	0.0511	-0.22601	0.0852	no
Potassium	0.1867	-0.43214	0.0006	yes
Precipitation	0.0119	-0.10917	0.4105	no

Source: own calculations based on data from the CHMI and the CZSO.

Furthermore, multiple regression models were determined - first for two variables (one of them was precipitation) and then for all. Because total fertilizers also contain nitrogen, potassium and phosphorus, regression was calculated only for total fertilizers and precipitation (see Table 3). The largest value of the determination index is shown by the model, which contains all independent variables. This means that the strength of the dependence between the yield per hectare and all the independent variables can be described as very strong. The statistically significant variable is the result of stepwise analysis, which selected it as statistically important (according to the set criteria).

Table 3. Wheat - multiple regression model (1961 – 2019)

Independent variables	**Multiple index of determination R^2**	**p-value**	**Significant regression model**	**Stat. significant variables selected by stepwise regression**
Fertilizers-precipitation	0.0141	0.6723	no	none
N-precipitation	0.5593	<.0001	yes	N
P-precipitation	0.0676	0.1411	no	P
K-precipitation	0.2076	0.0015	yes	K
N-P-K-precipitation	0.8796	<.0001	yes	N, K precipitation

Source: own calculations based on data from the CHMI and the CZSO.

The results are influenced by the correlation array, which contains two significant clusters - related to the use of fertilizers before 1991 and after 1991 (lot is seen in phosphorus and potassium case, where there is multicollinearity - R = 0.9475 - see Table 4).

Table 4. Correlation matrix of independent variables (1961 – 2019)

Pearson Correlation Coefficients, N = 59 Prob > |r| under H_0: Rh_0=0					
	Wheat	Nitrogen	Phosphorus	Potassium	Precipitation
Wheat p	1.0000	0.7457 <.0001	-0.2260 0.0852	-0.4321 0.0006	-0.1092 0.4105
Nitrogen p	0.7457 <.0001	1.0000	0.3584 0.0053	0.1599 0.2263	-0.0691 0.6029
Phosphorus p	-0.2260 0.0852	0.3584 0.0053	1.0000	0.9475 <.0001	-0.0830 0.5321
Potassium p	-0.4321 0.0006	0.1599 0.2263	0.94753 <.0001	1.0000	-0.0805 0.5445
Precipitation p	-0.1092 0.4105	-0.0691 0.6029	-0.0830 0.5321	-0.0805 0.5445	1.0000

Source: own calculations based on data from the CHMI and the CZSO.

Stepwise analysis selected nitrogen, potassium, and precipitation as important variables. Nitrogen has the greatest benefit, contributing 55.6% to explaining the variance in wheat yield per hectare. Potassium has a significantly lower effect on the variability (31.2%). Precipitation with a share of less than 1% seems to be the least significant to explain the variability of the yield per hectare of wheat (see Tables 5 and 6).The model selected using stepwise analysis has the form:

$$y = 3.154 + 0.037 \cdot x_1 - 0.018 \cdot x_2 - 0.001 \cdot x_3 \qquad \textbf{(2)}$$

where:

x_1 – nitrogen, x_2 – potassium, x_3 – precipitation. All regression parameters are statistically significant.

Table 5. Wheat - Summary of Stepwise Selection (1961 – 2019)

Step	Variable Entered	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	Nitrogen	1	0.5560	0.5560	144.1090	71.38	<.0001
2	Potassium	2	0.3120	0.8680	6.1857	132.39	<.0001
3	Precipitation	3	0.0095	0.8775	3.9322	4.26	0.0438

Source: own calculations based on data from the CHMI and the CZSO.

Table 6. Wheat – Parameters Estimate of Stepwise Analysis (1961 – 2019)

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	3.1537	0.4347	7.4716	52.63	<.0001
Nitrogen	0.0375	0.0022	42.6962	300.78	<.0001
Potassium	-0.0181	0.0015	20.2787	142.86	<.0001
Precipitation	-0.0012	0.0006	0.6045	4.26	0.0438

Source: own calculations based on data from the CHMI and the CZSO.

If we divide the study period into 2, when in three decades until 1990 we assume less influence of climate change, and after 1990, on the contrary, greater influence on the course of precipitation, then we get the following results for wheat. Multiple regression models show that in the years 1961 - 1990, all independent variables have a higher significance (see Table 7). The strength of the dependence between the wheat yield per hectare and all the independent variables can be described as very strong.

Table 7. Wheat - multiple regression model (1961 – 1990)

Independent variables	Multiple index of determination R^2	p-value	Significant regression model	Stat. significant variables selected by stepwise regres.
Fertilizers-precipitation	0.6518	<.0001	yes	fertilizers
N-precipitation	0.8113	<.0001	yes	N
P-precipitation	0.7150	<.0001	yes	P
K-precipitation	0.2581	0.0178	yes	K
N-P-K-precipitation	0.9210	<.0001	yes	N, K

Source: own calculations based on data from the CHMI and the CZSO.

Stepwise analysis selected nitrogen, potassium, and precipitation as important variables. Nitrogen has the greatest benefit, contributing 78.90% to explain the variance in wheat yield per hectare. Patil, et al. (2012) determined sensitivity of wheat yield and soil nitrogen (N) losses to stepwise changes in means and variances of climatic variables using the FASSET model for period 1961 – 90. Large response in grain yield, N uptake and soil N cycling, and in their variability was predicted when summer precipitation was varied, whereas only N leaching responded to changes in winter precipitation. Doubling the duration of dry series lowered grain yield and N removed by grain, but increased N leaching, whereas doubling the duration of wet series showed opposite effect. Predicted responses to changes in precipitation patterns were larger on coarse sand than on sandy loam. Potassium has a significantly lower effect on variability (11.59%). Precipitation with a share of 1.39% seems to be the least significant to explain the variability of the yield per hectare of wheat (see Table 8). As stated by Petrovic et al. (2019) who monitored the climate elements condition (temperature and precipitation) for the time period from 1991 to 2011 in Serbia, correlation between precipitation and wheat yield was negative in certain months. This indicates that increased amount of precipitation in selected months negatively impact wheat yield. At certain stages of growth and development, wheat need for water is different, so the impact to yield would be different.

The model selected using stepwise analysis has the form:

$$y = 3.449 + 0.041 \cdot x_1 - 0.025 \cdot x_2 - 0.001 \cdot x_3 \qquad \textbf{(3)}$$

where:

x_1 – nitrogen, x_2 – potassium, x_3 – precipitation. All regression parameters are statistically significant.

Table 8. Wheat – Summary of Stepwise Selection (1961 – 1990)

Step	Variable Entered	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	Nitrogen	1	0.7890	0.7890	40.7897	104.70	<.0001
2	Potassium	2	0.1159	0.9049	6.1178	32.88	<.0001
3	Precipitation	3	0.0139	0.9187	3.7217	4.44	0.0448

Source: own calculations based on data from the CHMI and the CZSO.

For the period 1991 - 2019, the results of multiple regression are shown in tab. 9. The highest index of determination has a model that contains all independent variables (R^2 = 0.6397). This means that the chosen independent variables can explain 63.97% of the variance of the variable yield per hectare of wheat.

Table 9. Wheat - multiple regression model (1991 – 2019)

Independent variables	Multiple index of determination R^2	p-value	Significant regression model	Stat. significant variables selected by stepwise regr.
Fertilizers-precipitation	0.6123	<.0001	yes	fertilizers
N-precipitation	0.6317	<.0001	yes	N
P-precipitation	0.2143	0.0435	yes	P
K-precipitation	0.0879	0.3022	no	none
N-P-K-precipitation	0.6397	<.0001	yes	N

Source: own calculations based on data from the CHMI and the CZSO.

The regression model containing all explanatory variables has the highest dependence strength. On other hand, Li et al. (2015) presented their statistical modelling practices for predicting rain fed corn yield in the Midwest U.S. They stated that interannual variations in prediction performance are linked to yield variability and degree of wetness, with higher R^2 in years with larger yield variability but increasingly larger root-mean-square error toward wetter years and extreme dry years. Statistically insignificant is the model containing the independent variable potassium (K)-precipitation. These are variables whose effect has not been proven even in the case of a simple regression function. Multicollinearity is demonstrated here for phosphorus and potassium. This dependence between fertilizers has also been demonstrated for rape and potatoes. Stepwise analysis selected nitrogen as the most important variable. This explanatory variable can explain 62.39% of the variance of the explanatory variable. The remaining independent variables then account for 1.58% of the total variability. It is therefore clear that fertilization, especially with nitrogen fertilizers, is essential for the yield per hectare of wheat. This also agrees with findings of Chloupek et al. (2004) who analysed yields of cereals over 75 years and stated, that the impact of the weather was less than the influence of fertilisation. The summary results of a simple regression are shown in tab. 10. This is an explanation for the variance in the yield per hectare of wheat regardless of other independent variables. The results show that in all periods, the greatest dependence strength was found for the independent variable "nitrogen". The greatest effect of precipitation (5.52%) manifested itself in the period after 1990. Unfortunately, unlike nitrogen, the effect of precipitation in all these models was insignificant ($p = 0.22$ for the period 1991 to 2019, or 0.35 for the years 1961 - 1990).

Table 10. Wheat - summary results of a simple regression

Independent variables	**R^2 1961-2019**	**R^2 1961-1990**	**R^2 1991-2019**
Total fertilizers	0.0013	0.6197	0.6123
Nitrogen	0.5560	0.7890	0.6239
Phosphorus	0.0511	0.6770	0.2117
Potassium	0.1867	0.2206	0.0718
Precipitation	0.0119	0.0313	0.0552

Source: own calculations based on data from the CHMI and the CZSO.

For other crops, the results of multiple regressions are shown in Table 11. For a complex regression involving all four inputs (nitrogen-phosphorus-potassium-precipitation), the regression models for both crops are reported to be significant for all periods. The strength of the dependence between the hectare yield of selected crops and all independent variables is the highest (last rows of both tables). Interestingly, the multiple index of determination with all independent variables is higher for oil-seed rape in the first period (1961-90), while for potatoes it is the opposite. This may be related to a significant reduction in the use of compound fertilizers in oil-seed rape after 1990 and a consequent decline in yields for this crop in the 1990s.

Table 11. Summary results of a multiple regression

Oil-seed rape			
Independent variables	**Multiple index of determination R^2 1961 - 2019**	**Multiple index of determination R^2 1961 - 1990**	**Multiple index of determination R^2 1991 - 2019**
Fertilizers-precipitation	0.0007	0.6057	0.4744
N-precipitation	0.5062	0.7079	0.5268
P-precipitation	0.0456	0.6390	0.0969
K-precipitation	0.1523	0.2864	0.0067
N-P-K-precipitation	0.7639	0.7438	0.5448
Potatoes			
Fertilizers-precipitation	0.0099	0.4277	0.3744
N-precipitation	0.3667	0.4604	0.5250
P-precipitation	0.0850	0.4200	0.0038
K-precipitation	0.1711	0.2702	0.0247
N-P-K-precipitation	0.6612	0.4653	0.6432

Source: own calculations based on data from the CHMI and the CZSO.

4. Conclusion

The results show that nitrogen fertilization is the most important input factor for winter wheat. The effect of precipitation in a simple regression proved to be insignificant. The total annual precipitation even negatively correlates with wheat yield, which is confirmed by other authors. This is probably related to the period in which these rainfalls occur. For winter crops, rooting and good tillering in autumn are probably more important, which can of course be supported by fertilization with nitrogen fertilizers, than too heavy rainfall in spring, especially during the flowering period. Furthermore, it turned out that in the first period (1961 - 1990) there is a smaller residual variance than in the period after 1990, which is confirmed by multiple determination indices for all inputs. For example in the case of winter rape, we can also observe greater fluctuations in yields per hectare, especially in the 1990s, when the consumption of fertilizers also decreased due to economic changes, the abolition of subsidies and the reduction of production in agriculture. On the other hand, yields of potatoes increased in the second period and variability is lower, although total production in this commodity is declining. For further research, the authors expect to include detailed data on monthly precipitation in order to more accurately differentiate the moisture requirements of winter crops and spring crops in certain months. They will also try to include other variables, especially temperature data, which, as other research around the world suggests, can significantly affect crop yields in combination with other inputs reported here.

Acknowledgements
This paper was created within the framework of the project NAZV QK1910299 - Sustainable management of natural resources with emphasis on non-productive and productive capabilities of soil.

References

Akumaga, U. et al. (2018), "Utilizing Process-Based Modeling to Assess the Impact of Climate Change on Crop Yields and Adaptation Options in the Niger River Basin, West Africa", *Agronomy*, vol. 8(2), no. 11, 19 p. ISSN 2073-4395, DOI 10.3390/agronomy8020011

Chloupek, O., Hrstkova, P. and Schweigert, P. (2004), "Yield and its stability, crop diversity, adaptability and response to climate change, weather and fertilisation over 75 years in the Czech Republic in comparison to some European countries", *Field Crops Research*, vol. 85, p. 167 - 190, ISSN 0378-4290, DOI 10.1016/S0378-4290(03)00162-X

Li, Y. et al. (2019), "Toward building a transparent statistical model for improving crop yield prediction: Modeling rainfed corn in the U.S", *Field Crops Research*, vol. 234, pp. 55–65, ISSN 0378-4290, DOI 10.1016/j.fcr.2019.02.005

Patil, R. et al. (2012), "Sensitivity of crop yield and N losses in winter wheat to changes in mean and variability of temperature and precipitation in Denmark using the FASSET model", *Acta Agriculturae Scandinavica: Section B, Soil & Plant Science*, vol. 62, no. 4, pp. 335–351, ISSN 1651-1913. DOI 10.1080/09064710.2011.615758

Petrović, G., Labović, B. and Dasic, B. (2019), "The influence of climate elements on the yield of agricultural crops in the area of Sumadija in Serbia", *Economics of Agriculture*, vol. 66, no. 1, pp. 173 – 187, ISSN 0352-3462, DOI 10.5937/ekoPolj1901173P

Tao, F. et al. (2016), "Variability in crop yields associated with climate anomalies in China over the past three decades", *Regional Environmental Change*, 16(6), pp. 1715–1723, DOI 10.1007/s10113-015-0920-0

Trnka, M. et al. (2012), "Could the changes in regional crop yields be a pointer of climatic change?", *Agricultural and Forest Meteorology*, vol. 166–167, pp. 62-71, ISSN 0168-1923, DOI 10.1016/j.agrformet.2012.05.020

Verón, S. R., De Abelleyra, D. and Lobell D. B. (2015), "Impacts of precipitation and temperature on crop yields in the Pampas", *Climatic Change,* vol. 130, pp. 235–245, ISSN 0165-0009, DOI 10.1007/s10584-015-1350-1

Webber, H. et al. (2015), “Climate change impacts on European crop yields: Do we need to consider nitrogen limitation?”, *European Journal of Agronomy*, vol. 71, pp. 123–134. ISSN 1161-0301, DOI 10.1016/j.eja.2015.09.002

Xiao, G. et al. (2008), “Impact of recent climatic change on the yield of winter wheat at low and high altitudes in semi-arid northwestern China”, *Agriculture, Ecosystems & Environment*, vol. 127(1/2), pp. 37–42. ISSN 0167-8809, DOI 10.1016/j.agee.2008.02.007

ANALYSIS OF CSS ORGANIZATION STYLES AND EXPENSIVE PROPERTIES IN REGARD TO RENDERING PERFORMANCE

Jan Masner[1], Pavel Šimek[2], Jan Jarolímek[3], Vladimír Očenášek[4] and Jan Pavlík[5]

[1, 2, 3, 4, 5] Department of Information Technologies, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]masner@pef.czu.cz, [2]simek@pef.czu.cz [3]jarolimek@pef.czu.cz, [4]ocenasek@pef.czu.cz, [5]pavlikjan@pef.czu.cz

Annotation: The paper addresses a challenge that might come together with an onset of 5th generation (5G) mobile networks. The vigorous increase of network speed (and latency decrease) will lead to higher demand on rendering speed of web sites. Internet and World Wide Web are used by various smart applications in agriculture. More and more, web sites are used for marketing purposes in agriculture. More small-scale farms are selling and promoting own products through own web site. The paper focuses on a display speed of web pages in terms of rendering CSS. We have developed experimental small-scale website using three variants of CSS organizations. Afterwards, we conducted experimental testing to compare the three variants. Additionally, we investigated impact of using expensive CSS properties. We gathered various metrics. Based on the results we conclude that the organization which separates the styles into multiple files performs best.

Key words: CSS, rendering, WWW, 5G, HTML

JEL classification: L86, C88, M15

1. Introduction

Last decades have seen a significant progress in the field of precision agriculture. Besides Precision agriculture, several terms are used for the same concept amongst the professional society nowadays. Additionally, it includes *precision farming, smart agriculture, smart farming,* and *agriculture 4.0.* The concept of precision agriculture has been in the interest of the professional public since the 1990s. It generalizes the effort to identify solutions, tools and processes that can improve productivity and profitability while protecting the environment (Cambouris, Zebarth, Ziadi, et al. 2014). The current efforts are trying to manage the resources of the whole farms from crops to the final product. Information technologies in general are one of the most important enablers (Kai, Perumal 2010).

Usage of internet technologies and World Wide Web (WWW) still increases. Internet and web is used by smart agriculture applications, e.g. (Marchioni, Laura, Ruffoni 2018). More and more, web sites are used for marketing purposes in agriculture (Abishek, Bharathwaj, Bhagyalakshmi 2016). More small farms are selling and promoting own products through own web site. Alongside, local food web sites are important for sustainable urban development (Chen 2012). Small-scale web sites and applications can be used not only for marketing purposes, but also for monitoring of various smart solutions.

One of the challenges for the future is an onset of the use of 5th generation (5G) mobile networks. Many authors mention that the vigorous increase of network speed (and latency decrease) will lead to higher demand on rendering speed of web sites (Chima 2019; Lu 2018; Trias 2019). The network speed will be fast enough that the amount of time needed to download the web page data will be approaching zero. In other words, the time will be significantly lower than the time needed for page rendering. Even lightweight versions of the HTTP protocol for faster transfer may appear (Alhamad, Kazi 2014). Alongside, the World Wide Web Consortium (maintainer for many specifications of web-based technologies, including HTML) is planning to launch an initiative bringing together telecommunication operators, OS and browser vendors, and cloud providers to take full advantage of 5G on the Web (Hazael-Massieux 2019).

Generally, time needed from user request to display a web page in a browser is one of the key factors that determines, whether the user visits or later abandon the web site (Asrese, Eravuchira, Bajpai, et al. 2019; Shroff, Chaudhary 2017). Displaying of web sites and applications is a process which relies on many factors. Simplified, a page is downloaded and rendered. However, those two phases often take place simultaneously. Alongside the download speed, it is important to take into account a structure of the HTML source code and DOM (Document Object Model) tree complexity, JavaScript code, connected media and CSS (Cascading Stylesheets). CSS is a language used to define web appearance. A web page is not displayed to the user at once after fully downloaded and rendered. On the contrary, modern browsers try to display the web page progressively. Users can partially see the content while the page is still loading and rendering in the background. Therefore, the CSS is one of the most important factors which can affect the rendering (Mazinanian, Tsantalis 2016). It is necessary that the HTML is rendered with CSS as early as possible. The website appearance determines meaningfulness, usability and finally a user experience of the content (Benda, Šmejkalová, Šimek 2016). Additionally, one of the factors affecting rendering speed can be use of CSS styles or properties considered as expensive (McAnlis 2013; Frain 2017, p. 105).

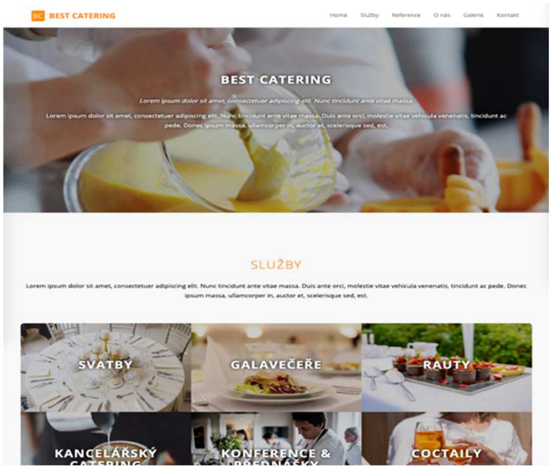
Other studies, that can be found in literature focuses on different aspects of rendering. For example Shroff and Chaudhary (2017) focused on a whole content level complexity including videos, images, JavaScript, and CSS. Rossberg et. al (2018) focused on efficiency and security of code while programming. Szabo et. al (2015) faced network related issues. Rendering speed during continuous browsing was addressed by (Nakano, Kamiyama, Shiomoto, et al. 2015). However, authors do not address the impact of CSS exclusively. Therefore, this study focuses on the CSS during rendering of web pages. There are several approaches (styles) for CSS development and its organization. The objective of the paper is to investigate those styles) for CSS organization and identify which is optimal for small-scale web sites. Partially, the study evaluates the use of expensive CSS properties.

2. Materials and Methods

Within the research we have developed experimental website. The website is based on a real small farmer web. The data were anonymized. The look and theme were slightly changed. The website was run on a public hosting service. The server runtime environment consists of a Linux based operating system, Apache 2.2 web server and PHP (PHP Hypertext Processor) 7.3. The PHP programming language is used to simplify development and serving of individual pages. The website itself is based on HTML5 (Hypertext Markup Language), CSS, and a necessary JavaScript using jQuery framework. The JavaScript code is loaded at the end of the document (before closing body tag). So, it does not affect page CSS rendering. We have developed three variants of a sample website using different popular approaches for organization of CSS. The tested website is shown in Figure 1.

Organization No.1 is based on one a single CSS file containing all style declarations. The web page contains 159 items in a DOM (Document Object Model) tree and CSS file contains 157 selectors. The file is linked in a header section of the page. **Organization No. 2** divides the styles to five separate files. The DOM tree contains 159 items. The CSS consists of 157 selectors split into separate files by 49, 21, 42, 40, and 5. All file are linked in a header section of the page. **Organization No. 3** is a component-based (or progressive) style. The CSS is divided into smaller parts, each corresponds to a component of a web page. The CSS code is linked right before the component. Therefore, browser loads only the used parts just before the rendering. Only the necessary styles are linked in header section (e.g. for layout). This approach can lead to reduction of downloaded data. On the other side, it leads to certain duplication of style declarations. The styles where divided into nine parts. Two of them were not necessary on the main page. DOM tree contains 159 items.

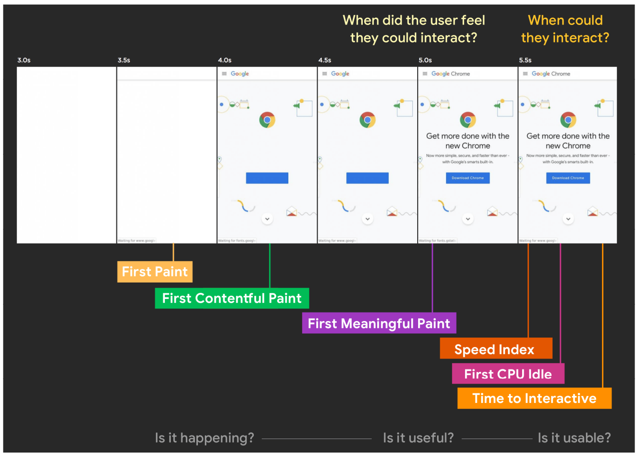
Figure 1. Tested website



Source: own processing

All the three organizations (variants of a web site) preserves the same HTML complexity (159 DOM tree items) as well as other attributes to ensure the same testing conditions. Thanks to this fact, we were able to determine the real influence of the CSS. For each organization we performed several tests to gather appropriate metrics, namely First Contentful Paint (FCP), First Meaningful Paint (FMP), Speed Index (SI), and Time to Interactive (TTI). All the metrics are visualized in Figure 2. FCP metric indicates the time needed for any part of the page's content to be rendered on the screen. FMP measures when the primary content of a page is visible to the user. So, it can be used to provide information when the user can see and read some meaningful information. Speed index focuses on what a visitor sees. It measures how quickly content is visually displayed during page load. Time to Interactive metric measures how long it takes a page to become fully interactive.

Figure 2. Visualization of page speed metrics



Source: (Osmani 2019)

Additionally, consumption of computing resources was measured, namely operation memory (RAM), Processor (CPU) and graphics card (GPU, when used for rendering). Each measurement was repeated 5 times. Extreme values and outliers were eliminated by repeating the measurement. Mean values were calculated and used for comparison. We used Google PageSpeed Insights cloud tool for the main measurement. Additional measurement was done using Mozilla Firefox development tools and WebPageSpeed.org to verify that the tools do not provide significantly different results. The provided measurements corresponded to the results gathered by the Google PageSpeed Insights. This one was used for later analyses. Moreover, the cloud tool guarantees a hardware and software independence. So, there is no need to measure on various devices and hardware configurations. Moreover, primary measurements are mobile-first. The results for the desktop are not significantly different – all times are proportionally shorter.

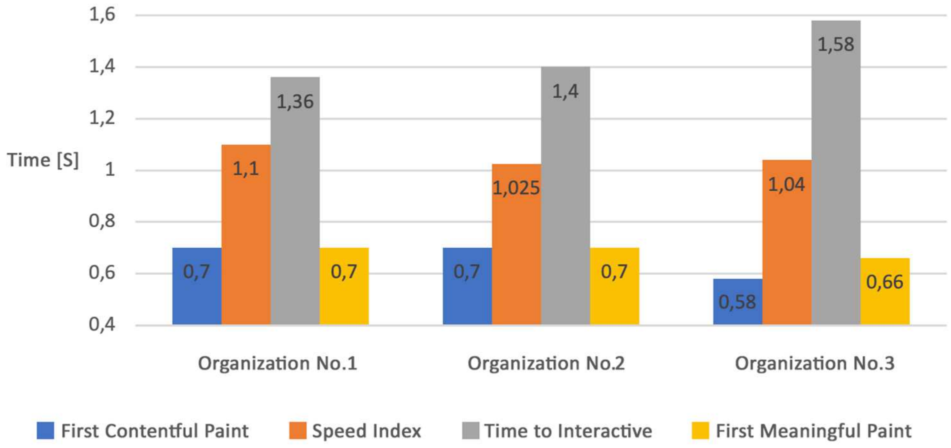
Among the expensive properties we evaluated *border-radius, box-shadow, opacity,* and *transform*. Measuring was conducted using Chrome development tools. We used metrics *Painting* and *Rendering*. By adding these metrics together, it is possible to determine the time, when the elements are displayed properly. When the properties are used sparingly, the impact on page rendering is not significant. The situation changes using the properties on more HTML elements, which is commonly used for example in various data listings. Therefore, we have measured the impact when using on 5, 25, 50, 100, 150, 300 elements.

3. Results and Discussion

Firstly, we performed measurement of three different approaches for organization of CSS. For each variant, the same page was used. Number of items in DOM tree was preserved in order to eliminate its influence on the results.

We measured four metrics to evaluate the speed of website rendering. Figure 2 compares three CSS organizations based on these metrics. It is apparent from the figure that the Organization No. 3 performs best in First Contentful Paint and First Meaningful Paint. Those two metrics are mostly important for users by the means of “something is happening”. Users can see that the content is loading. On the other side, as shown in Figure 3, values of Speed Index and Time to Interactive metrics indicate that the user has to wait more time to actually start browsing the website. Interestingly, results of this metric indicate that the interactivity does not depend exclusively on the JavaScript.

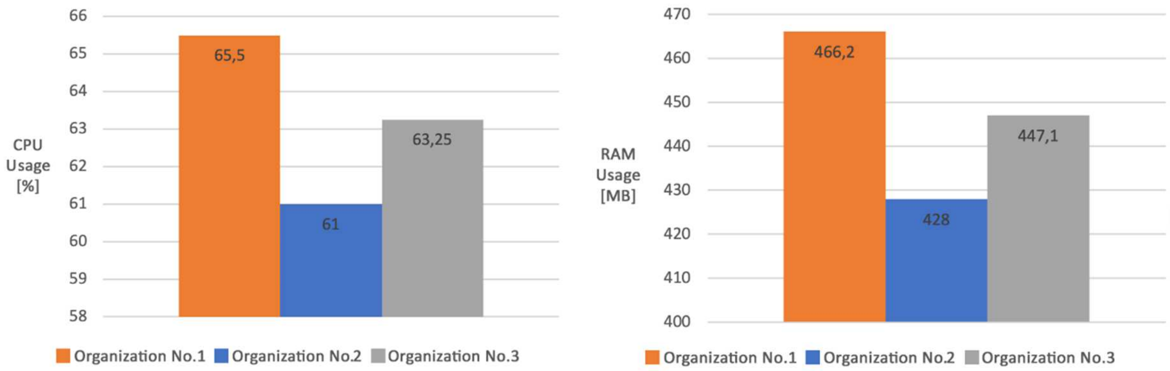
Figure 3. Results of metrics measurement. Values are calculated as means of 5 measurements



Source: own processing

The following figures illustrates the results of measuring consumption of computing resources. In Figure 4, there is clearly visible that the CSS Organization No. 1 consumes most CPU power. The lowest consumption has been identified for Organization No. 2, while the number 3 stands in the middle. The same results are illustrated for operation memory usage. A possible explanation for this result might be the splitting into more files and use of multi-core CPU. It is possible that the more CPU cores are used, the faster the results can be. This fact would need a separate study. Alongside the time metrics, CPU and memory usage suggests that single file organization (No. 1) consumes most resources.

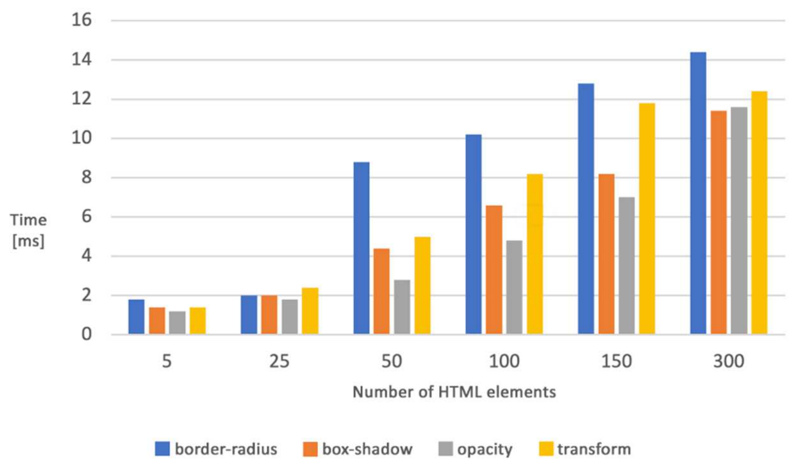
Figure 4. Consumption of processor and operation memory (RAM) during rendering process



Source: own processing

Finally, Figure 4 illustrates results of measurement of expensive CSS queries. The most expensive is visibly the border-radius. As the figure shows, for small number of elements the impact is not very significant. However, as the number of elements grows, the impact grows rapidly. The other properties grow exponentially. Despite that fact, the highest impact for all properties starts when using more than 25 elements. This number can be considered as the top limit of elements for one page. If more elements are needed, pagination or load more feature should be used.

Figure 5. Impact of expensive CSS properties on page rendering time



Source: own processing

4. Conclusion

Based on the results, a simple suggestion that the CSS Organization No. 2 (CSS in multiple files) can be concluded. This organization can be recommended especially for low performance devices. However, this conclusion is valid for small scale websites. On the other side, complex web sites can probably benefit from saving download times using component-based organization. The unused components are simply not loaded. However, the enormous increase in download speeds of the future 5G networks can negate this fact. The second experiment showed that the expensive CSS properties have the biggest impact from 25 elements. Preliminary tests suggest that using GPU acceleration the Organization No.3 performs better. It has also an impact on the rendering of expensive properties.

The presented findings serve as a basis of methodology for further research on website rendering performance. This study focused on CSS exclusively. The performance is affected also by other attributes such as HTML complexity and JavaScript code. There are also various methods for optimization, such as compression. Various other metrics can be used for measurements to answer specific research questions. Investigating those attributes is a topic for future work and research. One of the options is to investigate impact of complex CSS selectors.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019MEZ0004 – Machine Learning Classification model to Identify User Activities During Usability Testing.

References

Abishek, A. G., Bharathwaj, M. and Bhagyalakshmi, L. (2016), "*Agriculture marketing using web and mobile based technologies*", Proceedings - 2016 IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development, TIAR 2016. ISBN 9781509006151

Alhamad, D. Z. and Kazi, K. (2014), "*Light weight HTTP for transport and content sharing in 5G cellular networks*", 2014 11th Annual High Capacity Optical Networks and Emerging/Enabling Technologies (Photonics for Energy), HONET-PfE 2014. ISBN 9781479969401

Asrese, A. S., Eravuchira, S. J., Bajpai, V., Sarolahti, P. and Ott, J. (2019), "*Measuring web latency and rendering performance: Method, tools, and longitudinal dataset*", IEEE Transactions on Network and Service Management. DOI 10.1109/TNSM.2019.2896710

Benda, P., Šmejkalová, M. and Šimek, P. (2016), "Usability analysis of agricultural portal eAGRI in terms of the general public", *Agris On-line Papers in Economics and Informatics*. DOI 10.7160/aol.2016.080402

Cambouris, A. N., Zebarth, B. J., Ziadi, N. and Perron, I. (2014), "Precision Agriculture in Potato Production", *Potato Research*, Vol. 57, no. 3–4, p. 249–262. DOI 10.1007/s11540-014-9266-0

CHen, S. (2012), "*Civic Agriculture: Towards a Local Food Web for Sustainable Urban Development*", APCBEE Procedia. DOI 10.1016/j.apcbee.2012.03.027

CHima, R. (2019), "5G in Software Application Development". [online]. 2019. [Accessed 29 April 2020]. Available from: https://www.bbconsult.co.uk/blog/5g-software-application-development

Frain, B. (2017), "*Enduring CSS*". Packt Publishing. ISBN 978-1-78728-280-3

Hazael-Massieux, D. (2019), "*Web5G: Making Web and 5G Networks Work Together*". ERCIM NEWS. April 2019. No. 117, p. 29–30

Kai, C. Y. and Perumal, N. (2010), "*Intelligent Informatics Platform for Precision Agriculture*", Workshop Proceedings of the 6th International Conference on Intelligent Environments. p. 141–147. ISBN 978-1-60750-639-3; 978-1-60750-638-6

LU, L., 2018. How to Prepare Your Website for 5G | Brandignity. [online]. [Accessed 29 April 2020]. Available from: https://www.brandignity.com/2018/03/how-to-prepare-your-website-for-5g/

Marchioni, I., Laura, M. and Ruffoni, B. (2018), "A web interface for a sustainable agriculture in Mediterranean area", *IN VITRO CELLULAR & DEVELOPMENTAL BIOLOGY-PLANT*. Vol. 54, no. 1, p. S121

Mazinanian, D. and Tsantalis, N. (2016), "A*n Empirical Study on the Use of CSS Preprocessors*"

Mcanlis, C. (2013), "*CSS Paint Times and Page Render Weight - HTML5 Rocks*". [online]. [Accessed 30 April 2020]. Available from: https://www.html5rocks.com/en/tutorials/speed/css-paint-times/

Nakano, Y., Kamiyama, N., Shiomoto, K., Hasegawa, G., Murata, M. and Miyahara, H. (2015), "*Web performance acceleration by caching rendering results*", 17th Asia-Pacific Network Operations and Management Symposium: Managing a Very Connected World, APNOMS 2015. ISBN 9784885522963

Osmani, A. (2019), "AddyOsmani.com - Web Page Usability Matters". [online]. [Accessed 29 April 2020]. Available from: https://addyosmani.com/blog/usability/

Rossberg, A., Titzer, B. L., Haas, A., Schuff, D. L., Gohman, D., Wagner, L., Zakai, A., Bastien, J. F. and Holman, M. (2018), "B*ringing the web up to speed with webassembly*", Communications of the ACM. DOI 10.1145/3282510

Shroff, P. H. and CHaudhary, S. R. (2017), "*Critical rendering path optimizations to reduce the web page loading time*", 2nd International Conference for Convergence in Technology, I2CT 2017. ISBN 9781509043071

Szabo, G. and Racz, S. (2015), "*Network enhancement of web rendering time.*", Proceedings - IEEE INFOCOM. ISBN 9781467371315

Trias, G. (2019), "*The Impact of 5G on Web Design*". [online]. [Accessed 29 April 2020]. Available from: https://www.biggerpicture.agency/insights/impact-of-5g-web-design

FREQUENT DISCOUNTS AND LOSS OF VAT FOR THE STATE BUDGET OF CZECH REPUBLIC: SCENARIO ESTIMATIONS FOR MILK, EGGS AND POULTRY

Lukáš Moravec[1], Mikhail Krivko[2], Luboš Smutka[3] and Daniela Šálková[4]

[1, 3, 4] Department of Trade and Accounting, [2,] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1] moravec@pef.czu.cz, [2]krivko@pef.czu.cz, [2]smutka@pef.czu.cz, [4]salkova@pef.czu.cz

Annotation: The practice of using price discounts as a tool to increase sales volumes has become widely applicable among retail chains in Czech Republic. Combined with significant purchasing power of retailers this can lead to sub-cost purchase prices. Consumers might be considered as main beneficiaries of frequent price discounts, as they are offered the opportunity to purchase specific categories of food products at lower cost. At the same time, lowered consumer price leads to lowered value added tax (VAT) revenues for state budget. The paper attempts to estimate one of the potential impacts of frequent price discounts, the loss of VAT for the state budget due to low retail prices of milk, eggs and poultry. Estimation is based on data obtained from Czech Statistical Office and employs Monte Carlo simulation to capture the stochastic element of retail markups. Main results of the estimation suggest, that annual loss of VAT for budget can reach up to 16,020 mln CZK, loss of VAT for milk, eggs and poultry can reach up to 11,370 mln CZK, 1,140 mln CZK and 3,510 mln CZK respectively. Marginal cost to the state budget decreases with the number of supply chain stages employing sub-purchase prices. Further possibilities to improve the estimates of VAT loss are shown, namely including price elasticity of demand into the model, as well as adjusting input parameters of the model used in the estimation.

Key words: Czech Republic, VAT, frequent price discounts, milk, eggs, poultry.

JEL classification: Q11, Q13, Q18

1. Introduction

Value added tax (VAT) is one of the main sources of state budget revenues in Czech Republic. Since it is an indirect tax on consumption, value of VAT is calculated on the basis of consumer prices. Consumer prices in market economy are the result of market forces and are being set by retailers. Theoretically, consumer price of a commodity should be set as an equilibrium between the price that consumer is willing to pay for a commodity and the price at which seller (in many cases, retail chains) is willing to sell the product. Nevertheless, in practice distortions of different nature arise in each economy. Retailers' promotional activities in form of frequent price discounts can be an example of such a distortion. In extreme cases, retailers sell food products at sub-purchase prices, or in other words at prices lower than the prices at which the retailer has actually bought the product. These practices might become an interesting economic phenomenon when retailers exercise their significant market power and conduct promotional price activities more frequently, passing the cost of such promotional activities to previous stages of supply chain, namely to industrial food producers and farmers. As a result of such situation, VAT revenues from discounted food prices decreases, and state budget suffers loss of VAT tax revenue.

The aim of current paper is to estimate potential losses of VAT tax revenues for state budget of Czech Republic due to frequent price discounts in presence of sub-purchase prices for milk, eggs and poultry.

Competition in food retailing has attracted a lot of attention in recent years. This is due, among other things, to the fact that retail is a part of the food supply chain that is very easy to see through consumer food purchases. Retail concentration is high in many countries and is growing at a rapid pace. Supermarkets have penetrated a wide range of markets in Europe, Asia, Latin America and Africa (Reardon et al., 2003). This expansion includes some supermarket chains operating in several countries (Wrigley and Lowe, 2010). Using data on store level from supermarkets in Vermont, USA, Cotterill (1986) has found that higher prices were associated with more concentrated markets. However, this conclusion was called into question by Newmark (1990), which showed that the relationship between concentration and prices did not exist when other factors (such as a change in income levels) were considered. Several concerns also point to the seller's strength with implications for suppliers in the manufacturing and agricultural sectors (OECD, 2014). Given the growing market power of retail chains, there is concern about the growing role and concentration of retailers in the whole food supply chain. Recent studies of the retail-processor relationships have found that retailers have more influence on food distribution than processors (Digal and Ahmadi-Esfahani, 2002; Villas-Boas, 2007).

Frequent price discounts have received significant attention in economic literature. Some of the works noted short-term increase in sales of the promoted product (Hawkes, 2009), increasing price sensitivity of customers with each new wave of price reductions (van Heerde and Neslin, 2008, van Heerde et al., 2008) and leading to new waves of price promotions (Guiltinan and Gundlach, 1996, Kopalle et al., 1999, Dekimpe and Hanssens, 1999, van Heerde et al., 2000). Retailers might even fall into a price promotional trap (Bolton et al., 2006). Most of the studies focuses on impacts of price promotions on retail chains, while relatively smaller portion of literature studies impacts on other stakeholders, such as suppliers and state.

Current paper aims to fulfill the gap in current scientific discussion related to pricing in retail chains by adding a perspective of value added tax losses that state budget incurs due to extreme reductions in consumer prices of specific basic commodities, such as milk, eggs and poultry. The presence of VAT loss does not necessarily mean harm for the state budget, since the value of loss can be assessed only arbitrarily, however the range of loss confirmed by estimations might be useful for design of economic policy in countries where frequent price discounts have become a new normal.

2. Materials and Methods

Possible loss of VAT revenues for state budget can be estimated as a difference between actual revenues (real situation) and revenues in the opposite case (ideal situation). As final value added tax collected to the state budget is calculated as a percentage of consumer price for the commodity, VAT loss equation might take the following form:

$$\Delta_{VATi} = c_i r_0 q_{1i}\left(R_{1i} - R_{2i} + E_{di} R_{2i}\left(1 - \frac{R_{2i}}{R_{1i}}\right)\right) \quad \textbf{(1)}$$

Where Δ_{VATi} – difference in VAT revenue for the budget in real and ideal situation; c_i – production cost of the commodity i; r_0 – VAT rate for the commodity i; q_{1i} - number of units of product i sold in real situation on market within frequent price discounts; E_d – price elasticity of demand for commodity i; R_{1i} – product of markups on each stage of supply chain of commodity i in real situation on the market; R_{2i} – product of markups on each stage of supply chain of commodity i in ideal situation on the market.

R_{1i} and R_{2i} can be further explained by following equations:

$$R_{1i} = r_{11}r_{12}r_{13} \tag{2}$$

Where r_{11}, r_{12}, r_{13} - markups, increased by 1, on each stage of supply chain, in real situation on the market.

$$R_{2i} = r_{21}r_{22}r_{23} \tag{3}$$

Where r_{21}, r_{22}, r_{23} - markups, increased by 1, on each stage of supply chain, in ideal situation on the market.

Number of units sold in real situation on market within frequent price discounts can be estimated from the market size of the product:

$$q_{1i} = \alpha_i \times Q_i \tag{4}$$

Where Q_i – market size for the commodity i in respective units;

α_i – coefficient, showing how many units of commodity i have been sold within frequent price discounts.

Current estimation assumes zero price elasticity of demand, as commodities in scope of current paper (milk, eggs and poultry) are basic food products. Nevertheless, the precision of the estimation can be improved by including price elasticity into the calculation.

We use conservative estimation of 25% for coefficient α_i in terms of current paper. This estimation is less than other estimations (Nielsen, 2019) due to not-scientific nature of other estimations.

Mark-ups from the first group (r_{1i}) are set up as per the following scenarios:

1. $r_{11} < 1$; $r_{12} \geq 1; r_{13} \geq 1$; this scenario represents the case, when farmers sell commodity at the price lower than their cost of production.
2. $r_{11} \geq 1$; $r_{12} < 1; r_{13} \geq 1$; this scenario represents the case, when industrial producers (i.e. dairies in case of milk) sell commodity at the price lower than their cost of production, which includes purchasing cost of commodity from farmers.
3. $r_{11} \geq 1$; $r_{12} \geq 1; r_{13} < 1$; this scenario represents the case, when retailers sell commodity at the price lower than their cost, which includes purchasing cost of commodity from industrial producers.
4. $r_{11} < 1$; $r_{12} < 1; r_{13} \geq 1$; this scenario represents the case, when both farmers and industrial producers sell commodity at the price lower than their cost of production.
5. $r_{11} \geq 1$; $r_{12} < 1; r_{13} < 1$; this scenario represents the case, when farmers sell commodity with margin (mark-up is higher than zero), while industrial producers and retailers sell commodity at the price lower than their cost.

6. $r_{11} < 1$; $r_{12} < 1$; $r_{13} < 1$; this scenario represents the case, when all participants of supply chain sell commodity at the price lower than their cost of production.

As mark-ups from the first group (r_{1i}) contain a portion of random effect in real market situation, a Monte Carlo estimation with 1000 repetitions has been employed. Within the pre-defined conditions of each of the scenarios, estimation was based on the random values of variables r_{11}, r_{12} and r_{13}. Each scenario estimation contained 27000 data cases. Parameters of supply chain for the estimated scenarios are shown on the Table 1.

Table 1. Parameters of supply chain used in Monte Carlo estimations of VAT loss for milk, eggs and poultry

Commodity	Production cost, CZK	Range of markup rate $\boldsymbol{r_{11}}$	Range of markup rate $\boldsymbol{r_{12}}$	Range of markup rate $\mathbf{r_{13}}$	Markup rate $\boldsymbol{r_{21}}$	Markup rate $\boldsymbol{r_{22}}$	Markup rate $\boldsymbol{r_{23}}$
Milk	8.13	0.75-1.3	0.75-1.3	0.75-1.3	1.3	1.3	1.3
Eggs	1.75	0.75-1.3	1	0.75-1.3	1.3	1	1.3
Poultry	23.3	0.75-1.3	0.75-1.3	0.75-1.3	1.36	1.46	1.3

Source: Czech Statistical Office, year 2019.

Note: supply chain for eggs does not include intermediary industrial processing, therefore markup rate r_{12} is set to 1.

Mark-ups from the second group (r_{2i}) are set up in accordance to farmers', producers' and consumers' prices differences obtained from Czech Statistical Office for the year 2019.

Value of VAT loss per each of the scenarios is calculated as an arithmetic mean value with alpha-level 5%.

3. Results and Discussion

Values of estimated annual loss of VAT revenue for the state budget of Czech Republic in 2019 are shown on the Table 2. As can be seen, scenario 6 are showing the largest loss of VAT revenues, which is not surprising as this scenario assumes sub-purchase prices on each stage of supply chain. Mean value of VAT loss for this scenario totals to 11,368 million CZK. Scenarios 1, 2 and 3 are the ones with the smallest VAT loss, and differences in mean values of VAT loss as per these scenarios are only in the third decimal number. At the same time, there is the same small difference between scenarios 1,2,3 and scenarios 4,5. This shows the obvious fact that the total loss of VAT is not dependent on the stage of supply chain, where sub-purchase prices arise – total loss is rather dependent on the number of supply chain stages where sub-purchase prices arise.

Table 2. Estimated loss of VAT for state budget due to frequent price discounts in 2019, milk

Scenario	Mean, CZK billion	Confidence interval, CZK billion	Lower limit, CZK billion	Upper limit, CZK billion
1	-7.703	0.014	-7.717	-7.689
2	-7.701	0.014	-7.715	-7.687
3	-7.698	0.014	-7.712	-7.684
4	-9.806	0.011	-9.818	-9.795
5	-9.811	0.011	-9.822	-9.799
6	-11.368	0.009	-11.377	-11.359

Source: own calculations, alpha-level 5%.

Note: negative value means loss of VAT tax revenue for the state budget.

Difference in averages between scenarios 1,2,3 and scenarios 4,5 is 2,108 million CZK, which is equal to increase of 27.37%. Interestingly, difference between scenario 6 and average of scenarios 4,5 is 1,559 million CZK, or 15.9 %. Based on these two figures, marginal cost (in terms of additional loss of VAT) for the budget is decreasing with the number of supply chain stages which applies sub-purchase prices.

Results of VAT loss estimation in case of eggs are shown on the Table 3. As there is no intermediary step of industrial producer in supply chain for eggs, scenario 2 assumes the smallest loss of VAT revenue, which is estimated on the level of 430 million CZK. There is no difference in the value of VAT loss between scenarios 1,3,4 and 5, because each of these scenarios assumes sub-purchase prices on only one stage of supply chain. Scenario estimations for eggs show lower VAT loss in comparison to milk, mostly due to lower production costs per unit.

Table 3. Estimated loss of VAT for state budget due to frequent price discounts in 2019, eggs

Scenario	Mean, CZK billion	Confidence interval, CZK billion	Lower limit, CZK billion	Upper limit, CZK billion
1	-0.842	0.003	-0.845	-0.839
2	-0.430	0.003	-0.434	-0.427
3	-0.842	0.003	-0.845	-0.839
4	-0.842	0.003	-0.845	-0.839
5	-0.842	0.003	-0.845	-0.839
6	-1.145	0.003	-1.147	-1.142

Source: own calculations, alpha-level 5%.

Note: negative value means loss of VAT tax revenue for the state budget.

Estimation of VAT loss for poultry shows different picture, as shown on the Table 4. As can be seen, VAT loss in case of poultry is higher than in case of eggs but lower than in case of milk. Smallest VAT loss is estimated in scenarios 1,2,3, and largest VAT loss is estimated for the scenario 6. These results are in line with estimations for other commodities, however the most peculiar fact is that poultry does not seem to be the main driver of VAT loss due to frequent price discounts. Among the commodities in scope of current study, the largest VAT loss attributed to frequent price discounts has been confirmed for milk.

Table 4. Estimated loss of VAT for state budget due to frequent price discounts in 2019, poultry

Scenario	Mean, CZK billion	Confidence interval, CZK billion	Lower limit, CZK billion	Upper limit, CZK billion
1	-2.593	0.003	-2.597	-2.590
2	-2.594	0.003	-2.598	-2.591
3	-2.595	0.003	-2.599	-2.592
4	-3.119	0.003	-3.122	-3.116
5	-3.118	0.003	-3.121	-3.115
6	-3.505	0.002	-3.508	-3.503

Source: own calculations, alpha-level 5%.

Note: negative value means loss of VAT tax revenue for the state budget.

In case of poultry, difference in averages between scenarios 1,2,3 and scenarios 4,5 is 524 million CZK, which is equal to increase of 20.20%. At the same time, difference between scenario 6 and average of scenarios 4,5 is 387 million CZK, or 12.41 %. These differences show the same pattern as in case of the milk, confirming that lower marginal cost for the budget might be associated with increasing number of supply chain stages with sub-purchase prices.

Table 5 offers summary of VAT loss estimations as per each of the scenarios.

Table 5. Summary of estimated VAT loss as per scenarios for milk, eggs and poultry in 2019

Scenario	Milk, CZK billion	Eggs, CZK billion	Poultry, CZK billion	Total per scenario, CZK billion
1	-7.70	-0.84	-2.59	-11.14
2	-7.70	-0.43	-2.59	-10.73
3	-7.70	-0.84	-2.60	-11.13
4	-9.81	-0.84	-3.12	-13.77
5	-9.81	-0.84	-3.12	-13.77
6	-11.37	-1.14	-3.51	-16.02

Source: own calculations, alpha-level 5%.
Note: negative value means loss of VAT tax revenue for the state budget.

The topic of tax gap in terms of VAT is being addressed in several initiatives of European Union, for example in report of Center for Social and Economic Research (2018) .However, current estimation of VAT loss for state budget does not fit into the classification proposed by the authors of the mentioned report, therefore estimation in current paper represents additional source of VAT revenue for state budget.

According to the Ministry of Finance of Czech Republic, VAT revenues for state budget in 2019 totaled to 291.32 billion CZK, excluding excise duty on mineral oils and tobacco products (Ministry of Finance of the Czech Republic, 2020). Maximum estimated VAT loss of 16.02 billion CZK for all three commodities in scope of current research represents therefore 5.5% of all VAT revenues. Taking into consideration the assumption that only 25% of these commodities are being sold in terms of frequent price discounts, estimated gap in VAT revenues shows significant value for public finance. As an example, estimated total VAT loss for three commodities is more than tax revenues from real estate acquisition tax (13.87 billion CZK in 2019) and can be compared to excise duty on tobacco products (55.92 billion CZK in 2019) or mineral oils (84.03 billion CZK in 2019).

4. Conclusion

Estimation of VAT loss (or VAT tax gap) as per the proposed methodology has revealed additional source of tax revenue for the state budget of Czech Republic. Within the assumptions of current research, possible VAT loss is in the range of 10.73 – 16.02 billion CZK. Among the chosen commodities, milk has the highest value of VAT loss (7.7 - 11.37 billion CZK), while VAT loss is significantly lower in case of eggs (0.84 – 1.14 billion CZK). VAT loss has significant value, that can be compared with tax revenues from real estate acquisition tax and excise duties from tobacco products and mineral oils.

It has been shown, that increase in VAT loss is associated with number of supply chain stages where sub-purchase prices arise. Interestingly, marginal cost to the state budget decreases with number of supply chain stages with sub-purchase prices.

The precision of proposed estimated value of VAT loss can be further improved. Firstly, estimations are made within the assumption of zero price elasticity of demand, which is not necessarily true for milk, eggs and poultry. Therefore, consumer demand for these commodities might decrease with elimination of frequent price discounts, and actual VAT tax revenue for state budget might be lower in ideal case. Secondly, the quality of input parameters used in the estimation can be improved by involving information obtained from market participants, such as farmers, food processors and, to some extent, retailers.

Specific attention can be drawn to policies that might address closing of estimated tax gap in VAT. The source of estimated VAT tax gap is located in the current business environment of the country, therefore any state intervention into usual business practices might have negative externalities, such as shortage of goods or increased food spending for the most vulnerable social groups. For example, Kubicova et al. (2019) have identified price as second most important factor affecting demand for milk and dairy products, after quality, which should be carefully considered by regulators in order to avoid potential distortion of the market equilibrium. This fact might also be a subject to further research.

Generally, the extent to which frequent price discounts can affect different stakeholders, such as state budget, has been outlined by the current estimations. While there is a space for constructive critics connected with the methodology of estimation, importance of addressing such an economic phenomenon has been supported by the shown amount of possible VAT loss for three commodities.

Acknowledgements
This paper is a partial result of the research project No. 2019B0010 - Czech Social System Fraud Rate Estimation and System Optimization Proposals, supported by the Internal Grant Agency (IGA) of Faculty of Economics and Management, CULS Prague.

References

Bolton, R. N., Shankar, V. and Montoya, D. Y. (2006), “Recent Trends and Emerging Practices in Retailer Pricing”, in Krafft M., Mantrala M. K. (eds): *Retailing in the 21st Century: Current and Future Trends*. Springer Berlin Heidelberg, Heidelberg: pp. 255–269

Center for Social and Economic Research (2018). “*Study and Reports on the VAT Gap in the EU-28 Member States: 2018 Final Report”,* TAXUD/2015/CC/131. Available: https://ec.europa.eu/taxation_customs/sites/taxation/files/2018_vat_gap_report_en.pdf. [Accessed 15 Oct. 2019]

Cotterill, R. W. (1986), “Market power in the retail food industry: evidence from Vermont”, *Review of Economics and Statistics*, vol. 68, no. 3, pp. 379–386, ISSN 0034-6535, DOI 10.2307/1926014

Dekimpe, M. G. and Hanssens, D. M. (1999), “Sustained spending and persistent response: A new look at long-term marketing profitability”, *Journal of Marketing Research*, vol. 36, no. 4, pp. 397–412, ISSN 0022-2437, DOI 10.1177%2F002224379903600401

Digal, L. N. and Ahmadi-Esfahani, F. Z. (2002), “Market power analysis in the retail food industry: A survey of methods”, *The Australian Journal of Agricultural and Resource Economics*, vol. 46, no. 4, pp. 559–584, ISSN 1467-8489, DOI 10.1111/1467-8489.00193

Guiltinan, J. P. and Gundlach, G. T. (1996), “Aggressive and Predatory Pricing: A framework for analysis”, *Journal of Marketing*, vol. 60, no. 3, pp. 87–102, ISSN 0022-2429, DOI 10.1177%2F002224299606000306

Hawkes, C. (2009), “Sales promotions and food consumption”, *Nutrition Reviews*, vol. 67, no. 6, pp. 333–342, ISSN 0029-6643, DOI 10.1111/j.1753-4887.2009.00206.x

Kopalle, P. K, Mela, C. F. and Marsh, L. (1999), “The dynamic effect of discounting on sales: Empirical evidence and normative pricing implications”, *Marketing Science*, vol. 18, no. 3, pp. 317–332, ISSN 0732-2399, DOI 10.1287/mksc.18.3.317

Kubicová, Ľ., Predanocyová, K. and Kádeková, Z. (2019), “Factors Affecting the Demand for Milk and Dairy Products in the Slovak Republic", AGRIS on-line Papers in Economics and Informatics, vol. 11, no. 4, pp. 39-47, ISSN 1804-1930, DOI 10.7160/aol.2019.110404

Ministry of Finance of the Czech Republic, Výsledek hospodaření státního rozpočtu v roce 2019 je o 11,5 mld. lepší než očekávání, Prague, 2020, [Online], Available: https://www.mfcr.cz/cs/aktualne/tiskove-zpravy/2020/pokladni-plneni-sr-37026 [Accessed: 3 Jan. 2020]

Newmark, C. M. (1990), “A new test of the price-concentration relationship in grocery retailing”, *Economic Letters*, vol. 33, no. 4, pp. 369–373, ISSN 0165-1765, DOI 10.1016/0165-1765(90)90090-N

Nielsen, (2019), “Tisková konference Svazu obchodu a cestovního ruchu ČR a Nielsen”, Prague, [Online], Available: http://www.socr.cz/file/5332/TK_SOCR_%C4%8CR_a_Nielsen_prezentace_12062019_finaln%C3%AD.pdf [Accessed 15 Oct. 2019]

OECD (2014), “*Competition issues in the food chain industry*”, OECD Policy Roundtables, OECD, Paris: 1–489

Reardon, T., Timmer, C. P., Barrett, C. B. and Berdegué, J. (2003), “The rise of supermarkets in Africa, Asia and Latin America”, *American Journal of Agricultural Economics*, vol. 85, no. 5, pp. 1140-1146, ISSN 0002-9092, DOI 10.1111/j.0092-5853.2003.00520.x

van Heerde, H. J., Gusbrechts, E. and Pauwels, K. (2008), “Winners and Losers in a Major Price War”, *Journal of Marketing Research*, vol. 45, no. 5, pp. 499–518, ISSN 0022-2437, DOI 10.1509%2Fjmkr.45.5.499

van Heerde, H. J., Leeflang, P. S. H. and Wittink, D. R. (2000), “The estimation of pre- and postpromotion dips with store-level scanner data”, *Journal of Marketing Research,* vol. 37, no. 3, pp. 383–395, ISSN 0022-2437, DOI 10.1509%2Fjmkr.37.3.383.18782

van Heerde, H. J. and Neslin, S. A. (2008), “Sales Promotion Models”, In: Wierenga B. (ed): *Handbook of Marketing Decision Models*. New York: Springer Science and Business Media, New York: 107–162

Villas-Boas, S. B. (2007), “Vertical relationships between manufacturers and retailers: inferences with limited data”, *Review of Economic Studies*, vol. 74, no. 2, pp. 625–652, ISSN 0034-6527, DOI 10.1111/j.1467-937X.2007.00433.x

Wrigley, N. and Lowe, M. (2010): “*The Globalisation of Trade in Retail Services*”, Report commissioned by the OECD Trade Policy Linkages and Services Division for the OECD Experts Meeting on Distribution Services, Paris, [Online], Available: https://pdfs.semanticscholar.org/22f0/7614eed7b98db01ac51278baf9551beeb656.pdf?_ga=2.147680695.1268993636.1582475698-272671774.1582475698 (accessed Nov 2019)

INFORMATION AND COMMUNICATION TECHNOLOGIES IN BOSNIAN AGRICULTURE: POTENTIAL AND CHALLENGES

Vesna Mrdalj[1] and Hamid El Bilali[2]

[1] Department of Economics and Development, Faculty of Tropical AgriSciences, CULS Prague, Czech Republic
[2] International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM-Bari), Valenzano (Bari), Italy

[1]vesna.mrdalj@agro.unibl.org

Annotation: Today, almost all activities of modern agriculture imply the use of information and communication technologies (ICT). The paper reviews the main ICTs used in agriculture – with a particular reference to smart agriculture, digital agriculture and precision agriculture – and provides an overview on the adoption of ICT in Bosnia and Herzegovina's agriculture; both in terms of adoption level as well as factors that enable or hamper the adoption of these technologies. It draws upon a review of literature and semi-structured interviews with key informants. Although agriculture is considered one of the most socio-economically important sectors for Bosnia and Herzegovina, it faces different challenges such as underutilized resources and production potential, low productivity, low technical and technological level, underdeveloped agri-food value chains, low competitiveness of most products on the international market and a large import dependency. In order to modernize the domestic agribusiness sector, one way is to introduce new IC technological solutions into agricultural production. In Bosnia and Herzegovina, for most farmers as well as consumers, ICT is still a major novelty and unknown. The introduction of ICT in domestic agricultural production would favor transition towards sustainable agricultural production through increasing resource productivity, reducing management costs and inefficiencies, as well as improving the coordination of agri-food chains. Based on the overview, some recommendations – relating to policy, research and practice – are provided in terms of how to foster the use of ICT in Bosnian agriculture.

Key words: agriculture, ICT, Bosnia and Herzegovina, sustainable agriculture, smart agriculture, digital agriculture, precision agriculture.

JEL classification : N54, O33, Q01, Q16, Q56

1. Introduction

Nowadays, almost all economic activities imply the use of information and communication technologies (ICT). There are several definitions and interpretations of ICT. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2002) ICT is *"the combination of informatics technology with other, related technologies, specifically communication technology"*. Meanwhile, the Organization for Economic Co-operation and Development (OECD 2002) states the main function of ICT is to *"capture, transmit and display data and information electronically*". Another definition comes from the World Bank (2002) "*Information and Communication Technologies consist of hardware, software, networks and media for collection, storage, processing, transmission and presentation of information*".

Considering the fact that food system faces many *sustainability challenges* such as climate change, biodiversity loss, water scarcity, and food insecurity(Postel 2000; IAASTD 2009; Bruinsma 2011; Foley et al.2011; FAO 2014,2016), transition towards *sustainable solutions* has gained increasing importance. According to Markard et al. (2016) sustainability transitions can be defined as *"long-term, multi-dimensional, and fundamental transformation processes* *through which established socio-technical systems shift to more sustainable modes of production and consumption"* (p. 956). Spaargaren et al. (2013) state that food sustainability transitions refer to structural changes that give rise to new production and consumption modes and practices that are more sustainable. Allahyari (2009) pointed out that knowledge and related information, skills, technologies, and attitudes will play a key role in sustainable agriculture. Furthermore, Bello and Aderbigbe (2014) and Singh et al. (2014) claimed that moving towards sustainability in agriculture and food systems call for innovative solutions and appropriate technologies such as ICT.

Generally, IC technological solutions may be considered as one approach to accelerate the food sustainability transition.

Bosnia and Herzegovina (BiH) is a country in transition process, which has also affected the agriculture sector. Agriculture has economic and social importance. High share of agriculture in gross domestic product (GDP), high employment rate and deficit in foreign trade are considered the main features of the sector's importance to the economic development of BiH. The country is administratively divided into two entities (Federation of Bosnia and Herzegovina and Republic of Srpska) and one district (Brcko). In terms of legal and institutional framework, according to the Constitution, agriculture and rural development is managed by relevant entity ministries for agriculture, forestry and water management. Entity ministries and district are responsible for the design and implementation of agricultural policies.

Agriculture in BiH faces many challenges such as underutilized resources and production potential, low productivity, low technical and technological level, underdeveloped agri-food value chains, low competitiveness of most products on the international market and a large import dependency (Volk et al., 2017).

In order to restructure and modernize the domestic agribusiness sector, one way is to introduce innovative solutions and technologies such as ICT. The introduction of ICT in domestic agricultural production would favour transition towards sustainable agriculture through increasing resource productivity, reducing management costs and inefficiencies, as well as improving the coordination of agri-food chains (El Bilali and Allahyari, 2018).

Based on all abovementioned, the present paper reviews the use of ICT in agricultural sector in Bosnia and Herzegovina. Section 3 (Results and Discussion) is structured as follows: subsection 3.1 reviews the main ICTs used in agriculture worldwide with a particular reference to precision agriculture, smart farming and digital agriculture; subsection 3.2 describes the situation of agriculture in BiH, points out the socio-economic relevance of the sector as well as the challenges that it faces, and reviews references to ICT in the agricultural policy at state and entity levels; subsection 3.3 provides an overview on the attempts to adopt ICT in Bosnian agriculture and highlights factors that affect the adoption of these technologies. Based on the overview, some recommendations on how to foster the use ICT in Bosnia and Herzegovina's agriculture are provided in conclusions.

2. Materials and Methods

The paper draws upon secondary data from a review of the scholarly and grey literature, and primary data from semi-structured interviews with key informants.

A review of scholarly literature on ICT use in Bosnian agriculture was carried out on all databases of Clarivate Analytics - Web of Science (viz. Web of Science Core Collection, Current Contents Connect, KCI-Korean Journal Database, MEDLINE®, Russian Science Citation Index, SciELO Citation Index). The search was performed on 13 March 2020 using the following query: *(Bosnia OR Balkan) AND (agri* or farming or food) AND ("information and communication technology" OR "information technology" OR "communication technology" OR "smart farming" OR "smart agriculture" OR "digital farming" OR "digital agriculture" OR "precision farming" OR "precision agriculture")*. The search yielded only 7 documents; following the scrutiny of titles and abstracts, 6 documents were excluded (Gagic, 2013; Glibetic et al., 2011; Gurinovic et al., 2010, 2016, 2018; Vasa et al., 2018) and only one (Arapovic and Karkin, 2015) resulted eligible. This outcome is a clear indicator of the huge gap regarding research on ICT use in agriculture in Bosnia and the Balkans at large. Therefore, different combinations of the above-mentioned keywords were used to carry out searches in grey literature on Google Scholar.

Semi-structured interviews, informed by a previously prepared interview guide, were carried out by e–mail and phone with key informants (i.e. representatives of entity ministries, state and entity agencies) in the period February–April 2020. Questions addressed *strategic goals* in programing documents of agricultural and rural development at state and entity level related to the development and/or improvement of the *sub-components of information system* in agriculture; *sub-components* of information system that already exist (i.e. developed at state and entity level); *sub-components* of information system used for the analysis and design of entity agricultural policies (i.e. measures for support to agricultural and rural development); *jurisdiction and responsibility* in the development and keeping of registers (viz., farm, phytosanitary, animal identification registers); *application of ICT* at agricultural holdings level; *obstacles* regarding the introduction of ICT in agriculture (e.g. financial resources); *participation* of entity ministries in *domestic and international projects* aimed at promoting and the adoption of ICT in agriculture.

3. Results and Discussion

3.1. ICT use in agriculture

Nowadays, different ICTs are used in agriculture (Lehmann, Reiche and Schiefer, 2012; FAO and ITU, 2016; World Bank, 2017; El Bilali and Allahyari, 2018; El Bilali *et al.*, 2020). These range from traditional communication aids (e.g. radios, telephones, televisions) to computers, internet and mobile applications, Cloud computing, Big Data analytics and information systems, Internet of Things (IoT) and Internet of Services (IoS), remote sensing using geographic information systems (GIS), and block chain (World Bank, 2011, 2017; FAO and ITU, 2019). Among the prominent ICTs that are increasingly used in agriculture can be enumerated GIS, wireless technologies, Global Positioning System (GPS), computer-controlled devices and automated systems (e.g. milking stations), RFID (Radio-frequency identification) and smartphone mobile apps. While ICTs were traditionally used, in developing and developed countries like, in the transfer of information to farmers (cf. extension and advisory services)

(UN-ESCAP, 2008; Lehmann, Reiche and Schiefer, 2012; Bello and Aderbigbe, 2014; Sylvester, 2015), the recent developments in the field have opened new avenues for the digitalisation of agriculture and food sector. Indeed, various terms are used nowadays to refer to ICT application in agriculture (El Bilali et al., 2020) such as e-agriculture (Kolshus et al., 2015; FAO, IFPRI and OECD, 2017), digital agriculture (CEMA-Agri, 2017; DLG, 2018), precision agriculture (McBratney *et al.*, 2005; Allahyari, Mohammadzadeh and Nastis, 2016; Magnin, 2016; Schrijver, Poppe and Daheim, 2016; Balafoutis *et al.*, 2017) and smart agriculture (Smart AKIS, 2016; AgroCares, 2019).

Smart farming is about the use of modern ICTs to optimise complex farm and farming systems (Smart AKIS, 2016; AgroCares, 2019). The application of ICTs in agriculture is leading to a revolution in agriculture viz. 'Third Green Revolution' (Smart AKIS, 2016), following revolutions in plant breeding and genetics, or 'fourth revolution' (Walter et al., 2017), after plants/animals domestication, crop rotation systematic use, and 'Green Revolution'. The focus of smart farming is on access to and smart use of data rather than on precision in farming operations (cf. precision agriculture). Indeed, smart agriculture implies the application of a wide array of ICTs (e.g. mobile devices such as smart phones and tablets) to have access to real-time farm information and data (e.g. soil moisture, crop growth stage, weather forecast, animal health, etc.) thus allowing producers to make timely, informed decisions (AgroCares, 2019). It involves the combined application of different ICT solutions such as the IoT, Big Data, GPS, precision equipment and devices (e.g. sprayers), sensors, robotics and artificial intelligence (AI), unmanned aerial vehicles/drones, etc. Smart farming is, therefore, connected to three different, yet interrelated, technology fields viz. precision agriculture, management information systems, robotics and agricultural automation (Smart AKIS, 2016). In the context of smart farming, the IoT technologies play a pivotal role as they serve as interface between the operator/farmer, on the one hand, and sensors and machines, on the other hand. The incorporation of IoT connectivity, GPS and cameras makes possible the remote operation and monitoring of robotic tractors, machines (e.g. seeding machines) and drones. Drones are used in smart farming both to collect data (e.g. crop health), that put the farmer in the position of making informed decisions, as well as to perform different operations (e.g. spraying). Meanwhile, the main function of sensors is to collect data on different parameters (e.g. weather, soil moisture, air quality, light conditions, irrigation water amount). Simply put, pulling together drones and sensors is what makes the IoT i.e. a network of physical devices (cf. things) that are judiciously equipped with electrical connectivity (cf. internet) in such a way to enable the collection, processing (e.g. aggregation) and exchange of data. Indeed, the IoT use allows a better and more operational integration between the physical world and electronic systems (Smart AKIS, 2016).

Precision agriculture (Allahyari et al., 2016; Balafoutis et al., 2017; Ess & Morgan, 2003; McBratney et al., 2005) relies on the application of sensors for optimizing the use of resources and inputs (e.g. pesticides, fertilizers, irrigation water) (Mintert et al., 2016). The advent of precision agriculture (PA) dates back to 1980s when producers started to have economical access to GPS technologies. Modern precision farming consists in combining sensors, satellite navigation and GPS technology, and IoT (Schrijver et al., 2016). Magnin (2016) argues that precision farming is shaped by trends in different fields such as Big-data, advanced-analytics, robotics, aerial imagery, sensors, sophisticated weather forecasts. The wide deployment of modern ICT devices, such as smartphones as well as IoT systems, determined a quick adoption of PA solutions in many countries such as China and Japan. These so-called

‘AgInformatics’ have been heavily invested in by multinationals such as Monsanto, Dow AgroSciences and Deere Co, and applied, inter alia, in fields mapping, equipment maintenance and other farming operational activities (Berti and Mulligan, 2015). In fact, modern precision agriculture technologies (PATs) comprise machine guidance (e.g. driver assistance, auto-guidance), variable rate technologies (VRTs for different operations such as planting/seeding, irrigation, pesticide application, nutrient application), controlled traffic farming (i.e. a system confining to permanent traffic lanes all machinery load thus reducing soil compaction and land degradation), precision physical weeding technology (Balafoutis *et al.*, 2017). In VRTs, sensor data make it possible to tailor inputs amounts to crop needs and to take into account differences in fields/plots (e.g. soil heterogeneity and soil fertility gradients) instead of the application of the same input amount to the whole treated area (Balafoutis *et al.*, 2017). There are nowadays different applications used in precision crop farming for, among others, precision irrigation, crop scouting (cf. pest management), yield forecasting/monitoring, variable rate fertilisation, and recordkeeping. However, a large share of the market is devoted to precision irrigation technologies (BIS Research, 2018). Precision agriculture technologies are nowadays not only present in all crop production stages, and even the whole food food chain (viz. production, processing, distribution/retail, consumption) (El Bilali and Allahyari, 2018), but also increasingly used in livestock production (Banhazi et al., 2012; FAO et al., 2017). For example, virtual fence technology relies on the use of remote-sensing signals and sensors to manage large cattle herds (Umstatter, 2011). Furthermore, it is expected that autonomous milking robots will foster the growth of smart farming solutions in the livestock sector (BIS Research, 2018).

Digital farming is based on the integration of smart farming and precision agriculture concepts and technologies. Its focus is on creating meaningful value-added from collected data and actionable intelligence (CEMA-Agri, 2017). Digital farming relies on the consistent, harmonious combination of smart farming and precision agriculture methods, the use of Big Data alongside high-performing web-based data platforms, and the networking of the farm within its digital ecosystem (DLG, 2018). Examples of existing data exchange platforms include Farm Mobile, Fieldscripts, Agriplace, Farm Business Network, and FIspace (Poppe, 2016).

3.2. Agriculture in Bosnia and Herzegovina

The agricultural sector presents an important component of Bosnia and Herzegovina’s economy. The contribution of agriculture to Bosnia and Herzegovina's economy development is reflected through the high share of the sector in GDP, the high level of persons in employment and the deficit in foreign trade. During the period 2006 – 2016, the agriculture's share in GDP was 7% on average. The contribution of the agricultural sector to total employments in the period 2016 - 2018 was 18% on average. Bosnia and Herzegovina is considered as a net importer of agricultural products. For example in the period 2014 - 2017, agri-food import value of Bosnia and Herzegovina's ranged between 2.752 and 3.125 billion BiH convertible marks[10] and exports from 649 million BAM to 1.009 billion BAM (Mrdalj et al., 2019). In Bosnia and Herzegovina, agriculture does not have only economic importance, but also social and environmental one. About 81% of Bosnia and Herzegovina’s territory is rural with an estimated 61% of population in relation to total number of inhabitants. Agriculture

[10] International code BAM; 1 EUR = 1.95583 BAM.

is central to rural communities in Bosnia and Herzegovina (National Human Development Report, 2013). Although agriculture is considered one of the most socio-economically important sectors for Bosnia and Herzegovina and the fact that country has great potentials for agricultural development that are reflected in favorable agro-climatic conditions, cultivation of a large number of different agricultural crops (e.g. cereals, vegetables, fruits, milk, meat), quality agricultural land, it still faces different challenges such as underutilized resources and production potential, low productivity, low technical and technological level, underdeveloped agro-food value chains, low competitiveness of most products on the international market and a large import dependency. Over the last years, a big challenge for Bosnia and Herzegovina's agriculture has been climate change, leading to frequent droughts and floods.

In terms of legal framework, according to the Constitution of Bosnia and Herzegovina, the design and implementation of agricultural policy is at entity level; the Federation of Bosnia and Herzegovina (FBH) and the Republic of Srpska (RS). At the entity level, the Federal Ministry of Agriculture, Water Management and Forestry and the Ministry of Agriculture, Forestry and Water Management of Republic Srpska are in charge of the formulation and implementation of agricultural policy, as well as the Department for Agriculture, Forestry and Water Management in Brcko District (BD). In the Federation of Bosnia and Herzegovina, apart from entity level, there is the structure for agricultural policy at canton level (10 cantons). In both entities, there are certain forms of support to the development of agriculture and rural areas provided by municipalities. The Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina is at state level competent for foreign trade and custom policy, as well as for performing tasks and duties within the jurisdiction of Bosnia and Herzegovina related to defining policies and basic principles, coordinating activities and consolidating entity plans with those of international institutions in the area of agriculture. As already stated, each administrative unit (entities and district Brcko) in Bosnia and Herzegovina is responsible of creating, adopting and implementing its own agricultural policy, i.e. strategic documents for agriculture and rural development. In Bosnia and Herzegovina, between 2013 and 2015, new strategic documents for agriculture and rural development were adopted, covering the periods up to 2019 and 2020; these include the Mid-term development strategy for agricultural sector in the Federation of Bosnia and Herzegovina 2015-2019 (2014), the Program for rural development of the Federation of Bosnia and Herzegovina 2015 - 2020 (2014), the Strategic plan for the development of agriculture and rural areas in the Republic of Srpska 2015 - 2020 (2015) and the Strategic plan for rural development of Bosnia and Herzegovina 2018 - 2021 (2018) (Volk et al., 2019).

The Mid-term development strategy for agricultural sector in the Federation of Bosnia and Herzegovina 2015-2019 (2014) emphasized the need to adopt new technologies and innovation in the agriculture sector, more effective utilisation of available resources and the improvement of quality of life in rural areas. Regarding the European integration, this document clearly states the need to harmonize the institutional and legal framework of the FBH with the EU legislation (i.e. *acquis communautaire*) and the Common Agricultural Policy (CAP). In the context of institutional building, this means putting in place a *modern information system*, administrative management and monitoring of agricultural policies (Volk et al., 2017). The Strategic plan for the development of agriculture and rural areas in the Republic of Srpska (2015-2020) contains six strategic goals related to increasing of productivity, higher marketability of agricultural products, improving vertical and horizontal integration of the agricultural sector, higher competitiveness, sustainable management of natural resources and mitigation of climate changes, and balanced rural integrated development. Also one of the strategic goals *is the systematic support* for agriculture and rural development. The systematic support for the development of agriculture and rural sector is focused, among other activities, on establishing information's *system in agriculture*, which implies the improvement and/or development of:

- Farm Register (systematic monitoring of the state of agriculture sector and control payments to support agriculture);
- Animal Identification Register (creation of basis for new way for payments to support livestock production and preconditions for milk and dairy products export, animal health protection);
- Farm Accountancy Data Network (FADN) (creation of basis for collecting data for decision making by agricultural policy makers, as well as for decision making at farm level by farmers);
- Agricultural Market Information Service (AMIS) (increasing the degree of marketability and achieving better purchase and sale prices of agricultural products);
- Phytosanitary register (monitoring and control of seed production, as well as entities involved in production, purchase and storage of potato and other plants),
- Land Parcel Identification System (LPIS) (digitizing of agricultural land data and creation of preconditions for allocation of EU funds) and
- Agriculture Forecast-Reporting System (AFRS) (improving of monitoring and movement of harmful organisms and plant diseases with regard to reducing the number of treatments and chemical protection).

The Strategic plan for rural development of Bosnia and Herzegovina 2018 - 2021 (2018) defined six strategic areas of support, whereby last area is related to the improvement of institutional capacities and harmonization of legal framework in agriculture and rural development at all levels of government in accordance with constitutional competences in direction to approximation to the CAP. Within this strategic goal, one activity is creating an information base for programming and monitoring of agricultural policies, as well as establishing an *agricultural information system*, which implies agricultural census and further improvement of Farm Register and Client Register, Animal Identification Register, FADN, AFRS and establishing of AMIS and LPIS in accordance with constitutional jurisdiction.

Reviewing strategic documents for agriculture and rural development, it is obvious the commitment of all government levels in Bosnia and Herzegovina to the systematic support of the sector, including all activities related to establishing *agricultural information system sub-components,* leading to the creation of an environment for the support to the development of the sector as whole. On the other side, Bosnia and Herzegovina signed the Stabilization and Association Agreement with the European Union (SAA) and in accordance with it the country has an obligation to ensure harmonization of *agricultural information system sub-components* and to enable automated delivery of data. Some of the mentioned *sub-components of the agricultural information system* in Bosnia and Herzegovina are established and are in the phase of continuous improvement.

3.3. Adoption of ICT in agriculture in Bosnia and Herzegovina

As already stated, some *sub-components of the agricultural information system* in Bosnia and Herzegovina such as farm register, animal identification register, phytosanitary register are established. Farm Register in Bosnia and Herzegovina is decentralized, i.e. each entity is responsible for own Farm Register, but both use the same application. Within the Veterinary Office of Bosnia and Herzegovina operates the Agency for Animal Identification as an operative body that is responsible for animal identification and movement control system (AIMCS) as well as for registration all farms, slaughterhouses and cattle markets, including the newly formed state database (SDB). Regarding the animal identification register, the entity competent ministries (Regional office for data collection in the Republic Srpska) collect and provide data to the Agency for Animal Identification. For several years, negotiations have been going between relevant stakeholders in this area (entity ministries and Veterinary office at BiH level) related to decentralization, i.e. establishing entity animal identification register and management with own data. On BiH level, the phytosanitary register is established and led by the Administration of Bosnia and Herzegovina for Plant Health Protection, an administrative organization within the Ministry for Foreign Trade and Economic Relations of Bosnia and Herzegovina (MoFTER). Entities in Bosnia and Herzegovina are responsible for phytosanitary register keeping, using the same application like at BiH level. Introduction of FADN in Bosnia and Herzegovina is a results of the project *"Strengthening and Harmonization of Information systems in agricultural and rural sector of Bosnia and Herzegovina",* funded by the European Union and that started in July 2010. In addition to MoFTER, the project was implemented through the following institutions: 1) entity ministries of agriculture, 2) statistical agencies in both entities, and 3) departments for advisory services in entities. The departments for advisory services had the task to collect data from agricultural holdings. In the first year of the project, there was plan to collect data from 120 agricultural holdings (60 in FBiH and 60 in RS). The project of introduction of FADN on agricultural holdings in FBiH was active in the period 2010 - 2011. After one year from the project start (i.e. in 2011) all activities with FADN were stopped because of a lack of financial funds, which could guarantee the sustainability of FADN keeping. Conversely to FBiH, the FADN is still active in the Republic of Srpka, i.e. activity of FADN records are supported by the entity ministry for agriculture and currently 64 agricultural holdings are in FADN system. Like at the beginning of the project, the Department for advisory services by the Ministry of Agriculture, Forestry and Water Management is responsible for data collecting from agricultural holdings.

In Bosnia and Herzegovina, the establishment and development of AMIS requests significance financial funds and one of possibility are EU funds. Referring to the impact of the introduction of the Agricultural Market Information System (AMIS) in BiH, Arapovic and Karkin (2015) argue that "*ICT may have a significant role in tackling information asymmetry and consequently promote market integration*" (p. 56). The implementaion of Adaptation Protocol of the SAA between Bosnia and Herzegovina and European Union started in 2017. The World Bank has accepted the obligation to assess the impact of SAA, and the approach to analysis presented by the World Bank team included three phases of analysis: 1) income analysis of changes in trade regime at the level of agricultural holdings and sector level; 2) analysis of gaps and cost estimation of compliance with EU food safety standards; 3) impact of investments in agricultural and rural development on employment, production and value added in agriculture (World Bank, 2017a). The final report of the analysis contains only an assessment of the possible effects of implementation of the adapted SAA on foreign trade balance and production. Based on the analysis, the World Bank pointed out to several key messages. In respect to improving the competitiveness of the agri-food sector in Bosnia and Herzegovina in transforming environment, one of the key areas is "*investments in an integrated information system for decision making, where both compliance mechanisms (food safety measures, registers) to EU accession and other information (prices of important products, weather data, extension services, etc.), can build resilience and improve capacity to respond to trade and climate pressure on small producers, hence making them more competitive in a rapidly changing agro–ecological and socio–politic environment"* (p. 2).

At the level of the entity of the Federation Bosnia and Herzegovina, the Ministry of Agriculture, Water Management and Forestry is responsible for improvement of farm and client register, keeping of phytosanitary register, collecting and providing data to the Agency for animal identification, LPIS and FADN[11]. The *sub-component* of the information system LPIS is not yet established, while establishing and implementation of FADN, as already mentioned, was not successful. In 2016, *Software* and *Farmer Web Portal* have been developed. The *Software* has a goal to ensure transparency and efficiency by data processing related to financial support to agriculture development. The *Farmer Web Portal* is an application designed to assist farmers for the exercise of the right on financial support in agriculture and rural development[12].

At the level of the entity of the Republic of Srpska, the Ministry of Agriculture, Forestry and Water Management is responsible for improvement of Farm Register, keeping of phytosanitary register, collecting and providing data to the Agency for animal identification and FADN. Currently, the Ministry of Agriculture, Forestry and Water Management is in the phase of developing the Veterinary Information System as a unified system of registers, records and databases aimed to provide an efficient access and management of data in order to protect health and animal welfare. Like in the Federation of Bosnia and Herzegovina, LPIS is not established yet. Regarding to AMIS, there intention by the competent ministry for establishing this system. Overall, the investments in these *sub-components* (AMIS) require significant financial funds and one option to overcome that are EU funds.

The Department for Advisory Services in Agriculture by the Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska leads two important projects related to the adoption of ICT in agriculture in RS entity; (1) Introduction and Using of *etFarm Software* and, (2) Setting up of Agro-meteorological Stations in order to Establishing of Primary Measuring Network. The first project – Introduction and using of *etFarm Software* started in January 2020. It is a Software that enables the use and analysis of satellite products for the purpose of detecting the type of crops on agricultural land as well as determining the health state of crop in order to optimize agro-technical measures. The first activity in using this software was the marking of plots that will serve as the basis for the model that detects the crops. *etFarm Software* operates on the principle of collecting visual and radar satellite images by which plant indices are calculated for each plot at spatial resolution of 10 m. The software allows the competent Ministry to easily determine the eligibility of agricultural producers for applying for government financial support, but also, for the first time, provides clear picture on on the area that is under certain crops. In the future, the plan of the Ministry

[11] https://fmpvs.gov.ba/

[12] https://www.farmerportal.ba/#/

of Agriculture, Forestry and Water Management of the Republic of Srpska is to extend the use of *Software* to agricultural producers.

Since 2016, the Department for Advisory Services in Agriculture by the Ministry for Agriculture, Forestry and Water Management has started activities to set up agro-meteorological stations on the territory of the Republic of Srpska in order to establish the primary measuring network. After the installation of the agro-meteorological stations, the Ministry, through a project supported by UNDP in Bosnia and Herzegovina and Dutch Government, started developing *CARPO Software* that allows the integration of different types of stations (besides those owned by Ministry), into the system that will used free of charge. In addition to collecting data from the agro-meteorological stations, *CARPO Software* also collects the weather forecast data, and based on it calculates the potential risks of disease and pests. The aim of the CARPO system is to create conditions for the prognosis and prevention of crop damage and sustainable use of the pesticides. Although the project was completed in 2018, Department for Advisory Services is still actively working to maintain and improve *CARPO Software*. Currently, 48 stations are integrated into the system and 5 models for the most important crop diseases were implemented. As a part of CARPO project, a *mobile application* was created for agricultural producers. Indeed, agricultural producers can download this application from Google Play Store and starting from March 2020 they receive free expert recommendations from the reporting and forecasting service.

Aldosari et al. (2017) revealed in their research study that most of the respondents agreed that mobile phones and the internet can be useful sources of agricultural information and only 1.6 and 5.5% of the respondents, respectively, strongly disagreed about the reliability of these information sources. Moreover, Brezinščak and Mesić (2018) provided an overview of software applications created in Croatia, used mostly in Croatian language, divided into different groups of agriculture related applications: agriculture management information apps; agriculture information resource apps; agriculture calculator apps; agriculture news apps and agriculture weather apps. However, the analyzed literature suggests that the adoption of ICT tools is higher in Croatia than in BiH.

In terms of how many agricultural producers use these services, it is sure not enough, which is understandable, since the systems are completely new and no serious promotion has been done. *etFarm Software* started in 2020 and in this year it will not be probably widely used by agricultural producers, but it was adopted by the Ministry staff. So far, there are 250 registered users of *CARPO Software*, which is certainly not enough, but the Department was able only in 2020 to start sending recommendations to agricultural producers, which, on the other side, allowed many producers to learn more about this software.

Ilić-Kosanović et al. (2019) examined the perception of small farmers in Serbia regarding organic production and ICT use in relation to their level of education. The study included 143 farmers from Raška district and results showed a statistically significant effect of the level of education on the perception of small farmers on the use of ICT, i.e. main difference in perception exists between farmers with elementary education and those with high education (e.g. high school).

Drones, as component of smart farming, are used both to collect data that put the farmer in the position of making informed decisions, as well as to perform different operations. The Department for Advisory Services in Agriculture currently owns one *drone*. In 2019, it acquired *multispectral camera* that provide the capture of crops in plots. The current situation with COVID 19 has hindered the first test shots of crops. In 2020, several smaller web solutions are developed with the aim to support the Ministry staff by providing services for the Farm Accountancy Data Network (FADN) and monitoring of IFAD project[13] users.

The importance of the adoption ICT in agriculture is also recognized by the academic community in Bosnia and Herzegovina. In support of this there is one of currently projects *VIRAL* (*Vitalising ICT Relevance in Agricultural Learning*), co-funded by the Erasmus + Programme of the European Union. The project should contribute to the development of robotics, programming, mobile applications and using of drones in agriculture.

Based on the overview on the adoption of ICT in agriculture in BiH, it can be argued that the main factor of success and challenge in making ICTs available and accessible for farmers and rural communities is *capacity development*, i.e. ability to effectively use technologies and information at institutional level and *provision of ICT projects and initiatives* by institutions and academia. Access to and adoption of ICT content by farmers is still on unsatisfactory level and demands more efforts in promotion and education as well as the inclusion of farmers in ICTs projects and initiatives. Large investments are needed to ensure the introduction of new technologies in order to modernize and increase the competitiveness of agriculture. The lack of financial funds hampers the adoption of these technologies in practice.

4. Conclusion

Bosnia and Herzegovina is a transition economy faced with different challenges that also affect the agriculture sector such as underutilized resources and production potential, low productivity, low technical and technological level, underdeveloped agri-food value chains, low competitiveness on the international market and a large import dependency. Overcoming these challenges requires moving towards sustainability solutions in agriculture. One of possible ways to bring about such a sustainability transition is the adoption of information and communication technologies (ICT). Agricultural policies at all government levels support the establishment and development of information system in agriculture in order to build information bases and to fulfill necessary obligations in the context of the EU integration process. Indeed, strategic and program documents related to agriculture and rural development highlight the establishment and development of an information system in agriculture with different subcomponents (viz. Farm Register, Animal Identification Register, FADN, AMIS, Phytosanitary Register, Land Parcel Identification System, Agriculture Forecast-Reporting System). Furthermore, competent agricultural ministries at entity level started with ICT projects and initiatives in order to assist farmers in agricultural production. Nevertheless, ICT is still a novelty among Bosnian farmers and agri-food chain actors, and the adoption level is largely unsatisfactory. Therefore, in order to maximize the benefits of ICT and foster the adoption of these technologies in agriculture, it is necessary to provide more actions by institutions, academia and research communities to develop innovative and sustainable ICT infrastructure.

---

[13] The Republic of Srpska has received a loan from the International Fund for Agricultural Development (IFAD) toward the cost of the Rural Competitiveness Development Project. The programme development objective is to enable smallholders and other poor rural groups to take advantage of fruits, vegetable, non-timber forest products and other potential subsector development for the sustainable improvement of their social and economic conditions.

References

Agency for Statistics of Bosnia and Herzegovina (2018). *Gross Domestic Product by Production, Income and Expenditure Approach.* Sarajevo. Available at: http://www.bhas.ba/tematskibilteni/TB%20BDP%202016_BS_www.pdf

Agency for Statistics of Bosnia and Herzegovina (2018). *Labour Force Survey 2018. Sarajevo.* Available at: http://www.bhas.ba/tematskibilteni/LAB_00_2018_Y1_0_BS.pdf

AgroCares (2019), "*What is the difference between precision, digital and smart farming?",* Available at: https://www.agrocares.com/en/news/precision-digital-smart-farming (Accessed: 29 June 2019)

Allahyari M.S. (2009), "Agricultural sustainability: *Implications for extension systems". African J Agric Res* 4:781–786

Allahyari, M. S., Mohammadzadeh, M. and Nastis, S. A. (2016), "Agricultural experts' attitude towards precision agriculture: Evidence from Guilan Agricultural Organization, Northern Iran", *Information Processing in Agriculture*, 3(3), pp. 183–189. doi: 10.1016/j.inpa.2016.07.001

Aldosari, F., Al Shunaifi, M.S., Ullah, M.A., Muddassir, M., Noor M.A. (2017), "Farmer's perception regarding the use of Information and Communication Technology (ICT) in Khyber Pakhtunkhwa", Northern Pakistan. *Journal of the Saudi Society of Agricultral Sciences* 18(2), 211 -217. DOI 10.1016/j.jssas.2017.05.004

Arapovic, A. O. and Karkin, Z. (2015), "The Impact of Agricultural Market Information System in Bosnia & Herzegovina on Market Integration: Assymetric Information and Market Performance", *Khazar Journal of Humanities and Social Sciences*, 18(1), pp. 56-67. DOI 10.5782/2223-2621.2014.18.1.56

Balafoutis, A. *et al.* (2017), "Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics", *Sustainability*, 9(8), p. 1339. DOI 10.3390/su9081339

Banhazi, T. M. *et al.* (2012), "Precision livestock farming: Precision feeding technologies and sustainable livestock production", *International Journal of Agricultural and Biological Engineering*, 5(4), pp. 1–8. DOI 10.3965/j.ijabe.20120504.006

Bello, O. A. and Aderbigbe, F. (2014), "ICT in Agricultural Sustainability and Food Security", *International Journal of Emerging Technology and Advanced Engineering*, 4(3), pp. 508–513

Berti, G. and Mulligan, C. (2015), "*ICT & the future of food and Agriculture"*. Ericsson, Stockholm

Bruinsma J. (2011), "*Looking ahead in world food and agriculture: Perspectives to 2050*". FAO, Rome

Brezinščak, L. and Mesić, M. (2018), "Review of software applications for agricultural production in Croatia", *Agronomski glasnik, 80* (2), 129-142. DOI 10.33128/ag.80.2.5

El Bilali H. and Allahyari M.S. (2018), "Transition towards sustainability in agriculture and food systems: Role of information and communication technologies", *Information Processing in Agriculture*, 5(4), pp. 456–464. DOI 10.1016/j.inpa.2018.06.006

El Bilali, H. *et al.* (2020), "Information and Communication Technologies for Smart and Sustainable Agriculture", Brka, M. et al. (eds) *Answers for Forthcoming Challenges* *in Modern Agriculture*. Cham (Switzerland): Springer, pp. 321–334. DOI 10.1007/978-3-030-40049-1_41

El Bilali, H. and Allahyari, M. S. (2018), "Transition towards sustainability in agriculture and food systems: Role of information and communication technologies", *Information Processing in Agriculture*, 5(4), pp. 456–464. DOI 10.1016/j.inpa.2018.06.006

BIS Research (2018), "*Global Smart Farming Market"*. Basel, Switzerland

CEMA-Agri (2017), "*Digital Farming: what does it really mean?*", Brussels. Available at: http://www.cema-agri.org/images/publications/position-papers/CEMA_Digital_Farming_-_Agriculture_4.0__13_02_2017_0.pdf

DLG (2018), "*Digital Agriculture – Opportunities, risks, acceptance*", German Agricultural Society (DLG e.V), Frankfurt am Main. Available at: https://www.smart-akis.com/wp-content/uploads/2018/03/Folder_Position_Digitalisierung_e_IT.pdf

Ess, D. R. and Morgan, M. T. (2003), "*The precision farming guide for agriculturalists*", Third Edit. Moline, IL (USA): Deere and Company

FAO (2014), "*Building a common vision for sustainable food and agriculture - Principles and Approaches",* Rome

FAO (2016), "*The State of Food and Agriculture - Climate Change, Agriculture and Food Security*", Rome

FAO, IFPRI and OECD (2017), "*Information and Communication Technology (ICT) in Agriculture - A Report to the G20 Agricultural Deputies*", Rome. Available at: http://www.fao.org/3/a-i7961e.pdf

FAO and ITU (2016), "*E-Agriculture Strategy Guide - Piloted in Asia-Pacific countries*", Bangkok. Available at: http://www.fao.org/3/i5564e/I5564E.pdf

FAO and ITU (2019), "*E-agriculture in action: Blockchain for agriculture - Opportunities and challenges*", Bangkok

Foley JA, Ramankutty N, Brauman KA, et al (2011), "Solutions for a cultivated planet", *Nature* 478:337–342. DOI 10.1038/nature10452

Gagic N. (2013), "*Unused Potentials of Electronic Business for the Increase of Sales of Agricultural Mechanization*", In Kosutic, S. (Ed.), Proceedings of the 41st International Symposium on Agricultural Engineering, Feb. 19-22, 2013, Opatija (Croatia). University of Zagreb, Zagreb (Croatia). pp. 13-23

Glibetic M., Kadvan A., Tepsic J., Martacic J.D., Djekic-Ivankovic M. and Gurinovic M. (2011), "Management of food composition database harmonized with EuroFIR criteria using a web application", *Journal of Food Composition and Analysis*, 24(4-5), pp. 741-743. DOI 10.1016/j.jfca.2010.09.002

Gurinovic M., Kadvan A., Bucchini L., Matthys C., Torres D., Novakovic R., Smiths R. and Glibetic M. (2010), "EURRECA nutritional planning and dietary assessment software tool: NutPlan", *European Journal of Clinical Nutrition*, 64, pp. S38-S42. DOI 10.1038/ejcn.2010.59

Gurinovic M., Milesevic J., Kadvan A., Nikolic M., Zekovic M., Djekic-Ivankovic M., Dupouy E., Finglas P. and Glibetic M. (2018), "Development, features and application of DIET ASSESS & PLAN (DAP) software in supporting public health nutrition research in Central Eastern

European Countries (CEEC)", *Food Chemistry*, 238, pp. 186-194. DOI 10.1016/j.foodchem.2016.09.114

Gurinovic M., Milesevic J., Novakovic R., Kadvan A., Djekic-Ivankovic M., Satalic Z., Korosec M., Spiroski I., Ranic M., Dupouy E., Oshaug A., Finglas P. and Glibetic M. (2016), "Improving nutrition surveillance and public health research in Central and Eastern Europe/Balkan Countries using the Balkan Food Platform and dietary tools", *Food Chemistry*, 193, pp. 173-180. DOI 10.1016/j.foodchem.2015.03.103

IAASTD (2009), "*Agriculture at a Crossroads*". International Assessment of Agricultural Knowledge, Science and Technology for Development. Global Report. Washington, DC

Ilić-Kosanović T., Pažun B., Langović Z., Tomić S (2019), "Perception of small farmers in Serbia regarding the use of ICT and possibilities of organic agricultue", *Ecnomics of Agriculture,* 66(4), pp. 989- 1001. DOI 10.5937/ekoPolj19049891

Kolshus, K. *et al.* (2015), "*E-agriculture 10 year Review Report: Implementation of the World Summit on the Information Society (WSIS) Action Line C7", ICT Applications: e-agriculture*. Rome. Available at: www.fao.org/3/a-i4605e.pdf

Lehmann, R. J., Reiche, R. and Schiefer, G. (2012), "Future internet and the agri-food sector: State-of-the-art in literature and research", *Computers and Electronics in Agriculture*, 89, pp. 158–174. DOI 10.1016/j.compag.2012.09.005

Magnin, C. (2016), "*How big data will revolutionize the global food chain*", Available at: https://www.mckinsey.it/file/6335/download?token=BhKeEm5a

Markard J, Raven R, Truffer B (2012), "Sustainability transitions: An emerging field of research and its prospects", Res Policy 41:955–967. DOI 10.1016/j.respol.2012.02.013

McBratney, A. *et al.* (2005), "Future directions of precision agriculture", *Precision Agriculture*, 6(1), pp. 7–23. DOI 10.1007/s11119-005-0681-8

Ministry of Foreign Trade and economic Relations of Bosnia and Herzegovina (2018), *"Bosnia and Herzegovina Rural Development Strategic Plan (2018 - 2021) - Framework Document"*. Available at: http://www.mvteo.gov.ba/attachments/en_Home/Other_pages/Agriculture,_food,_forestry_and_rural_development/Agriculture_and_rural_development/Strategic_Plan_for_Rural_Development_of_BiH___Eng.pdf

Mintert, J. *et al.* (2016), "The Challenges of Precision Agriculture: Is Big Data the Answer?", *Paper presented at the Southern Agricultural Economics Association (SAEA) Annual Meeting; San Antonio, Texas; February 6-9, (2015)*. Available at: https://ageconsearch.umn.edu/bitstream/230057/2/THE CHALLENGES OF PRECISION AGRICULTURE _manuscript_SAEA_2016.pdf

Mrdalj, V. *et al.* (2019), "*Comparative advantages and intra - industry trade for meat sector in Bosnia and Herzegovina's trade*", VIII International Symposium on Agricultural Sciences AgroRes 2019,Book of Proceddings. Available at: http://agro.unibl.org/wp-content/uploads/2019/07/Book-of-Proceedings-AgroReS-2019.pdf

OECD (2002), "R*eviewing the ICT sector definition: Issues for discussion*". Paris

Poppe, K. (2016), "*Big opportunities for big data in food and agriculture*", Available at: https://www.oecd.org/tad/events/Session 2_Krijn Poppe OECD Big Data.pdf (Accessed: 10 March 2018)

Postel S.L. (2000), "Entering an era of water scarcity: The challenges ahead". *Ecol Appl* 10:941–948. DOI 10.1890/1051-0761

Schrijver, R., Poppe, K. and Daheim, C. (2016), "*Precision agriculture and the future of farming in Europe*", European Parliamentary Research Service, Brussels. DOI 10.2861/020809

Singh M, Marchis A. and Capri E. (2014), "*Greening, new frontiers for research and employment in the agro-food sector*", Sci Total Environ 472:437–443. DOI 10.1016/j.scitotenv.2013.11.078

Smart AKIS (2016), "*What is Smart Farming?"*, Available at: https://www.smart-akis.com/index.php/network/what-is-smart-farming/ (Accessed: 13 June 2019)

Spaargaren G, Oosterveer P, Loeber A (2013), "*Sustainability transitions in food consumption, retail and production*", Food Practices in Transition: Changing Food Consumption, Retail and Production in the Age of Reflexive Modernity. Routledge, New York, pp 1–30

Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska (2015), "*Strategic plan for development of agriculture and rural areas in the Republic of Srpska (2015-2020)", Available at:* https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mps/%D0%BC%D0%B8%D0%BD%D0%B8%D1%81%D1%82%D0%B0%D1%80%D1%81%D1%82%D0%B2%D0%BE/Documents/Strategija%202020.pdf

Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska, Agruculture Projects Coordination Unit (APCU) (2019). Baseline Review: Rural Competitivenss Development Project (RCDP) for IFAD

Sylvester, G. (2015), "*Success Stories on Information and Communication Technologies for Agriculture and Rural Development*", Bangkok. Available at: www.fao.org/3/a-i4622e.pdf

Umstatter, C. (2011), "The evolution of virtual fences: A review", *Computers and Electronics in Agriculture*, 75(1), pp. 10–22. DOI 10.1016/j.compag.2010.10.005

UNDP (2013), *"National Human Development Report 2013. Rural Development in Bosnia and Herzegovina; Myth and Reality*", Sarajevo, Bosnia and Herzegovina. Available at: https://www.undp.org/content/dam/bosnia_and_herzegovina/docs/Research&Publications/Democratic%20Governance/Rural%20development%20in%20Bosnia%20and%20Herzegovina/BiH_NHDR_Brochure_08072013.pdf

UN-ESCAP (2008), "*Information and communications technology for food security and sustainable agriculture in the knowledge economy*", Available at: http://www.unescap.org/sites/default/files/CICT_1-E.pdf

UNESCO (2002), "*Information and communication technology in education*", Available at: http://unesdoc.unesco.org/images/0012/001295/129538e.pdf. Accessed 22 Mar 2018

Vasa L., Angeloska A. and Trendov N. M. (2018), "Comparative analysis of circular agriculture development in selected Western Balkan countries based on sustainable performance indicators", *Economic Annals-XXI*, 168(11-12), pp. 44-47. DOI 10.21003/ea.V168-09

Volk, T., M. Rednak, E. Erjavec, I. Rac, E. Zhllima, G. Gjeci, S. Bajramović, Ž. Vaško, M.Kerolli-Mustafa, E. Gjokaj, B. Hoxha, D. Dimitrievski, A. Kotevska, I. Janeska Stamenkovska, D. Konjevic, M.Spahic, N. Bogdanov, M. Stevović (authors), B. Ilic, D. Pavloska - Gjorgjieska, P. Ciaian (editors). *Agricultural policy developments and EU approximation process in the Western Balkan countries*, EUR 29475 EN, Publications Office of the European Union, Luxembourg, (2019), ISBN 978-92-79-98107-4, DOI 10.2760/583399, JRC114163

Volk, T., M. Rednak, E. Erjavec, E. Zhllima, G. Gjeci, S. Bajramović, Ž. Vaško, D. Ognjenović, J. Butković, M. Kerolli-Mustafa, E. Gjokaj, B. Hoxha, D. Dimitrievski, A. Kotevska, I.J. Stamenkovska, A. Martinovic, D. Konjevic, M. Spahic, N. Bogdanov, R. Papić, S. Todorović (authors); Volk, T., E. Erjavec, P. Ciaian, S. Gomez y Paloma (eds.) (2017), *Monitoring of agricultural policy developments in the Western Balkan countries*, European Commission, Joint Research Centre, EUR 28527 EN, doi:10.2760/73968 (Print), DOI 10.2760/146697 (PDF)

Walter, A. *et al.* (2017), "Smart farming is key to developing sustainable agriculture", *Proceedings of the National Academy of Sciences*, 114(24), pp. 6148–6150. DOI 10.1073/pnas.1707462114

World Bank (2002), "*Information and Communication Technologies - A World Bank Group Strategy*", Washington DC.

World Bank (2011), "*ICT in agriculture: connecting smallholders to knowledge, networks, and institutions*", Washington, DC. Available at: http://documents.worldbank.org/curated/en/455701468340165132/ICT-in-agriculture-connecting-smallholders-to-knowledge-networks-and-institutions

World Bank (2017), "*ICT in Agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions*", Updated edition. Washington DC. Available at: http://documents.worldbank.org/curated/en/522141499680975973/pdf/117319-PUB-Date-6-27-2017-PUBLIC.pdf

World Bank (2017a), "*The Stabilization and Association Agreement (SAA) between Bosnia and Herzegovina (BiH) and the European Union: Impacts of the adaptation protocol (AP) on the agriculture and food sector*". Available at: http://documents.worldbank.org/curated/en/613781501678744055/pdf/117863-WP-PUBLIC-BiH-SAA-Study-Final-Revised.pdf

EVALUATION OF BUYING HABITS OF YOUNG GENERATION WHEN BUYING FAIRTRADE FOODS IN THE CZECH REPUBLIC

Miroslava Navrátilová[1], Markéta Beranová[2] and Josef Abrhám[3]

[1, 2, 3] Department of Trade and Accounting, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]navratilovam@pef.czu.cz, [2]mberanova@pef.czu.cz, [3]abrhamj@pef.czu.cz

Annotation: In the last two decades, the agro-food sector has undergone many changes in the context of intensifying globalization processes and has faced a number of new challenges. The emergence of alternative business concepts for example such as Fair Trade is a consequence of these processes worldwide. Fair trade concept is a global movement based on the idea of solidarity between the rich North and the poorer South. This idea allows an every individual to express personal attitudes and opinions in relation to social and environmental global issues. FT production offerings are currently a natural part of the majority of retail outlets and this business concept has begun to be accepted by the majority community. The aim of the paper is to evaluate the buying habits of the young generation in the area of Fairtrade food purchases and to identify its preferences in terms of the place of realization of these purchases.

Key words: agro-food sector, buying habits, consumer, fair-trade

JEL classification: F10, F18

1. Introduction

Fair trade can be seen as a political movement (Van Dam, 2019), but also as a form of trade practice and production relations (Le Mare, 2008). The development of the fair trade movement can be divided into periods. Each period is characterized by certain business and economic activities (Davies, 2007). The concept is based on the principle of social and economic solidarity between the poorer and richer parts of the world (Durevall, 2020). The Fair Trade concept enables the individual consumer to influence, at least in part, the distribution of forces in world trade through his individual purchasing choices and to declare his personal attitudes and preferences (Lee et al., 2015). In the last two decades, the concept and spectrum of marketed production has expanded (Coppola et al., 2017).

Agricultural products represent some of the first and most important internationally traded commodities within the Fair Trade concept (Sama et al., 2018; Raynolds, Murray and Wilkinson, 2007). The concept of Fair Trade is currently considered an alternative to conventional trade (Śmigielska, Dąbrowska and Radziukiewicz, 2015). Commonly traded commodities are primarily coffee, tea, and chocolate, which are available in restaurants and university campuses, but also in many multinational supermarket chains throughout Europe and the United States (Hainmueller, Hiscox and Sequeira, 2015).

In real life, consumers' purchasing decisions are influenced by many factors. Consumers make constant compromises between price, quantity, brand, sensory quality, nutritional values, etc. (Grunert, Hieke and Wills, 2014). Many consumers today appreciate products that are made in an environmentally responsible way (Sama et al., 2018). They are also interested in the conditions of the production process (Dragusanu, R, Giovannucci and Nunn, 2014). This creates a new dimension of quality labels in national and international retail markets. This process affects the ethics of the production process and trade (Bissinger and Leufkens, 2017). Thus, the importance of ethical consumption and sustainable development in consumer perception is growing (Coppola et al., 2017). Consumers within the Fair Trade business concept can be considered as ethical and socially responsible consumers (Lima Coelho, 2015).

The current young generation is more open to new concepts of products and services. They perceive new products as a means of self-expression or symbols of their desired lifestyle. (Kim and Jang, 2014). The country of origin plays an important role in the perception of food quality among the younger generation (van den Bergh and Behrer 2012). All these factors are important for the preference of the Fair Trade concept in the young generation.

The aim of the paper is to evaluate the buying habits of the young generation in the area of Fairtrade food purchases and to identify its preferences in terms of the place of realization of these purchases. The introduction of this paper includes a theoretical background of the examined issue. Section of materials and methods describes how primary data were analyzed and research was made. Section of results and discussion present results obtained, in discussion are compared final results of own research with similar studies of other authors on similar topics.

2. Materials and Methods

Theoretical background for this paper was based on an analysis of sources gained from scholar papers and special literature. Primary data were obtained through the survey.

Respondents were young persons from Generation Y, aged 15 – 34, from selected regions of the Czech Republic. Total number of respondents was 840. Respondents were selected by quota selection by classification of Czech statistical office. The questionnaire survey was held during year 2017. General Sociodemographic information about groups of respondents are summarized in the following table.

Table 1.General information about respondents in quota selection

Gender	Females	417	49.6%
	Males	423	50.4%
Age	15 - 19 Years	170	20.2%
	20 - 24 Years	200	23.8%
	25 - 29 Years	210	25.0%
	30 - 34 Years	260	31.0%
Highest education level obtained	Elementary	194	23.1%
	Secondary with no graduation exam	194	23.1%
	Secondary with graduation exam	285	33,9%
	University	167	19.9%
Permanent residence	Prague	347	41.3%
	Ústí nad Labem region	229	27.3%
	South Bohemian region	176	21.0%
	Karlovy Vary region	88	10.5%
Net income of households - monthly	More than 50 000 CZK	144	17.1%
	25 000-49 999 CZK	305	36.3%
	Below 24 999	152	18,1%
	Didn't answered	239	28.5%

Source: Own research, 2017

Results were obtained by descriptive methods of statistics as relative and absolute frequency. Contingency tables were based and tested by Pearson's chi-square test. Significance level (α) was set at 0.05. If the value of $\chi 2$ test was equal to or greater than value of critical $\chi 2$ test on significance level $\alpha = 0.05$, null hypothesis about independency was rejected (Vaughan, 2001). In case when null hypothesis was rejected, Cramér's *V* is possible to count (Abbott and McKinney, 2013). Hypotheses for χ^2 testing were set:

Table 2. Summary of stated hypotheses

Nr. of hypothesis	Text of Hypothesis
$H_0 1$	Realization of Fairtrade food purchases does not depend on the gender of respondent.
$H_0 2$	The implementation of Fairtrade food purchases does not depend on the gender of respondent's age.
$H_0 3$	Realization of Fairtrade food purchases does not depend on the gender, age and respondent's education.
$H_0 4$	Realization of Fairtrade food purchases does not depend on the region of respondent's permanent residence.
$H_0 5$	Realization of Fairtrade food purchases does not depend on the income of respondent's household.

Source: Own research, 2017

Abbreviations used: FT = Fair Trade.

3. Results and Discussion

In this part of the article the research results are presented and discussed. Darian et al. (2015) consider the efforts to increase the wages and working conditions of farmers and workers involved in their production to be important reasons for purchasing FT products. Participants in the questionnaire survey (n = 840) stated in 43.5% (365) the reason for purchasing this production was the possibility to improve working conditions and in 38.0% the effort to contribute to higher wages of workers. Ladhar and Tchetgna (2015) emphasize the importance of value orientation of consumers when buying FT, particularly in the context of beliefs about social justice and equality of people. More than half (54.0%, 454 people) of respondents (n = 840) stated that they did not know the concept of Fair Trade. Less than a quarter (23.1%, 194) of the respondents answered that they knew the Fair Trade concept in detail. Approximately the same number of participants (22.9%, 192) declared a partial knowledge of the term (answer: "Yes, I have heard about it, but I do not know exactly what it is").

For trade with a group of Fairtrade products, knowledge of this issue among consumers is a primary prerequisite for its implementation. Therefore, only a group of respondents who showed at least some knowledge of fair trade (n = 386) was further examined. This is confirmed by De Pelsmacker and Janssens (2007), who based his research suggested that abstract knowledge of the business concept of fair trade can lead to an increased willingness to buy FT products. Pérez and García de los Salmones (2017) also see the importance of consumer information in the context of France Télécom, as this has a positive effect on their attitudes. Within this group of respondents (n = 386), it was verified whether they had ever purchased food from Fair Trade production. The final results are summarized in the following table.

Table 3. Realization of purchases of Fairtrade products

Answer/number of respondents	Number of respondents	In %
Yes, regularly	28	7.3%
Yes, but only irregularly	166	43.0%
No, but I'm thinking about it	73	18.9%
No, and I don't even plan to	43	11.1%
I don't know, I don't follow the product label	76	19.7%
Total	386	100.0%

Source: Own research, 2017

Approximately half of the respondents who declared knowledge of Fair Trade (n = 386) stated that they had ever bought Fairtrade food (50.3%, 194). About one tenth (11.1%, 43) took a negative attitude towards purchasing these products. Less than a fifth expressed the opinion that they did not examine product labeling (19.7%, 76).

The obtained responses were further tested in relation to sociodemographic characteristics (see Table 2, hypotheses $H_0 1$ - $H_0 5$).

Table 4. Realization of purchases of Fairtrade products according to the gender of respondents

Gender/ Answer	Yes, regularly	Yes, but only irregularly	No, but I'm thinking about it	No, and I don't even plan to	I don't know, I don't follow the product label	Total
Woman	20	104	42	19	35	220
Men	8	62	31	24	41	166
Total	28	166	73	43	76	386
Relative frequencies within gender						
Woman	9.1%	47.3%	19.1%	8.6%	15.9%	100.0 %
Men	4.8%	37.3%	18.7%	14.5%	24.7%	100.0 %
Total	7.3%	43.0%	18.9%	11.1%	19.7%	100.0 %
Adjusted residuals						
Woman	1.60	1.95	0,10	-1.80	-2.15	
Men	-1.60	-1.95	-0.10	1.80	2.15	

Source: Own research, 2017

The calculated statistics $\chi 2$ for Table 4, which is 11.14 is higher than the critical value (9.49) with 4 degree of freedom at the level of significance 0.05. Therefore we can reject the null hypothesis $H_0 1$. The purchase of Fairtrade products depends on gender. However, the strength of the dependence, measured by Cramer's *V*, is weak (0.17). Analysis of the adjusted residue method shows that a statistically significant difference occurs in the response combining lack of interest in purchasing and inability to know the product. Exactly 15.9% of women and 24.7% of men declared these facts. Aoki, Akai and Ujiie (2017) identify a typical ethical consumer with a person of a younger woman with higher education and middle to higher income. Turčínková, Brychtová and Urbánek (2012) also point out the difference in the consumer behaviour of men and women, who consider the gender of the respondents to be one of the determining factors determining his consumer behaviour. Kim and Jang (2014) state that young women of generation Y tend to spend more on luxury or exceptional goods.

Table 5. Results of tested hypotheses (H_02 - H_05)

Value types/Value results of hypothesis	H_02	H_03	H_04	H_05
Degree of freedom	12	12	12	12
$\chi 2$	11.71	19.07	16.10	18.37
Critical value	21.03	21.03	21.03	21.03

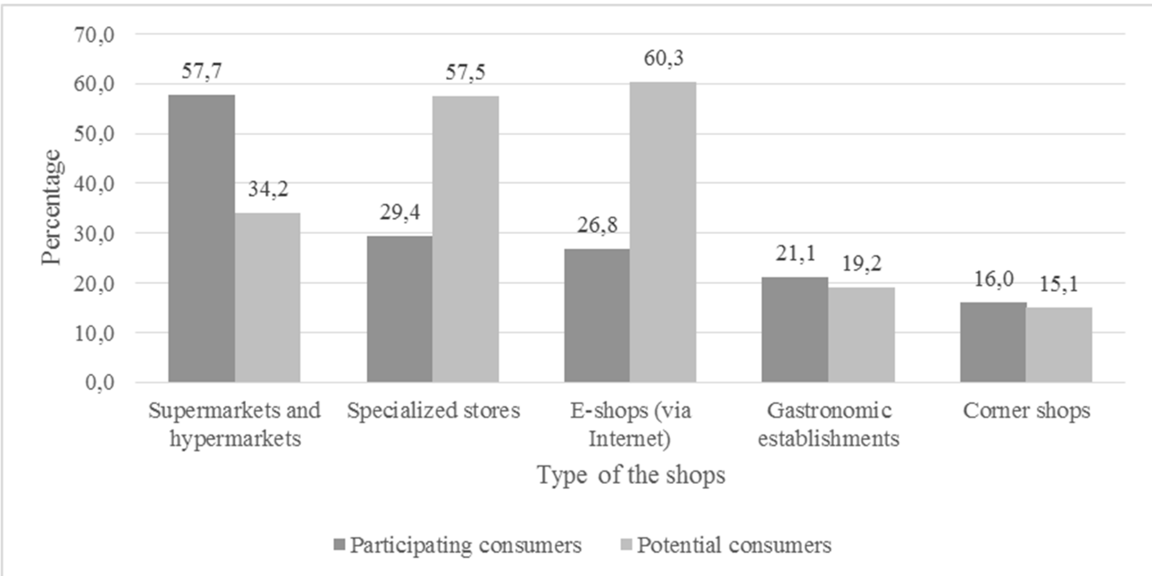
Source: Own research, 2017

The results show that, in terms of the monitored demographic characteristics, only a weak dependence of Fair Trade purchases on gender was demonstrated. Dependence on other demographic indicators has not been statistically confirmed. However, this is only a test within a group of respondents who already have some awareness of Fairtrade products. Based on the structure of the answers, the respondents (n = 386) were divided into three categories:

1. participating consumers (answers "yes, regularly" and "yes, sometimes I buy such a product, but only irregularly", n = 194),
2. potential consumers (answer "no, but I'm thinking about it", n = 73),
3. rejecting and inactive consumers (answers "no and I don't plan to" and "I don't know, I'm not following the product label", n = 119).

Subsequently, attention was paid to the individual defined categories of young consumers according to the above definition. Regarding the place of purchase, it can be stated that there are significant differences between the actual places of purchase and the perception of potential consumers (Figure 1).

Figure 1. Places of purchase of Fairtrade food



Source: Own research, 2017

As can be seen from Figure 1, the main place of actual purchase of Fairtrade products are supermarkets and hypermarkets, which identified 57.7% as the place of purchase of this type of production, (112). Almost 30.0% of respondents buy in specialized stores and more than a quarter (26.8%, 52) through the Internet. Approximately one-fifth (21.1%, 41) of the respondents identified the answer "in gastronomic establishments - cafes and restaurants". The mainstreaming and corporatization of Fair Trade activities is an example of the overlap between the activities of social enterprises, which seek to combine market-oriented approaches with social ambitions and CSR strategies that seek to integrate social aspects into core business strategies (Grant and Palakshappa, 2018). Pulker et al. (2018) state that supermarkets and hypermarkets have unprecedented political and economic power in the world food system and are important bearers of social responsibility. The alternative concept of Fair Trade is currently accepted by most companies, which testifies to its success. It is known that all successful alternative trade concepts often lead to conventionalization (Friedland, 2010).

The awareness of potential consumers about the places of purchase, which defines their expectations, differs significantly from the real situation. The preference of e-shops and specialized stores is obvious, they are mentioned by about 60% of potential applicants. In supermarkets, which in many cases purposefully offer Fairtrade products, only a third of potential applicants expect them. Only a fifth or even fewer potential consumers were expecting other possible places of purchase.

More than half of respondents (52.6%, 202) state that fair products are expensive. To identify the consumer preferences of the young generation in relation to FT production regardless of the price factor. If respondents were to choose between FT and a regular product and their price was identical, almost 70% of people (68.1%, 263) said they would rather buy a FT product. Less than 10% (8.8%, 34) would prefer a conventional product. Fairtrade products, which guarantee a fair profit to their producers, have a higher price than conventional production. Another question, therefore, examined the willingness of young consumers to pay a higher price. More than half of the respondents (56.4% of those who know the FT concept) are willing to accept a higher price. While a lower or higher level of reluctance was declared by 34.8% of respondents. Based on a comparison of retail prices, Bissinger (2019) states that the price of Fairtrade products in retail is approximately twice as high as their equivalents from normal production. They explain this fact by higher margins of traders, because Fair Trade production is traded in smaller volumes, which represents higher costs for retailers. The willingness of consumers to pay a higher price for Fair Trade is also stated by Akaichi et al. (2016). Andorfer and Liebe (2015), on the other hand, based on their field experiment with Faitrade coffee, expressed the view that the price factor is important for consumers, which outweighs the consumer's perception of the moral message of production. Young people who grew up in a period of peace and prosperity show lower price sensitivity and emphasize the quality and freshness of products (Kim and Jang, 2014).

More than half of the respondents (54.4%, 210), who declared knowledge of FT (n = 386), were of the opinion that there is a shortage of Fairtrade products on the Czech market. In terms of perception of accessibility, 43.8% (169) of young people answered that Fairtrade products are not commonly available in shops where they make purchases. The finding that almost 70.0% (68.1%, 263) of people consider Fairtrade products to be well identifiable can be described as positive. This fact indicates the importance of the issue of food labeling. According to the authors, this finding can be viewed in a broader context than just within the business concept of FT. This view is also shared by Messer, Costanigro and Kaiser (2016), who point to the increased interest of consumers, when buying food in transparent information. Such as nutritional values, countries of origin or specific aspects of food production. Rousseau (2015) considers the impact of Fairtrade on consumers to be greater than that of organic labels, but notes that the impact of labeling on consumer preferences has its limits.

4. Conclusion

The results show that approximately half (50.3%, 194) of the total number (n = 386) of young people aged 15-34 who have knowledge of FT sometimes bought food under the Fair Trade concept. Less than 20.0% (18.9%, 73) of the respondents admitted that they were considering a purchase. In total, 30.8% (119) do not perceive food labeling (19.7%) or reject trade fair

(11.1%). A closer examination of the places of purchase has shown that the different types of retail units differ, where purchases were actually made and where potential consumers assume that they can be made. The most frequent places of Fairtrade food purchases were supermarkets and hypermarkets (57.7%), specialized stores (29.4%) and e-shops (26.8%). Consumers who have not yet bought FT production have stated that they would do so through e-shops (60.3%) and specialized shops (57.5%). Almost all participants in the questionnaire survey (n = 840) stated that they routinely buy food in supermarkets and hypermarkets. The above findings show that the behaviour of young consumers when buying food and Fair Trade production does not show differences in terms of the place of their implementation. The limits of the research carried out can be described as the fact that it was carried out in only one country. The implementation of a similar questionnaire survey in the future perspective is expected.

Acknowledgements
This work was also supported by the Internal Grant Agency of Faculty of Economics and Management, Czech University of Life Sciences Prague - grant number 2020B0002 – "The impact of climate change on the economic performance of the viticulture and wine-making sector in the Czech Republic".

References

Abbott, M. and McKinney, J. (2013), "*Understanding and applying research design*", Hoboken, John Wiley & Sons, ISBN 978-1-1-118-09648-2

Akaichi, F., de Grauw, S., Darmon, P. and Revoredo-Giha, C. (2016), "Does Fair Trade Compete with Carbon Footprint and Organic Attributes in the Eyes of Consumers? Results from a Pilot Study in Scotland, The Netherlands and France", *Journal of Aricultural & Environmental Ethics*, vol. 29, no. 6, pp. 969-984, ISSN 1187-7863, DOI 10.1007/s10806-016-9642-7

Andorfer, V. A. and Liebe, U. (2015), "Do information, price, or morals influence ethical consumption? A natural field experiment and customer survey on the purchase of Fair Trade coffee", *Social Science Research*, vol. 52, pp. 330–350, ISSN 0049-089X, DOI 10.1016/j.ssresearch.2015.02.007

Aoki, K., Akai, K., and Ujiie, K. (2017), "A choice experiment to compare preferences for rice in Thailand and Japan: The impact of origin, sustainability, and taste", *Food Quality and Preference*, vol. 56, part B, pp. 274–284, ISSN 0950-3293, DOI 10.1016/j.foodqual.2016.03.001

Bissinger, K. (2019), "Price Fairness: Two-Stage Comparison of Conventional and Fairtrade Prices", *Journal of International Consumer Marketing*, vol. 31, no. 2, pp. 86-97, ISSN 0896-1530, DOI 10.1080/08961530.2018.1482525

Bissinger, K. and Leufkens, D. (2017), "Ethical food labels in consumer preferences", *British Food Journal,* vol. 119, no. 8, pp. 1801-1814, ISSN 0007-070X, DOI 10.1108/BFJ-10-2016-0515

Coppola A., Verneau, F., Caracciolo, F. and Panico, T. (2017), "Personal values and pro-social behaviour: The role of socio-economic context in fair trade consumption", *British Food Journal,* vol. 119, no. 9, pp. 1969-1982. ISSN 0007-070X, DOI 10.1108/BFJ-10-2016-0474

Darian, J. C., Tucci, L., Newman, C. M., Naylor, L. (2015), "An Analysis of Consumer Motivations for Purchasing Fair Trade Coffee", *Journal of International Consumer Marketing*, vol. 27, no. 4, pp. 318-327, ISSN 0896-1530, DOI 10.1080/08961530.2015.1022920

Davies, I. A. (2007), "The eras and participants of fair trade: an industry structure/stakeholder perspective on the growth of the fair trade industry", *International Journal of Business and Society*, vol. 7, no. 4, pp. 455-470. ISSN 1511-6670, DOI 10.1108/14720700710820533

De Pelsmacker, P. and Janssens, W. (2007), "A Model for Fair Trade Buying Behaviour: The Role of Perceived Quantity and Quality of Information and of Product-specific Attitudes", *Journal of Business Ethics*, vol. *75, no. 4*4, pp. 361-380, ISSN 0167-4544, DOI 10.1007/s10551-006-9259-2

Dragusanu, R., Giovannucci, D. and Nunn, N. (2014), "The Economics of Fair Trade", *Journal of Economic Perspectives*, vol. 28, no. 3, pp. 217-236. ISSN 0895-3309, DOI 10.1257/jep.28.3.217

Durevall, D. (2020). "Fairtrade and Market Efficiency: Fairtrade-Labeled Coffee in the Swedish Coffee Market", *Economies*, vol. 8, no. *2*, pp. 1-17, ISSN 2227-7099, DOI 10.3390/economies8020030

Friedland, W. H. (2010), "New Ways of Working and Organization: Alternative Agrifood Movements and Agrifood Researchers", *Rural Sociology*, vol. 75, no. 4, pp. 601-627, ISSN 0036-0112, DOI 10.1111/j.1549-0831.2010.00031.x

Grant, S. and Palakshappa, N. (2018), "Social enterprise push or corporate social responsibility pull? The mainstreaming of fair trade", *International Journal of Nonprofit and Voluntary Sector Marketing*, vol. 23, no. 4, ISSN 1465-4520, DOI 10.1002/nvsm.1625

Grunert, K. G., Hieke, S. and Wills, J. (2014), "Sustainability labels on food products: Consumer motivation, understanding and use", *Food Policy*, vol. 44, pp. 177-189, ISSN 0306-9192, DOI 10.1016/j.foodpol.2013.12.001

Hainmueller, J., Hiscox, M. J. and Sequeira, S. (2015) "Consumer Demand for Fair Trade: Evidence from a Multistore Field Experiment", *Review of Economics and Statistics*, vol. 97, no. 2, pp. 242-256, ISSN 0034-6535, DOI 10.1162/REST_a_00467

Kim, DH and Jang, SCh. (2014), "Motivational drivers for status consumption: A study of GenerationY consumers", *International Journal of Hospitality Management,* vol. 38, pp. 39-47. ISSN 0278-4319, DOI 10.1016/j.ijhm.2013.12.003

Ladhari, R. and Tchetgna, N. M. (2015), "The influence of personal values on Fair Trade consumption", *Journal of Cleaner Production,* vol. 87, pp. 469-477, ISSN 0959-6526, DOI 10.1016/j.jclepro.2014.10.068

Le Mare, A. (2008), "The Impact of Fair Trade on Social and Economic Development: A Review of the Literature", *Geography Compass,* vol. 2, no. 6, pp. 1922-1942, ISSN 1749-8198, DOI 10.1111/j.1749-8198.2008.00171.x

Lee, M.-Y., Jackson, V., Miller-Spillman, K. A. and Ferrell, E. (2015), Female consumers′ intention to be involved in fair-trade product consumption in the U.S: The role of previous experience, product features, and perceived benefits. *Journal of Retailing and Consumer Services*, *23*, 91-98, ISSN 0969-6989, DOI 10.1016/j.jretconser.2014.12.001

Lima Coelho, S. (2015), "Fair trade consumers in Portugal: values and lifestyles", *International Journal of Consumer Studies*, vol. 39, no. 5, pp. 437-444, ISSN 1470-6431, DOI 10.1111/ijcs.12232

Messer, K. D., Costanigro, M., and Kaiser, H. M. (2016), "Labeling Food Processes: The Good, the Bad and the Ugly", *Applied Economic Perspectives and Policy*, vol. 39, no. 3, pp. 407-427, ISSN 2040-5804, DOI 10.1093/aepp/ppx028

Pérez, A. and García de los Salmones, M. del M. (2017), "Information and Knowledge as Antecedents of Consumer Attitudes and Intentions to Buy and Recommend Fair-Trade Products", vol. 30, no. 2, pp. 111-133, ISSN 1049-5142, DOI 10.1080/10495142.2017.1326358

Pulker, C. E., Trapp, G. S. A., Scott, J. A., and Pollard, C. M. (2018), "Global supermarkets' corporate social responsibility commitments to public health: a content analysis", *Globalization and Health*, vol. 14, no. 1, pp. 1-20, ISSN 1744-8603, DOI 10.1186/s12992-018-0440-z

Raynolds, L. T., Murray, D. L, and Wilkinson, J. (2007), *Fair trade: the challenges of transforming globalization*. New York, NY, Routledge, ISBN 9780415772037

Rousseau, S. (2015), The role of organic and fair trade labels when choosing chocolate. *Food Quality and Preference*, vol. 44, pp. 92-100, ISSN 0950-3293, DOI 10.1016/j.foodqual.2015.04.002

Sama, C., Crespo-Cebada, E., Díaz-Caro, C., Escribano, M. and Mesías, F. J. (2018), "Consumer Preferences for Foodstuffs Produced in a Socio-environmentally Responsible Manner: A Threat to Fair Trade Producers?", *Ecological Economics*, vol. 150, pp. 290-296, ISSN 0921-8009, DOI 10.1016/j.ecolecon.2018.04.031

Śmigielska, G., Dąbrowska, A. and Radziukiewicz, M. (2015), "Fair Trade in Sustainable Development. The Potential for Fair Trade Market Growth in Poland", *Amfiteatru Economic Journal*, vol. 17, special no. 9, pp. 1244-1258, ISSN 2247-9104

Turčínková, J., Brychtová, J. and Urbánek, J. (2012), "Preferences of men and women in the Czech Republic when shopping for food", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 57, no. 3, pp. 173-178, ISSN 2464-8310, DOI 10.11118/actaun201260070425. ISSN 2464-8310

Van Dam, P. (2019), "Challenging Global Inequality in Streets and Supermarkets: Fair Trade Activism since the 1960s", In C. O. Christiansen and S. L. B. Jensen, *Histories of Global Inequality: New Perspectives* (pp. 255-275), Cham, Springer, ISBN 978-3-030-19162-7

Van den Bergh, J. and Behrer, M. (2012), "*Jak cool značky zůstávají hot: marketing zaměřený na mladou "generaci Y*", Brno, BizBooks, ISBN 978-80-265-0002-5

Vaughan, L. (2001), "*Statistical methods for the information professional: a practical, painless approach to understanding, using, and interpreting statistics*", Medford, Information Today, ISBN 1573871109

EUROPEAN TRENDS IN ECONOMICS OF FOOD MANUFACTURING INDUSTRY

Zdeňka Náglová[1], Josef Slaboch[2], Pavel Kotyza[3] and Luboš Smutka[4]

[1, 2, 3, 4] Department of Economics, Faculty of Economics and Management, Czech University of Life Sciences

[1]naglova@pef.czu.cz, [2]jslaboch@pef.czu.cz, [3]kotyza@pef.czu.cz, [4]smutka@pef.czu.cz

Annotation: Food industry in European union is an important sector concerning share of turnover, number of employees, gross value added on the whole manufacturing sector. Importance of this food provider in each EU country is different. This article aims to point out the main trends, key aspect, problems and challenges of the EU food industry also from the perspective of its position in national and EU economy. For this purpose, we used Eurostat data between years 2007-2017 (or 2018 if was published). We compare the main indicators such as a number of employees, companies, turnover, wages and salaries and gross value added. There are significant differences in the analysed indicators between individual countries. All countries entering after 2004 are lagging behind EU 28 average of the sector.

Keywords: food manufacturing industry, competitiveness, European Union, comparison

JEL classification: L66, Q18, C22

1. Introduction

The food industry as an important segment in the food value chain is a crucial element determining the success and sustainability of agricultural production. Both segments are crucially connected while one will not succeed without the other. Also, without food manufacturing/processing country lose additional value-added and national income (Phiri, et al. 2020). Even though in liberal perspective this argument could be questioned, the European Union approach presents an opposite. Many primarily products cannot be imported due to dissimilarity of quality standards (Beestermöller et al, 2018; Kareem et al, 2018) and therefore the EU local agricultural production is still the important provider of inputs for food manufacturing. Evidence of Kareen et al (2018) also presents, that some less import demanding sectors are overprotected. At the same time, EU is the largest global exporter of agri-food products with a total value exceeding 135 billion EUR in 2018 (EC, 2019).

Economic trends in food manufacturing and internal competitiveness of individual EU member industries were assessed by EU project led by Wijnands et al (2007) concluded that in EU food industry is wee in comparison to USA and Canada and comparable with Brazil, Australia. Surprisingly the report also found, that EU food companies do not perceive EU food legislation as a disadvantage but rather EU companies' view on the food legislation was positive.

Food industry (NACE 10) is the largest manufacturing sector in the EU with turnover 1,192 billion Euro (15.1% share), the following is automotive industry, machinery and equipment. With 4.72 million people employed belongs to a leading employer in the EU, while its share on EU gross value added is low. Also, labour productivity is below the average in the manufacturing industry. Food manufacturing is in the EU represented by almost 250,000 companies, most of them are small and medium-sized companies with a 47.5% share on turnover 61% share in employment (Food Drink Europe, 2020).

Over last 3 decades, food industry development and concentration (Blazkova, 2012; Szwacka-Mokrzycka, 2015) was highly influenced by FDI in new EU member states and market concentration of retail (Špička, 2016). The FDI was mostly targeted on industries with high concentration leading to (i) investors growth, (ii) improvements to competitiveness of the host country' industry (Jansik, 2004) and (iii) employment sustainability (Maitah et al, 2014). Even if investments are done, the support provided, "old" EU member states are still competitive leaders in the food and beverage industry (Notta and Vlachvei, 2019).

As the European Union members are very diverse, the main aim of the article is to point out main trends, key aspects, problems and challenges of the European food industry also from the perspective of its position in national and European economy.

2. Materials and Methods

The article uses aggregated data of food industry enterprises (C10 Manufacture of food products) from Eurostat database. The evaluation of selected indicators is done for all EU member states for the period 2008-2017 (2018).

We selected basic structural indicators (number of enterprises[14] and number of employees[15]) to show the importance of this sector. In the article, we calculated the share of employees in food industry for each country on the whole EU food industry. Based on this information (number of enterprises and number of employees) we estimated the average size of enterprise.

As economic indicators, we used production value, labour productivity, wages and salaries. There is evaluated the share of production value[16] in each country on the whole EU food industry. The average wages[17] per year were also analysed. And, of course, very important indicator gross value added[18] is stated per employee to express the labour productivity. In the article, we included only the differences according to EU average values.

There is also stated the average value of the indicator (for available years) and the trends are evaluated by average annual growth rate (AAGR) in these years. By indicators average size of business, average wages and labour productivity we included also the average value for the whole EU.

3. Results and Discussion

Manufacture of foods products accounts for about 13% of the total manufacturing industry in the EU 28, if we focus on the share in production value. However, there are very significant differences between EU countries. Cyprus has the highest share, food industry contributed by 40% to the production value of manufacturing. Denmark, Greece, Spain, France, Croatia, Netherlands and Poland reached share at the level of about 20%. On the contrary, countries with the lowest share (5-8%) are the Czech Republic, Germany, Luxembourg, Slovenia or Slovakia. The total production value was 929 billion euro in 2018. This segment of the manufacturing industry consists of more than 200 thousand enterprises in the EU,

[14] According to Eurostat (2020a) number of enterprises is defined as a count of the number of enterprises active during at least a part of the reference period.

15 According to Eurostat (2020a) number of employees is defined as those persons who work for an employer and who have a contract of employment and receive compensation in the form of wages, salaries, fees, gratuities, piecework pay or remuneration in kind.

16 According to Eurostat (2020a) definition production value measures the amount actually produced by the unit, based on sales, including changes in stocks and the resale of goods and services.

17 According to Eurostat (2020b) are the total expenditure borne by employers for the purpose of employing staff. They include employee compensation, vocational training costs, other expenditure.

18 Gross value added (Eurostat, 2020a) is defined as output value at basic prices less intermediate consumption valued at purchasers' prices. GVA is calculated before consumption of fixed capital. GVA is conceptually close to GDP (Gross domestic product), but unlike GDP available in a breakdown by branch of economic activity.

with a slightly declining tendency over the observed period. Over the period, the average number of EU enterprises reached 260,159 companies with decreasing trend, but in 2017 it was only 211,912 companies. In this case, France and Italy have the highest number of food processing companies. with a share of slightly over 20% in each country. This means almost half of the food processing entities occurs in only two countries. These are mainly smaller business entities - see Table 1, which shows the average size of businesses in the member countries.

Table 1. Number of employees in average company of food manufacturing (EU28; 2008-2017)

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average number of companies	AAGR – amount of companies
Austria	17.8	18.1	18.5	18.9	19.7	19.9	20.2	20.3	20.7	20.9	3,522	-0.4%
Belgium	10.5	10.9	10.7	10.5	11.4	11.7	11.1	11.7	12.2	12.1	6,952	-1.3%
Bulgaria	19.6	18.4	17.9	16.9	16	15.5	15.3	14.9	14.5	14.7	4,988	2.2%
Croatia	19	18	19.4	19.6	19.8	19.6	19.1	19	19.4	19.3	2,810	-0.9%
Cyprus	11.9	12.1	14	14.3	13.8	12.6	12.5	13.2	13.6	14.1	826	-0.8%
Czech Republic	18.2	16.3	14.5	12.9	12.5	12.4	12.1	12.2	11.6	11.1	7,146	4.3%
Denmark	39.3	35.9	35.1	39.1	39.5	38.6	38.1	37	35.4	36	1,489	-1.0%
Estonia	37.6	34.5	34.3	32.9	31.2	28.4	28.2	24.9	22.3	20.6	461	6.3%
Finland	20.1	20	20.4	20.2	20.5	21	21.5	20.4	21.4	21.6	1,659	-0.7%
France	8	9.4	9.6	9.4	9.3	9.2	9.2	8.6	9.9	11.7	56,251	-1.6%
Germany	25	33.3	24.6	25.6	26.5	27.7	27.1	29.3	32.6	36.6	26,207	-1.6%
Greece	4.2	4.2	4.5	4.5	5.1	4.7	5.1	5.3	5.7	6.2	15,264	0.0%
Hungary	21.8	20.9	20.3	19.6	19.7	19.9	19.7	20.1	19.6	19.7	4,416	0.7%
Ireland	32.7	30.3	30.3	28.3	27.4	26.6	27	27.2	27.3	25.9	1,501	5.1%
Italy	5.2	5.8	5.7	5.5	5.6	5.7	5.8	5.9	6.1	6.4	54,410	-1.0%
Latvia	40.7	35.5	31.4	31.4	28.1	26.3	26	21.5	19.5	19.7	873	5.3%
Lithuania	37.7	36.9	34.6	31.6	27.8	27.5	25.6	25	23.5	24.4	1,385	3.5%
Luxembourg		31.4	30.9	32.7	35.4	37.4	37.5	39.7	42.4	41.9	132	-1.8%
Malta						6.5			7.7	7.6	372	-0.6%
Netherlands	27.9	27.7	26.7	26.6	25.3	21.7	21.8	20.9	20.5	20.4	5,059	4.3%
Poland	25.1	27.9	27.6	28	27.1	30	29.5	26.8	28	26.7	14,047	-0.3%
Portugal	9.1	9.3	9.6	9.6	9.4	9.1	9.2	9.4	9.7	10	9,417	-0.9%
Romania	19.9	19.6	20.6	21.9	21.2	20.6	19.9	19.7	19.8	19.1	8,193	-0.3%
Slovakia	51.1	46.3	13.5	13.2	13.8	13	12.8	13.7	11.9	11.1	2,316	35.3%
Slovenia	15.9	14.4	13.1	11.6	10.9	7.4	6.6	6.5	6.2	6.4	1,648	10.3%
Spain	13.3	13.4	13.2	13.1	13	12.9	13	13.5	14.4	14.6	23,181	-0.4%
Sweden	16.2	16	15.8	15.2	14.6	14.1	13.5	13.1	13.1	12.8	3,536	2.0%
UK	57.4	57	58.9	57.6	52.9	52.8	51.6	49.6	50.2	51	7,085	2.4%
EU 28	14.1	14.9	14.6	14.5	14.5	14.5	14.4	14.4	15.1	15.9	260,159	-0.5%

Source: own processing based on Eurostat data

The table 1 shows that, for example, the above-mentioned Italy and France have a very low number of employees per company, 6 in Italy (size of micro-enterprises); and 11 in France. Greece or Slovenia are other countries, where we can observe the existence of micro-enterprises with an average of around 6 employees. On contrary, for example in Denmark or Germany, the average business employs 36 people (small businesses) and in the United Kingdom, even entities have more than 50 employees. It means they are already medium-sized enterprises. In this case, a higher concentration and association in larger companies is evident. Interesting to observe is situation in Slovakia. Between 2008 and 2017 average size decreased from 51 employees per business to 11, which was given by enormous increase in many food manufacturing businesses (mostly between 2009/2010 number of enterprises in Slovakia almost quadrupled). Over analysed decade, the number of employees increased by 2 in EU28 average showing slow direction leading to a higher concentration.

An interesting indicator is the country position concerning production value share of the EU food manufacturing (Table 2). The highest shares are achieved by Germany and France (16-18%). If we add Italy with (12%), it is clear that only three EU countries create almost 50% of the EU food value. Other countries with a share of 10% are Spain and the United Kingdom. The relatively high share of the Netherlands at the level of 7% is also interesting, despite its smaller area (approximately half of the Czech Republic). On the other hand, countries such as Bulgaria, Czech Republic, Estonia, Ireland, Greece, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Portugal, Slovakia, Austria, Slovenia, Finland and Sweden have the lowest share in the total production value. Together, all these countries account for only 15% of the total production value in 2018.

Table 2. Country share in Production value of EU food manufacturing (2008-2018, in %)

Country	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average production value (mil. euro)**	**AAGR – production value**
Austria	1.7	1.7	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.8	14,196	3.0%
Belgium	4.2	4.4	4.5	4.5	4.3	4.5	4.3	4.4	4.5	4.5	3.9	36,407	3.5%
Bulgaria	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	3,666	3.9%
Croatia	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3,711	-1.2%
Cyprus	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1,161	1.4%
Czech Republic	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1	1	1.1	9,618	-0.4%
Denmark	2.6	2.3	2.2	2.3	2.4	2.5	2.3	2.3	2.3	2.2	2.2	19,405	1.1%
Estonia	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2		1,242	3.7%
Finland	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1	1	1	8,950	0.9%
France	18.1	16.8	16.3	16.4	16.1	16	16.6	16.1	15.8	16	16	136,855	1.5%
Germany	19.4	18	18.1	18.3	18.1	18.3	17.9	17.3	17.6	18	17.3	150,591	2.2%
Greece	1.4	1.4	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	10,611	1.2%
Hungary	1.1	1	0.9	1	1	1	1	1	1	1	1	8,280	1.9%
Ireland	2.4	2.4	2.5	2.5	2.7	2.4	2.6	2.7	2.6	2.5	2.5	21,081	3.6%
Italy	13.5	13	12.8	12.7	12.5	12.6	12.4	12.6	12.6	12.4	12.8	106,284	1.9%
Latvia	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1,384	1.1%
Lithuania	0.4	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3,139	3.4%
Luxembourg		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	620	5.6%
Malta											0	348	N/A
Netherlands		6.4	6.2	6.4	6.4	6.8	6.6	6.7	7	7	7.1	56,638	4.7%
Poland	5	4.3	4.6	4.8	5.1	5	5	4.9	5	5.3	5.8	41,863	3.9%
Portugal	1.5	1.4	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.3	1.3	10,729	1.3%
Romania	1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	7,702	1.8%
Slovakia	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2,822	1.9%
Slovenia	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1,606	0.9%
Spain	10.8	9.9	9.9	10	9.7	9.5	9.8	10	10.2	10.4	10.8	84,368	2.5%
Sweden	1.8	1.6	1.7	1.8	1.8	1.8	1.7	1.6	1.6	1.6	1.5	14,045	1.6%
UK	10.5	9.8	10.4	9.7	10.2	9.9	10.3	11.1	10.4	9.9	9.6	85,107	2.4%

Source: own processing based on Eurostat data

It is also interesting to monitor the share of production value per one employee. In this respect, the EU 28 countries can be divided into several groups. The first group consists of the countries of the eastern part of the EU, which have this indicator at a very low level - it is in the range of about 55-90 thousand euro per employee (Bulgaria, Romania, Latvia, Lithuania, Slovakia and also Croatia). The second group consists of the Czech Republic, Poland, Hungary, Cyprus, Portugal, Estonia, Luxembourg, Greece and Slovenia, indicator ranges from 110 to 135 thousand euro/employee. The third group consists of the rest of the countries of Western Europe, where this indicator is in the range of 220-510 thousand euro /employee. The highest average values per employee are observed in Ireland, Netherlands and Belgium.

Table 3 shows the number of employees in the food industry. A total of 4.121 million employees are employed in the EU 28 food industry (2017). During the period under review, the total number of employees increased by 10%. France, Germany and Italy contributed significantly to this growth. In France number of employees increased by 130,000, by 55 thousand in Germany and by 36 thousand in Italy. However, the most significant increase in relative terms was in Greece, where the number of employees increased by 44% between 2008 and 2017 (30 ths.), followed by Ireland (22%; 10 ths.).

In the EU 28, over time, the number of employees has increased in 17 countries. In Germany works about 20% of EU food sector employees, followed by France (around 15%), the United Kingdom and Poland (both 10%). Mostly in countries with lower production value per employee, the number of employees decreased. These are a total of 11 countries (Bulgaria, Czech Republic, Denmark, Estonia, Croatia, Latvia, Lithuania, Hungary, Romania, Slovenia and Sweden). The highest decrease is observed in the case of Latvia (25%; -7 ths.).

Table 3. Country share in employees of EU28 food manufacturing (2008-2017, in %)

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average number of employees	AAGR – number of employees
Austria	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.8	1.8	68,764	1.4%
Belgium	2.1	2.1	2	2	2	2	2	2	2	2	78,999	0.1%
Bulgaria	2.2	2.3	2.2	2.1	2	2	2	2.1	1.9	1.9	80,619	-1.0%
Croatia	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.3	54,130	-0.7%
Cyprus	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	10,882	1.0%
Czech Republic	2.6	2.6	2.4	2.4	2.4	2.3	2.3	2.4	2.2	2.2	92,660	-1.3%
Denmark	1.6	1.4	1.3	1.5	1.5	1.5	1.5	1.4	1.3	1.3	55,768	-1.8%
Estonia	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	13,089	-0.6%
Finland	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	34,453	0.0%
France	12.4	14.1	14.1	13.8	13.9	13.8	14.1	12.8	13.8	14.6	534,690	2.8%
Germany	19	17.9	19.4	20	20.1	20.1	19.5	19.7	19.8	19.1	757,258	0.9%
Greece	1.7	1.7	1.8	1.7	1.8	1.8	2.1	2.2	2.2	2.3	75,727	4.3%
Hungary	2.4	2.3	2.3	2.2	2.3	2.3	2.3	2.4	2.2	2.2	88,917	-0.4%
Ireland	1	1	1	1	1	1	1.1	1.2	1.2	1.2	41,235	2.4%
Italy	7.8	8.3	7.9	7.9	8.1	8.1	8	8.1	8.1	8.2	313,409	1.3%
Latvia	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	22,935	-2.9%
Lithuania	1.1	1	1	1	1	1	1	1	1	0.9	39,084	-1.5%
Luxembourg		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	4,803	2.0%
Malta						0.1			0.1	0.1	2,581	-7.1%
Netherlands	3	3.1	3	2.9	3	3	3	3.1	3	2.9	116,422	0.6%
Poland	9.9	9.9	9.7	9.6	9.7	9.5	9.7	9.8	9.5	9.4	375,786	0.2%
Portugal	2.4	2.4	2.3	2.3	2.2	2.2	2.2	2.3	2.2	2.3	89,037	0.1%
Romania	4.5	4.3	4.1	4.2	4.2	4.3	4.2	4.2	4	3.9	163,442	-0.8%
Slovakia	0.9	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.8	0.8	32,995	0.7%
Slovenia	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.3	13,887	-0.8%
Spain	8.4	8.1	7.9	7.8	7.8	7.6	7.6	7.8	8.1	8.2	308,965	0.6%
Sweden	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	50,881	-0.7%
UK	9.7	9.5	9.7	9.6	9.2	9.5	9.5	9.7	9.8	10	374,095	1.1%

Source: own processing based on Eurostat data

When monitoring the number of employees, it is appropriate to add the average wage of an employee per year, as shown in table 4. To some extent, it can be stated that the average wage correlates with the production value per employee (correlation coefficient, in this case, is 0.86). EU 28 is characterized by a very significant disproportion of wages. The EU28 average annual wage of the food manufacturing sector is at the level of 20 thousand euro. The highest average wage is reported from Denmark (47 thousand euro per employee and year). The poorest economies such as Romania and Bulgaria reach average annual wage per employee of about

6,200 and 4,800 euro, respectively. For comparison, the Czech Republic shows an average annual wage of 11 thousand euro in 2017. Here we need to clarify that EU means of 20 thousand euro is heavily affected by unequally distributed labour force among countries, where most of the labour is located in Germany, Italy and France and thus affecting average wage. Also, poorest countries reported the fastest average long-term growth of wages, 6.8% for Bulgaria and 5.1% for Romania.

Table 4. Average wage per year per employee (2008-2017, thousands of euro)

Country	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Average wage**	**AAGR -**
Austria	26	26.2	25.9	26.8	27.6	28.5	29.1	29.8	30	30.5	28.0	3.2%
Belgium	28.8	30.5	30.6	30.7	32.4	34.2	34.8	34.8	35.3	36.3	32.8	2.8%
Bulgaria	2.5	2.9	3.1	3.3	3.5	3.6	3.7	4	4.4	4.8	3.6	6.8%
Croatia	9.6	9.7	9.6	9.5	9.1	9.1	9.1	9.2	9.7	10.2	9.5	-0.1%
Cyprus	16.1	16.4	16.8	16.8	16.1	15.5	15.4	15.3	15.9	15.9	16.0	1.0%
Czech Republic	8.7	8.5	9.3	9.5	9.5	9.1	8.8	9.2	9.9	11	9.3	1.5%
Denmark	41.5	43.3	43.8	38.6	39	40.6	41.3	43.7	46	47.2	42.5	-0.5%
Estonia	8	8	8	8.2	8.9	9.5	10.2	10.7	11.4	12	9.5	4.0%
EU 28	17.3	18.6	19	19.1	19.5	19.8	20.2	20.8	21	21.6	19.7	6.0%
Finland	30	30.6	30.6	31.6	33.4	33.6	34	34.1	34.6	35.7	32.8	2.0%
France		25.3	25.6	26.7	27.5	28.2	28.3	31.9	28.8	30.9	28.1	4.1%
Germany	21.7	22.3	21.7	22	22.5	22.9	23.7	24.4	24.4	26	23.2	2.9%
Greece	17.8	19.8	19.7	19.6	18.1	16.7	15	15.3	14.8	14.4	17.1	1.9%
Hungary	7.8	7.2	7.5	7.7	7.8	7.9	7.9	8.2	8.7	9.9	8.1	2.4%
Ireland	38.5	37.7	37.1	36.3	36.6	37	38.3	36.6	37.7	38.9	37.5	2.6%
Italy	23.6	23.9	24.8	24.9	25.1	26.2	26.3	26.8	27.1	27.4	25.6	3.0%
Latvia	6	5.5	5.2	5.5	5.8	6	6.5	7.3	7.6	8.3	6.4	1.0%
Lithuania	5.9	5.6	5.5	5.8	6	6.4	6.7	7.1	7.8	8.6	6.6	2.9%
Luxembourg		27.3	28.8	29.6	29.7	29.1	30.5	30.1	30.2	32	29.7	4.0%
Malta	data not available											
Netherlands		31.3	33.5	34.3	34.6	35.6	37.6	38.4	38.7	39.4	35.9	3.3%
Poland	8.3	6.9	7.8	8.2	8.4	8.7	9	9.3	9.3	10.4	8.6	3.0%
Portugal	10.6	11	11.2	11.3	11.2	11.4	11.5	11.6	11.8	12.1	11.4	1.6%
Romania	3.7	3.5	3.7	3.8	3.8	3.9	4.2	4.7	5.5	6.1	4.3	5.1%
Slovakia	7.5	7.8	7.9	8.1	8.5	8.7	8.8	9	9.5	9.9	8.6	3.8%
Slovenia	15.4	15.6	16.3	16.3	16.3	16.3	16.9	17	17.6	18	16.6	1.0%
Spain	21.7	22.3	22.7	23.1	22.8	23.4	23	23	22.2	22.6	22.7	1.1%
Sweden	28.5	26.9	30.2	33	34.8	35.9	35.4	35.5	35.4	35.9	33.2	2.0%
UK	27.9	25.9	26.3	25.5	29	27	29.1	33.1	31.4	29.9	28.5	2.1%

Source: own processing based on Eurostat data

The table 5 shows the differences between Gross value added (GVA) per employee of the EU28 and member state. It is clear from the results that the highest GVA per employee is generated by companies in Ireland (+101 thousand euro per year in comparison to EU28). Other countries with high added value compared to the average are the Netherlands and Belgium (approximately 40-45 thousand euros higher to EU), also over the period under review, a significant increase is evident in these two countries - an increase of 25-30% compared to 2008. Out of the 28 countries, 11 countries show significantly higher added value than the EU 28 average. In some countries, we observe a slow decrease towards the average. In Spain and France, where the GVA per employee was down by 8 and 5 thousand euro respectively. Another group consists of countries where value-added fluctuate around the average - Germany, Luxembourg. We observed a significant decrease in Greece. In 2017, GVA per employee was down by 35% compared to 2008 (-15.7 ths. euro). The third group of countries is characterised by lower GVA per employee. Bulgaria and Romania had the lowest values. Czech Republic, Estonia, Hungary, Poland and Portugal reached about half the labour productivity of the average EU28.

Table 5. Difference of annual Gross value added per employee compared to the EU 28 average (2008-2017, thousands of euro)

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Average labour productivity	AAGR of labour productivity
Austria	13.8	11.3	11	11.7	10.5	10.3	9.9	10.9	12.8	14.6	54	1.7%
Belgium	28.9	30.7	29.4	27.4	30.5	31.8	35.9	35.9	39.1	38.1	75	2.6%
Bulgaria	-31	-32.8	-33.8	-34	-33.6	-35.4	-35.8	-36	-34.8	-34.3	9	5.9%
Croatia	-19.3	-20.8	-23.4	-23.8	-25.2	-27.2	-28.2	-28.5	-27.5	-27	18	0.0%
Cyprus	-9.6	-8.9	-11.4	-14.8	-15.1	-17.1	-17	-17.6	-15.5	-16.3	28	0.5%
Czech Republic	-17.8	-18.7	-20.7	-19.9	-21.3	-22.9	-24	-24.6	-22	-21.4	21	2.2%
Denmark	26.8	29	32.9	21.7	24.3	23.8	23.8	31.1	32	31.5	70	2.2%
Estonia	-21.1	-22.1	-24.3	-24.5	-22.6	-23.4	-21.6	-23.1	-22.1	-20.4	20	4.8%
Finland	17.8	18.3	16.6	15.4	19.2	18.3	16.7	14.1	14.6	16.7	59	1.3%
France	16.8	10.7	9.1	10.4	11.6	10.1	10.6	16	9.3	11.9	54	0.8%
Germany	1.2	1.7	-2.1	-3.5	-3.6	-4	-3.2	-2.1	-0.9	1.4	41	2.1%
Greece	7.4	11.7	6.6	4	-0.7	-6.2	-12.8	-13.8	-17.4	-15.7	39	-4.2%
Hungary	-21.3	-21.8	-24.2	-24.8	-25.6	-26.5	-26.6	-27.3	-25.7	-23.9	18	3.1%
Ireland	84.5	83.3	100	114	113	138	142	133	118	101	156	2.5%
Italy	19	16.6	20.6	19.3	18.3	18.2	19	19.6	20.6	20.2	62	1.7%
Latvia	-25.1	-28	-29.3	-30.9	-29.6	-30.5	-31	-30.3	-30.1	-29.7	13	2.7%
Lithuania	-27.3	-26.5	-29.3	-27.9	-28.2	-29.1	-30	-28.7	-27.7	-25.9	15	7.6%
Luxembourg		2.2	0.6	1.4	1.4	-2.9	-0.4	-0.8	-0.2	1.1	44	1.5%
Malta	Data not available											
Netherlands		29.5	36.5	35.4	36.1	39.8	38.4	38.9	45.7	45.9	82	3.7%
Poland	-17.7	-21.3	-22	-21.5	-20.8	-21.9	-23	-23	-22.7	-20	21	2.8%
Portugal	-14.7	-15.5	-17.8	-19.2	-19.8	-20.3	-21.2	-22.3	-21.1	-19.1	24	1.5%
Romania	-27.7	-30.3	-32	-32.6	-33.2	-35.3	-35	-39.4	-37.8	-37.1	9	-1.0%
Slovakia	-23.4	-23.1	-24.4	-21.6	-23.7	-25.8	-26.2	-28	-27.7	-25.9	18	3.8%
Slovenia	-13.5	-15	-14.2	-13.5	-15.3	-16.2	-14.5	-13.8	-13.2	-13.4	28	3.3%
Spain	11.7	8.6	9	10.8	8.3	7.9	8.8	4.7	2.9	3.2	50	-0.1%
Sweden	17.5	13.7	19	23.3	22.7	26.3	23.7	23.3	24.2	25.1	65	2.9%
UK	23.5	17.6	18	17.4	23.2	19.9	23.1	32	26.8	17.8	65	0.7%
EU28	37.6	39.2	41.2	41.8	42	43.9	44.9	45.9	45.5	45.2	43	2.1%

Source: own processing based on Eurostat data

4. Conclusion

There are significant differences in the analysed indicators between individual countries. In terms of the share of the production value of the food industry in the total manufacturing industry, this sector is of great importance in Cyprus. On the contrary, this share is the lowest in the Czech Republic, Germany or Slovakia, for example. The number of businesses in the EU has a declining trend, but leading to business concentration.

Most of the food manufacturing businesses are present only in 2 two countries - France and Italy. Food businesses in the EU are mainly smaller. However, in Denmark and Germany the average size is around 36 employees (small businesses) and in the United Kingdom even over 50, ie. already medium-sized enterprises. The number of employees in the food industry increased during the period under review, mainly in France and Germany. These countries plus Italy create almost 50% of the production value of the EU food industry. Differences in wages are observed. All countries entering after 2004 does not reach EU 28 average of the sector. Closest to EU average are employees in Slovenia and Cyprus. A similar situation is observed for Gross value added per employee, where Bulgaria and Romania reach lowest values and all post-2004 members are below EU 28 average.

In the Czech Republic, the share of the food industry in the total manufacturing industry is low. Czech food industry enterprises lag behind the EU average in size, wages, labour productivity. Further development of Czech food industry is crucial for sustaining viable and competitive agricultural sector.

Acknowledgements

This paper is supported by a grant of the National Agency for Agricultural Research (NAZV). The project title is "Dualita v českém zemědělství: výhoda nebo nevýhoda pro zemědělství nové generace?" (QK1920398).

References

Beestermöller, M., Disdier, A. C. and Fontagné, L. (2018), "Impact of European food safety border inspections on agri-food exports: Evidence from Chinese firms", *China Economic Review*, vol. 48, pp. 66-82, ISSN 1043-951X, DOI 10.1016/j.chieco.2017.11.004

Blažková, I. (2016), "Convergence of market concentration: evidence from Czech food processing sectors", *AGRIS on-line Papers in Economics and Informatics*, no. 8, pp. 25-36, ISSN 1804-1930, DOI 10.7160/aol.2016.080403

de Paula, N. (2000), "Structural change in the food industry: a survey on the trends towards concentration", *Revista de Economía e Sociología Rural*, no. 38, vol. 3, pp. 181-203, ISSN 1806-9479

EC, European Commission (2019), "*Monitoring Agri-trade Policy, MAP 2019-1*", Brussels, [Online], Available: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/news/documents/agri-food-trade-2018_en.pdf, [Accessed: 23 Nov. 2015]

Eurostat (2020a), "*Structural business statistic - Reference Metadata in Euro SDMX Metadata Structure (ESMS)*", Brussels, [Online], Available: https://ec.europa.eu/eurostat/cache/metadata/en/sbs_esms.htm, [Accessed: 23 Apr. 2020]

Eurostat (2002b), "*Structural business statistic, Eurostat products Datasets - Total wages and salaries*", [Online], Brussels, Available: https://ec.europa.eu/eurostat/web/products-datasets/-/tps00113, [Accessed: 23 Apr. 2020]

Food Drink Europe (2020), "*Data & Trends - EU Food & Drink Industry 2019*", Brussels, [Online], Available: https://www.fooddrinkeurope.eu/uploads/publications_documents/FoodDrinkEurope_-_Data__Trends_2019.pdf, [Accessed: 26 Apr. 2020]

Jansik, C. (2004), "Food Industry FDI-An Integrating Force between Western and Eastern European Agri-food Sectors", *EuroChoices*, no. 3, vol. 1, pp. 12-17, ISSN 1746-692X, DOI 10.1111/j.1746-692X.2004.tb00004.x

Kareem, F. O., Martínez-Zarzoso, I., and Brümmer, B. (2018), "Protecting health or protecting imports? Evidence from EU non-tariff measures", *International Review of Economics & Finance*, no. 53, pp. 185-202, ISSN 1059-0560, DOI 10.1016/j.iref.2017.08.012

Maitah, M., Hayat, A., Malec, K., and Eldeeb, O. (2014), "The impact of foreign direct investments on employment in the Czech Republic", *Research Journal of Applied Sciences*, no. 9, vol. 12, pp. 1001-1008, ISSN 1993-6079, DOI 10.36478/rjasci.2014.1001.1008

Notta, O., and Vlachvei, A. (2019), "Competitiveness Index of EU Food and Beverage Manufacturing Industries", *International Conference on Applied Economics,* Milan, pp. 635-650, ISSN 2198-7246, DOI 10.1007/978-3-030-38253-7_42

Szwacka-Mokrzycka, J. (2015), “The impact of concentration of production on market position of selected branches of food industry in Poland”, *Journal of Agribusiness and Rural Development*, no. 2, pp. 323-328, ISSN 1899-5772, DOI 10.17306/JARD.2015.34

Špička, J. (2016), “Market concentration and profitability of the grocery retailers in Central Europe”, *Central European Business Review*, no. 5, vol. 3, pp. 5-24, ISSN 1805-4862, DOI 10.18267/j.cebr.155

Phiri, J., Malec, K., Majune, S. K., Appiah-Kubi, S. N. K., Gebeltová, Z., Maitah, M., Maitah, K. and Abdullahi, K. T. (2020), “Agriculture as a Determinant of Zambian Economic Sustainability”, *Sustainability*, no. 12, vol. 11, pp. 45-59, ISSN 2071-1050, DOI 10.3390/su12114559

IMPACT OF AGRICULTURAL INSURANCE ON THE FARMING PRACTICE: CASE OF GEORGIA

Mariam Petriashvili

Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

petriashvili@pef.czu.cz

Annotation: Agricultural sector, unlike other sectors of the economy, faces specific risk factors, which largely depends on natural climatic conditions and the ongoing global meteorological changes. Because of given risks farmers' income is unpredictable and many of them fear whether they have ability to cope with overhead costs, family demands and also repay any loan. In 2014 the government of Georgia introduced agricultural insurance program aiming to broaden farmers' access to farm resources, positively changing farmers' attitude to risk and to achieve increased food supplies in the market. The research aims to determine whether agricultural insurance has any significant influence on the farming practices in the country. Two categories of respondents were surveyed to obtain the data required for the analysis. A sample of seventy insured and eighty uninsured farmers were selected and interviewed using a Likert scale questionnaire. Cobb-Douglas production function were used to compare production practices between insured and uninsured farmers in the study area. The study found out that the most of insured farmers improved farming practices and have more opportunity to sell greater proportion of their output on the market, however uninsured farmers are more productive and efficient in their resource use.

Key words: Agriculture, Risks, Insurance, Georgia

JEL classification: Q19, G22

1. Introduction

Agriculture is a major economic sector and a critical source of livelihood in many developing countries. Millions of poor people face prospects of tragic crop failure or livestock mortality when rainfall patterns shift or extreme events such as drought and floods become more frequent, as a result of climate change. Agricultural insurance is key in assisting farmers, herders, and governments to mitigate the negative financial impact of these adverse natural events (Ramirez, Ritchie and Sadoulet, 2016). In the absence of agricultural insurance, natural disasters (hail, strong winds, floods, frost, and droughts) can cause significant crop losses for farms and increase the financial vulnerability of farm households (Du, Feng and Hennesey, 2017). Jamaal, Natikar and Halakatti (2019) in his research "A Study on Farmers Knowledge about Crop Insurance Schemes in Northern Karnataka" discovered that the respondent farmers agreed to the following statements: agricultural enterprise is faced with risks and uncertainties; agricultural insurance is beneficial; agricultural insurance reduces farmers' worries and stress. Agricultural Insurance, in its widest sense may be defined as the stabilization of income, employment, price and supplies of agricultural products by means of regular and deliberate savings and accumulation of funds in small installments by many in favorable time periods to defend some or few of the participants in less favorable times (AXA, 2015). Smith and Glauber (2012) suggest that the perceived demand for agricultural insurance may be overstated, because farmers can use diversification and savings to cushion the impact of production shortfalls on consumption. Governments have traditionally put heavy emphasis on managing agricultural market through marketing boards, quotas, price support mechanism, input subsidies, and other mechanisms in order to stabilize producers' income. Governments perceive agricultural insurance as supplementing these traditional means by addressing production risks. (Pearcy and Smith, 2015).

The demand of agricultural insurance might depend on farmers' awareness and experience, individual loss ratios, indemnities, etc. In general, the literature finds that the demand for crop insurance is price inelastic, suggesting the necessity of large premium subsidies to increase farmers' participation (Coble and Barnett, 2012). On the other hand, some authors have criticized subsidized crop insurance on several counts. (Skees et.al., 2005).

Several governments in developing countries have recently tried to promote agricultural insurance, moving from small-scale pilots to large-scale agricultural insurance programs, mainly through the provision of agricultural premium subsidies. (Castillo, Boucher and Carter, 2016).

In 2014, the Government of Georgia initiated the Agricultural Crop Insurance Project. The aim of the program is to support the development of the agricultural insurance market to minimize production risks and thus stabilize farmers' income, encourage investment, and increase agricultural production. Within this project, insurance packages cover losses caused by weather-related disasters such as hail, flooding, and storms, as well as by autumn frost (though only for citrus). Farmers are granted the opportunity to insure a maximum of 5 hectares of land of crops other than grains. For grain, insurance is available for a maximum of 30 hectares of land. In the case of agricultural cooperatives, the maximum insured sum is 50, 000 GEL but the area of insured land is not limited (Law of Georgia on Approval of the Agricultural Insurance Program, 2014).

2. Materials and Methods

Seventy insured and eighty uninsured farmers were targeted in Georgia and I managed to get 113 (54 insured farmers; 49 uninsured farmers) completed and usable questionnaires. Selected farmers operate under similar environmental factors and they have similar characteristics. The collected data were analyzed to see if there were any significant differences between insured and uninsured farmers behavior in terms of their resource utilization, the level of production achieved, and the revenue generated.

Production functions have been widely used to compare the level of resource use between groups of farms. It shows a technical relationship between input and output in a production process. The production function estimates are used to disclose significant differences that exist between insured and uninsured farmers in terms of the characteristics of resource use, production and income. Different production functions can be specified as a basis to examine and compare production characteristics between farms. There is no given rule that a certain functional form is more appropriate than the other (Madala, 2013). However, for this type of study the Cobb-Douglas production function has been widely used and is the functional form applied in this comparative analysis. The choice was based on its advantages over other forms. Also, Mathematical calculations are simple in the model.

The study used econometric analysis as a basis to compare production practices between insured and uninsured farmers in the study area. Production functions project a physical relationship between inputs or factors of production and the resulting farm output represented as the dependent variable. A typical production function can be implicitly represented as:

$$Q=f(X) \tag{1}$$

where Q is the homogeneous output representing the endogenous variable and X, the n-dimensional vector of homogeneous inputs represented as explanatory variables.

For this study different functional forms were tested on the cross-sectional data collected, but the Cobb-Douglas function was chosen as the basis of result presentation because it enjoys a wider application in this type of study and because of the added information implied by its parameter estimates. It has been emphasized that linear and quadratic functions which were commonly used as alternatives are better suited to the analysis of experimental data than to the analysis of cross-sectional data. Obtained statistical estimates are used to compare production performance between the identified groups of respondents. The function is thus used to examine production performance and resource productivity between insured and uninsured farmers.

The Cobb-Douglas function can be implicitly presented as:

$$Q=AX^{b}X^{(1-b)} \tag{2}$$

where A is a positive constant term and b - positive fraction. Q and X are the variables, the relationship between which are examined by the equation. However, in order to specify the equation, the above implicit equation must be explicitly expressed by taking the log transformation of both sides as shown below;

$$\ln Q = \beta_0 + \beta_1 \ln X1 + \beta_2 \ln X2 + \text{----} + \beta_9 \ln X9 + u \tag{3}$$

where the respective variables in the equation are represented as follows:

Q, the dependent variable is the value of the farm output generated; value of planting seeds (local seed, X1 and improved seed (X2), fertilizer (X3) and farm size (X4) and value of labor employed on the farm (X5). Other variables include expenditure on agro-chemicals such as herbicides and pesticides (X6), expenditure on value added (X7), value of farm assets (X8) and (X9), a dummy variable used to represent the holding of an insurance policy.

β_0, β_1 -- β_9 are the parameters (coefficients) to be estimated, that respectively measures the relationship between the inputs and output in the production process, for the ninth inputs.

u is the error term which is assumed to be normally distributed with mean zero and constant variance. ln is the natural logarithm of the respective variables included in the equation. The essence of the log transformation is in recognition of the existence of error in the included variables, by the transformation the error is made to be nearly and normally distributed without any pattern in its relationship.

F-ratio was used to test the joint hypothesis to show whether the included variables exert any significant influence on the dependent variable, the value of farm output. It tests the null hypothesis that all the estimated coefficients are zero. The tests of the hypotheses are explicitly represented as follows:

$$HO: \beta_1 = \beta_2 = \text{-----} = \beta_8 = 0 \tag{4}$$

as against the alternative hypothesis that at least one of the coefficients are not zero

$$H1: \beta_1 \neq \beta_2 \neq \text{-----} \neq \beta_8 \neq 0. \tag{5}$$

The results of the data analyses are presented in the following section.

3. Results and Discussion

Three equations were specified, one for insured and uninsured farmers' pooled estimates and one each for them. The criteria for comparison between them were based on the characteristics of the parameter estimates of the respective production functions. These estimates include sign of the coefficients and the value, the significance of the coefficients, the R2 (and adjusted R2), F-value and the result of other diagnostic tests such as multicollinearity and heteroscedastic. The respective equations are shown in Table 1.

Table 1. Production Function Estimates for Surveyed Farmers

Variables	Insured Farms	Uninsured Farms	Pooled estimates
Intercept	5.1478 (10.217)	4.1275 (13.755)	5.1734 (14.9645)
Local seed (X1)	0.0643 (0.780)	0.22378*** (4.891)	0.1378*** (2.769)
Improved seed (X2)	0.0511 (0.698)	0.01645 (0.749)	0.03669 (1.188)
Fertilizer (X3)	0.16752 ** (1.783)	0.0634*** (1.789)	0.68844 * **(2.11)
Farm size (X4)	0.0692 (1.237)	0.191 (0.514)	0.05128* (1.51)
Labor (X5)	0.16117*** (2.834)	0.0673** (2.499)	0.11675*** (3.473)
Agro-chemicals (X6)	-0.0634 (0.534)	0.0298 (0.283)	0.017845 (0.167)
Value added (X7)	0.5137 (0.734)	0.01878 (1.075)	0.02997 (0.2176)
Value of farm asset (X8)	0.3954*** (3.957)	0.51553 *** (4.139)	0.012356 (6.67)
Dummy (X9)			-0.37546 (1.745)**
R2	0.78123	0.87872	0.80715
R-2 (adjusted)	0.69456	0.79345	0.71234
F-value	33.589***	313.078***	167.1623 ***
DW-statistic	1.7862	2.1346	1.7891

Source: Own Calculation

Considering the equation obtained for the insured farmers, the value of assets owned by the farmer and the labor utilized on the farm were significant ($p<0.01$). It appears that both inputs bring great influence on the level of output obtained by the farmers. The value of fertilizer used on the farm had a significant ($p<0.05$) influence as well on farm production among the insured farmers. This result is in line with Santeramo et.al. (2016). All the included variables except the use of agro-chemicals are positively and correctly signed.

For the uninsured farmer, three of the included explanatory variables were significant at the $p<0.05$ level: The value of local seeds, the stock of assets owned, and fertilizer used in production. Also use of farm labor was found to be significant at $p<0.05$ level. As explained above, the high significance of the parameter estimates of these variables implies that they exert great influence on the level of production achieved by the uninsured farmers.

It was found that the value of the stock of assets owned by farmers, labor, the use of local planting materials and holding of insurance policy were significant ($p<0.01$) and the use of fertilizer was significant ($p<0.05$). All the variables are positively signed implying that they are positively contributing to output but at different rates. Surprisingly, the use of modern planting materials and chemicals were not found to be significant in any of the specified equations. The R2 values indicated the proportion of the total variation in output that is accounted for by the included independent variables. An R2 value of 69.45 percent was obtained for the specified function for the insured farmers as compared to 79.34 percent for the uninsured farmers. While an R2 value of 71.23 percent was obtained for the pooled estimates of the two farm groups. The high percentage values show the equations to give good representation of the relationship between farm output and the included variables. The adjusted R2 values allow a comparison of the R2 between different equations even with differences in the number of included explanatory variables.

From the pooled equation, the efficiency of resource use among the farm groups can be compared. Efficiency is defined as the value of output that is generated per unit of input. The higher the value, the more efficient the farmer is. Different mathematical equations have been used to compare efficiency of resource use between farms. This study used the sign of the parameter estimates of the dummy variable in the pooled equation as measure of the efficiency of resource use between the farm groups. The sign of the dummy variable reveals the direction of the efficiency of resource use between the insured and uninsured farms. A positive signed coefficient indicates the efficiency moves toward the larger integer of the coded variables, that is, the insured farmers. Whereas a negative coefficient suggests that the efficiency measure will tend to the lower integer representing the uninsured farmers. The sign of the coefficient obtained in this analysis is negative, thereby showing that the uninsured farmers were more efficient in the bundle of resource use than the insured farmers.

The F-values of 33.59 and 313.08 were obtained for the insured and uninsured farmers' production functions, respectively. Also, an F-value of 167.16 was obtained for the pooled farms. All the F-values were significant ($p<0.01$). This showed that the included independent variables jointly exert great influence on the level of farm output generated by the respective farm groups. The estimates of the diagnostic tests did not show any problem of serial correlation or multi-collinearity in the function, see Table 2.

Table 2. Diagnostic Tests using LM Version

Test Statistics	Insured Farms	Uninsured Farms	Pooled estimates
Serial Correlation	CHSQ(1)=0.01239 (0.807)	CHSQ(1)=0.8613 (0.376)	CHSQ(1)=0.0634 (0.677)
Functional Form	CHSQ(1)=1.2849 0.193)	CHSQ(1)=0.3634 (0.587)	CHSQ(1)=2.3944 (0.129)
Normality	CHSQ(2)=78.6709 (0.000)	CHSQ (2)=1103.456 (0.000)	CHSQ(2)=799.1732 (0.000)
Heteroscedasticity	CHSQ(1)=0.04893 (0.717)	CHSQ(1)=0.0689 (0.867)	CHSQ(1)=0.5934 (0.377)

Source: Own Calculation

The high R2 values estimated, the significance of the F-values and the result of the diagnostic tests confirmed the quality of the estimates and they suggest that the equations can be relied upon for discussion, forecasting and for policy recommendation.

The research found that insured farmers are more commercially oriented. They used more modern farm inputs and choose enterprises that are more market oriented than the uninsured farmers, as confirmed by Hazell (1992). He was proving that agricultural insurance is one of the best strategies to address farm risks and encourage farmers to embrace modern farm inputs with greater potential for better and quality yields. However, the uninsured farmers are found to be more productive and efficient in the use of their farm inputs.

The impact of the agrochemical use is worthy of note. In the two farm groups it does not contribute substantially to farm output. Even among the insured farmers that used more of the input, it contributed negatively to farm output. There are some factors that can be identified to be responsible to this pattern of relationship. The input may not be applied as expected because of the high level of illiteracy. This opinion is supported by Jamaal et. al. (2019), as they found in their research that the insurance is seen to be risky for some farmers due to lack of enough knowledge.

The findings from this study are surprising in the light of the rationale for initiating the insurance program. Apart from the fact that insured farmers embraced modern farming practices, possibly because of their accessibility to farm credit, their farm output does not make them better farmers than the uninsured farmers. The operation of agricultural insurance should not be limited to climatic variability, but the government should complement their operations by making farm inputs readily accessible to farmers and that farmers are enlightened about their use.

4. Conclusion

One of the important assumptions of the agricultural insurance scheme was that its introduction would encourage farmers to positively change their farming practices. Specifically, insurance program was established for farmers to have better access to essential farm resources that would motivate them to be involved in modern farming practices, increase the quality and quantity of farm production and food supplies to the market. The study found that agricultural insurance influences on the range of inputs and production methods farmers used on the farm, however, did not prove better management and organizing of available resources for increased productivity. Evidence from the operation of the agricultural insurance scheme in the study area suggests that whilst insurance resulted in changes in production practices, this did not lead to a statistically significant increase in output and did appear to be associated with inappropriate application of some inputs with adverse consequences for farm profitability. Despite the fact, that more insured farmers used improved production practices, the level of productivity achieved did not justify the extra expense incurred. The analysis suggests that the insured farmer would generate more output and greater net profit by reducing their present level of resource use as compared to uninsured farmers. The latter still have the potential to generate more output than they are generating currently by increasing their use of resources.

References

AXA. 2015. Parametric Insurance: A Fitting Solution for the Weather-Sensitive - A Look at New Weather Risk Management Solutions to Protect People, Companies and Economies. AXA Corporate Solutions, Paris, 2015, [Online], Available: https://axa-prod.s3.amazonaws.com/www-axa-com%2F2c3da04e-12f8-489c-a356-ee84800d8550_axa_parametric_insurance.pdf, [Accessed: 23 Nov. 2019]

Castillo, M. J., Boucher, S. and Carter, M. (2016), "Index Insurance: Using Public Data to Benefit Small-Scale Agriculture", *International Food and Agribusiness Management Review*, vol. 19, issue A, pp. 93-114, DOI 10.22004/ag.econ.240698

Coble, K. H. and Barnett, B. J. (2012), "Why Do We Subsidize Crop Insurance?", *American Journal of Agricultural Economics,* vol. 95, no. 2, pp. 498-504, DOI 10.1093/ajae/aas093

Du X., Feng H. and Hennessy A.D. (2017), “Rationality of Choices in Subsidized Crop Insurance Markets”, *American Journal of Agricultural Economics*, vol. 99, no. 3., pp. 732-756, DOI 10.1093/ajae/aaw035

Hazell P. B. R. (1992), The Appropriate Role of Agricultural Insurance in Lower Income Countries. Journal of International Development, vol. 4, no. 6, pp. 567-581, DOI 10.1002/jid.3380040602

Jamanal, S. K., Natikar, K. V. and Halakatti S. V. (2019), “*A Study on Farmers Knowledge about Crop Insurance Schemes in Northern Karnataka*”, International Journal of Enviroment and Climate Change, vol. 9, no.12, pp. 691-700, ISSN 2581-8627

“Law of Georgia on Approval of the Agricultural Insurance Program” (2014), [Online], Available: https://matsne.gov.ge/ka/document/view/2474880?publication=0, [Accessed: 23 Apr. 2020]

Madala G. S. (2013), “*Limited Dependent and Quantitative Variables in Econometrics*”, Cambridge University Press, ISBN 978051181017, DOI 10.1017/CBO9780511810176

Pearcy J. and Smith H. (2015), “The Tangled Web of Agricultural Insurance: Evaluating the Impacts of Government Policy”, *Journal of Agricultural and Resource Economics*, vol. 40, no. 1., pp. 80-111, DOI 10.22004/ag.econ.197378

Ramirez J. A., Ritchie E. and Sadoulet E. (2016), “*Weather index insurance and shock coping: evidence from Mexico’s CADENA program*”, Policy Research Working Paper, Word Bank group, DOI 10.1596/1813-9450-7715

Santeramo F. G., Goodwin B. K., Adinolfi F., Capitanio F. (2016), “Farmer Participation, Entry and Exit Decisions in the Italian Crop Insurance Programme”, *Journal of Agricultural Economics*, vol. 67, no. 3, pp. 639-657, DOI 10.1111/1477-9552.12155

Skees, J., Varangis, P., Larson, D. and Siegel, P. (2002), “Can financial markets be tapped to help poor people cope with weather risks?”. *Policy Research working paper*, World Bank.

Smith, V. H. and Glauber, J. W. (2012), “Agricultural Insurance in Developed Countries: Where Have We Been and Where Are We Going?”, *Applied Economic Perspectives and Policy*, vol. 34, no. 3, pp 363–390, DOI 10.1093/aepp/pps029

FOOD IN THE CONTEXT OF SUSTAINABILITY - INSTAGRAM SOCIAL NETWORK ANALYSIS

Ladislav Pilař[1], Lucie Kvasničková Stanislavská[2], Michal Prokop[3] and Pia Jaaskelainen[4]

[1, 2, 3] Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic,
[4] South-Eastern Finland University of Applied Sciences, Finland

[1]pilarl@pef.czu.cz, [2]kvasnickova@pef.czu.cz, [3]mprokop@pef.czu.cz, [4] pia.m.jaaskelainen@xamk.fi

Annotation: Food sustainability is one of the key topics in the field of sustainability. Moreover, food is an integral part of human life. One of the important aspects of researching a problem is understanding the perception of the topic. One option for a deep understanding of social, cultural, and environmental issues is analyzing people's activities on social media in the area of food sustainability. The aim of this article is to identify the key topics and communities that are associated with the #sustainability and #food hashtags that are used together in Instagram messages. The data were recorded between November 13, 2017, and December 11, 2018. It is unique data because, on December 11, 2018, Instagram banned downloading data based on API. The software captured messages that used the hashtag #sustainability and also contained #food. A total of 38 565 Instagram messages written by 12 364 unique users worldwide were recorded during this period. Basic network analysis based on frequency characteristics and Eivenvector centrality identified key topics that are communicated on the Instagram social network: Organic, Vegan, Zero Waste, Eco Friendly, Food Wase, and Healthy food. Community analysis extracted 5 communities: Healthy sustainable living; Ecological sustainability; Support local agriculture; Community development, and Charity.

Keywords: Food Sustainability, Organic, Zero Waste, Eco Friendly, Food Waste, Instagram, Hashtag

JEL classification: M31, Q13

1. Introduction

The world faces the challenge of achieving sustainable food security (El Bialali, 2019). Given the current growth of the world's population and global globalization, the current food system is at the center of global social, environmental and economic challenges, which are moderated by challenges such as ecosystem degradation, resource scarcity and climate change (Kang et al., 2017; Bocchiola et al., 2019; Leisner, 2020). These challenges also mean changes with consumer preferences. For example, preferences for local and regional products, eco, organic products (Rojík et al., 2018; Chalupová, Prokop and Rojík, 2016; Zámková and Blažková, 2013). One option for a deep understanding of social, cultural and environmental issues, is analyzing people's activities on social media, which can provide valuable information on the attitudes of the global population to the problem under consideration (Hu et al. 2014; Pilař et at., 2018a,b,c,d; Pilař et at., 2019a,b). Moreover, social media was a space for public information dissemination in the form of networked mass communication, which is possible to use as space for information sourcing to support decision-making (Stevens et al., 2016). As Yoon et al. (2015) says, "Monitoring and identifying current technological trends "is crucial for government policy, research and development, strategic planning, social investment, and enterprise practices."

The potential of social network analysis is huge. Predictions indicate that by 2023, 3.2 billion people will be on social networks (Statista, 2020). Hashtag analysis is an alternative to the analysis of the entire content of the report (Pilař et al., 2017). Social media content analysis based on hashtags is a very valuable analysis that has been used in many areas, for example, Farmers Market (Pilař et al., 2018a), organic food (Pilař et al., 2018b), Sustainability (Pilař et al., 2019a) or Gamification (Pilař et al., 2019b).

The aim of this article is to identify the key topics and communities that are associated with the #sustainability and #food hashtags that are used together in Instagram messages.

2. Materials and Methods

Netlytic software was used to acquire messages from Instagram social network communication. The data were recorded between November 13, 2017, and December 11, 2018. It is unique data because, on December 11, 2018, Instagram banned downloading data based on API. The software captured messages that used the hashtag #sustainability and also contained #food. A total of 38 565 Instagram messages written by 12 364 unique users worldwide were recorded during this period. The data analysis is based on the Knowledge Discovery in Databases (KDD) process and is modified to the social media data analysis requirements with a focus on hashtags (Pilař et al., 2019a,b).

1) Content filtration – all content that did not start with a # character was removed from the total message content (it was not a hashtag)
2) Content transformation – hashtags have been converted to a uniform format that is readable by Gephi. It involves transforming all text to lowercase and separating individual hashtags with a comma. Hashtags # organic # food and #organic, #food
3) Hashtag reduction - To detect communities is necessary to process a hashtag reduction to remove micro-communities. A large number of communities is caused by an extensive number of hashtags that contained local hashtags and hashtags created by the users themselves.
4) Data Mining - The following methods were used for data analysis:

Frequency

Frequency is a value that expresses the hashtag frequency within a network.

Eigenvector Centrality

Eigenvector centrality is an extension of degree centrality and measures the influence of hashtags in a network. The value is calculated based on the premise that connections to hashtags with high values (hashtags with high degree centrality) have a greater influence than links with hashtags of similar or lower values. A high eigenvector centrality score means that a hashtag is connected to many hashtags with a high value, and is calculated as follows:

$$x_v = \frac{1}{\lambda} \sum_{t \in M(v)} x_t = \frac{1}{\lambda} \sum_{t \in G} a_{v,t} x_t \qquad (1)$$

where M(v) denotes a set of adjacent nodes and λ is a largest eigen value. Eigen vector x can be expressed by equation (2):

$$Ax = \lambda x \qquad (2)$$

Modularity

Most complex networks contain nodes that are mutually interconnected to a larger extent than with the rest of the network. Groups of such nodes are called communities (McCurdie, Sanderson and Aitken, 2018). Modularity (modularity value) represents an index that identifies the cohesion of communities within a given network (Newman and Girvan, 2004). Networks with high modularity show strong links between nodes inside modules, but weaker links between nodes in different modules (Knoke, 2008).

Community Analysis

The Community analysis (component analysis) then identifies the number of different components (in the case of community modularity) in the network based on the modularity detection analysis (Blondel, 2008), as follows:

$$\Delta Q = \left[\frac{\sum_{in} + 2k_{i,in}}{2m} - \left(\frac{\sum_{tot} + k_i}{2m}\right)^2\right] - \left[\frac{\sum_{in}}{2m} - \left(\frac{\sum_{tot}}{2m}\right)^2\right] \quad (3)$$

where ∑in is the sum of weighted links inside the community, ∑tot sum of weighted links incident to hashtags in community, ki sum of weighted links incident to hashtag i, ki, in sum of weighted links going from i to hashtags in community and a m normalizing factor as the sum of weighted links for the whole graph.

3. Results and Discussion

Based on the insertion of 38,565 Instagram messages, a network was created that contained 79 658 nodes, which was connected by 2 597 478 edges. Table 1 describes the basic characteristics of the reduced and non-reduced network.

Table 1. Basic characteristics of the reduced and non-reduced network connected to Food Sustainability in Instagram Social Network

Characteristic	Non-Reduced Network	Reduced Network
Number of nodes	79,658	1,025
Number of Edges	2,597,478	170,501
Average degree	65.216	333.122
Modularity	0.316	0.254
Number of Communties	126	5

Source: Own research, 2020

Based on the frequency analysis, it is possible to identify as 5 main hashes in connection with Food sustainability: 1) # organic, 2) #vegan, 3) #zerowaste, 4) #ecofriendly and 5) #foodwaste. Based on eigenvector centrality, the following 5 main hashtags can be identified: 1) #organic, 2) #vegan, 3) #zerowaste, 4) #healthyfood, and 5) #ecofriendly. Hashtags #sustainability, #food, #sustainable, #foodie, and #sustainablelivin are taken here as hashtags of one theme (Food Sustainability) and do not indicate another theme.

Table 2. Characteristics of top 20 hashtags sorted by frequency and Eigenvector-centrality

No.	Hashtag	Frequency	Modularity	Eigenvector-centrality	No.	Hashtag	Frequency	Eigenvector-centrality
1	#sustainability	38565	2	1,0000	1	#sustainability	38565	1,0000
2	#food	16217	2	0.9935	2	#food	16217	0.9935
3	#sustainable	6874	0	0.9833	3	#organic	6492	0.9855
4	#foodie	6694	2	0.9800	4	#sustainable	6874	0.9833
5	#organic	6492	2	0.9855	5	#sustainableliving	5207	0.9807
6	#vegan	6358	2	0.9726	6	#foodie	6694	0.9800
7	#zerowaste	5440	3	0.9683	7	#vegan	6358	0.9726
8	#sustainableliving	5207	0	0.9807	8	#zerowaste	5440	0.9683
9	#ecofriendly	4251	2	0.9609	9	#healthyfood	3520	0.9613
10	#foodwaste	4100	1	0.9484	10	#ecofriendly	4251	0.9609
11	#healthy	4027	3	0.9587	11	#healthy	4027	0.9587
12	#foodporn	3875	3	0.9307	12	#plantbased	3794	0.9557
13	#plantbased	3794	0	0.9557	13	#environment	3774	0.9553
14	#environment	3774	3	0.9553	14	#green	2843	0.9530
15	#healthyfood	3520	2	0.9613	15	#foodwaste	4100	0.9484
16	#instafood	3306	1	0.9280	16	#nature	2590	0.9447
17	#agriculture	3143	2	0.8448	17	#health	2545	0.9410
18	#green	2843	3	0.9530	18	#foodporn	3875	0.9307
19	#nature	2590	2	0.9447	19	#instafood	3306	0.9280
20	#health	2545	3	0.9410	20	#agriculture	3143	0.8448

Source: Own research, 2020

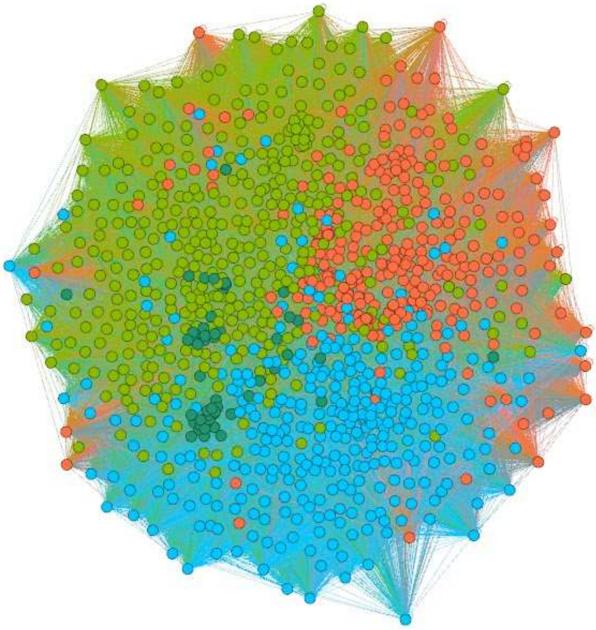
The results of the analysis of the importance of the hashtag in the network on the basis of frequency analysis and on the basis of eigenvector centrality analysis yield subtle results (see table 2). The only difference is #healthyfood, which got into the top 5 hashtags based on an analysis of Eigenvector centrality.

The results of community analysis show that there is one dominant community 1) Healthy sustainable living that focuses on a healthy sustainable lifestyle, which is characteristic by hashtags #sustainable; #sustainableliving; #environment; #zerowaste; #ecofriendly. This community includes about 56 % of the hashtags captured. The other two communities, which include about 33 % of hashtags 2) Ecological sustainability (17 %) which is characteristic by hashtags #vegan; #plantbased; #healthyfood; #health; #veganfood and 3) Support local agriculture which is characteristic by hashtags #organic; #agriculture; #fresh; #farmtotable; #eatlocal.

Subsequently, there are 2 smaller communities. 4) Community development that are focused on community developing, which is characteristic by hashtags #farming; #foodsovereignty; #education; #growyourown; #sustainabilityproject and community 5) Charities, which is characteristic by hashtags #volunteer; #youth; #poverty; #charity; #support (see table 3)

Community visualization and modularity value (see table 1) confirm low polarity value. This means that individual communities are not polarized among themselves, which affects both strategic product portfolio management and marketing management.

Figure 1. Community polarization



Source: Own research, 2020

Table 3. Characteristics of top 20 hashtags sorted by frequency and Eigenvector-centrality

Name of the Community	**Size of the Community**	**Key Hashtags**
Healthy sustainable living	56.29 %	#sustainable; #sustainableliving; #environment; #zerowaste; #ecofriendly
Ecological sustainability	17.17 %	**#vegan; #plantbased; #healthyfood; #health; #veganfood**
Support local agriculture	15.80 %	#organic; #agriculture; #fresh; #farmtotable; #eatlocal
Community development	5.85 %	#farming; #foodsovereignty; #education; #growyourown; #sustainabilityproject
Charity	4.88 %	#volunteer; #youth; #poverty; #charity; #support

Source: Own research, 2020

4. Conclusion

This article shows that an analysis of social networks such as Instagram provides valuable information about people's perceptions.

The area of Food Sustainability is a highly important area for testing from many angles. Both in terms of food safety, sustainable agriculture, ecological agriculture, but as the results of this research shows, there are also communities that focus on community development and charities. These areas, therefore, also need to be addressed.

Basic network analysis based on frequency characteristics and Eivenvector centrality identified key topics that are communicated on the Instagram social network: Organic, Vegan, Zero Waste, Eco Friendly, Food Wase, and Healthy food. Community analysis extracted 5 communities: Healthy sustainable living; Ecological sustainability; Support local agriculture; Community development, and Charity.

This conference paper identifies the basic areas that are communicated on social networks. In further research, it would be appropriate to set up an international team that would identify 1) regional differences in Food Sustainability on the basis of geolocation and using the social network Twitter 2) Identify trends in individual regions in relation to food sustainability based on artificial intelligence and longer time series.

Acknowledgments
This study was supported by the Internal Grant Agency (IGA) of FEM CULS Prague, registration no. 2020B0004 - Use of artificial intelligence to predict communication on social networks.

References

Blondel, V. D., Guillaume, J.-L., Lambiotte, R. and Lefebvre, E. (2008), "Fast unfolding of communities in large networks", *J. Stat. Mech. Theory Exp.,* P10008

Bocchiola, D., Brunetti, L., Soncini, A., Polinelli, F. and Gianinetto, M. (2019) "Impact of climate change on agricultural productivity and food security in the Himalayas: A case study in Nepal", *Agricultural Systems*, Elsevier BV, vol. 171, pp. 113–125, DOI 10.1016/j.agsy.2019.01.008

El Bilali, H. (2019) "Research on agro-food sustainability transitions: A systematic review of research themes and an analysis of research gaps", *Journal of Cleaner Production*, Elsevier BV, vol. 221, no. 1, pp. 353–364. DOI 10.1016/j.jclepro.2019.02.232

Hu, Y., Manikonda L. and Kambhampati S. (2014) "What we instagram: A first analysis of instagram photo content and user types", *Proceedings of the 8th International Conference on Weblogs and Social Media*, ICWSM 2014, pp. 595 - 598

Chalupová, M., Prokop, M., and Rojík, S. (2016), "Preference of the Regional Food and Recognition of Regional Labels in Vysočina Region (Czech Republic)", *European Countryside,* vol. 7, no. 1, pp, 109-122, DOI 10.1515/euco-2016-0009

Kang, S., Hao, X., Du, T., Tong, L., Su, X., Lu, H., Li, X., Huo, Z., Li, S. and Ding, R. (2017) "Improving agricultural water productivity to ensure food security in China under changing environment: From research to practice", *Agricultural Water Management*, Elsevier BV, vol. 179, pp. 5–17, DOI 10.1016/j.agwat.2016.05.007

Knoke, D. and Yang, S. (2008), "*Social Network Analysis*", 2nd ed.; Sage Publications, ISBN 978-1-4129-2749-9

Leisner, C. P. (2020) "Review: Climate change impacts on food security- focus on perennial cropping systems and nutritional value", *Plant Science*, Elsevier BV, vol. 293, DOI 10.1016/j.plantsci.2020.110412

McCurdie, T., Sanderson, P. and Aitken, L. M. (2018), "Applying social network analysis to the examination of interruptions in healthcare", *Applied Ergonomics. Elsevier BV*, vol. 67, pp. 50–60, DOI 10.1016/j.apergo.2017.08.014

Newman, M. E. J. and Girvan, M. (2004), "Finding and evaluating community structure in networks", *Physical Review E. American Physical Society (APS)*, vol. 69, no. 2, DOI 10.1103/physreve.69.026113

Pilař, L. Pitrová, J. Rojík, S. Gresham, G. (2018c), "What Does 'safe Food' Mean For Young Customers?", *Proceedings of the Agrarian Perspectives XXVII*, p. 236-242

Pilař, L., Balcarová, T., Rojík, S., Tichá, I. and Poláková, J. (2018a), "Customer experience with farmers' markets: what hashtags can reveal", *International Food and Agribusiness Management Review. Wageningen Academic Publishers*, vol. 21, no. 6, pp. 755–770. DOI 10.22434/ifamr2017.0039

Pilař, L., Kvasničková Stanislavská, L., Gresham, G. Pitrová, J. Rojík, S. Petkov, R. (2018d), "Questionnaire Vs. Social Media Analysis - Case Study Of Organic Food ", *Agris On-line Papers In Economics And Informatics*, vol. 10, no. 3, pp. 93-101. ISSN 1804-1930

Pilař, L., Kvasničková Stanislavská, L., Pitrová, J., Krejčí, I., Tichá, I. and Chalupová, M. (2019a) "Twitter Analysis of Global Communication in the Field of Sustainability", *Sustainability. MDPI AG*, vol. 11, no. 24, p. 6958, DOI 10.3390/su11246958

Pilar, L., Moulis, P., Pitrová, J., Bouda, P., Gresham, G., Balcarová, T. and Rojík, S. (2019b) "Education and Business as a key topics at the Instagram posts in the area of Gamification", *Journal on Efficiency and Responsibility in Education and Science. Czech University of Life Sciences Prague*, vol. 12, no. 1, pp. 26–33, DOI 10.7160/eriesj.2019.120103

Pilař, L., Poláková, J., Gresham, G., Rojík, S., Tichá, I. (2017), "Why People Use Hashtags When Visiting Farmers' Markets", *In Agrarian Perspectives XXVI: Competitiveness Of European Agriculture And Food Sectors*, pp. 287-292

Pilař, L., Stanislavská, L. P., Lucie Kvasničková, Jana Poláková, S. R., Roman Kvasnička, and Gresham, G. (2018b) "Customer Experience with Organic Food: Global View", *Emirates Journal of Food and Agriculture. Faculty of Food and Agriculture,* United Arab Emirates University, vol. 30, no. 11, pp. 918-926, DOI 10.9755/ejfa.2018.v30.i11.1856

Rojík, S., Chalupová, M., Tučková, K., Kauerová, L., Prokop, M., Rupprichová, T. (2018), Brand Quality and Origin Regionální potravina Ústecký Kraj by view of Customers, *Proceedings of the Agrarian Perspectives XXVII: Food Safety – Food Security,* Prague. Czech University Life Sciences Prague. pp. 284 - 290. ISBN 978-80-213-2890-7

STATISTA, Number of global social network users 2010-2023, 2020. [Online], Available: https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/, [Accessed: 23 Apr. 2020]

Stevens, T., Aarts, N., Termeer, C. and Dewulf, A. (2016), "Social media as a new playing field for the governance of agro-food sustainability", *Current Opinion in Environmental Sustainability, Elsevier BV*, vol. 18, pp. 99–106, DOI 10.1016/j.cosust.2015.11.010

Zámková, M. and Blašková, V. (2013), "The differences in the marketability of organic products in Greece and the Czech Republic", *Agricultural Economics*, vol. 59, no. 5, pp. 219-226, ISSN 1805-9295, DOI 10.17221/93/2012-AGRICECON

KEY COMPETENCES OF SHORT FOOD SUPPLY CHAIN PARTICIPANTS FOR CREATION OF ALTERNATIVE BUSINESS MODELS

Jana Pitrová[1], Katalin Kujáni[2], Judith Molnár[3], Andrea Kövesd[4], Kati Ferencz S.[5] and Arnauld Trollé[6]

[1] Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic, [2] Kisleptek, Hungary, [3] Kaposvár University, Hungary, [4]TREBAG, Hungary, [5]Spektrum Educational Center Foundation, Romania, [6]Savoir Faire et Découverte, France

[1]pitrovaj@pef.czu.cz, [2]kujanikatalin@gmail.com, [3]judith.molnar@civitas.ro, [4]andrea.kovesd@trebag.hu, [5]fskati@sec.ro, [6]arnaud.trolle@lesavoirfaire.fr

Annotation: Short food supply chains (SFSCs) has developed in different pathways within the EU countries. The well-organized SFSCs ensure the positive impact on the rural development and have many social, environmental and economic benefits. However, many SFSCs participants have difficulties to work separately and also due to their multifunctional role the necessary competencies for the deeper involvement in SFSC is missing. The main aim of this paper is to create a competence matrix of these competencies in five EU countries (CZ, PL, HU, FR, RO) by conducting the qualitative research (interviews and questionnaires) among the SFSC stakeholders. Based on the results, a large spectrum of competencies is identified – the most important ones are "Being ready to cooperate and able to manage cooperation" as well as "familiarity with specific food hygiene rules for small farmers/producers" and "Being able to compromise and manage conflicts, coming up with win-win solutions " and "Creativity and ability to assist the implementation of new ideas". The results suggested an emphasis on soft-skills and detailed knowledge in the topic of SFSCs.

Key words: alternative business model, short food supply chain, small farmers, rural facilitator, EU best practices, competencies.

JEL classification: Q13.

1. Introduction

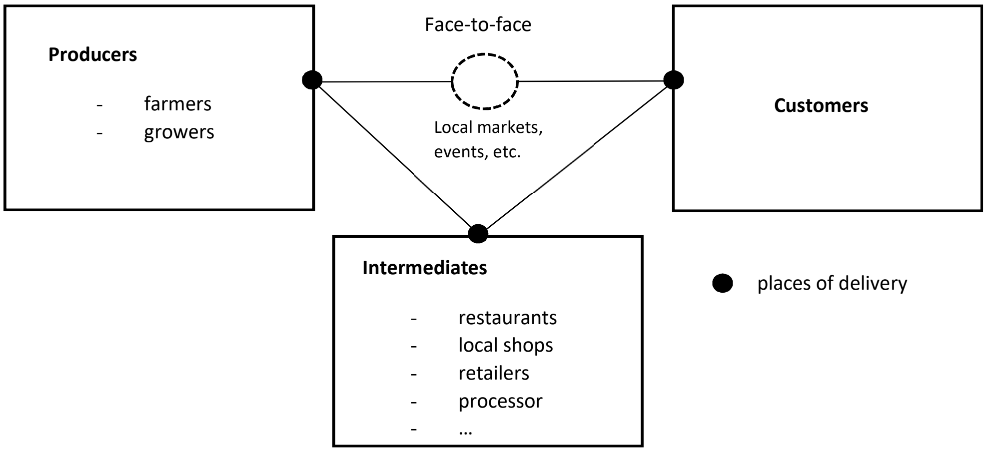
Short food supply chain (SFSC) development is an important tool for European food cultural heritage maintenance (Tanasa, 2014) and has numerous social, economic and environmental benefits. However, researches in recent years, as well as surveys of producers and consumers, have highlighted the problem that small producers have difficulties separately, so they need to work together to gain market access (Balcarová et al., 2016; Shepherd, 2007).

The strengthening of regional food markets is an effective tool of rural development which has a very positive impact on its economy (Demartini, Gaviglio and Pirani, 2017). Members of local food projects can discover a modern way to attract new consumers and sell more of their own products. Consumption of local products also encourages a reduction in the capacity of product transport, which presents several benefits, whether social - increasing road safety, environmental - reducing emissions or economical - lower transport costs. Short supply chains bring benefits to farmers and agricultural producers by reducing the number of companies involved in the supply chain, which may also cause an increase in the share of the resulting price, while bringing consumers a sense of on the quality and origin of the product (European Commission, 2014).

Short supply chains are built on trust and reciprocity (Mundler and Laughrea, 2016), they foster new relationships between producers and consumers, a sense of community and they provide quality products at affordable prices. The benefits for farmers are both economic and social. Economically, short supply chains allow for better redistribution of added value and farmers are less vulnerable to market risks (Vittersø et al., 2019). Moreover, they guarantee less asymmetric customer relationships by reducing the number of intermediaries, diversification and price control (Yacamán Ochoa et al. 2019). Socially, short supply chains promote social and professional recognition. For local economies, benefits are linked to creating new job positions, land use, revitalization of rural areas, support for local food production and the establishment of new farms (Todorovic, 2018). Short supply chains also encourage the consumption of seasonal products and they improve agricultural practices through interaction with consumers. Positive impacts also include crop biodiversity, reduction of chemical use, packaging and waste (Tanasa, 2014). Sustainable farming practices have a positive impact on the well-being of society, such as environmental quality, health or the coexistence of farmers and residents (Mundler and Laughrea, 2016).

Short supply chain relationships are characterized by the following scheme:

Figure 1. Scheme characterizing the short supply chain



Source: Todorovic et al., 2018

The new technologies and environmental factors are the secondary contributors in business model innovation for the food processors, the digitalization and e-commerce allowed to change the food distribution models (Nosratabadi. Mosavi and Lanker, 2020). Furthermore, consumption demand and product quality are two main factors affecting the business models of all the firms operating in the food supply chain regardless of their positions in the chain (Adekunle et al., 2018).

All the SFSC actors have their own business models and they try to do their best to design elegantly and accurately their business models to increase competitiveness. Moreover, social (Busb, Ongo and Liu, 2016), economic, and environmental factors (Borodin et al., 2016) affect the design of business models of businesses in the food supply chain. Therefore, survival in the sFSC is hard to manage (Ahumada and Villalobos, 2009) and it depends on the uniqueness of the business model. Several innovative projects (not just in the research countries) are testing cost-effective and sustainable solutions for more efficient logistics and distribution, allowing short food chains to share costs and resources, and tailor to the needs of larger customers. Sharing knowledge and skills is essential in developing these solutions and that´s also the aim of this paper.

2. Materials and Methods

The research aim of this paper is to conduct the competence matrix and the recommendation for the competences needed for the participation in SFSC based on the results of questionnaires filled in within the interviews with SFSC stakeholders. All data were collected by the partnership of the project funded by the European Commission (Erasmus + KA2, name Rural Facilitator Training in Agricultural Short Food Supply Chains) and the research countries consisted of the Czech Republic, France, Romania, Hungary and Poland. This research was made by interviewing the relevant SFSC actors and recognizing those activities where special competencies are needed. The main target groups were farmers, advisors and market organizers who already coordinated local farmers market or internet platform, or consumer supported agriculture, open farm networks, food hubs, local food logistics, marketing activities and farm advisers who understand the long and short food chains' challenges.

At the first stage participants from each country were interviewed due to the Covid-19 situation via phone or internet call services. The main aim was to identify the knowledge gap in the SFSC and also to point out the country specific risk, that would to reveal which knowledge, skills, competences and attitudes are the most required ones for an active and successful involvement in SFSC. The second part of the research was a questionnaire as a base for the competence catalog, that was filled at the end of the interviews by these stakeholders.
The steps of the methodology of the development include: 1, defining interviews methodology and set up an interview template; 2, recruiting interviewees; 3, interviews and questionnaires are conducted; 4, interviews and questionnaires are sum-upped; 4, competence matrix is created. There were 8-15 interviews in each country, collected from April to May 2020. The short questionnaires consisted of 25 questions, 20 aiming to rate the importance of a set of skills, competences and knowledge. The main goal of the survey was to get an insight from people with different professional/educational background on what competences, skills and knowledge should the desired facilitator role possess.

3. Results and Discussion

Summary of the interviews

The most important findings from the interviews, made in 5 countries with 54 participants are:
1) Farmers are often left alone and they don´t know how to access the information about SFSC.
2) The role of small farmers is already so complex (they are farmers, also food processors, traders, distributors, legal advisors at the same time), they don´t have enough financial capacities for hiring specialized employees with the necessary competences as the industrial farm.
3) International best practices show that collective actions of small farmers are more sustainable but in all the cases there is at least one driver, a person who can motivate the others.
4) Access to investment and market require special advisory system and knowledge flow.
5) Translation between farmers and consumers is often necessary.

For the better understanding of the competences needed for the SFSC participation a questionnaire was used to create the competence catalogue. These questionnaires had been filled by 54 participants, from 5 partner countries. The nations samples had different compositions, some of them can be seen as a representation of certain groups, while others are more of a mixture of people coming from a wide range of professional and educational background.

Table 1. Profile of participants

	Number of participants	Average age	Average years of agricultural experience
HUN	12	44,83	14,42
CZ	9	26,44	14,00
POL	11	45,09	20,36
RO	9	40	9,56
FR	13	44,33	12,85

Source: own research

Dispersion can be seen regarding the most important traits; the Polish and Czech results have significant overlapping at the most prior skills. The participants from both of these countries are among the agriculturally more experienced respondents, moreover, respondents from agricultural holdings were the most significantly represented in these two countries, what could be one of the reasons for the similarities. Romanian and Hungarian results show similarities as well. People from agricultural backgrounds made up a significant part of the sample (farmers, food producers etc.) which is explaining the mutual points of view.

Table 2 shows the results of the most and least important competences in each country. The trait with the lowest score was nearly unanimously "Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement)". Soft skills and cooperative aptness were both assessed as the most valuable traits, so receiving a low score on animation itself, could be a surprise. Theatre pedagogy however might have seemed a bit off for the respondents, thus explaining the low scores.

Table 2. Most and least important competences in each country

	Most important
HUN	Ability to assist in market sales/Being ready to cooperate and able to manage co-operations (4,83)
CZ	Familiarity with agricultural, food processing and agrotourism legislation (3,89)
POL	Familiarity with agricultural, food processing and agrotourism legislation (4,82)
RO	Familiarity with environmentally friendly solutions/Being ready to cooperate and able to manage co-operations (4,56)
FR	Being ready to cooperate and able to manage co-operations (4,54)
	Least important
HUN	Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement) (3,08)
CZ	Being up-to-date in matters of tourism (e.g. local festivals) (2,33)
POL	Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement) (2,45)
RO	Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement) (3,44)
FR	Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement) (2,00)

Source: own research

In the combined Table 3, the most important trait was "Being ready to cooperate and able to manage co-operations" (4,29) what was both Hungary's and France's and Romania's leading trait. When it comes to creating a new vocation, the ability to cooperate and being familiar with cooperation is a must, in order for the professional to successfully assimilate to the fabric of the existing situation.

Table 3. Combined hierarchy of the competences

	HUN	CZ	POL	RO	FR	COMBINED
Being ready to cooperate and able to manage co-operations	4,83	3,44	4,09	4,56	4,54	4,29
Familiarity with specific food hygiene rules for small farmers/ producers	4,42	3,44	4,64	4,44	3,85	4,16
Being able to compromise and manage conflicts, coming up with win-win solutions	4,50	3,22	4,18	4,33	4,38	4,12
Creativity and ability to assist the implementation of new ideas	4,67	3,44	4,18	4,33	3,92	4,11
Familiarity with agricultural, food processing and agrotourism legislation	3,75	3,89	4,82	4,33	3,46	4,05
Familiarity with specific quality assurances systems for small farmers	4,17	3,78	4,73	3,89	3,38	3,99
Familiarity with agricultural production, food processing and tourist services	3,92	3,56	4,73	4,11	3,46	3,95
Familiarity with various target group specific marketing channels.	4,42	3,22	4,00	4,44	3,38	3,89
Familiarity with customer demands and trends	4,42	2,78	4,00	4,44	3,77	3,88
Ability to assist in market sales	4,83	3,22	4,09	4,44	3,69	3,86
Familiarity with environmentally friendly solutions	4,25	2,89	4,18	4,56	3,08	3,79
Familiarity with proposals and grant options	4,08	3,22	4,73	3,67	3,23	3,79
Ability to assist in online sales. IT and social media knowledge.	4,50	3,44	4,00	3,78	3,15	3,78
Familiarity with food processing technologies	4,00	3,56	4,36	3,67	3,23	3,76
Up-to-date marketing knowledge	4,17	3,00	3,73	4,00	3,54	3,69
Ability to assist in pricing	3,75	3,33	3,64	4,00	2,92	3,53
Familiarity with local and regional gastronomy	3,83	2,67	3,45	3,67	2,92	3,31
Being up-to-date in matters of tourism (e.g. local festivals)	3,92	2,33	2,91	4,11	2,46	3,15
International perspective, familiarity with best practices	3,75	2,78	3,00	4,00	2,08	3,12
Possessing a comprehensive toolbox of theatre pedagogy and animation (for active involvement)	3,08	2,78	2,45	3,44	2,00	2,75

Source: own research

The second most important trait was “Familiarity with specific food hygiene rules for small farmers/producers” (4,16). This trait did not come first at any of the nation’s lists, but the combined score made it more important that the other traits coming first in the country analysis (green areas in fig. 3) The same can be told of the following two traits: “Being able to compromise and manage conflicts, coming up with win-win solutions” (4,12) and “Creativity and ability to assist the implementation of new ideas” (4,11). One is specific knowledge on SFSCs while the other is a soft-skill. “Familiarity with agricultural, food processing and agrotourism legislation” (4,05) was marked as the Czech Republic’s and Poland’s trait with the highest value, coming as the fifth element of this table. The cluster of the first five traits ranked by importance shows a diverse picture. The results of the interviews suggested an emphasis on soft-skills and detailed knowledge in the topic of SFSCs.

As also mentioned in a study of Charatsari, Kitsios and Lioutas (2019) farmers' engagement in SFSCs is still limited in many countries. They revealed in their study, that the farmers willingness to participate in SFSC is affected by the level in competences on issues pertaining to management, entrepreneurship, marketing, networking and cooperation. Karipidis, et al. (2009) also pointed out that for the successful SFSC implementation the skilled managers are needed, because the farmers have better expertise in production than in the management skills, that´s why the training of farmers is so important. Park, Mishra and Wozniak (2014) finds that the crucial for the SFSC operators are marketing skills, that are more likely to increase farm sales and emphasizes the importance of farmers education. Charatsari et al. (2019) proved that farmers´ competencies significantly affect their involvement in SFSCs, thus highlighting the importance of creating spaces that help farmers develop and exploit new capabilities, what strengthens the importance of the competencies definition of this paper and supports the training material creation, which will be the next step of the project.

4. Conclusion

Creating a background for alternative business models in SFSC has undoubtedly a positive impact on rural development and its economy. Not only the consumption of local food reduces the volume of product transport, it also reduces the number of intermediaries and companies involved in the supply chain, but it also brings more income to farmers and quality local products to consumers. In conclusion, short supply chain systems offer many benefits, whether sustainable methods, quality and fresh food, active community participation, connecting rural areas, or supporting local and regional economic development. However, there are missing competencies of SFSC participants that need to be indicated for their better involvement in the whole process, as also proved by a research of Charatsari et al., 2019. The presented research identified a large spectrum of knowledge and competence areas relevant for the human resource aspect of the SFSCs based on the interviews and questionnaires with the SFSC stakeholders. Some of the partner countries already have vocational or adult training opportunities available to address some of these knowledge and competences areas, but no complex training program for SFSC animators is available as such. As for the type of training that should be provided for people who would like to participate in SFSC, based on the results an adult training course would be suggested, involving e-learning elements and having a strong focus on competence development, including soft and social skills development. This will be the next step of the project Rural Facilitator. As it is obviously not possible to develop all the needed competence and knowledge areas in one training curriculum, it is the task of the Rural Facilitators project staff to prioritize and define the final competence catalogue of rural facilitators and to elaborate a training curriculum with the desired learning outcomes.

Acknowledgements
This research was conducted with the support of the Erasmus+ program of the European Union, grant number 2019-1-CZ01-KA202-061270 and with the support of the Internal Grant Agency (IGA) of FEM CULS Prague, registration no. 2019B0006 – Attributes of alternative business models management in food production.

References

Adekunle, A., Lyew, D., Orsat, V., Raghavan, V. (2018), „*Helping Agribusinesses—Small Millets Value Chain—To Grow in India*“, Agriculture, vol. 8, no. 3, DOI 10.3390/agriculture8030044

Ahumada, O., Villalobos, J. R. (2009), "Application of planning models in the agri-food supply chain: A review", *European Journal of Operational* Research, Elsevier, vol. 196, no. 1, pp. 1-20

Balcarová, T., Pilař, L., Pokorná, J., Tichá, I. (2016), **"**Farmers Market: Customer Relationship**"**, *Proceedings of the Agrarian perspectives XXV*, Prague, pp. 27-33, ISBN 978-8-0213-2670-5

Borodin, V., Bourtembourg, J., Hnaien, F. Labadie, N. (2016), "Handling uncertainty in agricultural supply chain management: A state of the art", *European Journal of Operational* Research, Elsevier, vol. 254, no. 2, pp. 348-359, DOI 10.1016/j.ejor.2016.03.057

Busby, J.S., Onggo, B.S.S, Liu, Y. (2016), "Agent-based computational modelling of social risk responses", *European Journal of Operational Research, Elsevier*, vol. 25, no. 3, pp. 1029-1042, DOI 10.1016/j.ejor.2015.12.034

Charatsari, C., Kitsios, F., Lioutas, E.. (2019), "Short food supply chains: the link between participation and farmers' competencies*", Renewable Agriculture and Food Systems*, pp. 1-10, DOI 10.1017/S1742170519000309

Demartini, E., Gaviglio, A., Pirani, A. (2017), "Farmers' motivation and perceived effects of participating in short food supply chains: Evidence from a North Italian survey*", Agricultural Economics (AGRICECON)*, vol. 63, no. 5, pp. 1-13, DOI 63.1-13.10.17221/323/2015-AGRICECON

European Commission, Místní potraviny a krátké dodavatelské řetězce, 2014, [Online], Available: https://enrd.ec.europa.eu/enrd-static/themes/local-food-and-short-supply-chains/cz/local-food-and-short-supply-chains_cz.html [Accessed: 23 April 2020]

Karipidis, P., Athanassiadis, K., Aggelopoulos, S. and Giompliakis, E. (2009), "Factors affecting the adoption of quality assurance systems in small food enterprises", *Food Control*, vol. 20, no. 2, pp. 93-98, DOI 10.1016/j.foodcont.2008.02.008

Mundler, P. and Laughrea, S. (2016), "The contributions of short food supply chains to territorial development: A study of three Quebec territories", *Journal of Rural Studies*, vol. 45, pp. 218-229, DOI 10.1016/j.jrurstud.2016.04.001

Nosratabadi, S., Mosavi, A., Lakner, Z. (2020), "Food Supply Chain and Business Model Innovation", *Foods*, vol. 9, pp. 132, DOI 10.3390/foods9020132

Park, T, Mishra, A.K. and Wozniak S.J. (2014), "Do farm operators benefit from direct to consumer marketing strategies?", *Agricultural Economics,* vol. 45, pp. 213–224, DOI 10.1111/agec.12042

Shepherd, A.W. (2007), "Approaches to linking producers to markets – A review of experiences to date", *Agricultural Management, Marketing and Finance Occasional Paper*, No. 13, Rome: FAO

Tanasa, L. (2014), "Benefits of short food supply chains for the development of rural tourism in Romania as emergent country during crisis ", *Agricultural economics and rural development*, New Series, vol. 9, no. 2, p. 109–224

Vittersø, G., Torjusen, H., Laitala, K., Tocco, B., Biasini, B., Csillag, P., Labarre, M. Lecoeur, J., Maj, A. Majewski, E., Malak Rawlikowska, A., Menozzi, D., Torok, A. and Wavresky, P. (2019), "Short Food Supply Chains and Their Contributions to Sustainability: Participants' Views and Perceptions from 12 European Cases", *Sustainability*, vol. 11, no. 17, DOI 10.3390/su11174800

Yacamán Ochoa, C., Matarán, A. Olmo, R., López, J. and Fuentes-Guerra, R. (2019), „The Potential Role of Short Food Supply Chains in Strengthening Periurban Agriculture in Spain: The Cases of Madrid and Barcelona", *Sustainability*. vol. 11, no. 7, pp. 1-19. DOI 10.3390/su11072080

SYSTEM APPROACH TO AGRICULTURAL KNOWLEDGE AND INNOVATION SYSTEMS

Lenka Platilová Vorlíčková

Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic

vorlickova@pef.czu.cz

Annotation: The Common Agricultural Policy EU reinforces the importance of transferring knowledge by requiring member states to modernise the sector with promoting knowledge transfer, innovation, and digitisation of agricultural and rural areas. The content analysis of selected publications reveals the research gap in the system approach of Agricultural Knowledge and Innovation Systems. Further research should focus on the precise identification of individual elements of AKIS, their mapping, and parameterising relevant to the behaviour of the system. Detailed analysis of the private sector and farmer buying behaviour in education and advisory service use is needed for the optimization of the system. A more open concept of the system would better reflect the current plurality of services and involve external entities and structural conditions. Another research gap is in the AKIS performance measurement and validation of knowledge transformation. For participatory models, mutual learning from other entities and tacit knowledge dissemination as well as the influence of new technologies and networking could be research topics. Future research must focus on the adaptation of AKIS to new conditions given by agriculture 4.0, artificial intelligence and machine learning.

Key words: extension services, agriculture, innovation, AKIS, research, knowledge transfer

JEL classification: Q16

1. Introduction

The importance of knowledge for business management and their competitiveness emphasize many authors, Drucker (2002), Tichá and Hron (2006), or Donate and Sánchez de Pablo (2015). It is confirmed by Price WaterHouse Coopers, KPMG Management Consulting, and the World Economic Forum (Griffiths and Koukpaki, 2010). Inkinen (2016) argues, based on extended literature review, that knowledge management practices enable firms to achieve goals through efficient and effective management of the firm's knowledge resources.

In many sectors of the national economy, the issue of innovation and knowledge development is left more to the strategic direction of individual entities. However, there are areas of business activity that significantly overlap companies. These include entrepreneurship in agriculture, the direction and further development of which can affect the health and quality of life not only of these entrepreneurs and their employees, but also the inhabitants of the region. It is therefore not surprising that global organizations as well as policymakers both in developing and developed countries are involved in the transfer of knowledge and information in agriculture.

2. Materials and Methods

The aim of the paper is to identify the research gaps in the system approach of Agricultural Knowledge and Innovation Systems (AKIS). It is to be answered: What is the evolution and current understanding of the concept of innovation systems in agriculture? What is a possible contribution of the system approach to the effectiveness or efficiency of the AKIS? What are the relevant elements of the knowledge and innovation systems in general and regarding the EU CAP?

The electronic databases Web of Science, ProQuest Central, EBSCOhost, and Google Scholar were searched for the terms "AKIS", "AIS", “Information system”, “Innovation system” “System approach” in title, abstract or key words. Search results were further filtered according the topic related to agriculture, agricultural economics, education, environmental, or rural development studies. Only full-text version, English written articles, and conference proceedings were used for the content analysis examining the research questions. The process of abstraction followed for the synthesis of pieces of knowledge.

3. Results and Discussion

The Food and Agriculture Organization (FAO) has been developing systems for innovation in agriculture for decades. It began with the top-down approach, where researchers were a source of information, advisors acted as mediators, and farmers were only passive recipients of it. In the 1980s, the system was expanded by other elements, including representatives of the private sector. At the same time, the roles of individual actors changed and the whole model became more decentralized. The next phase, the Agricultural Knowledge and Information Systems for Rural Development (AKIS/RD), again redefines the roles of individual elements of the whole system and unifies their contribution to agricultural development (FAO and WB, 2000). The arising knowledge triangle centred on the farmer and topped by private or public educational, research and advisory bodies, tasked with responding to the needs of farmers to improve their income, productivity, and well-being using available natural resources sustainably. The farmer is a partner throughout the system, not just a recipient, but an active co-creator.

3.1 Approaching the AKIS

Some authors favour the use of the acronym AKIS for Agricultural Knowledge and Innovation Systems and define it as a “*set of organizations or individuals in agriculture and the links and interactions between them that are involved in creating, transforming, transmitting, preserving, reusing, integrating, disseminating and exploiting knowledge and information for synergies to support decision-making, problem-solving and innovation in agriculture*” (Röling and Engel, 1991).

The difference in approaches in the linear and the participatory generation and communication of innovations is gradually apparent (Hoffmann et al., 2009). Participatory models, in which innovation results from the collaboration of firms, researchers, agents and users, favour more developed Western countries. Linear models persist in Central and Eastern Europe and Asia (FAO, 2015). Various participations forms exist, Ahuja, Ma and Hovell (2002) classified them according to the degree of beneficiaries’ initiative and involvement.

European AKISs are very diverse not only in terms of their strength but also in terms of integration degree. According to Knierim and Prager (2019) in fragmented AKIS, such as Portugal, Spain, the Netherlands, several independent knowledge networks operate parallel, while in integrated systems exist a coordination structure to align advisory services with AKIS, most notably in Luxembourg, Denmark and Ireland. However, these conclusions came from a survey based on unevenly large samples. Inclusion of the Czech Republic among the countries with relatively integrated AKIS is disputable. The current conception of the Czech AKIS does not consider non-governmental entities providing advisory services in agriculture (MZe ČR, 2016). Unresearched is the number, structure, and involvement of private entities in agricultural education and consulting services in the Czech Republic like the studies of Prager, Creaney and Lorenzo-Arribas, (2016) or Klerkx and Jansen (2010). The European Union (EU) develops AKIS through the Standing Committee on Agricultural Research (SCAR-AKIS), which has concluded that the old linear model of technology transfer from researchers to users is outdated, does not suit policymakers or stakeholders and should be replaced by a more interactive model of interconnected subsystems integrating knowledge creation, adaptation, consulting and training (SCAR, EU, 2016), (Knierim et al., 2017), (Knierim and Prager, 2015). It applies to all member countries and should lead to the creation of a single AKIS for the entire EU (SCAR, EU, 2019). Regarding the existing diversity of individual AKISs revealed by Knierim et al. (2019), this will require some preparatory steps and *further research aimed at evaluating existing AKISs* and identifying commonalities necessary for successful integration of national AKISs into Europe-wide.

The growing demand for innovative solutions increases the requirements for the efficiency of agricultural technology and innovation systems. A system approach seems to be appropriate for that purpose. It is necessary to set a single goal for all entities in the system first to enable its evaluation and performance measurement. To formulate such an objective, the marketing approach helps to *understand farmers' requirements*. While the implementation of change is frequently funded by the state, the need of responsibility of all research, advisory and educational subjects, individually and as a group, to both farmers and policymakers rises.

3.2 Contextual interpretation of AKIS

The key suggestions on the nature of innovation and innovation capacity made by the World Bank (WB) state that research should be an important, but not always a central element of innovation (WorldBank, 2006). Farms competitiveness depends above all on cooperation in the field of innovation. The WB also emphasizes the need for social and environmental sustainability, an integral part of economic success, which must be reflected in possible interventions. Attention should be paid to the finding that the market does not sufficiently encourage entities to interact and that the public sector needs to play a central role in these interactions. According to the WorldBank (2006), interventions are necessary to build capacity and encourage learning that enables the industry to respond to ongoing competitive challenges. The central concept of AKIS as well as other development activities should be the involvement and organisation of all stakeholders.

Although most research on agricultural innovation systems has been conducted in developing countries, similar criteria for well-functioning systems can be applied to developed countries. The basic characteristics of a well-functioning agricultural innovation system include mutual learning from other organisations to innovate, strengthening individual and collective capacity to innovate, researching and developing supply and demand based technology, innovation agents focusing on comprehensive and dynamic interactions, dissemination of knowledge across networks, dissemination of knowledge in both tacit and codified form, and decentralized management of innovation processes (Klerkx, Mierlo and Leeuwis, 2012). On the contrary, exist technological, social, economic, and cultural differences within often heterogeneous groups of actors, which may be resulting from different incentive systems for public and private actors or differences between local knowledge systems and formal scientific knowledge systems.

When modelling AKIS, it is important to keep in mind that the system takes its place in a broader context from which it is not separate. Agricultural knowledge and information processes must be examined against the environment that generates and shapes laws and incentives affecting not only performance in the agricultural sector but also structural conditions such as markets, inputs, resource base, infrastructure, structures through which stakeholders influence the whole system (Anandajayasekeram et al., 2008), (Prager et al. 2017). The purpose of AKIS is to facilitate the exchange, transfer, and translation of knowledge in the agri-food sector to meet current and future challenges. Spendrup and Fernqvist (2019) speculate that gaps in existing AKIS may be attributed to a lack of knowledge about the innovation implementation processes, ways of information passing and transfer from research into practice, and about the responsibilities distribution and risk-taking in the system. This raises questions regarding the roles of other actors and the future structure of AKIS.

3.3 Importance of cooperation in AKIS

There is no perfect model for agricultural systems as admitted Ahuja, Ma and Howell (2002), yet systems can be useful in field research and technology transfer. Improvements in models and applications such as more thorough testing and validation in various conditions, more precise works with experimental data distributed in time and space are expected. It is required to create complex shared databases based on standard experimental protocols and measured values related to modelling variables so that the parameters of the conceptual model can be experimentally verified (Ahuja, Ma and Howell, 2002). Bahaddin et al. (2018) state that while individual systems have different details, properties, and attributes, most patterns of behaviour are common. Many system archetypes, e.g. systemic structures that are often observed in various problem settings and capture the essence of thinking in system thinking, have been identified that explain similar topics implemented in various managerial problems. The speed with which new knowledge and methods are available also plays an important role. In the development, parameterization and evaluation of system models will be necessary to deepen and rationalize mutual communication and coordination.

Participatory models are supported by the European Innovation Partnership on Agricultural Sustainability and Productivity (EIP-AGRI), which emphasizes the role of farmers as co-creators of knowledge through the mobilization of tacit knowledge. Farmers are increasingly using networking to interconnect, but also to connect with other partners, such as advisory organizations, local governments, universities, and non-agricultural organizations (Pappa et al., 2018). Information and communication technologies (ICT) facilitate networking, especially when used to share and exchange knowledge. Given the importance that EIP-AGRI attaches to innovation, it will be necessary to create agricultural training and innovation networks fostering tacit knowledge sharing. According to Madureira et al. (2016) is current knowledge of the features and configuration of best-functioning multidisciplinary innovation networks insufficient. Adaptations of AKIS need to consider the availability of information and communication technologies for farmers and other elements of the system, but also for agriculture 4.0, which will be reflected in changes throughout AKIS, as it brings new and different technologies. As Hermans et al. (2019) highlight, innovations could be expected such as robotics, nanotechnology, gene modification technology, artificial intelligence, and machine learning that can have global effects on future agriculture and food systems and major transformation potential. It supports concepts such as vertical agriculture and food systems, digital agriculture, bioeconomy, circular agriculture, and aquaponics.

To the most frequently studied key elements of sectoral innovation systems belongs the interaction mechanism, which clearly shows the important role of networks and interactions for innovation in the agri-food sector, while other elements of the innovation system seem to be less well explored. Research on innovation in the agri-food complex does not usually cross sectoral boundaries. The current finding (Spendrup and Fernqvist, 2019) shows that the research on innovation in the agri-food complex is focusing on the sectoral system within its existing boundaries and the conventional structure involving agricultural advisors, agricultural research, agricultural infrastructure and, where appropriate, customers of agricultural production.

4. Conclusion

Current knowledge of system approach to AKIS offers some research opportunities reflecting the requirements for perspective integration of the national AKIS into the Europe-wide. Considering the generally used characteristics of the system as a set of elements or objects with certain *attributes and connections* or relationships between them, AKIS can be characterized using these elements and relationships. Further research may focus on the precise identification of individual elements of the systems and their parameters relevant to the behaviour of the system. Attention should be paid to the representatives of the private sector and external entities and stakeholders but also to the farmers´ buying behaviour on the market with education and advisory services. The relationships between the individual elements of the system should be defined, possibly using the classification of collaboration based on individual participants involvement and participation in knowledge transfer (Ahuja et al., 2002). Based on the results, commonalities for successful integration of national AKISs into Europe-wide could be defined.

Another research aim could be to *validate the transformations of knowledge*. Given the nature of AKIS, that knowledge acquired in one part of the system is transformed into information for use in another one, is knowledge transformation probably the most important process taking place in AKIS. Röling (1990) identified nine transformations of knowledge in AKIS. Reflecting social, technological, and environmental changes in the configuration of best-functioning multidisciplinary innovation networks may be another research topic. The efficiency and effectiveness indicator for *AKIS performance measurement* may be constructed.

Various *approaches to the analysis and evaluation* of systems exist, both static to support innovation and dynamic innovation creation. Spielman, Ekibor and Davis (2009) refer Social Network Analysis mapping of institutional links, visualizing relationships between multiple actors, and evaluating the position of actors in the system. Innovation history is method based on recording innovation processes using timelines, focusing on the important events, relationships, and activities that define these events and influence the outcome of the innovation process. Klerkx, Mierlo and Leeuwis (2012) highlight its suitability for AKIS. Spielman Ekibor and Davis (2009) also proposed comparison with other systems using scorecards, indexes, or index-based benchmarking. Modelling based on game theory, due to the insight into the value framework of innovation systems, illustrates the spontaneous processes in the social field of self-organization and the influence of public policy and organizational structure on these processes. Klerkx, Mierlo and Leeuwis (2012) add Institutional analysis examining the impact of institutional assumptions and constraints on the performance of innovation systems or parts thereof and Analysis of the innovation system using different categories of system failures and collapses in contingency towards groups of actors.

Acknowledgements
This article was created with the support of the Internal Grant Agency (IGA) of FEM CULS in Prague, registration no. 2019B0006 – Attributes of alternative business models management in food production.

References

Ahuja, L., Ma, L. and Howell, T.A. (eds.) (2002), ”*Agricultural System Models in Field Research and Technology Transfer”,* USA: Lewis Publ., CRC Press LLC Boca Raton, 376 p.

Anandajayasekeram, P., Puskur, R., Hoekstra, D. and Sindu, W. (2008), “*Concepts and practices in agricultural extension in developing countries: A source book*”, Washington, DC, USA, Nairobi, Kenya: IFPRI (International Food Policy Research Institute) and ILRI

Bahaddin, B., Mirchi, A., Watkins, D., Ahmad, S., Rich, E. and Madani, K. (2018), “System Archetypes in Water Resource Management”, In *World Environmental and Water Resources Congress*, Reston, VA: American Society of Civil Engineers, pp. 130-140, DOI 10.1061/9780784481400.012

Donate, M. J. and Sánchez de Pablo, J. D. (2015), “The role of knowledge-oriented leadership in knowledge management practices and innovation”, *Journal of Business Research*, vol. 68, no. 2, pp. 360-370, ISSN 01482963, DOI 10.1016/j.jbusres.2014.06.022

Drucker, P. F. (2002), “The Discipline of Innovation”, *Harvard Business Review*, vol. 80, no 8, pp. 95-103

FAO (2015), “*Innovation in family farming in Europe and Central Asia. FAO background paper no. ECA/39/15/2 prepared for the thirty-ninth session of the European Commission on Agriculture*”, 22-23 September 2015, Budapest, Hungary

FAO and WorldBank (2000), “*Agricultural Knowledge and Information Systems for Rural Development (AKIS/RD): Strategic vision and guiding principles”,* Rome: FAO & World Bank.

Griffiths, D. and Koukpaki, S. (2010), “Are We Stuck With Knowledge Management?”, *International Journal of Knowledge and Systems Science*, vol. 1, no. 4, pp. 41-60. DOI 10.4018/jkss.2010100103

Inkinen, H. (2016), “Review of empirical research on knowledge management practices and firm performance”, *Journal of Knowledge Management*, vol. 20, no. 2, pp. 230-257, DOI 10.1108/JKM-09-2015-0336

Hermans, F., Geerling-Eiff, F., Potters, J. and Klerkx, L. (2019), “Public-private partnerships as systemic agricultural innovation policy instruments – Assessing their contribution to innovation system function dynamics”, *NJAS - Wageningen Journal of Life Sciences,* vol. 88, pp.76-95, DOI 10.1016/j.njas.2018.10.001

Hoffmann, V., Gerster-Bentaya, M., Christinck , A. and Lemma, M. (2009), “*Handbook: Rural Extension Volume 1*”, Margraf Publishers GmbH, Scientific books

Klerkx, L. and Jansen, J. (2010), “Building Knowledge Systems for Sustainable Agriculture: Supporting Private Advisors to Adequately Address Sustainable Farm Management in Regular

Service Contacts", *International Journal of Agricultural Sustainability*, vol. 8, pp. 148–163, DOI 10.3763/ijas.2009.0457

Klerkx, L., van Mierlo, B. and Leeuwis, C. (2012), "Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions", In *Farming Systems Research into the 21st Century: The New Dynamic.* Dordrecht: Springer Netherlands, pp. 457-483, DOI 10.1007/978-94-007-4503-2_20

Knierim, A., Prager, K., (2015), "*Agricultural Knowledge and Information Systems in Europe: Weak or strong, fragmented or integrated?",* Universität Hohenheim, https://430a.uni-hohenheim.de/fileadmin/einrichtungen/430a/PRO_AKIS/About/OVERVIEW.OF.AKIS.IN.EUROPE.AKIS_characterisation_briefing_final.pdf [Accessed: 23 February. 2020]

Knierim, A., Kernecker, M., Erdle, K., Kraus, T., Borges, F. and Wurbs, A. (2019), "Smart farming technology innovations – Insights and reflections from the German Smart-AKIS hub", *NJAS - Wageningen Journal of Life Sciences*, vol. 90-91, DOI 10.1016/j.njas.2019.100314

Knierim, A., Labarthe, P., Laurent, C., Prager, K., Kania, J., Madureira, L. and Ndah, T. H. (2017), "Pluralism of agricultural advisory service providers – Facts and insights from Europe", *Journal of Rural Studies*, vol. 55, pp. 45–58, DOI 10.1016/j.jrurstud.2017.07.018

Madureira, L., Knierim, A., Ferreira, D., Prager, K., Boenning, K. and Caggiano, M. (2016), "Agricultural networks across EU: What are the key features to enhance farmers' ability to learn and to innovate in cooperation with other actors?", *Proceedings of the 12th European IFSA Symposium,* Harper Adams University, United Kingdom, vol. 1, pp. 31 – 44

Ministerstvo zemědělství České republiky. (2016), "*Koncepce poradenského systému Ministerstva zemědělství na období 2017 – 2025*". MZe ČR. [Online], Available: http://agri.cz/public/web/file/514229/Koncepce_poradenskeho_systemu_MZe_2017___2025.pdf [Accessed: 23 February. 2020]

Pappa, E., Koutsouris, A., Ingram, J., Debruyne, L., Cooreman, H. and Marchand, F. (2018), "Structural aspects of on-farm demonstrations: key considerations in the planning and design process", *13th European International Farming Systems Association (IFSA) Symposium*, Greece

Prager, K., Creaney, R. and Lorenzo-Arribas, A. (2017), "Criteria for a System Level Evaluation of Farm Advisory Services", *Land Use Policy,* vol. 61, pp. 86–98, DOI 10.1016/j.landusepol.2016.11.003

Röling, N.G. (1990), "The agricultural research-technology transfer interface: a knowledge systems perspective", in Kaimowitz, D. (ed.), *Making the link; agricultural research and technology transfer in developing countries.* pp. 1-42

Röling, N. and Engel, P. (1991), "The development of the concept of Agricultural Knowledge Information Systems (AKIS): Implications for extension", In Rivera, W. and Gustafson, D.J., *Agricultural extension: Worldwide institutional evolution and forces for change*, pp. 125-139. Amsterdam: Elsevier Science Publishers.

SCAR, EU (2016), "Agricultural Knowledge and Innovation Systems Towards the Future", Brussels: Publications Office of the European Union, ISSN 1831-9424 KI-NA-27-692-EN-N DOI 10.2777/324117

SCAR,EU. (2019), "*Preparing for Future AKIS in Europe*", Brussels: European Commission.

Spendrup, S. and Fernqvist, F. (2019), "Innovation in Agri-food Systems – A Systematic Mapping of the Literature", *Int. J. Food System Dynamics*, vol. 10, no. 5, pp. 402-427. ISSN 1869-6945, DOI 10.18461/ijfsd.v10i5.28

Spielman, D. J., Ekboir, J. and Davis, K., (2009), "The art and science of innovation systems inquiry: Applications to Sub-Saharan African agriculture", *Technology in Society*, vol. 31, no. 4, pp. 399-405, DOI 10.1016/j.techsoc.2009.10.004

Tichá, I. and Hron, J. (2006), "Knowledge in the business strategy context", *Agricultural Economics (Zemědělská ekonomika)*, vol. 52, no. 1, pp 7-11, DOI 10.17221/4991-AGRICECON

WorldBank. (2006). "Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems", Washington DC: World Bank.

THE IMPACT OF RUSSIAN FOOD EMBARGO AND EXPORT PROMOTION POLICY ON AGRI-FOOD TRADE BETWEEN THE EU AND THE EEU

Roman Anatolievich Romashkin[1], Sergey Victorovich Kiselev[2] and Antonina Resmyatova[3]

[1] Eurasian Center for Food Security, Lomonosov Moscow State University, Russia
[2, 3] Faculty of Economics, Lomonosov Moscow State University, Russia

[1]ecfs.msu@gmail.com, [2]servikis@yandex.ru, [3]t_resm@mail.ru

Annotation: Having restricted the imports of certain agri-food products from Western countries in 2014, Russia consistently conducts a policy aimed at import substitution and promotion of agri-food exports. Such policy impacts on economic growth prospects, food and nutrition security in Eurasian Economic Union (EEU) member states as well as their trade with other partners, including the EU. Despite the fact of Russia's food embargo imposition and consequent trade shift towards Asia-Pacific region, the EU remains the main trading partner for the EEU. This paper is addressed to trade patterns changes in EEU agri-food market as well as transformation of trade flows between the EU and the EEU influenced by Russian food embargo policy. The rates of substitution of EU food products by EEU domestic production are estimated for selected commodities. The conditions for Russian agri-food export expansion in the EEU market are assessed, as well as the main risks for further trade development between the EU and the EEU are identified.

Key words: food embargo, trade complementarity, import substitution

JEL classification: Q17, Q18

1. Introduction

The Eurasian Economic Union (EEU) was established in 2015 as a successor of the Customs Union and Common economic space of Belarus, Kazakhstan and Russia. Nowadays this regional economic integration block comprises 5 member states, including Armenia and Kyrgyzstan. The EEU is formed following the example of its neighboring economy and the main trading partner - the EU. However, the EEU's economy is quite small relatively to the EU. As of 2018, for nominal GDP and agricultural output the European economy exceeds the Eurasian one by 3.4 and 8.3 times, respectively (calculations based on EC and EEC, 2019).

Russian economy is the core of the EEU. In terms of GDP it accounts for 87% and in terms of agricultural output – for 75% of the Eurasian common market (EEC, 2019). Facilitating access to the Russian market was one of the main reasons for Armenia, Belarus, Kazakhstan and Kyrgyzstan to participate in the Eurasian integration project (Kofner, 2020).

EEU members trade dependency on the Russian market causes their vulnerability associated with political, economic and trade conditions in Russia. Particularly, Russia's food embargo towards Western countries and subsequent import substitution and export promotion policy have certain impacts on economic growth prospects, food and nutrition security in EEU member states as well as their trade with other partners, including the EU.

A number of studies have estimated the impacts of the Russia's food embargo on the EU agri-food production and trade as well as Russian and EEU members markets. In general, many researchers pointed out that the overall effects on the EU is minor. The reduction of exports to Russia was compensated by growth of exports to the other markets (traditional and new ones) and increase in intra-EU trade (Uzun and Loginova, 2016; Kiselev et al., 2016; Boulanger et al., 2016; Kutlina-Dimitrova, 2017; Cheptea and Gaigné, 2020). At a sectoral level the ban impacted more severely on exports of dairy products.

In addition, imposition of food embargo coincided with a slowdown in Russian economy due to drop in crude oil prices and depreciation of national currency. These led to increasing domestic prices against the background of reducing real incomes of population, poverty growth (Nesavisimaya gazeta, 2019) and deteriorating quality of domestic food products. National currency depreciation and decline in population incomes caused decrease in consumption and a sharp fall in agri-food imports (Shagaida and Uzun, 2017). Volchkova and Kuznetsova (2019) estimated total consumers' losses to Rub 445 billion (about \$7.1 billion) or Rub 3000 (about \$48) per each Russian citizen throughout 2018. In such situation, the Russian government considers export promotion policy as a driver for increasing agricultural production and maintaining producer incomes. Elaborating measures for implementing such policy started in 2018, when a record value of \$25 billion in Russian agri-food exports was reached (Romashkin, Cherkasova and Avdeev, 2020). In this regards Russian government has an ambitious goal to increase agri-food exports to \$45 billion in 2024.

Given the existence of a single customs territory within the EEU, the aim of this paper is to examine the impact of the Russian food embargo and subsequent export expansion policy on agri-food trade between the EU and the EEU.

2. Materials and Methods

The study is based on International Trade Center data on EU and EEU yearly exports and imports of agri-food products corresponding to 1-24 groups of the Harmonized System (HS) of tariff nomenclature. These data were analyzed using descriptive statistics and index approaches to characterize the basic trends, quantitative and structural changes in EEU agri-food trade after import ban, including trade with the EU.

Import and export values for six-year period of 2013-2018 were analyzed to estimate agri-food trade transformation between the EU and the EEU. In 2013, chosen as the last year before imposing the embargo, over 80% of the Russian imports of banned products valued at €5.2 billion came from the EU (Cheptea and Gaigné, 2020).

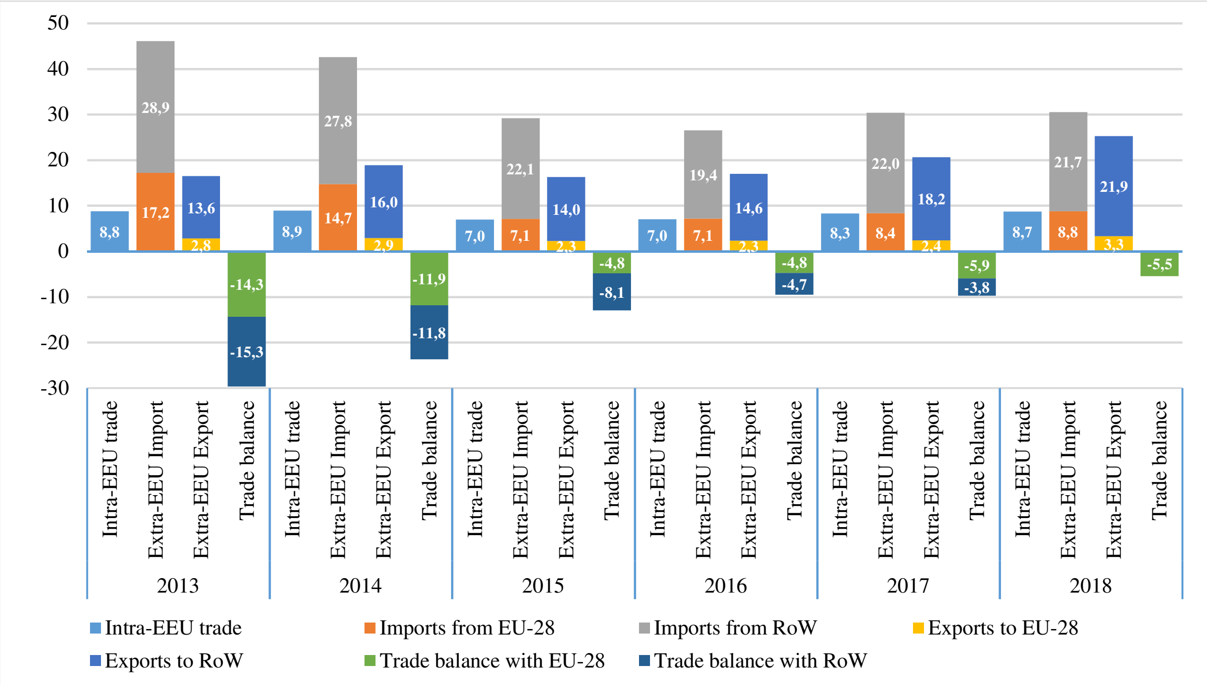
For selected commodities the rates of substitution of EU products by EEU ones in the Russian market were measured. Such indicators represent the corresponding ratios of growth in intra-EEU trade volumes of particular products to their volumes imported from the EU in 2013.

To characterize the basic trends in agri-food trade between the EU and the EEU as well as between Russia and other EEU member states, their export and import profiles at 4 digit - HS codes were compared based on calculations of trade complementarity indices for the period of 2001-2018. These indices are calculated for a particular year as the difference between the share of the commodity group in one country's exports and the share of that commodity group in another country's imports. The resulting difference is modulo summed across all commodity groups, divided by two and subtracted from 100 (WB, 2020). The index is zero when no goods are exported by one country or imported by the other and 100 when the export and import shares exactly match.

3. Results and Discussion

Despite Russia's food embargo policy and consequent trade shift towards Asia-Pacific region, the EU remains the main trading partner for the EEU. In 2013-2018 the agri-food trade between the EEU and the EU decreased from $20 to $12.1 billion (Figure 1). The share of the EU in extra-EEU agri-food imports reduced from 37.3% to 28.8% against the background of growing intra-EEU trade from 16.0% to 24.4% in the total EEU agri-food trade. However, current share of intra-EEU agri-food trade is three times lower than the share of intra-EU agri-food trade, not to mention the difference between the trade values. In addition, the share of the EEU in EU agri-food exports decreased from 3% in 2013 to 1.5% in 2018 against the background of growing European agri-food exports by 4.5% during the considered period.

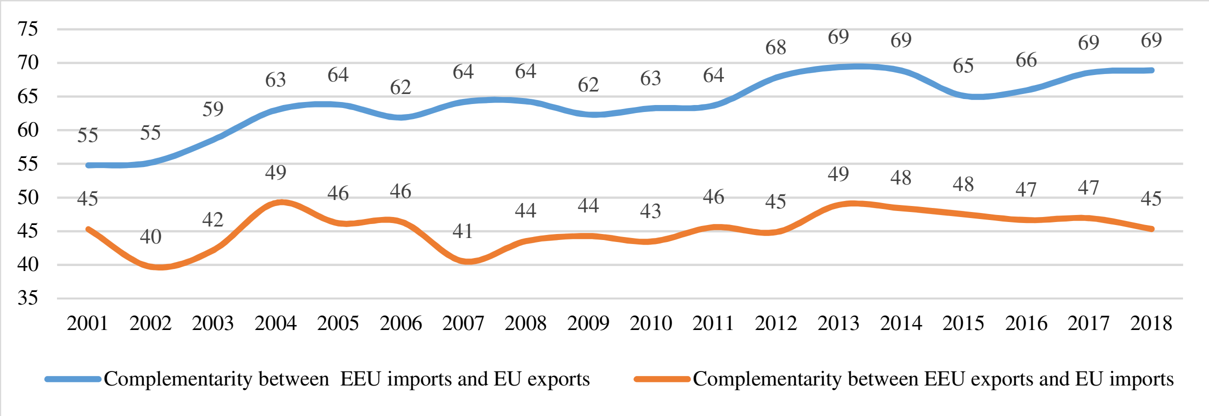
Figure 1. EEU agri-food trade (2013-2019, $ billion)



Source: calculations based on ITC Trade Map

The EEU continues to be a net importer in agri-food trade with the EU. Supply of agri-food products from the Eurasian region to the EU market is more than 2.5 times lower of the counter-trade flows. Prior to the food embargo imposition, there had been a six-fold excess of agri-food products supply in favor of the EU. It is important to note that recently the EEU has become a net exporter in agri-food trade with the rest of the world. However, the negative balance in agri-food trade with the EU is likely to remain in the future, as EU export profile is more in line with EEU import profile compared with the compliance between EEU export and EU import (Figure 2). In addition, complementarity between EEU agri-food exports and EU agri-food imports tends to decrease, that indicates deteriorating conditions for EEU products supply to the EU. In turn, the high level of complementarity of EU – EEU agri-food trade points to no economic reasons for the decision of the Russian authorities to restrict trade with the EU, as strongly evidenced by high consumer losses.

Figure 2. Agri-food trade complementarity indices between the EU and the EEU (2001-2018, %)



Source: calculations based on ITC Trade Map

The food embargo imposition and the subsequent devaluation of Russian ruble led to the reduction of agri-food imports from the EU to Russia as early as 2014 (Table 1). At the same time, European export towards other EEU countries increased. Particularly Belarus increased imports from Europe by 72.3%. This fact indicates the existence of opportunities for smuggling some of the banned products into Russia through Belarus (Kiselev et al., 2015; BBC, 2019) as well as legal deliveries of Belorussian processed foods produced from raw materials of EU origin (Liefert and Liefert, 2015). However, there was a sharp decline in agri-food imports for all EEU members in 2015 due to devaluation of national currencies. As a result, in 2018 compared to 2013, Russia reduced imports by 52.1%, Belarus - by 25.6%, other EEU countries - by 21.2%. About 83% of EU agri-food exports destined to the EEU is consumed in the Russian market.

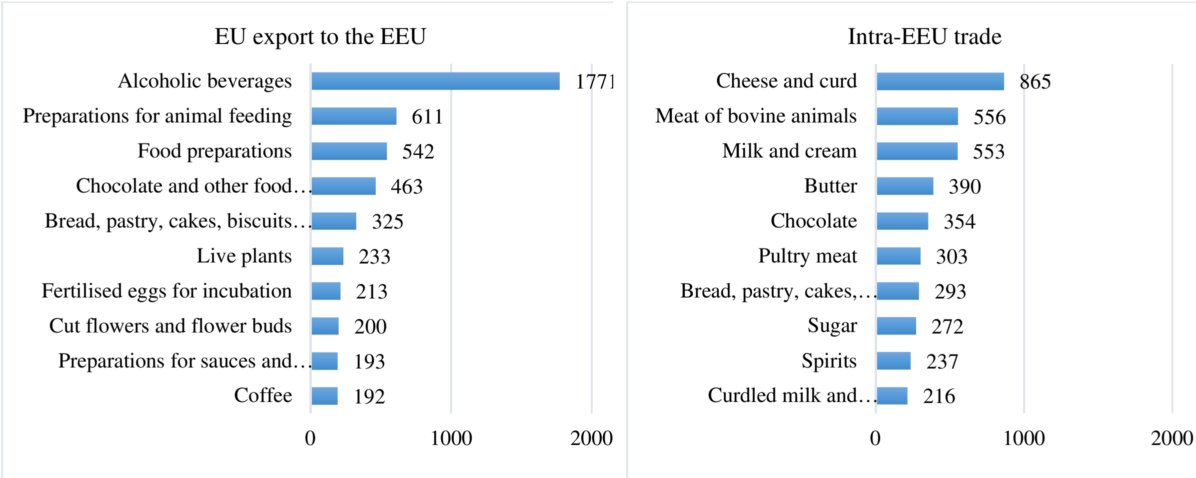
Table 1. EU agri-food exports to EEU countries (2013-2018)

	Value of EU export to EEU countries ($ billion)				Structure of EEU import from the EU (%)			
	Russia	Belarus	Rest of the EEU	Total	Russia	Belarus	Rest of the EEU	Total
2013	15,2	1,3	0,7	17,2	88,5	7,5	4,0	100,0
2014	11,8	2,2	0,8	14,7	79,8	15,0	5,2	100,0
2015	5,5	0,9	0,5	6,9	79,5	12,7	7,8	100,0
2016	5,6	1,0	0,4	7,1	79,1	14,6	6,3	100,0
2017	6,7	1,1	0,5	8,4	80,4	13,3	6,2	100,0
2018	7,3	1,0	0,5	8,8	82,9	10,9	6,2	100,0
2018 to 2013, %	-52,1	-25,6	-21,2	-48,9	-	-	-	-

Source: calculations based on ITC Trade Map

There were significant changes in the range of European agri-food products supplied to the EEU. Particularly cheese, pork, fruits disappeared from the top-10 of goods imported from the EU. These goods accounted for more than a quarter of European exports to the EEU before the embargo. Currently supply of EU agri-food products to the Eurasian market is comparable to the value of intra-EEU agri-food trade. However, the major traded goods are different (Figure 3).

Figure 3. Top-10 agri-food products for EU export to the EEU and intra-EEU trade (2018, $ million)



Source: calculations based on ITC Trade Map

One third of EU agri-food exports to the EEU consists of alcoholic beverages, preparations for animal feeding and food preparations. Intra-EEU trade is stick around dairy products and beef. In this regard, it is worth noting that commodities from the EU can hardly be substituted by EEU production, while lifting the food embargo could lead to the displacement of EEU producers from Russian market by European suppliers. This statement is justified by $1.9 billion of EU dairy products supply value in EEU market before the embargo.

Analysis of cross-border trade depicts a significant decrease in physical supply to the Eurasian market against the background of growing intra-EEU trade volumes almost for all selected products excepted pork (Table 2). However, the rates of substitution of EU products by the EEU ones are rather modest. According to our calculations, substitution rate for cheese corresponds to 37%, for tomato – 26% and for butter – 23%. The volume of EEU imports from the rest of the world decreased for all commodities, except for apples and pears. After the embargo, 45% of apples and pears imported from the EU were substituted by imports from the rest of the world in EEU market. In general, reducing EU agri-food import was partially mitigated by growing Russian domestic production stimulated by import substitution and export promotion policy.

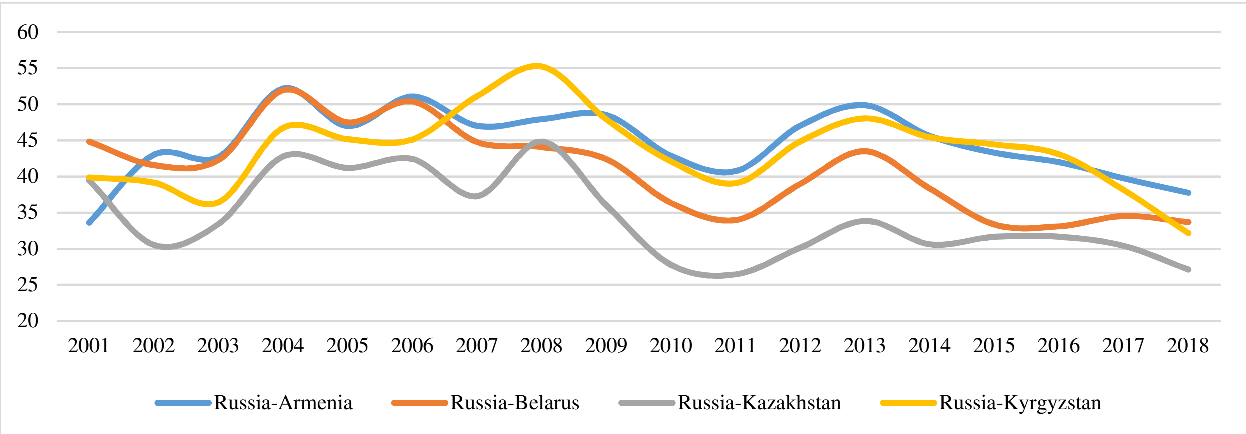
Table 2. EEU trade volumes for selected agri-food products (2013 and 2018, thousand tones)

	2013					2018				
	Imports from the EU		Imports from RoW	Intra-EEU trade	Total cross-border supply to the EEU	Imports from the EU		Imports from RoW	Intra-EEU trade	Total cross-border supply to the EEU
	Russia	Rest of the EEU				Russia	Rest of the EEU			
Cheese	261,5	3,4	49,4	153,6	468,0	0,0	5,4	41,7	249,2	296,3
Butter	35,3	2,5	54,1	66,4	158,3	0,0	1,5	23,7	74,4	99,7
Apples and pears	983,5	258,2	692,2	170,2	2104,1	0,0	266,7	1131,0	174,8	1572,5
Tomatoes	210,8	52,4	644,9	66,6	974,7	0,0	22,2	592,3	120,4	734,9
Pork	365,5	72,5	234,8	42,9	715,7	0,0	11,2	64,9	16,7	92,7

Source: calculations based on ITC Trade Map

High dependency of intra-EEU agri-food trade on the Russian market may have a negative impact on sustainability and inclusiveness of national food systems of the Eurasian countries. The main reasons for that are stagnation of the Russian economy and decrease in consumer demand, which were exacerbated by coronavirus outbreak and the lack of wide-scale policy measures to directly support household incomes and provide social protection of the most vulnerable population groups. In the short term, such situation would most likely lead to a shift in the demand of Russian consumers towards staple domestic foods, causing a decline in consumption of EU food products. In the medium term, possible disruptions in supply chains and impositions of trade restrictive measures along with rising unemployment and poverty levels worldwide may result in reduction of Russian exports and oversupply in domestic agri-food market. This might catalyze the substitution of EEU food products in the Russian market by domestic ones and lead to further decrease in EU export to the Eurasian market. Russian merchandise expansion to the Eurasian agricultural market with substitution of EU agri-food export is unlikely due to the low level of trade complementarity between Russia and other EEU member states (Figure 4).

Figure 4. Agri-food trade complementarity indices between Russian exports and other EEU member states imports (2001-2018, %)



Source: calculations based on ITC Trade Map

4. Conclusion

Even though Russia's trade restriction policy and its "turn towards the East", the EU remains the main partner and net exporter in agri-food trade with the EEU. The positive balance in such trade for the EU is likely to remain in the future, considering the high level of EU – EEU agri-food trade complementarity. In addition, the compliance between EU export and EEU import profiles indicates that there were no economic reasons for Russian authorities to restrict trade with the EU. Though imposed embargo contributed to the increase in intra-EEU trade volumes, the rates of substitution of EU products by the EEU ones were rather modest. In general, reducing EU import was partially mitigated by growing Russian domestic production.

Exacerbated by the coronavirus outbreak, stagnation of EEU member states economies and further decrease in demand would most likely lead to a consumer shift towards staple domestic foods, causing decline in EU food exports to the EEU. As part of dealing with these issues, an official dialogue between the EU and the EEU might contribute to the elaboration of measures for providing food and nutrition security along with developing sustainable food systems in Eurasia. Such measures may include investment cooperation aimed at localization of innovative agro-industrial productions in the Eurasian region.

Acknowledgements
This research was conducted at Lomonosov Moscow State University and financially supported by the Russian Foundation for Basic Research (Grant No 20-010-00639A).

References

BBC, Russian Service, 2019, “Belarusian suppliers of sanctions products to Russia were jailed”, [Online], Available: https://www.bbc.com/russian/news-48035455, [Accessed: 22 Apr. 2020]

Boulanger, P., Dudu, H., Ferrari, E. and Philippidis, G. (2016). “Russian roulette at the trade table: a specific factors CGE analysis of an agri-food import ban”, *Journal of Agricultural Economics*, vol. 67, issue 2, pp.272–291, ISSN 1477-9552, DOI 10.1111/1477-9552.12156

Cheptea, A. and Gaigné, C. (2020), “Russian food embargo and the lost trade”, *European Review of Agricultural Economics*, vol. 47, issue 2, pp. 684–718, ISSN 0165-1587, DOI 10.1093/erae/jbz032

EC, European Commission, Eurostat, European Union: agriculture statistical factsheet, DG Agriculture and Rural Development, Farm Economics Unit, 2019, [Online], Available: http://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/agri-statistical-factsheet-eu_en.pdf, [Accessed: 15 Apr. 2020]

EEC, Eurasian Economic Commission, Eurasian Economic Union in Figures: Short Statistical Collection, Moscow, 2019, [Online], Available: http://www.eurasiancommission.org/ru/act/integr_i_makroec/dep_stat/econstat/Documents/Brief_Statistics_Yearbook_2019.pdf, [Accessed: 15 Apr. 2020]

ITC Trade Map, International Trade Center, Trade statistics for international business development, [Online], Available: http://www.trademap.org, [Accessed: 15 Apr. 2020]

Kiselev, S., Strokov, A., Zhorova, M. and Belugin, A. (2015), “Agroindustrial complex of Russia under conditions of sanctions and necessity of providing the food security”, *Agrarian and industrial complex: economy, management*, no. 2, pp. 12-18, ISSN 0235-2443, DOI 10.33305/201-74

Kiselev, S., Strokov, A., Zhorova, M. and Belugin, A. (2016), “The impact of food trade restrictions on the Russian agriculture” *Proceedings of the Agrarian perspectives XXV*, Prague, pp. 147 - 154, ISBN 978-80-213-2670-5

Kofner, J. (2020), “Did the other EAEU Member States Profit from Eurasian Integration and Russia’s Countersanction Policy?”, Institute for Security Policy (ISP), [Online], Available: http://www.institutfuersicherheit.at/did-the-other-eaeu-member-states-profit-from-eurasian-integration-and-russias-countersanction-policy/, [Accessed: 18 Apr. 2020]

Kutlina-Dimitrova, Z. (2017), “The economic impact of the Russian import ban: a CGE analysis”, *International Economics and Economic Policy*, vol. 14, no. 4, pp. 537–552, ISSN 1612-4804, DOI 10.1007/s10368-017-0376-4

Liefert, W. and Liefert, O. (2015), “Russia's economic crisis and its agricultural and food economy,” *Choices*, vol. 30, no. 1, pp. 1-6, DOI 10.22004/ag.econ.200161

Nesavisimaya gazeta (2019), “Population incomes continued to fall”, [Online], Available: http://www.ng.ru/economics/2019-12-30/4_7763_econ02.html, [Accessed: 22 Apr. 2020]

Romashkin, R., Cherkasova, O. and Avdeev, M. (2020), “Priorities and promising directions of development of Russian agro-food exports”, *Economy, labor, management in agriculture,* no.1, pp. 38-45, ISSN 2077-3595, DOI 10.33938/201-38

Shagaida, N. and Uzun, V. (2017), “Development tendencies and challenges of Russian agriculture”, [Online], Available: http://ssrn.com/abstract=3090839, [Accessed: 20 Apr. 2020]

Uzun, V. and Loginova, D. (2016), “Russian food embargo: minor losses in western countries”, *Russian Economic Developments*, issue 9, pp. 32-37, [Online], Available: https://www.iep.ru/files/RePEc/gai/recdev/recdev-2016-9-725.pdf, [Accessed: 15 Apr. 2020]

Volchkova, N. and Kuznetsova, P. (2019), “How much do counter-sanctions cost: well-being analysis”, *Journal of the New Economic Association*, vol.43, issue 3, pp.173-183, ISSN 2221-2264, DOI 10.31737/2221-2264-2019-43-3-10

WB, World Bank, Trade Indicators, [Online], Available: http://wits.worldbank.org/wits/wits/witshelp/Content/Utilities/e1.trade_indicators.htm, [Accessed: 15 Apr. 2020]

POSITION OF THE CZECH REPUBLIC IN EU FIELD CROP PRODUCTION

Tamara Rudinskaya[1] and Zdeňka Náglová[2]

[1, 2] Institute of Agricultural Economics and Information, Mánesova 1453/75, 120 00 Prague 2

[1]rudinskaya.tamara@uzei.cz, [2]naglova.zdenka@uzei.cz

Annotation: The paper deals with the position of Czech Republic in EU field crop production. The aim of paper is to characterize field production of the Czech Republic, especially in terms of its contribution to Czech agriculture, to provide comparison with other Member States, and to describe the characteristic of producers with respect to their size. For this purpose, selected indicators from EUROSTAT database were used for comparison across the EU 28 Member States. The results showed significant differences between Member States concerning physical and economic size structure, and economic characteristics of farms with crop production. The characteristics of Czech average farm differ compared to average EU farm in average acreage of farm, number of AWU and livestock unit, but the number of farms belongs to the lowest. In the largest category of farm size has the biggest share the Czech Republic and Denmark. Large farms have advantages and disadvantages, that should be considered when preparing the Common Agricultural Policy for the next period.

Key words: field crop production, comparative analysis, Member States, competitiveness, EU market

JEL classification: O13, Q17, L22

1. Introduction

Agriculture represents one of the largest and important sectors in the world which secures food supply around the world. It is necessary to know the behavior of agricultural sector in EU (Gradinaru and Mocuta, 2017). European agriculture faces to a climate changes in terms of changing cultivation or selection other crops. There is also negative expectation with impacts on crop production in EU (Olsen et al., 2011). Chavas (2008) points out trend of farm specialization, and the development of large specialized animal, milk or pork meat production.

The structure of Czech agriculture with predomination of a large farms is a result of historical development of farm structures, agricultural policies and market effects. Large farms in the Czech Republic were established in the period of collectivization, when in the 1950s, individual farms were merged or entered collective units – the joint agricultural cooperatives or state farms. The process of collectivization that lasted until the beginning of the 1970s had a significant impact on the Czech farm structure (Hudečková, 1995). Urbánová et al. (2018) investigated farm size across EU-28 in terms of physical size and the indicator of standard output and concluded that the Largest average farm size have Slovakia and the Czech Republic.

An important agricultural production specialization of the Czech Republic is field crop production, which significantly affects whole Czech agriculture. The share of TF 16 is about 14% on total crop production with 23% of agricultural land farmed.

Specialist other field crop production (TF 16 grouping) include quite wide range of production. It means root crops, cereals, oilseeds and others. Importance of this branch is different among EU countries and offers options to analyze the position of each country more deeply with respect to countries' competition on the market.

One of the important crops, that belongs to TF 16 is sugar beet. Sugar beet cultivation has a long tradition in the Czech Republic, and, despite the restructuring of sugar refineries and the reduction of the size of sugar beet and sugar production in the Czech Republic, this sector remains an important part of our agriculture. However, it should be noted that the sugar market in Europe is highly concentrated - dominated by eight large transnational alliances, with these alliances controlling less than 90% of EU sugar production (Špička, Janotová, 2015).

The aim of the paper is to characterize field production (TF 16) of the Czech Republic in terms of farms size, and to describe the differences in selected indicators among EU countries.

The questions addressed in the paper are:

1.What is the meaning of production orientation TF 16 in different Member States?

2.What is the size structure of farms with field crop production?

3. Do the production and economic indicators vary across farms with different size?

2. Materials and Methods

Paper provides comparative analysis of Czech and European Union farms with crop production in terms of their structure. Analysis uses data of EUROSTAT and database to compare field crop production (TF 16) in the Czech Republic and in EU Member States. The paper deals with questions of the position of crop production in total agricultural production, or what is the size structure of farms with crop production; analyses the position of crop production in agriculture, characteristics of farms, their size structure, difference between farms of various size.

At first, the importance of this sector in whole EU is evaluated on general level according to selected factors: the share of field crop production on total agriculture production, its development in time (comparison in years 2005 and 2016), and the share on total crop production. Then the share on total number of agriculture holdings, total agricultural land, and AWU (annual working unit) is assessed.

Next part consists of comparison of average field crop production farms in each EU country. The average agricultural area, number of workers, number of farms, the farm size and herd size in 2016 are compared. Because the farms size belongs to one of the specifics of Czech agriculture, we compare the characteristics of Czech and EU farm according to their size (agricultural area, number of workers and herd size) in general. The structure of different farm size in EU countries is also evaluated.

3. Results and Discussion

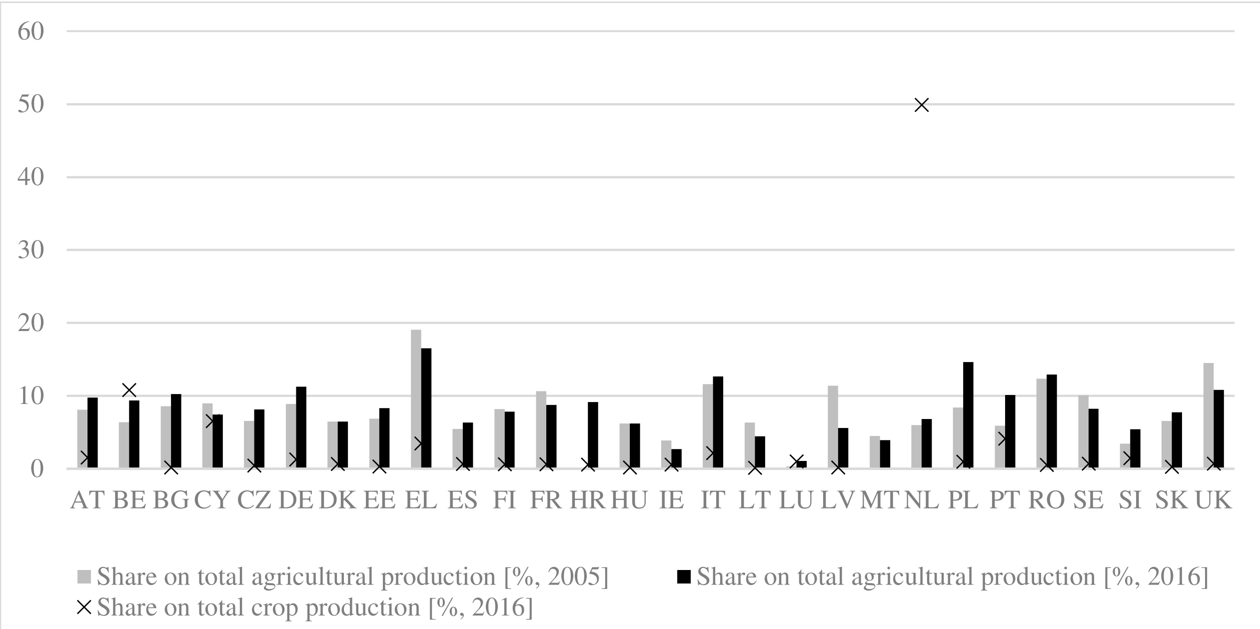
Figure 1 shows the significance of TF 16 production in 2005 and 2016 in the EU. The share of total agricultural production in the EU in 2016 ranged from 1 to 16.5%. The figure shows that TF 16 has a significant share on total agricultural production in Greece in 2016, i.e. 16.5%, followed by Poland with 14.6% and Romania with 12.9%. In the case of Poland, the share of TF 16 on total agricultural production increased more than twice. On the other hand, Luxembourg recorded the lowest share on total production with 1%, Ireland 2.7% and Malta 3.9%.

The EU average increased slightly from 8% to 8.3% over the years. The highest increase was reported by the aforementioned Poland and Portugal. Decreases occurred mainly in Latvia, Great Britain and Greece.

The Czech Republic is characterized by an 8.1% share of total agricultural production with an increase of 1.6% compared to 2005. Almost similar percentages are reported for example in Sweden, Finland and Estonia.

Poland has the largest share of TF 16 on crop production in 2016 (almost 50%). The European average is around 3.4%. Belgium has the second highest share 10.8% and Cyprus 6.6%. A very low share of crop production (below 1%) can be observed in a number of countries, such as Bulgaria, the Czech Republic, Denmark, Hungary, Romania, Sweden.

Figure 1. Significance of TF 16 production in 2005 and 2016



Source: own processing from Eurostat data, 2020

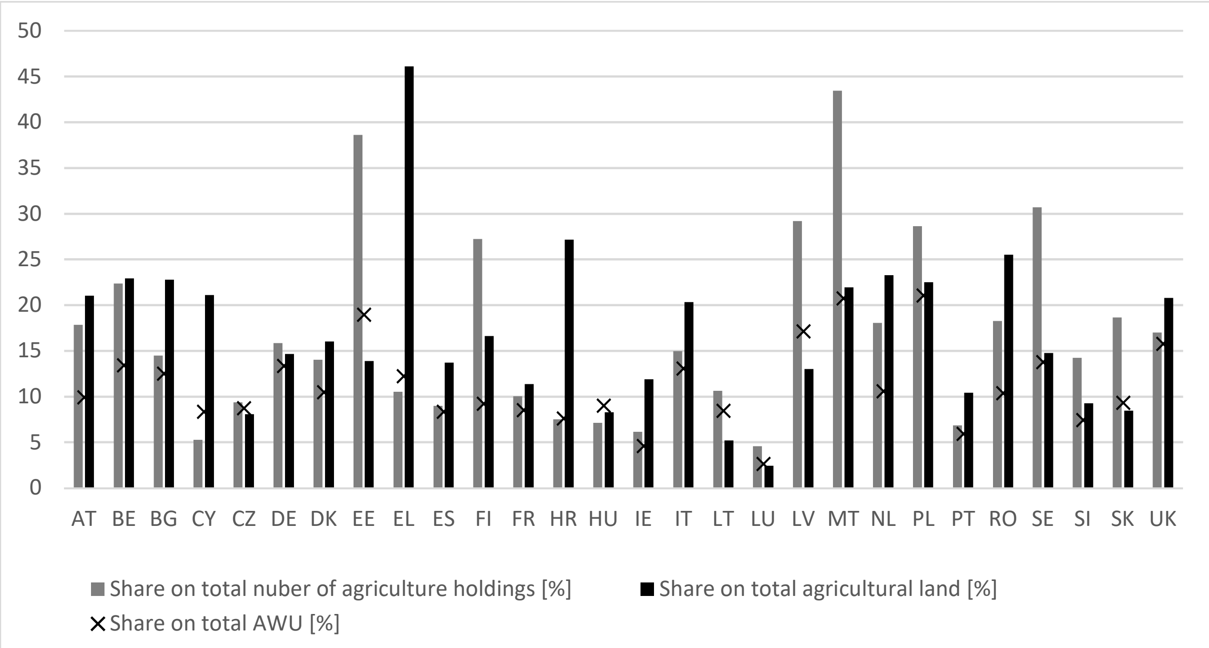
The share of specialized holdings on agricultural land and the total number of farms shows a considerable variation (figure 2). The share on the number of holdings ranges from 4.6 to 43.4%, and the share on agricultural land ranges from 2.4 to 46.1%. Malta has an important position in the production orientation of TF 16 in terms of the number of farms. In the country, these enterprises account for 43.4% of the total number of farms. Estonia has the share of 38.6%, Latvia - 39.2% and Lithuania - 38.6%. However, the share on total agricultural land in these countries is not so significant. These are probably smaller farms. On the other hand, this specialization has a very small share on the number of farms in Luxembourg, Ireland and Cyprus, where the share is below 6%. The farms with specialization on TF 16 account for the largest share on total agricultural land in Greece (46.1%), Croatia (27.1%) or Romania (25.5%).

High number of the employed persons, i.e. the share on total number of AWUs, is evident in Malta (20.7%), which also has a significant share on the number of farms. Higher share of employed persons on total AWU has Poland, (21.1%), followed by Estonia (19%).

The TF 16 is of minor importance in Ireland and in Luxembourg, where the share on both the number of enterprises and AWU is one of the lowest.

In the Czech Republic there are 9.3% of farms engaged in this type of farming, with the shares of our foreign neighbors being higher (Poland 28.6%, Slovakia 18.6%, Germany 15.8%, Austria 17.8%). The same applies to the share of agricultural land and AWU.

Figure 2. Characteristics of farms with TF 16 production specialization



Source: own processing from Eurostat data, 2020

Table 1 represents the characteristics of the average farm with TF 16 production specialization in 2016. According to these data, the average Czech enterprise can be characterized by an area of 112 ha, 3.6 full-time employees, 12 livestock units and VIII class of economic size (standard production between EUR 100,000 and EUR 250,000). The characteristics of the average EU farm are quite different. According to Bouma Varallyay and Batjes (1998) in Europe, there are large differences between countries, also in climatic conditions, land use, infrastructure and also in political and economic conditions. The Czech Republic differs considerably from these characteristics. The area of the average Czech farm is significantly higher than in other countries, while the area is close to the average farm in Great Britain with 110 ha, while the European average farm with a production specialization of TF 16 has an area around 35.4 ha. On the other hand, the small size of average farm is apparent in Malta (0.6 ha), Slovenia (4.5 ha) or Romania (5.1 ha). Land can be considered also as a factor limiting the development of the farm and its usage can be also affected by Common Agricultural Policy (abolishment reduces the farmed area) (Bartolini and Viaggi, 2013). Land is also most applicable as an indicator of farm size (Ciaian Kancs and Swinnen, 2010). The Czech Republic stands out also in another indicator, i.e. the number of AWU employees, which is 3.6. The European average is 1 AWU. According to Bartolini and Viaggi (2013) the number of workers is in relation with farmed area. A farm with similar area, the United Kingdom, reaches 1.4 AWU. Another specific feature of the Czech farm is the size of the herd, i.e. 12.1 LSU, which is differs from any European farm (the EU average is 1.6 LSU). Looking at another indicator, i.e. the economic size class, a number of other farms, such as Denmark, France, Germany or the Netherlands, are approaching the average Czech enterprise. The number of farms in the CR is among the lowest, i.e. total of 2 480 holdings, which is also decreasing over time. The opposite situation is evident in Romania, where it is over 624 thousand enterprises (with stable development of their number), with very low agricultural area, number of AWU, LSU or economic size class. This fragmentation of land can also affect the agricultural and rural development. These fragmentations can be caused by land reforms, mainly in Central and East Europe (Rembold, 2003). Large fragmentations can be seen also in Poland, where the average agriculture area is 8 ha and number of farms larger than 400 thousand. According to Hartvigsen (2014) it is due farms structures before second world war, not due to land reforms. Czech Republic is opposite example with very low fragmentation. According to Zolin and Caldogno (2012) in Southern EU countries are mostly small farms with large fragmentation, but in Northern EU there are larger farms.

Table 1. Characteristics of the average enterprise of production specialization TF 16 (2016)

Country	Average agricultural area [ha]	Number of workers [AWU]	Herd size [LSU]	Farm size Economic size class	Number of farms
Belgium	37.6	0.9	3.7	VII	8 250
Bulgaria	34.6	1.1	0.4	IV	29 360
Czech Republic	112.2	3.6	12.1	VIII	2 480
Denmark	85.3	1.1	2.2	VIII	4 910
Estonia	21.4	0.6	0.3	IV	6 450
Finland	27.4	0.5	0.5	V	13 530
Francie	69.1	1.3	4.7	VIII	45 730
Croatia	42.0	1.2	0.7	V	10 090
Ireland	68.8	0.9	1.2	V	8 420
Italy	14.9	0.7	0.1	VI	171 430
Cyprus	12.8	0.8	0.1	V	1 840
Lithuania	9.5	0.8	0.4	III	15 980
Latvia	12.3	0.6	0.2	II	20 420
Luxembourg	35.0	1.0	0.2	VI	90
Hungary	12.6	1.2	0.5	IV	30 600
Malta	0.6	0.3	0.0	I	4 000
Germany	56.0	1.5	5.2	VIII	43 720
Netherland	41.6	1.5	1.5	VIII	10 050
Poland	8.0	0.9	0.5	IV	403 660
Portugal	21.4	1.0	0.7	VI	17 710
Austria	23.8	0.4	0.5	VI	23 620
Romania	5.1	0.3	0.1	II	624 470
Greece	29.2	0.8	0.2	V	71 950
Slovakia	33.4	0.9	2.3	VI	4 780
Slovenia	4.5	0.6	0.4	III	9 950
Spain	37.6	0.8	0.3	VI	84 710
Sweden	23.0	0.4	0.4	V	19 320
United Kingdom	110.2	1.4	4.0	VII	31 430

Note: The nomenclature of economic size classes is as follows (according to Standard output, EUR): (I) < 2000, (II) 2000 <4000, (III) 4000 < 8000, (IV) 8000<15000, (V) 15000 < 25000, (VI)25000< 50000, (VII) 50000<100000, (VIII) 100000<250000, totally XIV classes.

Source: own processing from Eurostat data, 2020

There are differences in farm size among EU countries. In EU the number of farms decreases bud their size increases, but an opposite trend is evidenced in the Czech Republic (Janovská et al., 2017). Farms in the Czech Republic, which have the highest percentage, i.e 13.7% in the category of EUR 8,000 - 14,999 of standard output, can be characterized by the area of 12.2 ha, 0.6 full-time workers with 1.1 LSU (table 2). The European average is higher in terms of land area and number of workers. Other farms enterprises characteristic for the Czech Republic are farms with over EUR 500,000 of standard production, have an average area of 953.3 ha, employ 123 workers and have 26.6 LSU. The EU average for a given size group shows an area lower by more than 340 ha, with less than 10 workers, but with a slightly larger herd size (31 LSU). Looking at the other size categories, the Czech Republic also differs from the EU. The smallest size category (up to EUR 2 000) is almost 7 hectares larger than the EU and corresponds to European average for the EUR 4 000 - 7 999 category. Herd size is also higher in almost all categories compared to the EU average.

Table 2. Characteristics of farms of production specialization TF 16 in individual economic size classes (2016)

	Czech Republic			**EU**		
	Agricultural area [ha]	Number of workers [AWU]	Herd size [LSU]	Agricultural area [ha]	Number of workers [AWU]	Herd size [LSU]
<2 000	9.1	NA	0.5	2.3	0.3	0.0
2 000-3 999	8.5	0.1	0.6	5.9	0.6	0.2
4 000-7 999	8.3	0.6	0.9	9.9	0.7	0.2
8 000-14 999	12.2	0.6	1.1	16.1	0.9	0.3
15 000-24 999	17.6	2.3	1.3	23.8	1.0	0.6
25 000-49 999	28.9	3.1	1.8	35.1	1.3	1.0
50 000-99 999	55.7	4.0	2.1	65.9	1.5	1.8
100 000-249 999	101.2	6.9	3.7	105.4	1.9	4.2
250 000-499 999	273.3	13.9	5.4	200.5	2.8	11.3
>499 999	953.3	123.4	26.6	611.4	9.6	31.1

Source: own processing from Eurostat data, 2020

Urbánová et al. (2018) point out that standard output can be the better indication for farm size analysis and remuneration of subsidies than utilized agricultural area. Table 3 provides a more detailed look at the structure of agricultural holdings of the production orientation TF 16 according to their economic size. In the largest size category (over EUR 499 999), the Czech Republic (7.7%) and Denmark (7.1%) have the largest shares. In contrast, enterprises of smaller size categories (up to EUR 25 000 of standard output) are characteristic for a number of countries such as Bulgaria, Finland, France, Luxembourg, Hungary, the Netherlands, Austria, Greece, Slovakia and Slovenia. In these countries, more than 90% of companies with this amount of output is located, while most of the enterprises are situated in the lowest size category up to EUR 2,000 of standard output. In the Netherlands this share represents 91.5% of enterprises, in Greece 82% or in Luxembourg and France respectively 75.9%. On the other hand, the Czech Republic has a highly fragmented structure among individual size categories, with the largest number of enterprises in the size group from EUR 8,000 to 14,999 (i.e 13.7%). Some studies (Bojnec and Latruffe, 2013) also investigated the relation between size, subsidies and performance of farms and showed positive effects. Smaller farms are less effective. Mid-sized firms can cumulate disadvantages. They are too small to be efficient, but too large to gain profits.

Table 3. Structure of farms of production specialization TF 16 by economic size (2016)

%	Eur									
	<2000	2000-3999	4000-7999	8000-14999	15000-24999	25000-49999	50000-99999	100000-249999	250000-499999	>499999
Belgium	2.8	4.2	7.5	10.4	11.4	17.7	18.4	18.7	7.0	1.9
Bulgaria	57.0	13.8	12.4	6.2	4.1	2.6	1.7	1.1	0.6	0.5
Czech Republic	9.7	6.5	12.9	13.7	10.5	12.5	10.1	11.7	4.4	7.7
Denmark	9.2	10.6	14.1	13.0	7.1	7.5	9.4	14.1	7.9	7.1
Estonia	0.8	11.1	14.5	14.5	11.7	12.0	11.3	12.5	6.5	5.1
Finland	64.0	15.3	8.1	4.3	2.5	2.0	2.0	1.2	0.3	0.3
France	75.9	11.6	3.8	1.3	0.7	0.8	1.7	2.3	1.3	0.8
Croatia	10.2	14.7	23.9	22.4	13.3	9.9	4.2	1.3	0.1	0.1
Ireland	35.0	13.9	13.8	8.8	6.4	8.0	7.5	5.1	1.1	0.5
Italy	30.8	4.2	5.6	5.7	6.3	5.7	7.8	17.0	12.4	4.5
Cyprus	30.7	17.1	20.1	12.6	6.6	7.3	3.6	1.5	0.3	0.2
Lithuania	15.6	17.2	17.7	13.5	10.7	9.7	7.3	5.7	1.6	1.0
Latvia	27.7	15.2	11.4	10.9	8.2	11.4	9.2	4.3	1.1	NA
Luxembourg	75.9	11.6	6.1	3.4	1.4	1.0	0.3	0.2	0.1	0.0
Hungary	73.0	13.1	6.2	3.5	1.6	1.0	0.6	0.7	0.2	0.2
Malta	NA	11.1	22.2	22.2	11.1	22.2	11.1	11.1	NA	NA
Germany	69.3	7.4	7.2	5.9	3.3	3.1	1.9	0.9	0.4	0.5
Netherland	91.5	4.5	2.0	1.0	0.8	0.3	NA	NA	NA	NA
Poland	0.4	1.9	6.8	10.0	9.8	12.9	15.6	23.0	13.2	6.5
Portugal	50.2	14.3	9.3	4.9	3.6	5.4	5.4	5.3	1.2	0.4
Austria	43.7	21.8	14.4	9.1	4.5	3.6	1.7	0.8	0.2	0.1
Romania	44.3	21.2	12.6	7.8	3.0	3.7	2.5	2.5	1.2	1.0
Greece	82.0	11.3	3.7	1.4	0.6	0.4	0.2	0.2	0.1	0.0
Slovakia	48.9	27.0	14.7	4.8	1.9	1.1	0.7	0.7	0.1	0.1
Slovenia	41.2	23.0	17.6	8.2	2.9	2.3	1.0	1.9	0.8	1.5
Spain	0.1	21.9	30.1	21.1	11.4	7.7	4.2	3.0	0.4	0.2
Sweden	9.1	28.2	28.7	15.6	7.5	4.6	2.4	2.2	1.2	0.6
United Kingdom	27.9	18.7	13.5	9.4	5.1	4.6	4.4	7.2	5.2	4.1

Source: own processing from Eurostat data, 2020

4. Conclusion

The results show significant differences between Member States concerning size structure and economic characteristics of farms with crop production (TF 16).

Importance of field crop production differs in EU countries. The highest share of this branch on agricultural production is in Greece (16.5%), Poland (14.6%) and Romania (12.9%). On the opposite, the share is very low in Luxembourg, Ireland and Malta. But Malta has very high share of field crop production farms on total number of farms (43.4%). The characteristics of Czech average farms differ compared to average EU farm in area of farm, number of AWU and livestock unit, but the number of farms belongs to the lowest. In the largest category of farm size (above 499 999 EUR) has the biggest share the Czech Republic (7.7% of total field crop production farms) and Denmark (7.1%).

The questions related to the structure of Czech agriculture are very important. Generally, market power is positively related to farm size. The policy measures that aimed to reduce or compensate for power of large-scale farms were mostly insufficient or had only partial effects.

One of the main obstacles for large farms is a lack of human resources, especially in the livestock sector, where the requirements toward labour qualification are high. Another problem is a high competition for better farmland resources among large farms as well as between large and small farms. Finally, there is uncertainty about future capping of direct payments in the next CAP programming period (after 2021) and potential limitation of investment support.

Acknowledgements

The paper is a part of the solution of project QK1920398 supported by the Ministry of Agriculture of the Czech Republic – NAZV - program ZEMĚ.

References

Bartolini, F. and Viaggi, D. (2013), "The common agricultural policy and the determinants of changes in EU farm size", *Land Use Policy,* vol. 31, pp. 126-135, ISSN 0264-8377, DOI 10.1016/j.landusepol.2011.10.007

Bojnec, Š. and Latruffe. L. (2013), "Farm size, agricultural subsidies and farm performance in Slovenia", *Land Use Policy*, vol. 32, pp. 207-217, ISSN 0264-8377, DOI 10.1016/j.landusepol.2012.09.016

Bouma, J., Varallyay, G. and Batjes, N.H. (1998), "Principal land use changes anticipated in Europe", *Agriculture, Ecosystems & Environment*, vol. 67, no. 2-3, pp. 103–119, ISSN 0167-8809, DOI 10.1016/S0167-8809(97)00109-6

Chavas, J. P. (2008), "On the economics of agricultural production", *Agricultural and Resource Economics*, vol. 52, no. 4, pp. 365-380, ISSN 1467-8489, DOI 10.1111/j.1467-8489.2008.00442.x

Ciaian, P., Kancs, D. A. and Swinnen, J. F. (2010), "*EU Land Markets and the Common Agricultural Policy*", Brussels, Centre for European Policy studies, ISBN 978-92-9079-963-4

Gradinaru, I. and Mocuta, D. (2017), "Farm structures in the European Union", *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, vol. 17, no. 1, pp. 223-230, ISSN 2285-3952

Hartvigsen, M. (2014), "Land reform and land fragmentation in Central and Eastern Europe", *Land Use Policy,* vol. 36, pp. 330-341, ISSN 0264-8377, DOI 10.1016/j.landusepol.2013.08.016

Hudečková, H. (1995), "Privatizace v zemědělství a obnova venkova", *Sociologický časopis*, vol. 31, no. 4, pp. 449-462, ISSN 2336-128X

Janovská, V., Šímová, P., Vlasák, J. and Sklenička, P. (2017), "Factors affecting farm size on the European Level and the national level of the Czech Republic", *Agricultural Economics-Czech*, vol. 63, no. 1, pp. 1-12, ISSN 1805-9295, DOI 10.17221/317/2015-AGRICECON

Olsen, J. E., Trnka, M., Kersebaum, K. C., Skjelvag, A. O., Seguin, B., Peltonen-Sainio, P., Rossi, F., Kozyra, J. and Micale, F. (2011), "Impacts and adaption of European crop production systems to climate change", *European Journal of Agronomy*, vol. 34, no. 2, pp. 96-112, ISSN 1161-0301, DOI 10.1016/j.eja.2010.11.003

Rembold, F. (2003), "*Land fragmentation and its impact in Central and Eastern European countries and the Commonwealth of Independent States*", Land Reform nr. 1/2003, FAO.

Špička, J. and Janotová, B. (2015), "Efektivnost pěstitelů a rentabilita produkce cukrové řepy v ČR", *Listy cukrovarnické a řepařské*, vol. 131, no. 7-8, pp. 217-222, ISSN 1805-9708

Urbánová, M., Dobošová, L, Kozáková, J. and Čeryová, D. (2018), "Physical and Economic Size of Farms in the EU 28 – Focus on Slovakia", *Proceedings of the Agrarian perspectives XXVII*, Prague, p. 408-415, ISBN 978-80-213-2890-7

Zolin M.B. and Caldogno, A.R. (2012), "Beyond the European rural areas: the need for strategic approaches", *Transition Studies Review*, vol. 18, no. 3, pp. 613–629, ISSN 1614-4007, DOI 10.1007/s11300-012-0218-6

STATISTICAL STUDY OF DEVELOPMENT OF SMALL AND MEDIUM ENTERPRISES IN AZERBAIJAN

Orkhan Rza

Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

rza.orkhan@gmail.com

Annotation: The main purpose of the study is to study small and medium enterprises in the Republic of Azerbaijan in a market economy statistical research and assessment of the formation, current status and development of its activities. The role and features of small and medium business in the formation of new structures of the market system in the Republic of Azerbaijan were revealed. The current state of small and medium enterprises in the country has been statistically studied and its development has been statistically assessed. The development of small business in the regions of the country has been statistically studied. The main directions of state support for small business have been identified. The information base of the research consists of annual journals of the State Statistics Committee of the Republic of Azerbaijan, Internet resources, materials of mass media, as well as scientific researches of various authors. The following statistical methods are used in the research: table, graph, index, analysis of time series, method of average and relative relations, etc. This research deals with the formation and development of small and medium enterprises in a market economy. The role of small business in the development of the economy, its functions and features were studied, the limits of the criteria for financing small businesses, the rules of organization of statistical accounting and the system of indicators were determined.

Keywords: SMEs, Azerbaijan, Development, Finance and Statistics

JEL Codes: O10, R11

1. Introduction

A small to mid-size enterprise (SME) is a business that maintains revenues, assets or number of employees below a certain level. Within the framework of economic reforms in 1995 on "State Program of privatization of state property in the Republic of Azerbaijan in 1995-1998" and in 2003

The Laws of the Republic of Azerbaijan “On State Assistance to Small Entrepreneurship” came into force, and the regulatory framework was improved. The activity of business entities in Azerbaijan, which provided 15.3% of the gross domestic product in 2006, has become more prominent in the development of various sectors of the economy and regions of the country. (Statistical Committee 2018) Since the early 1990s, the state has implemented a number of measures and special programs that will lead to the development of small and medium-sized businesses. As a result, radical changes are taking place in the structure of the economy; economic structures, institutions and economic relations are being formed in accordance with the new economic system. A wide range of entrepreneurs has been formed in the Republic of Azerbaijan, and small business has become an independent sector of the national economy. In 2010-2018, there was a growing trend in the dynamics of key macroeconomic indicators of small businesses. (CESD- Center for Economic and Social Development 2017)

The Cabinet of Ministers of the Republic of Azerbaijan has outlined the “criteria of SMEs” on the 6th of June 2015, as a means of enlightening the channels of adopting the straight influences of improvements towards SMEs. A new order with small alterations was accepted in June 2016, and is presently valid. The new order has abridged the expressing standards of SMEs; according to this new order, as shown in Table 1, categorization is expressed by the size of the enterprise, and not by the segment in which it works (President.az, 2016).

Table 1. Criteria of determination of SMEs in Azerbaijan

Entity category in terms of size	Average number of employees (People)	Financial Balance Sheet Value (AZN)	Annual Net Sales Revenue (AZN)
Micro	1-10	150,000-200,000 AZN	150,000-200,000 AZN
Small	11-50	200,000-3,000,000 AZN	200,000-3,000,000 AZN
Medium	51-250	3,000,000-30,000,000 AZN	3,000,000-30,000,000 AZN
Large	251 and above	≤ 30,000,000 AZN	≤ 30,000,000 AZN

Source: Cabinet of Ministers of the Republic of Azerbaijan, Regulation: 2005/ № 556

According to the State Statistics Committee of the Republic of Azerbaijan, in 2015, the share of small businesses in the non-oil sector was 5.8 percent in value added, 0.7 percent in gross profit, 6.5 percent in the average annual number of employees and 9.2 percent in investments in fixed assets. (Statistical Committee 2017) This information covers legal entities and individuals who are considered to be small business entities, and as of July 1, 2016, 83,017 units or 79.7 percent of enterprises operating in the country fell to the share of these enterprises. Also, as of this date, the main part of small enterprises in the country operated in trade (31.2 percent), construction (12.1 percent), agriculture (10.7 percent) and other services (13.5 percent). (Statistical Committee 2017)

In this table showing the classification of enterprises in Azerbaijan according to the new regulation and also in European Union is given below.

Table 2. Classification of SMEs in Azerbaijan and EU

Azerbaijan	Micro	Small	Medium	All SMEs	Large	Total
Enterprises Number	237,815	81,235	2,138	321,188	645	321,883
%	73 %	25,83 %	0.66 %	99.78 %	0.2 %	100.0 %
Employment Number	245,657	176,568	145,876	568,101	447,865	1,015,966
%	24 %	17 %	14 %	56 %	44 %	100 %
EU	Micro	Small	Medium	All SMEs	Large	Total
Enterprises Number	23,323,938	1,472,402	235,668	25,032,008	47,299	25,079,312
%	93.0%	5.9%	0.9%	99.8%	0.2%	100%
Employment Number	43,527,668	29,541,260	24,670,024	97,738,952	49,045,644	146,784,592
%	29.7%	20.1%	16.8%	66.6%	33.4%	100.0%

Source: The State Statistical Committee of the Republic of Azerbaijan, Micro, small and medium entrepreneurship in Azerbaijan/ Eurostat, National Statistical Offices, DIW Econ, 2017

2. Materials and Methods

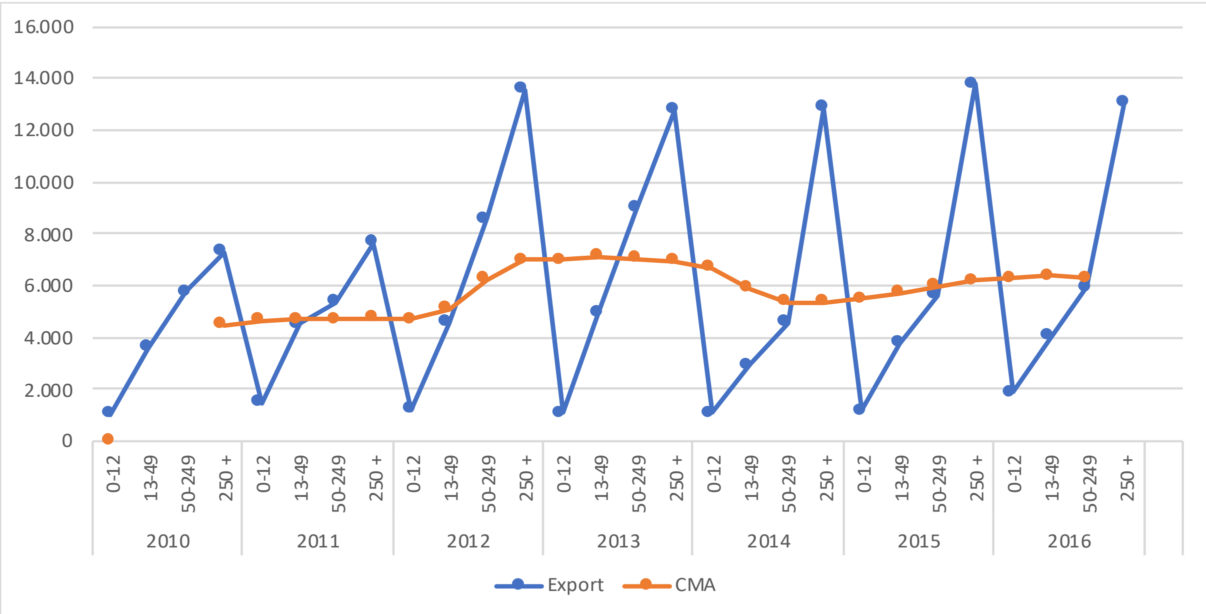
This research was carried out in parallel with the use of qualitative and quantitative methods. Several methods were used simultaneously, including those of description, analysis, statistics, system and generalization. The object of research is the activity of small and medium enterprises engaged in entrepreneurial activity in Azerbaijan, the issues of financial security, which are important for their sustainable development and expansion of activities, the subject of problems arising in financing such entities, their solution, generally existing methods of financing and improvement of directions. Quantitative and qualitative methods were used in the research. These methods include comparative analysis, statistical method, graphical analysis, scientific abstraction, logical generalization and others.

During the research, scientific researches and books of Azerbaijani scientists, reports of the State Statistics Committee for statistical research 2010-2018, as well as changes during 2019, a number of issues related to the Cabinet of Ministers, the Ministry of Taxes, as well as the Republic of Azerbaijan Legislative acts and norms, statistical reports on the use of the Fund for Entrepreneurship Development were used. (Bayramov, et al., 2017)

According to the statistics provided by the Ministry of Economy of the Republic of Azerbaijan for

2016, the number of entrepreneurship themes in all segments of the economy was totaled 895,984.As it turns out, in 2018, the number of entrepreneurship subjects augmented by 98,161, as related to 2017. According to given indicators, 39.2% of total industrialists were registered in the city of Baku and 60.8% in other regions of the country. (Statistical Committee 2017)

Figure1. Export of enterprises by business size in Azerbaijan (million US dollars)



Source: The Republic of Azerbaijan Ministry of Economy, 2019

According to the State Customs Committee of the Republic of Azerbaijan, the foreign trade turnover of the Republic of Azerbaijan in 2016 amounted to 31.02 billion US dollars, including imports of 9.19 billion US dollars and exports of 21.83 billion US dollars. (CESD- Center for Economic and Social Development 2017) During this period, the Republic of Azerbaijan cooperated with 150 countries in the field of trade and the foreign trade balance was positive at $ 12.64 billion. The volume of foreign trade turnover of the Republic of Azerbaijan in 2015 amounted to 34,687.92 million. USD, including the volume of imports 10,712.50 mln. USD, and the volume of export was 23.975.42 mln. USD. During this period, the Republic of Azerbaijan cooperated with 149 countries in the field of trade and the foreign trade balance was positive 13.262.92 mln. It was the US dollar. Compared to 2014, the foreign trade turnover of the Republic of Azerbaijan in 2015 increased by 3.35 percent. In 2012, the share of the 27th group (excluding electricity) in the structure of exports of oil and gas industry products was 92.62%. At the same time, the volume of exports in the non-oil sector (excluding oil and gas products) increased by 5.78 percent ($ 96.79 million) compared to 2013. (OECD/European Union/ETF 2016)

Table 3. The share of small business entities in the economy of the Republic of Azerbaijan in 2010-2018, in percent

Indicators	2010	2012	2018
Value added	1.6	2,7	2,6
Non-oil sector	4,2	5,2	4,3
General benefit	0,2	0,4	0,7
Non-oil sector	2,7	3,3	3,5
Average annual number of employees	6,7	6,4	7,6
Non-oil sector	6,9	6,6	7,7
Fixed capital investments	3,9	3,5	4,2
Non-oil sector	7,3	4,6	6,4
Annual turnover	4,2	9,6	10,5
Non-oil sector	7,7	18,5	18,4

Source: The State Statistical Committee of the Republic of Azerbaijan, 2017

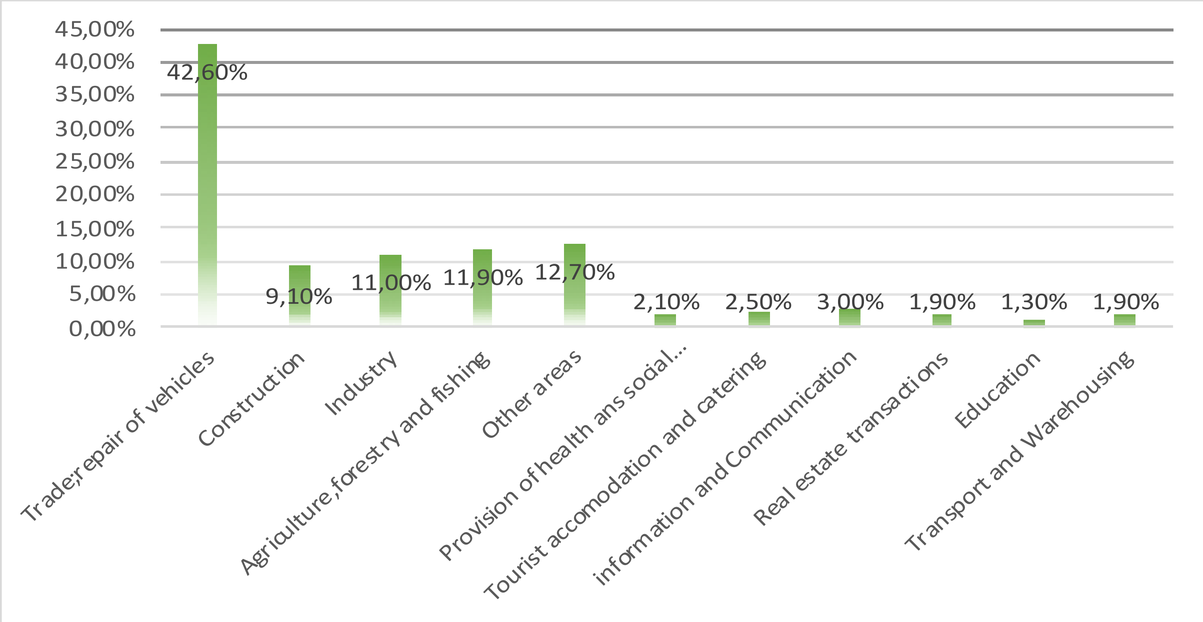
According to official statistics, the role of small businesses in the development of the country's economy has continued to grow from year to year.

Thus, in 2010, 1.6% of value added, 0.2% of gross profit, 6.7% of employees, 3.9% of fixed capital investments, 4.2% of annual turnover in the country - In 2018, these indicators were 2.6%, 0.7%, 7.6%, 4.2% and 10.5%, respectively. (World Bank Group, 2017)

It should be noted that the level of these indicators was higher in the non-oil sector. Thus, 4.2% of value added in the non-oil sector, 2.7% of gross profit, 6.9% of employees, 7.3% of fixed capital investments, 7.7% of annual turnover - In 2018, these indicators amounted to 4.3%, 3.5%, 7.7%, 6.4% and 18.4%, respectively. (World Bank Group, 2017)

During this period, significant changes have taken place in the number, dynamics and structure of enterprises by sectors of the economy. It is clear from the official statistics that as a result of market reforms in the economic life of the country, some types of economic activity have become attractive for Azerbaijani entrepreneurs. (Ministry of Economy, 2017).

Figure 2. Economic activity in the Republic of Azerbaijan in 2018 Structure of small non-state owned enterprises by types, %



Source: International Finance Corporation (2019). Study of Small and Medium Enterprises in Azerbaijan

Figure 3 explain in 2010, 2.0% of enterprises operating in the country were engaged in agriculture, forestry and fisheries, 2.3% in industry, 1.1% in construction, 64.6% in trade: repair of vehicles, 10% fell to transport and warehousing, 5.9% to tourist accommodation and catering, 0.2% to information and communication, 2.5% to real estate transactions, and 11.4% to other sectors.

In 2018, these figures are 1.8%, 3.4%, 1.2%, 49.1%, 15.1%, 6.9%, 0.2%, 0.8%, and 21.2, respectively. (Azerbaijan Statistical Committee 2017) At the same time, in 2018, 0.1% of enterprises operating in the country fell to the share of education, 0.2% to the provision of health and social services to the population. In 2010, 80.5% of small businesses by type of economic activity accounted for rent: repair of vehicles, transport and warehousing, accommodation of tourists and catering, in 2018 this figure was 71.1%. The following diagrams show the tendency observed in the structure of small business entities by types of economic activity in the Republic of Azerbaijan in 2010 and 2018. (Azerbaijan Statistical Committee 2017)

3. Results and Discussion

Various indicators are used to characterize the activities of small and medium-sized businesses, in particular, investment activity and financial condition. In other words, a comprehensive analysis of the system of indicators of statistics of small and medium enterprises allows to comprehensively characterize the situation and economic needs of economic entities, as well as to predict financial strategy in a market economy. Profit, which is the main indicator of the performance of small businesses, also increased during this period. The value added of small businesses in 2010 amounted to AZN 41.7 million, in 2011 to AZN 51.9 million, in 2012 to AZN 65.8 million, in 2013 to AZN 78.3 million, in 2014 AZN 85.3 million per year, AZN 122.8 million in 2015, AZN 165.4 million in 2017, AZN 175.4 million in 2018.

In 2018, 1169 units of 14971 single small business entities operating in all sectors of the economy were state-owned (7.7%), 13823 units (92.3%) were non-state-owned. 11.9% of small non-state owned enterprises are engaged in agriculture, forestry and fishing, 11.0% in industry, 9.1% in construction, 42.6% in trade; vehicle repair, 1.9% transport and warehousing, 2.5% tourist accommodation and catering, 3% information and communication 1.9% real estate 1.3% Education accounts for 2.1%, health and social services for the population and 12.7% for other sectors.

The development of small business is closely linked to the economic mechanisms and sectorial characteristics of a country. Therefore, when comparing the formation of small business in the country with the experience of developed countries, based on statistics, it is necessary to ignore the differences in the level of development of production and institutional infrastructure, the structure of national economies. To increase the number of SMEs in international relations and to promote their export to foreign markets. Profitable financing is applied in accordance with SME Travel Expenses, SME exports and software that ensures SMEs comply with international standards and regulations. In addition, "Made in Azerbaijan" products are produced and developed to promote the development and development of products.

As small business is an important element of the country's economic system, it is necessary to find ways and opportunities to solve the problem of investing in their production. At the present stage, the role of the state in attracting financial resources to small business remains relevant.

4. Conclusion

The research shows that small and medium business in the Republic of Azerbaijan has formed a potential. In other words, the current level of development of small and medium enterprises corresponds to the initial stage of the formation of a market economy and is still far from full realization of its potential. At the same time, despite the inefficiency of its sectorial structure, there was a positive trend in the development of small and medium enterprises during the period of economic reforms in the country. There are more than 200,000 small businesses in the country, including more than 14,000 small businesses. However, the share of small businesses in the products produced in Azerbaijan so far, as well as the application of advanced equipment and technology in production, etc. The share of small and medium enterprises in such important indicators has not reached the level of giving a strong impetus to socio-economic development. Suffice it to say that the output of small businesses in the country is below 5% of GDP, and the salaries of most employees are less than 350 AZN. Until 2014, agricultural owners were exempted from paying other taxes except land tax. The legislative framework for the creation of special economic zones, which is an important mechanism of state support for the development of entrepreneurship, has been formed. As a result of the reforms, the share of the private sector in GDP in 2017 increased to 85%, industrial production to 91%, construction to 67%, agricultural production to 99.8%, transport services to 78%, employment reached 70% of the population. In addition, national businesses face quality problems when entering foreign markets. As we know, the organization of production activities with high standards requires a lot of money. However, in recent years, a number of Azerbaijani companies and businesses have been able to export and sell products of the processing industry to foreign markets. However, a number of suggestions were made during the study, including the following:

It is more expedient to develop small and medium business in Azerbaijan. This is because small and medium-sized enterprises have less capital-intensive labor and adapt more quickly to the market environment. Even if such enterprises go bankrupt, it is not difficult to establish new small and medium enterprises.

To direct targeted state programs and measures to the development of promising areas of small and medium business in order to ensure the development of these areas.

Further improvement of the mechanism of applying tax benefits to small and medium enterprises in Azerbaijan in connection with the development of priority areas. Implement relevant amendments and additions to the tax legislation in this regard. At present, the average legislative framework for the development of entrepreneurship in Azerbaijan has been formed, and some work is being done to improve it, though not systematically. The main problem in Azerbaijan in this area is not the lack of a legal normative act, but the ineffectiveness of existing laws.

References

Bell, S. and Tayler, Y. (2016), Government procurement – a path to SME growth, http://blogs.worldbank.org/psd/government-procurement-path-sme-growth, pp. 24-38

Center for Analysis of Economic Reforms and Communication (2018), Azerbaijan Economic Reforms Review: Special Edition for ’Doing Business’ Reforms, http://ereforms.org/store/media/ekspert_yazilari/islahat%20icmali/%C4%B0yun/SYX_maliyy%C9%99_en.pdf

Hüseynli, İ. Q. (2008), “Statistical assessment of the investment opportunities of the enterprise in a market economy,” *The Journal of Economic Sciences: Theory and Practice*, No. 3, pp. 15-23, ISSN (Online) 2220-8739

IFC-Study of Small and Medium Enterprises in Azerbaijan, Baku, World Bank Group (2009), http://documents.worldbank.org/curated/en/302941468208153763/pdf/764170WP0Study00Box374375B00PUBLIC0.pdf

Islamic Corporation for the Development of the Private sector- SMEs Diagnostics In Azerbaijan, Baku,(2012), http://www.icdps.org/uploads/publication/doc/201609280910167156.Azerbaijan_SMEsDiagnostics.pdf

Levy, M. and Powell, P. (2004), Strategies for Growth in SMEs, 420 p., ISBN 9780080481166

Lukacs, E. (2005), “The economic role of SMEs in world economy, especially in Europe “ p. 3-12, *European integration studies*, ISSN 1588-6735

Ministry of Economy of the Republic of Azerbaijan- Entrepreneurship in Azerbaijan in Figures. Baku, (2017), http://economy.gov.az/images/pdf/sid_2016.pdf

OECD - Azerbaijan Driving Diversification through Strengthened Entrepreneurship, Publishing Paris, OECD (2019), https://www.oecd.org/eurasia/competitiveness-programme/eastern-partners/Azerbaijan-Driving-Diversification-through-Strengthened-Entrepreneurship.pdf

The State Statistical Committee of Republic of Azerbaijan, - Micro, small and medium entrepreneurship in Azerbaijan, Baku, (2016), http://www.stat.gov.az/? lang=en

CHALLENGES OF AGRICULTURE SECTOR: CASE STUDY OF KOSOVO

Jeta Sahatqija[1], Maitah Mansoor[2], Eylül Güven[3] and Seth Nana Kwame Appiah-Kubi[4]

[1, 2, 3, 4] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]sahatqija@pef.czu.cz s, [2]maitah@pef.czu.cz, [3]guven@pef.czu.cz, [4]appiah-kubi@pef.czu.cz

Annotation: This paper aims to examine the challenges that the agricultural sector has been facing in terms of resource scarcity in Kosovo. The total area of Kosovo is 1.1 million hectares out of which 56% is agricultural land, specifically with 185,765 active farms. The agricultural sector adds up to 11% of the Gross Domestic Product (GDP), 16% of the total exports and 29.8% of the total employment. Kosovo's economy is highly depended on the agriculture sector as it is estimated to be on the biggest sectors of the economy. Kosovo has undergone through profound changes over the past two decades; therefore, the legacy of the war is still apparent. The absence of reliable data specifically on the economy and agriculture has hindered development and implementation of effective policies and monitoring process of changes. Much of the current research lacks a comprehensive overview of current state of the sector. As such, this paper represents a step forward in an attempt to understand the current challenges that the sector has been facing in terms of resource scarcity. Primary data was collected from 47 farmers in Kosovo through unstructured questionnaires using random sampling technique. The questionnaire was distributed to 80 farmers; however, only 47 responded, thus, illustrating a 58.7% response rate. Findings show that growth is hindered by inadequate irrigation, fluctuations in the rainfall, land fragmentation, outdated technology concerning production and processing, limited market access; thus, ultimately leading to lack of competitiveness.

Key words: agricultural sector, Kosovo, developing countries, challenges

JEL Classification: Q10, Q15, Q54, Q55

1. Introduction

In 1995, agricultural production specifically crops, livestock, and vineyards accounted for 30 percent of Kosovo's GDP; 35 percent if including forestry and food processing. In 1999 the agricultural sector accounted for 60 percent of employment in the country (Beilock, 2005).

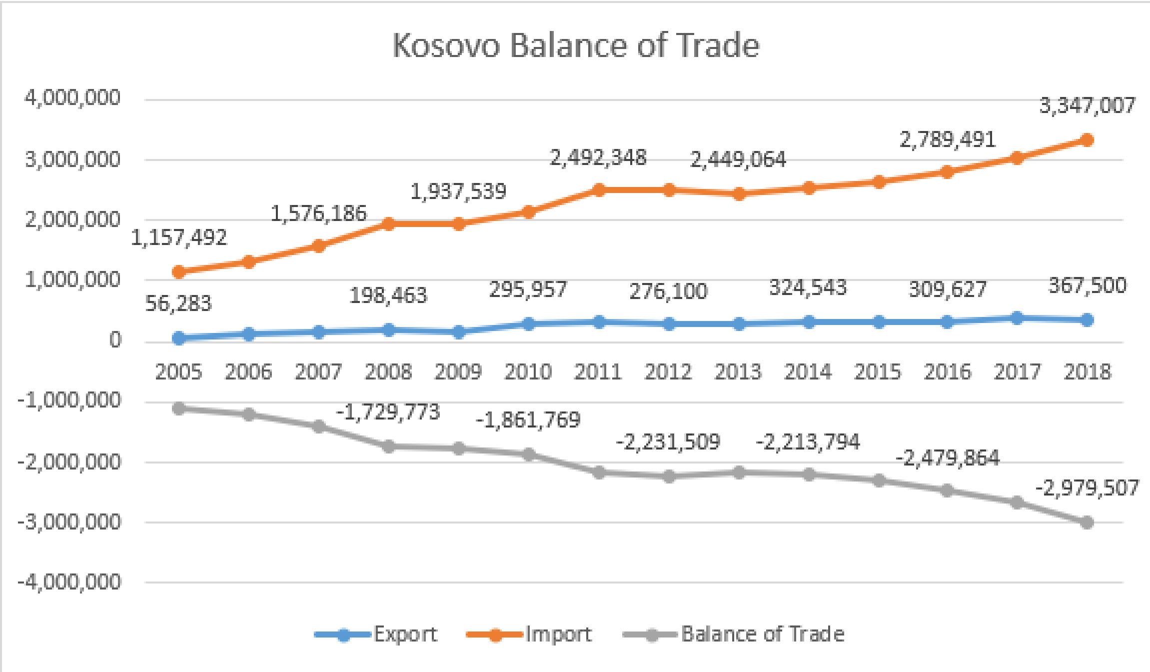
The 1999 war left Kosovo's economy in ruins. The agricultural sector underwent through heavy damage as the rural population was forced to leave their homes; thus, also leaving behind the livestock and equipment (MAFRD, 2014). As such, the post war era found the agricultural sector in a ruined state with unused land, lack of seeds, fertilizers, pesticides, and basic equipment.

The post war era also witnessed a massive congestion of urban areas where masses of population moved from rural areas to the cities (Gallopeni, 2015; Vituari, 2011). The massive migration to urban areas left a large portion of arable land unused. Under such circumstances, in 2000s the agricultural sector was a prime candidate towards economic development, mainly because of the amount of arable land and favourite climatic conditions for the production of basic grains and other commodities such as fruits, nuts, vegetables and livestock (USAID, 2015).

To date, the agricultural sector is the mainstream of income and employability for people living in the rural areas. It contributes 11% to the country's GDP and accounts for over 29.8% of total employment (IFC, 2018). With approximately a population of 1.8 million, 362,700 are involved in the agriculture sector in some way. Only 130,775 are registered as agricultural farmers (Muriqi, Karkas and Baranyai, 2019).

Despite the employment creation and the significance of the sector, Kosovo is facing an ongoing trade deficit. Since 1999, Kosovo had almost non-existent industries; therefore, it heavily relies on imported goods. To date, the situation remains the same, as Kosovo's trade deficit has reached the highest level in years at over €2.9 billion (KAS, 2019).

Figure 1. Kosovo Balance and Trade



Source: Kosovo Agency of Statistics, 2019

Current literature suggests that developing countries have a comparative advantage over developed countries, specifically within the agricultural and food productions sectors (Murphy and Shleifer, 1997); therefore, according to Gallopin (2003) the ability of the developing countries to gain access in global markets will depend not only on price but also the quality and safety of the products.

Tosuni and Vokrri (2015) suggest that Kosovo could tentatively soften the trade deficit using the productive land which currently is not optimally used. As such, the agriculture sector is therefore seen as a prime candidate in aiding the country's economy.

Kosovo has a total area of 1.1. million hectares, of which 56% being agricultural land and 41% forest (IAMO, 2010). There are approximately 185.765 agricultural farms out of which 185, 424 are small farms (Muriqi, Karkas and Baranyai, 2019). Typically, the land ownership in Kosovo is fragmented with small-scale privately owned land plots. According to the Kosovo Statistical Agency (2014), the average Utilized Agriculture Area (UAA) is 1.5 hectares per holding and it is spread across an average of seven small plots: thus, leading to inefficient performance despite the potential for technical efficiency improvements. A substantial number of these plots is not legally registered nor maintained. This is mainly because 30-40% of landowners are absent living in the urban areas of the country or migrated abroad. Land inefficiency is a leading impediment on the sector development.

The sector is highly hindered also by inadequate irrigation, fluctuations in the rainfall, outdated technology; thus, ultimately leading the market access and lack of competitiveness. As such, the agricultural sector requires substantial investments. Research in the field, has shown that all these combined, affect the participation of a developing country in international trade (Henson and Loader, 2001). The list of factors, which affects international trade for developing countries, holds true for the case of Kosovo as well; therefore, due to the lack of sufficient resources, Kosovo is failing to comply with international practises and regulations.

2. Materials and Methods

Located in the central part of the Balkan Peninsula, Kosovo has an area of 10, 887 km^2 and is surrounded with Albania, Montenegro, Republic of North Macedonia, and Serbia. It has a continental climate with temperatures between -20 degrees Celsius in winter and 35 degrees Celsius in summer; thus, offering ideal conditions for the promotion and development of agriculture. As such, this paper aims to examine the challenges that the agricultural sector has been facing in terms of resource scarcity.

The country was chosen primarily for having a developing economy, where the importance of exports has significant implications to the overall economic success of the country. While this is the practical significance in terms of the geographical choice, the implications for academia are also relevant since very little research in the field has been conducted within this region.

Considering the nature of this research paper, the study is heavily based on publicly available information, reports, analysis as well as publications. To reach a better understanding of the challenges that the agricultural sector is facing in terms of the resource scarcity, primary data was collected through unstructured questionnaires through random sampling. The questionnaire was distributed to 80 farmers; however, only 47 responded, thus, illustrating a 58.7% response rate.

Respondents were presented with the questionnaire and asked to elaborate. This allowed the researcher to receive responses which helped lead the discussion. As such, the respondents shared relevant data; thus, avoiding scenarios with interviewer expected answers.

For the purpose of this study, thematic analysis is used to examine patters and have a meaningful understanding of the data. It displays a rich description of data and is mainly used to explore questions about respondents' perspectives, practices and processes which influence a phenomenon. This goes in line with the aim of this study which aims to explore challenges faced in the agriculture sector due to resource scarcity. While in practice, oftentimes thematic analysis is used in conjunction with other qualitative research methods, one should note that thematic analysis is a method on its own (Braun and Clarke, 2006; Thorne, 2000). Braun and Clarke (2006) suggest that thematic analysis is a foundational method for qualitative analysis.

Themes were generated inductively from the raw data. Identified themes are strongly related to the data; therefore, this form of thematic analysis is data-driven (Braun and Clarke, 2006). While reviewing the themes, it became evident that some themes should be emerged and collapsed into others.

Finally, as a last step in data analysis, themes were named. In this process, it is important for the researcher to have a clear understanding of the background story that each theme tells so that it truly reflects on the naming process. The theme name was aimed to give the reader a sense of what the theme is about (Braun and Clarke, 2006).

As a result, themes identified, specifically challenges in the agricultural sector due to resource scarcity are:

- Lack of adequate irrigation systems
- Lack of technology
- Lack of information and knowledge

3. Results and Discussion

Lack of adequate irrigation Systems

The country is mainly spread between the Kosovo and Dukagjini region. In practice, areas close to the river streams are more suitable for irrigation. In both regions, Kosovo and Dukagjini there are around 50,000 ha which are very convenient for irrigation, meaning that these areas are located nearby rivers. In addition, there are around 100 ha which would be suitable if certain measures and systems were in place.

Currently the irrigation systems across the country are managed by central public enterprise "Iber Lepenc" respectively regional enterprises "Drini i Bardhe" and "Radoniqi-Dukagjini". An overview of the ha covered by each enterprise can be seen below:

Table 1. Official Irrigation Schemes

	Type of Irrigation	**Area (ha)**	**Irrigated Area (ha)**	**Irrigated area during peak season (ha)**
Ibër Lepenc	Sprinkler Irrigation	20,000	515	14,500
Radoniqi	Sprinkler Irrigation	8,600	4,700	5,000
Dukagjini	Sprinkler and Surface Irrigation	5,000	800	2,500
Drini i Bardhë Pejë	Surface Irrigation	6,500	1,300	2,500
Istog	Surface Irrigation	8,500	1,350	2,000
Lumi i Bardhë	Surface Irrigation	8,500	1,650	3,000
Total		57,100	10,315	29,500

Source: Ministry of Agriculture, Forestry and Rural Development, 2010

Farmers from both regions unanimously agree that the irrigation system remains a challenge. As the sophisticated irrigation systems come with higher costs, most of the farmers use the sprinkler system. Only those who could afford other systems at their own expenses are able to implement it; however, this number remains very low.

The Kosovo region is supplied by "Iber Lepenc" and most farmers use F100 irrigation sprinklers. A constant challenge remains the water supply; even though, the supply for irrigation is available from June 15th until September, the supply is not steady; therefore, leading to losses in the yield.

The same does not hold true for the Dukagjini region, mainly because this region is identified with a better arable land. With this advantage, farmers further confirm that they can choose from an array of crops to cultivate. While farmers from the Kosovo region are limited to maize which technically can grow with limited supply of water, the farmers from the Dukagjini region usually cultivate cereals, roots and tubers, pulses, vegetables, fruit, spices, and other crops.

While the drip irrigation infrastructure existed prior to the 1999, it was fully destroyed during the war to remain unrepaired to this day. While most of the respondents do not have the means to take the financial burden to repair it, few confirmed that on individual basis have repaired and are using it.

Lack of Technology

Lack of modern and adequate technology continues to hinder productivity as well as quality of the yield every season. Farmers have limited financial resources; therefore, unable to purchase modern adequate equipment required for the crop being cultivated. The very basic equipment is missing, let alone a more sophisticated one.

Majority confirm that the technology they use is mainly useful for cereal crop; thus, limited to other crops. The vehicles are small; thus, unable to plough deeper. Unfortunately for most farmers this poses a huge problem as it also effects the irrigation system and water reach.

In practice, most farmers must rent the equipment which they need to use. As expected, renting adds to the financial burden as the renting prices range between 0.25 cents to 350 euros depending on the type of the vehicle and duration of the lease. Farmers even added that a lot of the equipment they use dates back from the Yugoslavia's era; therefore, it is outdated.

Lack of Information and Knowledge

Inclusion of pupil in the education system, specifically those from the rural areas, remains a challenge. The migration of population to urban areas, has led to the closure of many schools in the rural areas. This was due because of the low number of students, oftentimes to non-existent. On the other hand, schools in the urban areas have been overloaded; thus, working in two to three shifts. Access in terms of transportation is not difficult, especially these last few years due to the new road infrastructure but also the operation of public transport in the deeper rural areas.

The low economic development and high unemployment rate has created a general perception that an individual can get employed even without a proper education. Unfortunately, vocational education and training is seen only as an alternative and only in cases when the student does not have sufficient GPA to register at the gymnasium. When looking at the agricultural education, the formal format starts with the Agricultural High School which is in three cities Prishtina, Lipjan and Gjilan as well as Vocational High Schools which have an agricultural branch and are in Ferizaj and Peja. This already limits access for many due to the distance. While respondents confirm that the access in terms of transport is not a problem, the means for paying for this transport and other expenses are a barrier. Many confirmed that they simply cannot afford it.

Informal training on the other hand has been a source of information and learning for many, especially for women after the 1999 war. Many were left without financial support; therefore, to survive, they had to learn the practices and take ownership of the business/land. The leading role as the head of the business was very new practice as in general men did all the work and women just helped. These trainings are mainly provided by international organizations with the aim of empowering the role of women in agriculture and business.

Traditionally, knowledge was mainly passed from a generation to another; therefore, on basis of practice. With this being said, the main source of information for many farmers are the sellers at the agricultural pharmacies. Respondents confirm that the sellers are the one who usually recommend quantities, combinations, seed types for the specific soils etc.

4. Conclusion

The main objective of this paper is to examine the challenges that the agricultural sector has been facing in terms of resource scarcity in Kosovo. The study is a reality check of the current state of being. The findings of the study are based on a qualitative approach specifically unstructured questionnaires using random sampling.

Thematic analysis is used to examine patterns have a meaningful understanding of the data. Themes were generated inductively from the raw data. Themes identified, specifically challenges in the agricultural sector due to resource scarcity include: i) irrigation systems; ii) lack of technology; iii) lack of information and knowledge.

In terms of the irrigation systems, findings show that farmers do not have access to sophisticated irrigation systems due to cost limitations. Most of the farms use the sprinkler system and only a very small portion could afford other systems. Water supply remains a challenge for the Kosovo region as it is not steady; however, respondents from the Dukagjini region fortunately confirm that this is not an issue. This is also due to the better soil quality. The soil quality and water supply also effect the crop being cultivated; therefore, the Kosovo region is limited to maize only, while the Dukagjini region cultivates an array of crops.

Findings show that the lack of adequate technology continuously hinders productivity and quality of the output. Farmers use old vehicles which are not adequate for the required cultivation. Renting equipment from those who have it comes with certain costs which are a barrier for most due to the difficult financial conditions. Finally, most farmers did not have access to formal education in agriculture. Their knowledge comes from practises passed from a generation onto another.

Farmers unanimously agree that sellers at agricultural pharmacies are a great source of knowledge for them and assist in purchasing the correct qualities as well as seeds, pesticides, and necessary resources. Nowadays, while formal education is accessible in terms of infrastructure, for most is too expensive to bear the cost that come with it. Informal trainings are carried; however, mostly are targeted at women mainly as an empowerment tool.

References

Beiloc, R. (2005), "Rethinking Agriculture and Rural Development in Kosovo", *South-Eastern Europe Journal of Economics*, vol. 3, no. 2, pp. 221–248

Braun, V., and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101. DOI 10.1191/1478088706qp063oa

Gallopeni, B. (2015), "Rural Urban Migration in Kosovo", *International Journal of Business and Social Science*, vol. 6, no. 9, pp. 96-105, ISSN 2219-1933

Henson, S. and Loader, R. (2001), "Barriers to agricultural exports from developing countries: The role of Sanitary and Phytosanitary Requirements", *World Development,* vol. 29, no. 1, pp. 85-102, ISSN 0305-750X, DOI 10.1016/s0305-750x(00)00085-1

IFC, International Finance Corporation, Agriculture Finance in Kosovo, Prishtine, 2018 [Online], Available: http://documents.worldbank.org/curated/en/235701550000063593/pdf/134583-WP-PUBLIC-12-2-2019-18-17-35-AgricultureFinanceinKosovo.pdf, [Accessed: 15 Mar. 2020]

KAS, Kosovo Agency of Statistics, Agriculture Census in the Republic of Kosovo, Prishtine, 2014, [Online], Available: https://ask.rks-gov.net/media/1375/final-results.pdf, [Accessed: 18 Apr.2020]

KAS, Kosovo Agency of Statistics, Economic Statistics: Kosovo International Trade Statistics, Prishtine, 2019, [Online], Available: https://ask.rks-gov.net/media/5016/international-trade-statistics-2018.pdf?fbclid=IwAR0zPPrAAhwfxF2yHwgo-WLDhQBPIY8mmQJZWSr2dtG4a7gXmDvu0zk1WJc, [Accessed: 25 Mar. 2020]

Leibniz Institute of Agricultural Development in Central and Eastern Europe IAMO. (2019). *"Agriculture in the Western Balkan Countries"*, Halle, IAMO, ISBN 978-3-938584-51-4

MAFRD, Ministry of Agriculture, Forestry and Rural Development, Green Report 2014, Prishtine, 2014, [Online], Available: https://www.mbpzhr-ks.net/repository/docs/192683_161214_GR_2014__ALB_Versioni_i_Printuar.pdf, [Accessed: 23 Apr. 2020]

Muriqi, Sh., Farkas, M. and Baranyai, Z. (2019), "Drivers of Cooperation Activity in Kosovo's Agriculture" *Agriculture*, vol. 9, no. 5, pp. 1-12, DOI 10.3390/agriculture9050096

Murphy, M. and Shleifer, A. (1997), "Quality and Trade", *Journal of Development Research*, vol. 53, no. 1, pp. 1-15, ISSN 0304-3878, DOI 10.1016/s0304-3878(97)00014-x

Thorne, S. (2000), "Data analysis in qualitative research", *Evidence-Based Nursing,* vol. 3, no. 3, pp. 68-70, DOI 10.1136/ebn.3.3.68

Tosuni, G. and Vokrri V. (2015), "Potential Export Markets for food processing, agriculture, wood processing, construction materials, tourism and artisanal crafts sectors" Prishtine: Ministry of Foreign Affairs Finland and UNDP, [Online], Available: http://www.ks.undp.org/content/dam/kosovo/docs/AFT/Potential%20Export%20Markets.pdf [Accessed: 10 Apr. 2020]

IFC USAID, United States Agency for International Development, Kosovo: 2014-2020 Country Development Cooperation Strategy, Prishtine, 2015, [Online], Available: https://www.usaid.gov/sites/default/files/documents/1863/Kosovo_Extended_and_Revised_Country_Development_Cooperation_Strategy_2014_-_2020_External_Version.pdf [Accessed: 2 Apr. 2020]

Vituari, M. (2015), "Agricultural and rural areas in the Western Balkans: Status Update" Trento: Osservatorio Balcani e Caucaso Transeuropa, [Online], Available: https://www.balcanicaucaso.org/eng/Areas/Bosnia-Herzegovina/Agriculture-and-rural-areas-in-the-Western-Balkans-status-update-95798 [Accessed: 15 Apr. 2020]

EVERYTHING BUT SOCIAL: A STUDY OF TWITTER ACCOUNTS AND SOCIAL MEDIA MANAGEMENT TOOLS

Alon Sela[1], John Phillip Sabou[2], Petr Cihelka[3], Murodjon Ganiyev[4] and Miloš Ulman[5]

[1, 2, 3, 4, 5] Department of Information Technologies, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]alonse2012@gmail.com, [2]sabou@pef.czu.cz, [3]cihelka@oikt.czu.cz, [4]ganiyev@pef.czu.cz, [5]ulman@pef.czu.cz

Annotation: The following work inspects the sources of Twitter messages, through two data sets in the Czech language. The first, is on a political topic and the second, on a non-political topic. We have found that while organic users capture about 85% of account both for political as for the nonpolitical topics, the use of social media management tools greatly differ between the two topics. While these management tools are not necessarily fully automated like bots, they cannot also be considered as organic users. When only focusing on commercial tools for tweets, a few well known social media management tools such as Hootsuite, Buffer, dlvr.it and Sprout Social capture 58% of the non-political messages, but as much as 82% of the political messages. These results strengthen the debate on the degree that Twitter can be used as a fair thermometer to capture authentic social-behavioral signals, as opposed to becoming a biased commercial communication tool. They also emphasize the important role of social media management tools in the social media eco system.

Key words: Twitter, social media management tools, political, non-political, Czech language, bots.

JEL classification: D38, C31, O33

1. Introduction

Social media are conduits for artificially shaping public life (Ratkiewicz *et al.*, 2011; Subrahmanian *et al.*, 2016; Woolley and Howard, 2017). Twitter is particularly a staple of messaging and narrative propagation among users that use Twitter to disseminate political discourse and how that takes place. Twitter data is unique from data shared by most other social platforms because it reflects information that users choose to share publicly. The data that users allowed to share (e.g. Direct Messages) are easily available to authorized developers via Twitter API (Twitter, no date).

Our project focuses on the Czech Republic and the use of Twitter to disseminate political discourse and mainly, how the social platforms have become from platforms that present society, to a battlefield of automated and semi-automated technologies for spreading messages. While the shape, size and time of information cascades, as well as the rates of automated bots are highly studied the role of professional social media management tools in these cascades are under researched. While these do not necessarily imply manipulation of information, the use of such tools does imply a higher level of professionalism, which is not a sign of a regular private user, but rather of a commercial (or political) interest (He *et al.*, 2015; Risius and Beck, 2015; Lamest and Brady, 2019).

Results from previous research show that communication professionals appreciate social media for the ease and speed with which information can be accessed and delivered, e.g. (Dickerson, Kagan and Subrahmanian, 2014). The weight given to social media by communication professionals is illustrated by the fact that a majority of them perceive coping with the digital evolution and social media to be the most important strategic communication issue of recent times (Zerfass et al., 2012). But anyone who has used it for commercial purposes may know that Twitter can be a tough platform to thrive on. Keeping engaging content demands constant attention and efficiency. Thus, social media management tools (SMMT) are required to help and ease the commercial use of Twitter.

More than 3.5 billion users worldwide used social media in 2019, with a majority of these using social media for their use (Kemp, 2019). Traditional content platforms (e.g., newspapers, magazines) typically use targeted content advertising to capture the attention of these users when producing news stories several times a day. However, posting numerus stories, on several different social media platforms, several times a day, as required by such professional content producers, required a complex orchestration. Here came handy the SMMT. Commercial interests often must employ a variety of SMMT in order to build a social media campaign around a product, service or political message (Kanuri, Chen and Sridhar, 2018). These tools go hand-in-hand with dedicated social media content platforms such as Twitter, Facebook and Instagram and their goal is to generate higher traffic around a preferred topic (Culnan, McHugh and Zubillaga, 2010).

This paper focuses on the use of information cascades that originate from casual or "organic" social media users versus professional content producers. If the individual accounts that spread politically content are using highly sophisticated SMMTs, then we can expect some bias in the natural information spread, as well as political content favoring using these tools. Therefore, we formulate the following research question: *Are there different tools used to communicate political vs. non-political content on Twitter?*

To answer this question, we will first describe our dataset and analytical approach in the Materials and Methods section. Second, we will present results of the dataset analysis and an overview of the most frequently used social media management tools in the results section followed by a discussion. Finally, we will summarize our contributions, limitations of the study and outline for our future directions in the conclusion section.

2. Materials and Methods

We initiated our study from the concept of social bots, which are fully computerized accounts that are claimed to occupy large portions of Twitter`s cyberspace (Varol *et al.*, 2017). Then, we realized that there also exists another actor that use social networks to spread potentially biased information, the SMMTs themselves. Admittedly, the link between what is biased and what is commercial are blurred, however we can infer that the owners of the SMMTs may be commercially inclined to support certain biased narratives at their discretion. SMMTs such as Hootsuite, Buffer or dlvr.it could be used in favor of one political program over another, in tandem with the platforms on which biased messages are spread. The use of bots is not technically illegal, but it can lead to civil action if user account is found to be misusing the social media platform, in this case Twitter Using social bots is against the terms of service of many platforms, especially Twitter (Twitter, 2017). However, a certain degree of automation is of course intended by making social media APIs available (Twitter, no date). For instance, many users, especially businesses still automate their Instagram activity in order to gain real followers rather than buying fake ones. This is commonly done through third-party social automation companies.

SMMTs on the other hand can also be used to manage an information cascade with bias opinion, but generally we do not hold the backers of these tools to the same standard as individual users that misuse the Twitter platform by social bots. The rapid propagation of information on social media typically spread by word of mouth and can impact the perception of political figures quickly with information that may or may not be true. When political information is propagated in this manner on purpose, the spread of information on social media for political means can be damaging both to politicians and the integrity of the political process of a country (Pfeffer, Zorbach and Carley, 2014). Our perspective for the research takes a somewhat irregular approach in that we suggest at looking at whether SMMTs themselves are propagators of bias. To do this we employed the use of Power law distribution to measure the saturation of politically loaded hashtags versus non-political hashtags.

Between October 2019 and January 2020, we collected tweets dealing with a politically related hashtag *#Babis* - the name of the Czech prime minister and compared it with non-political hashtags *#family and #rodina* (an equivalent of 'family' in Czech language). The collection of these two hashtags was necessary mainly to inspect if political topics included a higher usage of SMMTs compared to nonpolitical topics.

2.1 Power law distribution

Power Law distributions are found in very different types of phenomena. This theory claimed that for growing systems, where entities are added with time while favoring larger entities as connection partners, will result in a distribution of sizes for the entities that fits a power law distribution (Barabási, Ravasz and Vicsek, 2001). For example, in the case of human mobility into cities will follow a power law (Gabaix and Ioannides, 2004), since people favor migrating to larger cities over migrating to smaller cities (Blank and Solomon, 2000). Another example includes the distribution of relations in a social network, where new people entering a social network favor to connect to already popular individuals to amplify their popularity. This is the same case for social networks, where the distribution of connections in a social network will fit the power law (Broniatowski *et al.*, 2018).

Regarding a social network topology, the understanding of power law is important, since in many cases the effect can create a natural bias in the seemingly democratic essence of information sharing. As opposed to the case where social connections are distributed evenly according to a normal distribution and many opinions can appear, the power law rule dictates an exposure of fewer ideas that are spread by large hubs (i.e. large global sized media spreaders) on the account of many different ideas and an improved diversity of ideas in a society. This trend is amplified by search engines, which are rank web sites in the power law network of the internet (Sela *et al.*, 2016).

2.2 Tweet sources categorization

In order to tag the different commercial social network tools, as well as the other sources of tweets that are not necessarily casual users, we extracted the source link field from the data. The source link appears as an HTML link in the crawled data; for example Twitter for Android where the relevant link - http://twitter.com/download/android at this case, was extracted. The reoccurrences of these links were counted and sorted. Then, we selected the sources that included 95% of the total messages and analyzed them for the meaning of each source. Since the entire data set includes over 1,200 different sources, we only inspected the sources that represent 95% of activity, although these were only about 5% of all the different entities. Thus, the Twitter ecosystem is highly centralized since 5% of the sources are responsible for 95% of the messages. On the other hand, 5% of the additional messages were created by sources whose identification and verification would require an effort that would not be worth the additional information. After inspecting the main sources responsible for the spread of information in both the political and not political topics, we identified the sources into categories. The main categories included:

(1) *Organic users* which is a category inspired by a similar term ‘organic link’ associated with non-paid links in the Google search engine search results. We use organic users to indicate users that share messages not from commercial reasons. This category includes all Twitter smartphone apps i.e. iPhone, Android, iPad, Blackberry, Windows. We add to this category other social networks such as Facebook, Instagram and LinkedIn, since we could not evidence whether or not it was sent with a commercial intent, thus our estimations are in fact lower bounds.

(2) *Social media management tools (SMMT)* mainly included the tools such as Hootsuite, Buffer, dlvr.it, Sprout Social and some additional smaller tools (see Table 2). For the purpose of this paper we call these sources as non-organic management sources.

(3) *News category* denote traditional news portals that release tweets from their portals in order to increase the web traffic on their sites. There is naturally a commercial intent behind this category of tweets.

We later added three more additional categories, that although were much frequently represented in the sample, were required for a full categorization of the data. These additional categories included (4) Commercial / Shopping web sites, (5) Other (including web sites that were not indexed in Google), (6) Third party Twitter apps, which were not considered as potential social media management tools, but were also more professional, thus could not be considered as tools for the organic users.

3. Results and Discussion

First, we collected tweets with the following descriptive properties described in Table 1. We inspected the sources of messages to estimate the rate of occurrence for SMMT; i.e. users that are more than simply using Twitter for personal information sharing, but rather have a defined goal, and compared these rates to non SMMT.

The main sources for the two selected hashtags, #babis and #family (including the Czech #rodina) are presented under the category below. Note that the total number of tweets is substantially larger than the number of sources, which makes sense because some sources publish over few thousand times. We inspected the most frequently represented sources manually by searching them in Google search engine. Since there are over 1500 sources for both hashtags, we could not search for the meaning of all of them manually in a reasonable time. We thus started by inspecting the sources that appeared more frequently, then continued with less and less frequent sources, until we covered more than 95% of the tweets. As can be seen in Table 1, the organic users constitute the largest category with an almost identical rate of about 84% for #babis and 85.2% for #family. This category is followed by SMMT with 13.1% and 8.6% for #babis and #family respectively. Shopping or commercial website sources had a minor representation in the #family, but zero in #babis. While shopping and commercial sources are the third most important category for non-political tweets, the news is the third most important category for the political hashtag. Another interesting observation is centralization of political messages. While 3.4% (44 /1267) sources covered 95% of the sources for #babis, indicating a very centralized messages spreading system, this rate grew to 14% (51/349) for the #family hashtag.

Table 1. Data set characteristics

Hashtags	Political (#babis)	Non-political (#family, #rodina)
Total no. of tweets	194,704	16,289
No. of sources	1,267	349
% of data covered with sources inspected manually	95.7%	95.2 %
% of uniquely appearing sources	44/1,267 = 3.4%	51/349 = 14%
Platform categories		
Organic users	84.0%	85.2%
Social media management tools	13.1%	8.6%
Shopping / commercial	0.0%	2.8%
3rd party apps	1.0%	1.1%
Unknown	0.0%	1.5%
News	2.0%	0%
Other web sites	0.0%	0.9%

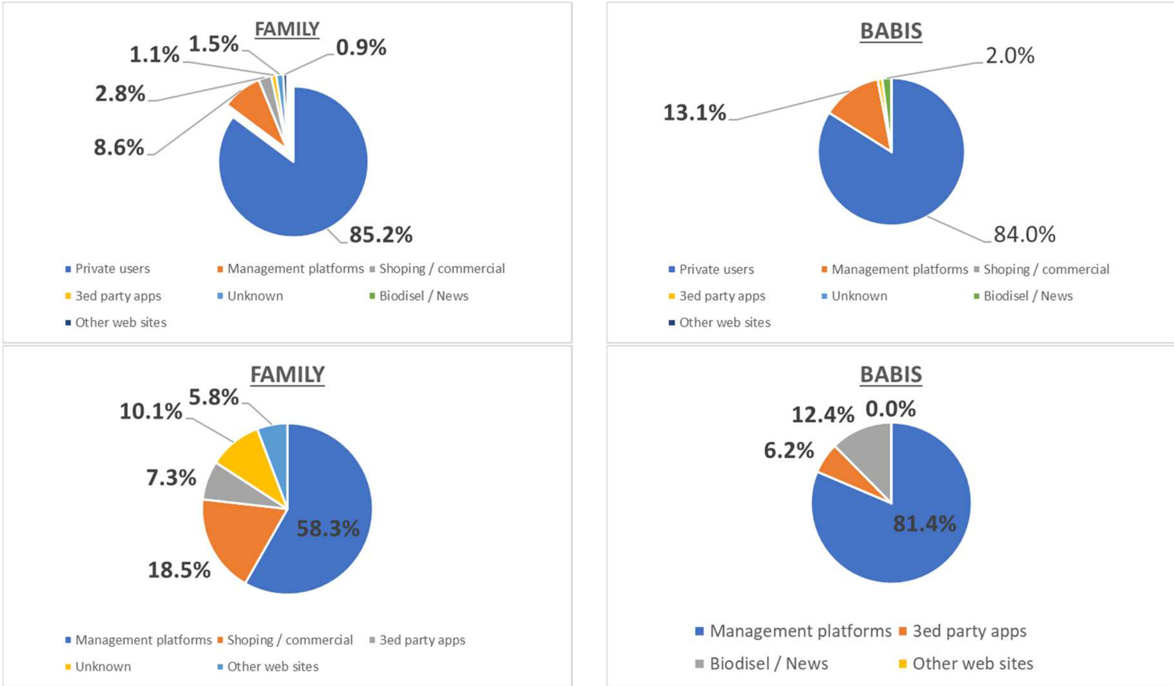
Source: own work

With a detailed look into data, we observed another interesting phenomenon. As seen in Figure 1, SMMT were responsible for 13.1% of messages in the political related dataset (#Babis), but only 8.6% in the non-political data (#family, #rodina). While this difference might seem of minor importance, when focusing only on the non-organic sources (lower images), this difference becomes very significant since SMMT are 81.4% in political tweets compared to 58.3% in the non-political topic. Also, the rates of messages emerging from social network management tools are between 9-13%, depending on the topic. While in the political topic (#babis), we can see as much as 13% of the messages emerging from professional tools, this rate is not more than 9% for non-political topics (#family, #rodina).

The upper images in the Figure 1 show the main types of publishers including regular private users for political (85.2%) and non-political (84%) topics. The lower images show the same data when regular users are excluded. While SMMT occupy 13% of the sources in the political topic (#babis), they account for less than 9% for the non-political topic (#family, #rodina).

Another important and dramatic difference between political and non-political topics is the degree of activity that results from social networks. While social networks (mainly Instagram) are responsible for 3,293 out of 186,357 messages (almost 2%) with the political #babis hashtag, the rate of non-political hashtags #family and #rodina is 25 folds higher and reaches 53.1% (7,716/15,513). This high rate is surprising and might need additional study to fully understand the reasons. Lastly, we have found that a significant portion of commercial web sites tend to promote their products through Twitter content, though these are mostly concentrating in non-political topics. While shopping and commercial related web sites are as much as 2.8% in the non-political data set, they are almost nonexistent in the political data set. These results can be possibly explained by the unwillingness of e-commerce businesses to support one party over another and thus reduce their possible client base, but this still needs further study.

Figure 1. Distribution of sources types by category



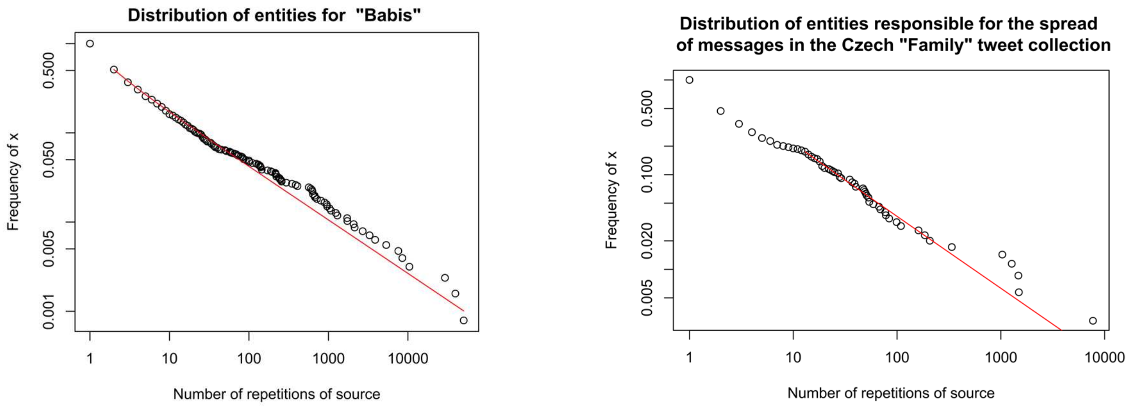
Source: own work

3.1 Distribution of different sources

Further, we investigated the distribution of different sources of publicized content on Twitter. The data was sorted according to the occurrences of each source in the spread. Note that regular (organic) users, which use Twitter through their own devices, are included in this count, but are still the largest group of content spreaders. As described in Figure 2 below, the ecosystem of message sources seems to show a clear power law effect, both for the Czech prime minister hashtag #babis (left) and for the neutral hashtags #family and #rodina (right).

The fit of the data to a power law distribution on a log-log scale reflects that the data is of a reasonable sample. Some deviation from the power law in the right image (lower right region), can also be due to the sample sizes, but overall, the fit is reasonably good. The implication of these results is that Twitter (as other social networks tools) is somewhat centralized, and that we should expect a very high variance between the highly connected users, which can reach many millions of connections to the regular users, which will not have more than a few hundred connections. These results are merely assigned that our data set is representative in terms of its distribution. Furthermore, although this is a natural phenomenon resulting from the preference of users to connect to more connected users, thus to the preferential attachment dynamics.

Figure 2. Distribution of sources responsible for tweets



Source: own work

3.2 Overview of Social Media Management Tools

Social media management tools (SMMT) has become a key instrument for organizations and individuals to understand communication and behavior of their publics (Tam and Jeong-Nam, 2019), consumer opinions (Chaney *et al.*, 2016) or generate traffic on e.g. news websites. However, the tools does not provide a prescriptive capability of suggesting what to post and when in order to maximize the post link clicks and advertising revenue (Kanuri, Chen and Sridhar, 2018). Further challenge in using SMMT is that social networks, such as Facebook, Twitter and Instagram, are increasingly restricting third-party access to their data (Tenkanen *et al.*, 2017).

Hootsuite is one of the most used and the oldest SMMT platform. It allows users to view and publish content from multiple networks at the same time (Chaney *et al.*, 2016). The tool enables the users to schedule posts, manage teams, and view analytics to improve the content strategy at all online profiles simultaneously (Geho and Dangelo, 2012). This makes it a good alternative for information manipulation since if one creates multiple accounts, they can all publish similar content at a similar period, thus create an illusion of a hype synthetically. Hootsuite provides also dense topic analytics, search, filter, track and measure performance. Hootsuite has both free and premium options and expansions.

Buffer, the second most used SMMT in our tweet datasets allows to plan, collaborate, publish, reply and analyze the messages and content. Similar to Hootsuite, Buffer is also designed to schedule posts, analyze their results and engage with their community across multiple social media accounts.

dlvr.it is the third most frequently used SMMT. It is designated mostly for automated schedules of posts on social media. As shown in Table 1, dlvr.it has limited functionality of analytics in comparison to the other SMMT.

Sprout Social is the fourth most used SMMT according to our sample. It has various features except for the indication of the number of scheduled posts and echo-auto schedule feed items. All abovementioned SMMT are similar to some degree in their aim to increase user's presence through multiple platforms and understand the publics responses.

Table 2. Comparison table of social network management tools features

Attributes	Hootsuite	Buffer	dlvr.it	Sprout Social
Number of social accounts	35	25	15	10
Number of scheduled posts	Unlimited	2000	Unlimited	N/A
Number of users	5	6	75	N/A
Auto #hashtags	N	Y	Y	N
Bulk Scheduler	Y	N	Y	Y
Streams Feeds	Y	N	Y	Y
Echo - Auto Schedule feed items	Y	Y	Y	N/A
Publishing calendar	Y	Y	Y	Y
Boosted posts	Y	N	Y	Y
Analytics	Y	Y	N/A	Y
Team collaboration	Y	Y	Y	Y
Post Scheduling	Y	N	Y	Y
Multi-platform	Y	Y	Y	Y
Facebook	Y	Y	Y	Y
Instagram	Y	Y	Y	Y
Twitter	Y	Y	Y	Y
YouTube	Y	N	Y	N
Pinterest	N	Y	Y	Y

Source: own work based on hootsuite.com, buffer.com, dlvrit.com, sproutsocial.com.

We compared the sources from which users publish tweets for a political hashtag #babis associated with the name of the Czech prime minister in relation to the neutral hashtags #family and #rodina. While the data sets were only collected over two hashtags; one of each domain, a clear difference was found in the proportion of professional social network management tools for the political topics. As expected, the political hashtag included a larger portion of sources that are professional social network management tools. While bots are highly studied due to their ability to amplify discussion of political topics (Woolley and Howard, 2016), social network management tools are legitimate services that also have capability to bias their information in the user's favor. Even though these are not necessarily biased in and of themselves, it is possible that professional users, such as content producers for a political party do influence Czech political discourse with the support of such tools.

Furthermore, one important attribute of SMMTs is the management of multiple accounts. They thus enable controlling and scheduling multiple accounts to orchestrate a campaign that seems authentic but is emerging from one single source. However, message scheduling should not be overestimated as its complexity in practice often makes even large content platforms such as media resort to simple rules of thumb (Kanuri, Chen and Sridhar, 2018). While we do not have evidence that message scheduling was done in politically related information cascades concerning the Czech prime minister, two of our findings suggest there is a high rate of Instagram related messages in the non-political data (53%) compared to a lower rate of 2% in the political data. This shows the importance of Instagram in contemporary social networks studies, as well as the shift of social media from textual to images and short video content (Tenkanen *et al.*, 2017).

4. Conclusion

Our work investigates an under studied field in the research on computational information biases on a sample of a political and non-political topic in the Czech Republic. We found that tweets containing the political hashtag (#babis) was more often published with social media management tools (SMMT) and was controlled by a few accounts than the non-political hashtag (#family or its Czech equivalent #rodina). We contributed to the body of knowledge since the role of SMMT in spread of both political and nonpolitical tweets is less studied. It might very much be that a large fraction of accounts suspected to be bots are in practice SMMT. The presence of SMMT involve a high potential for forming biases in social media platforms but are also in many cases promoted by the social platforms providers themselves.

This study sheds some light on the rates by which professional social media tools (SMMT) operate in both a political and a non-political hashtag. However, the line between content generated by the casual or “organic” social media users versus professional content producers is not a clear line and deserves further investigation.

Acknowledgements

This work was supported by the Ariel Cyber Innovation Center in conjunction with the Israel National Cyber directorate in the Prime Minister`s Office; The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019MEZ0003 – “Social Bots Involvement in Politically Biased Discussion on Social Media”.

References

Barabási, A.-L., Ravasz, E. and Vicsek, T. (2001), "Deterministic scale-free networks", *Physica A: Statistical Mechanics and its Applications*. Elsevier, vol. 299, no. 3-4, pp. 559–564, DOI 10.1016/S0378-4371(01)00369-7

Blank, A. and Solomon, S. (2000), "Power laws in cities population, financial markets and internet sites (scaling in systems with a variable number of components)", *Physica A: Statistical Mechanics and its Applications*, Elsevier, vol. 287, no. 1-2, pp. 279–288, DOI 10.1016/S0378-4371(00)00464-7

Broniatowski, D. A., Jamison, A. M., Qi, S., AlKulaib, L., Chen, T., Benton, A., Quinn, S. C. and Drezce, M. (2018), "Weaponized health communication: Twitter bots and Russian trolls amplify the vaccine debate", *American journal of public health*. American Public Health Association, vol. 108, no. 10, pp. 1378–1384, DOI 10.2105/AJPH.2018.304567

Chaney, P. *et al.* (2016), "What Are Consumers Saying About Your Business? A Primer on Monitoring Tools", *Journal of Marketing Perspectives*. Gulfport: Academy of Business Research, p. 70

Culnan, M. J., McHugh, P. J. and Zubillaga, J. I. (2010), "How large US companies can use Twitter and other social media to gain business value", *MIS Quarterly Executive*, vol. 9, no. 4, pp. 243-259

Dickerson, J. P., Kagan, V. and Subrahmanian, V. S. (2014), "Using sentiment to detect bots on twitter: Are humans more opinionated than bots?", in *2014 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2014)*. IEEE, pp. 620–627

Gabaix, X. and Ioannides, Y. M. (2004), "The evolution of city size distributions", in *Handbook of regional and urban economics*, Elsevier, vol. 4, pp. 2341–2378, DOI 10.1016/S1574-0080(04)80010-5

Geho, P. R. and Dangelo, J. (2012), "The evolution of social media as a marketing tool for entrepreneurs", *The Entrepreneurial Executive*. Jordan Whitney Enterprises, Inc, 17, p. 61

He, W., Li, Y, Tlan, X. and Tao, R. (2015), "Gaining competitive intelligence from social media data", *Industrial management & data systems*, Emerald Group Publishing, Limited, vol. 15, no. 9, p. 1622

Kanuri, V. K., Chen, Y. and Sridhar, S. (2018), ‘"Scheduling content on social media: Theory, evidence, and application", *Journal of Marketing*. Sage Publications Sage CA: Los Angeles, CA, vol. 82, no.6, pp. 89–108, DOI 10.1177/0022242918805411

Kemp, S. (2019), "Digital 2019: Essential insights into how people around the world use the internet, mobile devices, social media, and E-commerce", *Kepios Pte Ltd., We Are Social Ltd. And Hootsuite Inc.*

Lamest, M. and Brady, M. (2019), "Data-focused managerial challenges within the hotel sector", *Tourism Review*, Emerald Publishing Limited, ISSN 1660-5373, DOI 10.1108/TR-03-2017-0064

Pfeffer, J., Zorbach, T. and Carley, K. M. (2014), "Understanding online firestorms: Negative word-of-mouth dynamics in social media networks", *Journal of Marketing Communications*, Taylor & Francis, vol. 20, no. 1-2, pp. 117–128

Ratkiewicz, J., Conover, M., Meiss, M., Gonçalves, B., Patil, S., Flammini, A. and Menczer, F. (2011) "Truthy: mapping the spread of astroturf in microblog streams", *Proceedings of the 20th international conference companion on World wide web*, pp. 249–252

Risius, M. and Beck, R. (2015), "Effectiveness of corporate social media activities in increasing relational outcomes", *Information & Management*, vol. 52, no. 7, pp. 824–839. DOI 10.1016/j.im.2015.06.004

Sela, A., Shektman, L., Havlin, S. and Ben-Gall, I. (2016), "Comparing the diversity of information by word-of-mouth vs. web spread", *EPL (Europhysics Letters)*. IOP Publishing, vol. 114, no. 5, p. 58003, DOI 10.1209/0295-5075/114/58003

Subrahmanian, V. S., Azaria, A., Durst, S., Kagan, V., Galstyan, A., Lerman, K., Zhu, L., Ferrara, E, Flammini, A., Menczer, F., Stevens, A., Dekhtyar, A., Gao, S., Hogg, T., Kooti, F., Liu, Y., Varol, O., Shiralkar, P., Vydiswaran, V., MEi, Q., Hwang, T. (2016), "The DARPA Twitter bot challenge", *Computer*, IEEE, vol. 49, no. 6, pp. 38–46, DOI 10.1109/MC.2016.183

Tam, L. and Jeong-Nam, K. (2019), "Social media analytics: how they support company public relations", *The Journal of Business Strategy*, vol. 40, no. 1, pp. 28–34. DOI 10.1108/JBS-06-2017-0078

Tenkanen, H., Di Minin , E., Heikinheimo , V., Hausmann, A., Herbst, M., Kajala, L. and Toivonen, T. (2017), "Instagram, Flickr, or Twitter: Assessing the usability of social media data for visitor monitoring in protected areas", *Scientific reports*. Nature Publishing Group, vol. 7, No. 1, pp. 1–11, DOI 10.1038/s41598-017-18007-4

Twitter (2017), *Automation rules*.

Twitter (no date), *About Twitter's APIs*.

Varol, O., Farrara, E., Davis, C. A., Menzcer, F. and Flammini, A. (2017), "Online human-bot interactions: Detection, estimation, and characterization", *Eleventh international AAAI conference on web and social media*

Woolley, S. C. and Howard, P. (2017), "Computational propaganda worldwide: Executive summary", The Computational Propaganda Project

Woolley, S. C. and Howard, P. N. (2016), "Automation, algorithms, and politics| political communication, computational propaganda, and autonomous agents—Introduction", *International Journal of Communication*, vol. 10, no. 9, pp. 4882–4890

Zerfass, A., Verčič, D., Verhoeven, P., Moreno, A. and Tench, R. (2012), "European Communication Monitor 2012: Challenges and competencies for strategic communication: Results of an empirical survey in 42 countries", BrusselsEACD/EUPRERA

NEW CHALLENGES WITHIN THE EVALUATED SOIL-ECOLOGICAL UNITS VALUATION IN THE CZECH REPUBLIC

Josef Slaboch[1], Michal Malý[2] and Jiří Mach[3]

[1, 2, 3] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]jslaboch@pef.czu.cz, [2]maly@pef.czu.cz, [3]mach@pef.czu.cz

Annotation: The aim of this article is to determine the development of individual factors entering the final valuation of ESEU in the Czech Republic on the basis of a data set, which utilizes mainly climate changes and changes in the structure of arable land use in the period under review (2000-2018). Currently, individual ESEU prices range between CZK 1.15-19.79 CZK/m^2. In total, 2278 ESEU codes are defined in the Czech Republic. The basis of the ESEU valuation is the creation of type structures for valuation (TSV, in Czech OTS), which express the proportions of appropriate representation of the most important arable crops. The data set contains average monthly temperatures and precipitation in the Czech Republic for the period 2000-2018 and detailed characteristics of the arable crops representation again for the period 2004-2018. The results show that the share of some crops on arable land has changed significantly in the monitored period 2000-2018. It is mainly an increase in the share of oil-seed rape - an increase of 60% and legumes – an increase of 23% over the period under review. On the other hand, there is a very significant decrease in barley - a decrease of 30% and rye - a decrease of 60%. At the same time, there are also climate changes, which are reflected in the inaccurate classification of ESEU in the given climate region, due to the increasing average temperature and the change in the average rainfall. These factors must be included in the ESEU and updated. At the same time, the land valuation system serves as a tool for calculating the tax liability of farms within the real estate tax.

Key words: Soil, evaluated soil-ecological unit, climatic conditions, type structure for valuation

JEL classification: Q15, Q18, H21

1. Introduction

The presented paper deals with the methodology of ESEU valuation in the Czech Republic in connection with climate change. If we want to manage agricultural land properly and at the same time preserve it for future generations, it is necessary to define the quality of the soil comprehensively. According to Power and Myers (1989), soil quality is the ability to provide and sustain plant growth, which in itself includes factors such as degree of cultivation, organic matter content, structure, depth of soil profile, water capacity, permeability, pH, nutrient content, etc. Parr et al. (1992) adds that soil should increase animal health and vitality without compromising natural resources or the environment. Soil is the uppermost porous layer of solid earth's crust, which is composed of mineral particles of various sizes, living organisms, dead remains and at the same time is permeated with water and air (MoE, 2020). Soil quality, and thus yields, is determined primarily by soil fertility, which is the main prerequisite for agricultural production. In the Czech Republic, a comprehensive soil survey (CSS) was conducted, which represented the coordination of two basic areas, namely pedological soil survey (1960-1970) and a system of agronomic ploughland surveys to determine the state of available nutrients, soil reaction and liming needs (Němec, 2001). The evaluation of the agricultural land fund itself took place in the 1970s. The aim of the evaluation was the valuation and economic appraisement of all crucial factors of the area (especially the climate, relief, soil unit) with differences in production and cost assumptions of agricultural land. The basic components of the soil evaluation are the rating classification system and the economic characteristics of all its units, the interconnection of which enables the creation of a system of economic indicators in a unified evaluating information system. (Klečka, 1984). The valuation of the productive capacity of the land is based on the valuation of the difference in the efficiency of inputs in the land in specific conditions - it is a derivation of the price of parameterized production to the parameterized costs (Němec, 2001). For the purposes of an evaluation of agricultural land, a basic unit was created - ESEU. This unit represents a system for evaluating of production potential, based on several parameters. The ESEU consists of a 5-digit numerical code, which expresses the climatic region, the main soil unit, the slope of the land and the orientation to the cardinal points, and last but not least the depth of the soil profile and skeletality (Research Institute for Soil and Water Conservation – RISWC, 2020). Climate regionalization is very important for the needs of evaluation, because the yields of agricultural crops depend mainly on temperature and humidity (Mašát, Němeček and Tomiška, 2002). The ESEU system currently has 2278 codes, and in the future it is planned to expand the number of codes with new ones, especially other main soil units (RISWC, 2020). Soil quality can change over time due to various degradation factors. The state of soil degradation for the Czech Republic is reported, for example, by Šarapatka, Novák and Bednář (2010), where water erosion causes the most problems (according to Dostál et al. 2006 up to 50% of agricultural land is endangered), other types of physical or chemical degradation are also problematic (contamination, mining, compaction, acidification, etc.). The soil is especially prone to degradation in the spring, when it is not fully covered with vegetation protection. In this case, for example, grassing can be an effective intervention, but due to the decline in livestock breeding, it is not used (Petříková, 2006). Erosion and inappropriate management are not the only causes of soil degradation. As stated by Szturc, Karasek and Podhrazska (2017), another problem is the development of urban areas with associated infrastructure. Voltr (2011) mentions that there is also a significant decrease in the areas of the highest quality soils, mainly due to changes in soil cultures. Janků et al. (2016) state that the Czech Republic has lost more than 850 thousand hectares of agricultural land since 1927.

2. Material and Methods

The aim of this article is to determine the development of individual factors entering the final valuation of ESEU in the Czech Republic on the basis of the data set - these are mainly climate changes and changes in the structure of arable land use for the observed period 2000-2018. Currently, individual ESEU prices range from CZK 1.15-19.79 CZK/m^2, based on Decree No. 441/2013 Coll. A total of 2278 ESEU codes are agronomically defined in the Czech Republic. The basis of the ESEU valuation is the creation of valuation type structures (VTS), which express the shares of the appropriate representation of the most important crops on arable land, on the basis of which the individual ESEU codes are valued using the scoring method. The economic valuation itself is calculated on the basis of the gross annual rent effect (GARE), which represents the difference between revenues and costs in the parameterized crop production in a given VTS.

The data set used in the article contains average monthly temperatures in individual regions of the Czech Republic for the period 2000-2018, which are used to determine changes within individual climatic regions. Climatic regions are determined on the basis of several criteria - e.g. average temperature, annual total precipitation, etc. Other data used are total precipitation in individual regions in individual months of the year. Again, this data set is used for the period 2000-2018. The last data set is data on the representation of cultivated crops on arable land, for the period 2004-2018. Among the evaluated crops were selected: wheat, barley, rye, corn for grain, oats, rape, annual fodder crops, perennial fodder crops, legumes, potatoes, sugar beet and poppy. These crops were selected as part of their inclusion in the VTS and their share in the actual cultivation by farmers in individual regions of the Czech Republic is examined (their total share of arable land exceeds 92% in individual years). The basic tools of descriptive statistics are used for evaluation. Calculations of chain and basic indices are used for evaluation within the horizontal analysis. To calculate the structure of crops, a vertical analysis is used, examining the share of individual items in the total value - in this case, the share is calculated within individual regions of the CR.

3. Results and Discussion

The ESEU classification system has long been used in the CR for a number of legislative instruments - starting with the protection class of the agricultural land fund, the official price for determining the tax liability, for land layouts, etc. Due to the fact that the ESEU has not reflected the changes that have occurred since its inception, a certain update is necessary. The ESEU code itself is expressed by a five-digit number. The first part of the results is focused on the changes in weather that occurred during the period 2000-2018. The first number within the ESEU code is the climatic region, which is defined as follows - see Table 1.

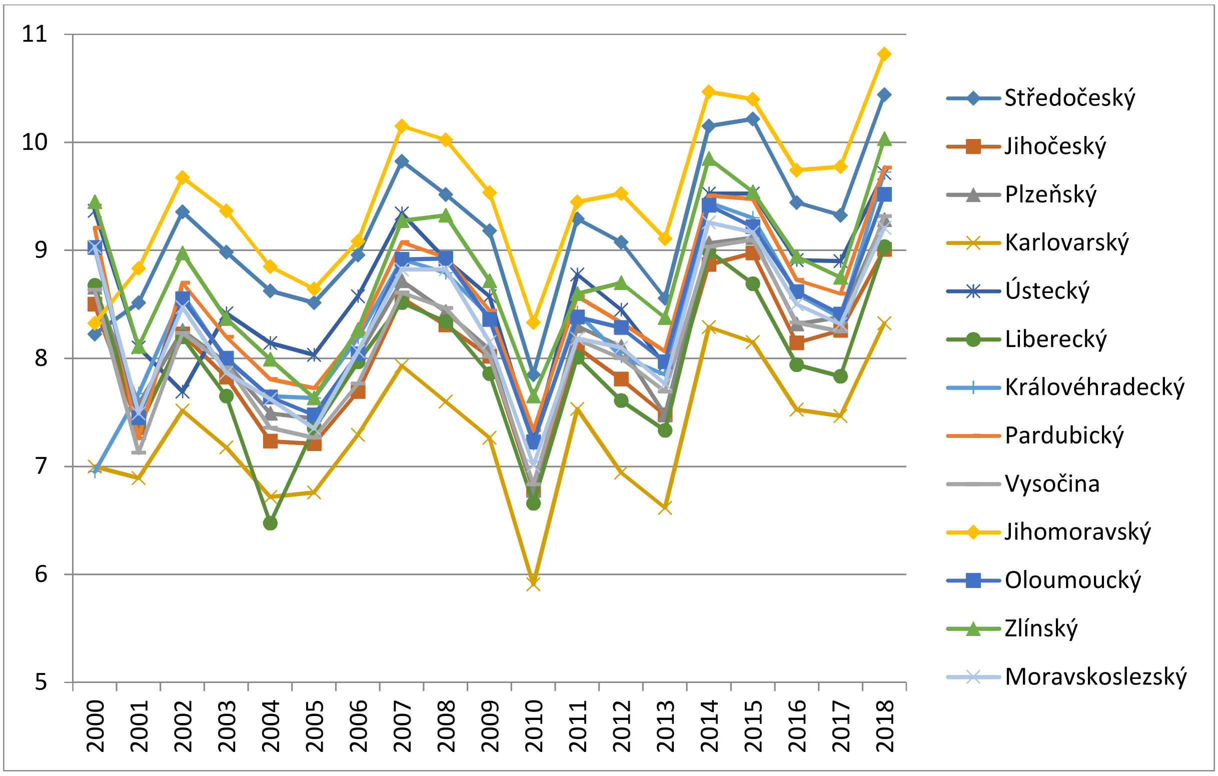
Table 1. Definition of climatic regions (CR)

CR code	Characteristic	Sum of temperatures over 10 °C	Mean temperature	Average rainfall totals per year (mm)	Probability of dry growing season	Moisture security in the growing season
0	Very warm, dry	2800 -3100	9 - 10	500 – 600	30 - 50	0 – 3
1	Warm, dry	2600 – 2800	8 – 9	below 500	40 – 60	0 – 2
2	Warm, slightly dry	2600 – 2800	8 – 9	500 – 600	20 – 30	2 – 4
3	Warm, slightly moist	2500 – 2800	(7) 8 – 9	550 – 650 (700)	10 – 20	4 – 7
4	Slightly warm, dry	2400 – 2600	7 – 8,5	450 – 550	30 – 40	0 – 4
5	Slightly warm, slightly moist	2200 – 2500	7 – 8	550 – 650 (700)	15 – 30	4 -10
6	Slightly warm, very moist	2500 – 2700	7,5 – 8,5	700 – 900	0 – 10	above 10
7	Slightly warm, moist	2200 – 2400	6 – 7	650 – 750	5 – 15	above 10
8	Slightly cold, moist	2000 – 2200	5- 6	700 – 800	0 - 5	above 10
9	Cold, moist	below 2000	below 5	above 800	0	above 10

Source: own processing on the data basis from RISWC

The first part of the results is focused on the development of weather in individual regions of the Czech Republic for the period 2000-2018. These are mainly the basic parameters for determining the climatic region – i.e. mean (average) temperature per year and total precipitation per year. Here it is evident that during the monitored period there are fluctuations in average temperatures for the individual regions. However, a growth trend has been seen since 2010. The interval of average temperatures is bordered by two regions - Jihomoravský (highest average annual temperature) and Karlovarský (lowest average annual temperature). In 2000, the interval of average annual temperatures ranged from 6.95 to 9.45°C. As can be seen from Graph no. 1, the lowest temperatures for the observed period were measured in 2010, when the temperature range of individual regions is between 5.91 - 8.33°C. These values do not differ significantly from the values in the last century - for example, the average temperature in the Czech Republic in 1986 was 7.2°C. From this year, however, the graph shows a gradual increase in average annual temperatures in individual regions. In 2018, we can state that the average annual temperatures are the highest for the observed period. In the Karlovarský region (which according to the underlying data is the coldest region), the average annual temperature in this year was 8.33°C (the average annual temperature common to South Moravia - Jihomoravský region - at the beginning of the century). If we focus on the warmest region - South Moravia, it is clear that the average annual temperature in this region was 10.82°C. Other regions - Středočeský and Zlínský - also exceeded the average annual temperature of 10°C. The increasing average annual temperature itself has an effect also on water evaporation and thus indirectly on drought in individual regions. Evaporation generally depends on temperature, wind and humidity - during dry weather at greater than during a humid weather - more in e.g. Vicente-Serrano et. al (2020).

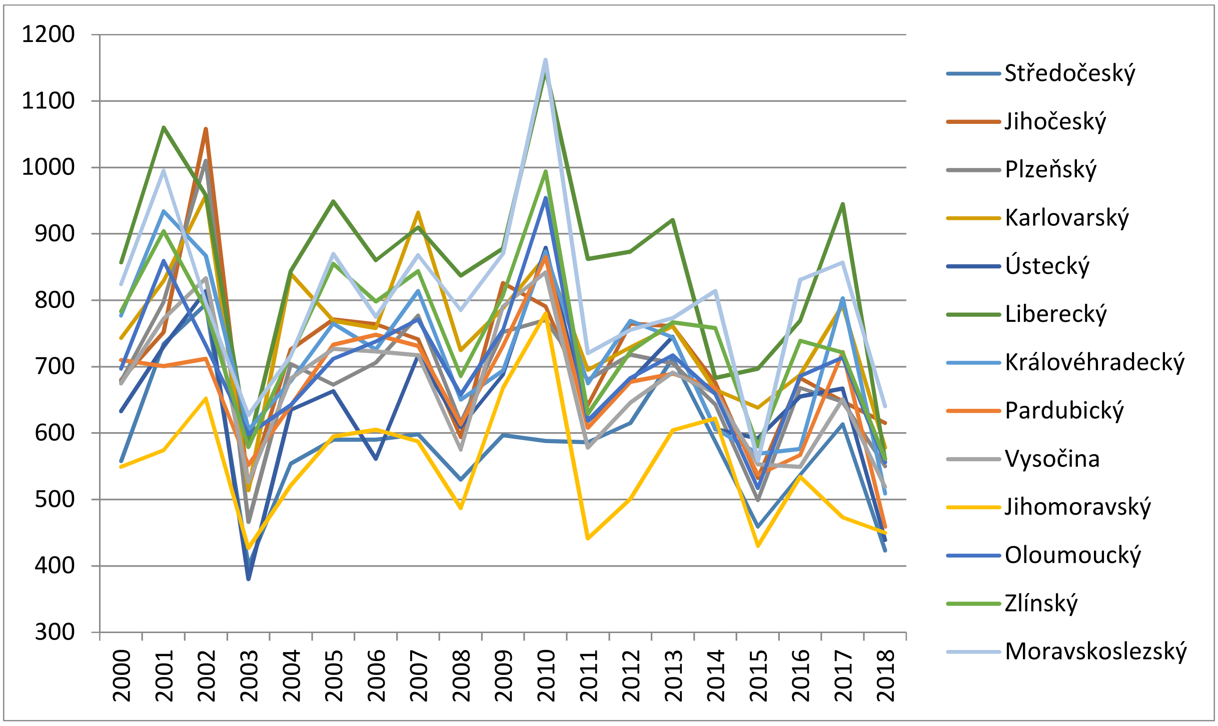
Graph 1. Development of average annual temperatures in individual regions (degrees of Celsius)



Source: own processing on the data basis from Czech Hydrometeorological Institute - CHMI

Another variable entering into the determination of the climatic region is the average total annual precipitation (rainfall). The development of precipitation in individual regions is highly volatile - see Graph no. 2. However, on the basis of data, it is possible to state and observe a slightly declining trend in the volume of precipitation, especially towards the end of the observed period. The results show that the Liberecký and Moravskoslezský regions have the highest value of total precipitation in the monitored period (on average they exceed 800 mm/year). The overall maximum was reached in 2010 with a value slightly exceeding 1150 mm/year - which also led to tragic events such as floods in the Olomoucký, Zlínský and Liberecký regions. Similarly was in 2002 (the graph shows a significant increase in the Jihočeský - South Bohemian - and Plzeňský - Pilsen - regions), when the total amounts in these mentioned regions exceeded the limit of 1000 mm/year, while the long-term average in these regions is about 700 mm/year. Drought has been much mentioned in the last few years. If we look at the individual regions in the period 2015-2018, it is possible to state that in the Středočeský (Central Bohemian) region 3 out of 4 years were very below average in terms of precipitation. During the monitored period, the average total precipitation is 582 mm/year, while in 2015 the precipitation was 459 mm/year, in 2016 it was 537 mm/year and in 2018 only 423 mm/year. The same situation as in the Central Bohemian Region is evident in all other regions, i.e. for the period 2015-2018, there is a situation where 3 out of 4 years have a significantly lower precipitation amounts than the long-term average. The only year when it was the opposite is 2017, when the data show a higher precipitation amounts than the long-term average in 8 of the 13 regions monitored (lower amounts were, for example, in Jihočeský, Plzeňský, Jihomoravský, Zlínský and Vysočina regions).

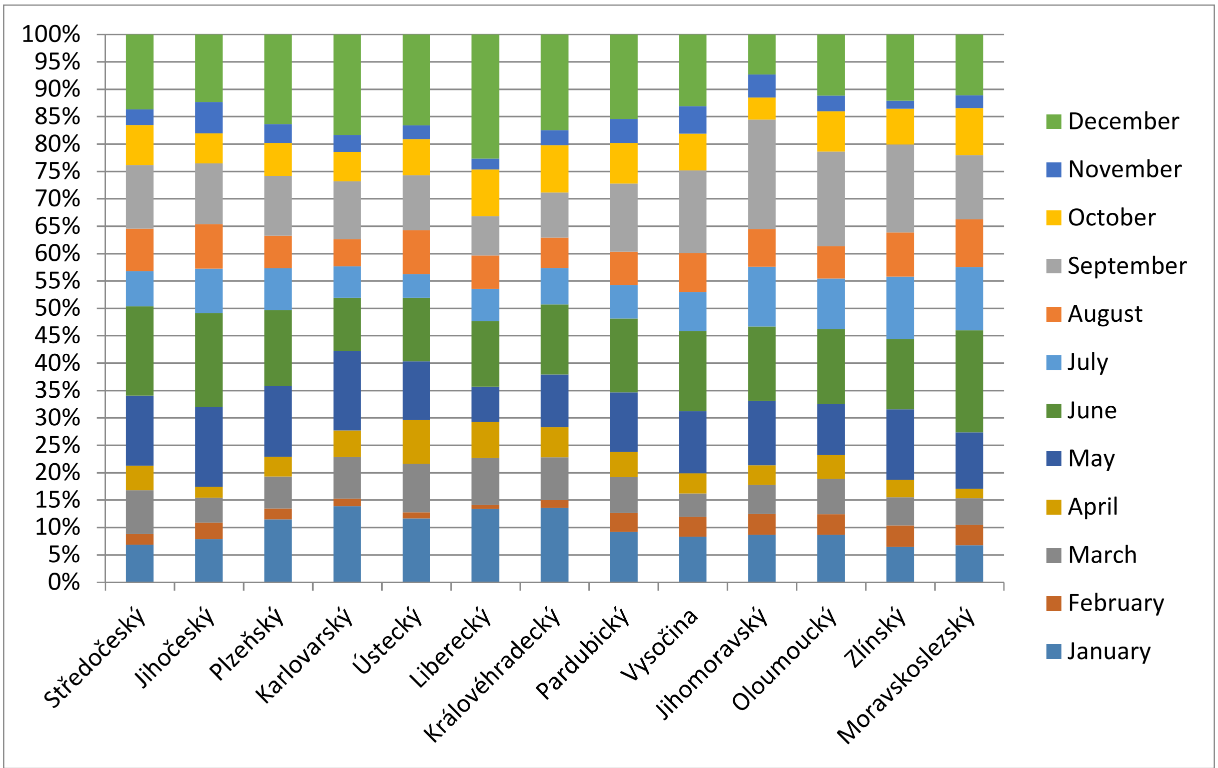
Graph 2. Development of annual precipitation in individual regions (mm/year)



Source: own processing on the data basis from CHMI

From the growing individual crops point of view, however, the precipitation distribution during the year is also important for farmers - it is also the intensity, etc. A more detailed look at Graph no. 3 shows the precipitation distribution according to individual months for 2018. The analysis itself is performed for each year separately, but due to the scope of the paper, it is not possible to list all years. The results show that at the beginning of the analyzed period the precipitation is relatively balanced in individual months, but differs within groups of regions. The first group consists of all regions except Liberecký, Jihomoravský, Moravskoslezský and Kálovéhradecký. The first group is characterised by a significant total precipitation in March, which ranges from 16 to 19% of the annual sum. Another significant volume of precipitation then occurs in July, when the share of precipitation is in the range of 16-22%. For the second group of regions (Liberecký and Královéhradecký), a more even distribution of precipitation into individual months is evident, when individual shares in the months are in the range of 7-10%. The third group then consists of the Jihomoravský and Moravskoslezský regions, which in 2000 is characterised by the highest rainfall income in July with a share of 25%. On the contrary, the lowest totals are in these two regions in August, September and October (in individual months the amount is at the level of 3.5-5%). For the first group of regions, we can say that during the first six months, the amounts are at the level of 48-53% - i.e. about half of the precipitation falls in half a year. For the second group we can say that in the first 6 months approximately 47% of precipitation will fall and for the last group then only 40% of the total precipitation, and a higher share is then in the second half of the year. The extreme case was the year 2002 and the floods in the Czech Republic. Here, the data show how important equability is in the distribution of precipitation within the year. In 2002, almost half of the precipitation fell in all regions during the month of June to August (the range is between 41-45%), which resulted in floods and a crisis situation. In the following years, as can be seen from the graph, the situation is more balanced and the highest precipitation sums are usually in the months of May, June, December and January.

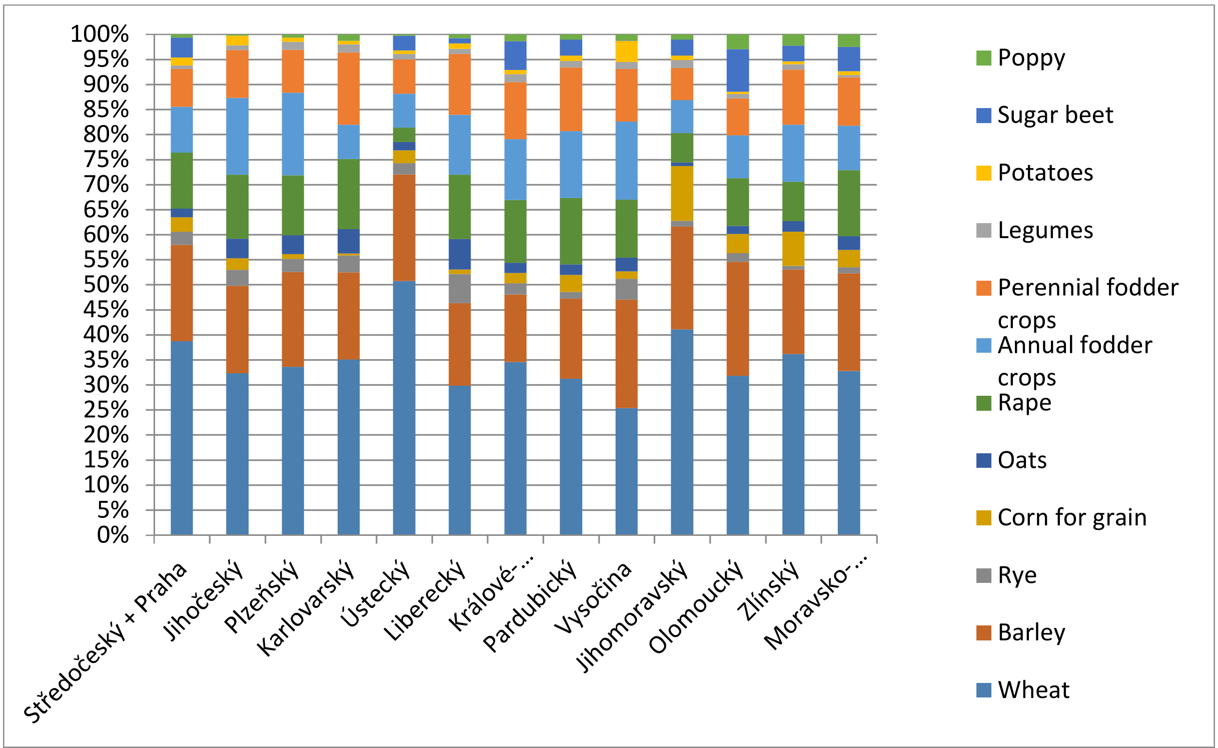
Graph 3. Distribution of precipitation by months in individual regions for 2018 (in %)



Source: own processing on the data basis from CHMI

The second part of the results is focused on the change in the structure of cultivated crops in individual regions of the Czech Republic for the period 2004-2018. Here it is clear that the shares of individual crops change over time. The shares of individual crops are processed for individual regions (see Graphs 4 and 5). The total agricultural area decreased by 108 thous. ha, which represents an average annual decrease of 7213 ha. Looking at the arable land, the situation is even more serious, in the period 2004-2018 the areas of arable land decreased by 232 thous. ha, which represents an average annual decrease of 15482 ha. If we express this situation using the basic index, then in 2018 we will get a value of 91%. When expressing the structure of individual cultivated crops in individual regions, significant differences are evident. In the Ústecký Region, wheat and barley are grown on 72% of arable land (2004). When adding other cereals, we get up to 78%. Rapeseed, annual and perennial fodder crops are then grown on the rest of the arable land. At the same time, it is necessary to emphasize that 90% of annual fodder crops is green corn for feeding or silage. The graph shows that in all regions, the dominant two cereals (wheat and barley) account for at least 45% of the arable land in the region. In individual regions, a very low share of perennial forage (clover, alfalfa) is also evident, with the exception of the Karlovarský and Pardubický regions, where the share of perennial forage on arable land is 13% (in other regions it is about 8%). It is also interesting to monitor the shares of sown areas of the crop in individual regions of the CR. In the case of wheat, the sown areas of which in 2004 were at the level of 863 thous. ha, the largest share of cultivation is represented by the Středočeský Region, which accounted for 21%, followed by the Jihomoravský Region with a large gap with a 13.6% share of sown areas. On the other hand, the Liberecký and Karlovarský regions have the lowest share of sown areas of wheat, with a share of 1.5%. In 2018, the sown areas of wheat decreased to the level of 820 thous. ha (a decrease of 5% over the observed period), while the shares of sown areas in individual regions do not change significantly.

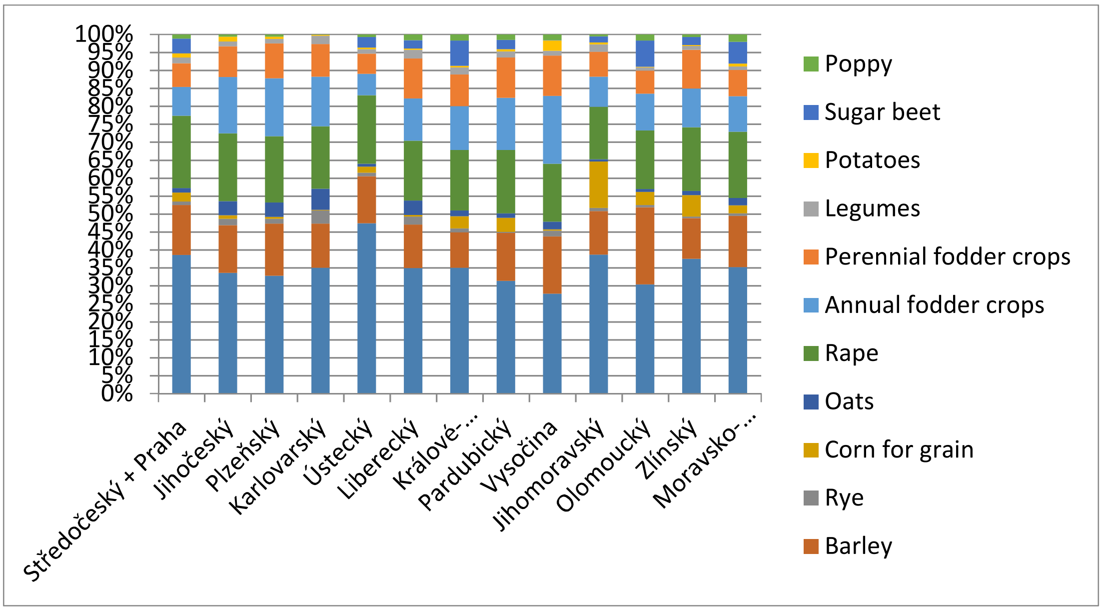
Graph 4. Share of individual crops on arable land (2004, in %)



Source: own processing on the data basis from Czech Statistical Office - CSO

When comparing the share of individual crops in 2004 and in 2018, a very significant increase in the share of rapeseed is evident. In 2004, its share of arable land was approximately 8-12% in individual regions, 5% in Jihomoravský and around 2.5% in Ústecký. Looking more closely at 2018 (Graph no. 5), it is clear that the share of rapeseed on arable land in individual regions reaches 18%, in the South Moravian Region is at the level of 13.5% (during the period there is an increase from 5 to 13.5% share of arable land). This increase is certainly strongly connected with the EU decision to reduce CO_2 emissions, when the Czech Republic produces a large amount of biofuel components, which are then added to fuels. During the monitored period, the sown areas of rapeseed increased from 260 thous. ha (year 2004) up to 411 thous. ha in 2018, which represents an increase of 60% (despite a significant decrease in the size of arable land). The Středočeský Region has the largest share of rapeseed areas sown with a share exceeding 22%, followed by the Jihočeský, Jihomoravský and Vysočina regions with a share of 10%. For the evaluated period 2004-2008, it can be concluded from the point of view of individual crops that there is a slight decrease in sown areas of wheat by 6%. In the case of barley, as the second most important cultivated cereal, there is a significant decrease in sown areas, namely by 30% (in absolute terms it is 144 thousand ha). The situation is very similar in the case of rye, where there is a decrease in sown areas by 58% (in absolute terms it is 35 thousand ha. Corn for grain is relatively stable, with a slight decrease in sown areas by 6%. In the case of rape, as already mentioned, there is a significant increase in sown areas, namely by 60% (increase by 161 thousand ha). Annual fodder crops for the observed period show almost no change - a decrease of 1%. In the case of legumes, the area sown increased by 23% during the period under review, which in absolute terms represents an increase in area of 7,000 ha. The last crops, which enter the VTS, are sugar beet and poppy, and during the observed period there was a slight decrease in the area sown for both crops by 8% and 3%, respectively. In terms of the structure of arable land use, the Středočeský Region is mainly focused on the cultivation of wheat, barley and rape. These three crops occupy 70% of arable land (2018). The rest then falls mainly on annual and perennial forage and sugar beet. The dominant cultivated crop is wheat, which in individual regions represents a share of arable land in the range of 28-44%. The Jihočeský and Plzeňský regions are very similar in terms of arable land use. The main crops are wheat, rape, annual fodder crops and barley. Together, these crops represent 80% of arable land. The relatively high share of annual and perennial fodder crops in the Liberecký, Karlovarský, Plzeňský, Královéhradecký, Pardubický and Vysočina regions is also interesting. In the above-mentioned regions, the share of fodder crops on arable land is over 20%, which is significantly more than in other regions.

Graph 5. Share of individual crops on arable land (2018, in %)



Source: own processing on the data basis from CSO

4. Conclusion

The results of the paper show some important conclusions. The characteristics of climate regions today do not correspond to real values. The results show that the average annual temperature is gradually increasing in individual regions, and the classification of agricultural land does not fully correspond to reality. Another important characteristic of climate regions is the annual total precipitation. The results show a gradual reduction in the total precipitation in individual years (especially for the period 2015-2018), which will lead to higher drought and at the same time to increase the probability of dry growing seasons, which may result in a significant reduction in production capacity. Due to the change in growing conditions (climatic region), it does not have to correspond to the GARE calculation, as the data on achieved yields or costs may be skewed. Last but not least, an analysis of the representation of crops on arable land was performed, which again does not fully correspond to the ratio of crops given by the VTS for the given agricultural land. The results show that, for example, in the Ústecký Region, the share of the two main cereals (wheat and barley) in arable land was up to 70% (2004). When comparing the share of individual crops in 2004 and in 2018, a very significant increase in the share of rapeseed is evident. In 2004, its share in arable land in individual regions was about 8-12%, in 2018 it was already about 18%. At the same time, the total agricultural area for the observed period decreased by 108 thous. ha, which represents an average annual decrease of 7213 ha. Looking at the arable land, the situation is even more serious, in the period 2004-2018 the areas of arable land decreased by 232 thousand. ha, which represents an average annual decrease of 15482 ha. The ESEU system has been used in the Czech Republic for a long time and is based on a number of legislative instruments, regulations, subsidies and practical applications (Agricultural Land Fund Protection Classes, official prices, ANC areas, land layouts, etc.). Due to the fact that natural conditions and the actual condition of the soil have changed since its inception, it is currently being updated. Using new methods, changes in climate regions in relation to drought and soil erosion are assessed, leading to a new economic assessment.

Acknowledgements

This paper was created within the framework of the project NAZV QK1920280 - Innovation of bonitation system of agricultural lands (ESEU) for the needs of state administration.

References

Dostal, T., Janecek, M., Kliment, Z., Krasa, J., Langhammer, J., Vaska, J. and Vrana K. (2006), "*Soil erosion in Europe: chapter Czech Republic*". In: Boardman J., Posen J. (eds). John Wiley & Sons Ltd., Chichester, pp. 107–116, ISBN: 978-0-470-85910-0, DOI 10.1002/0470859202.ch10

Janku, J., Jaksik, O., Kozak, J. and Marhoul A. M. (2016), "Estimation of land loss in the Czech Republic in the near future", *Soil and Water Research*, vol. 11, no. 3, DOI 10.17221/40/2016-SWR

Klečka, M. (1984), "*Bonitace čs. Zemědělských půd a směry jejich využité – vymezení a mapování bonitovaných půdně-ekologických jednotek – ČSSR* (Bonitation of agricultural lands and directions of their use – definition and mapping of ESEU)", Praha-Bratislava

Mašát, K., Němeček, J. and Tomiška, Z. (2002), "*Metodika vymezování a mapování bonitovaných půdně ekologických jednotek* (Methodology of delimitation and mapping of ESEU)", Praha: Výzkumný ústav meliorací a ochrany půdy - VÚMOP (Research Institute for Soil and Water Conservation – RISWC), p. 113, ISBN 80-238-9095-6

MoE, Ministry of Environment; MŽP, Ministerstvo životního prostředí, příroda a krajina – ochrana půdy – definice (Protection of soil), Praha, 2020 [Online] Available: https://www.mzp.cz/cz/definice_pudy, [Accessed: 19 Apr. 2020]

Němec, J. (2001), "*Bonitace a oceňování zemědělské půdy České republiky* (Bonitation and valuation of agricultural lands in the Czech Republic)", Praha, Výzkumný ústav zemědělské ekonomiky, ISBN 80-85898-90-X

Parr, J. F., Papendick, R. I., Hornick, S. B. and Meyer, R. E. (1992), "Soil quality: Atributes and relationship to alternative and sustainable agriculture", *American journal of alternative agriculture*, vol. 7, no 1/2, pp. 5 – 11, DOI 10.1017/S0889189300004367

Petříková, V. (2008), "Půdní eroze a energetické plodiny (Soil erosion and energy crops)", *Biom.cz* [Online], Available https://biom.cz/cz/odborne-clanky/pudni-eroze-a-energeticke-plodiny [Accessed 25 Apr. 2020], ISSN 1801-2655

Power, J. F. and Myers, R. J. K. (1989), "The maintenance or improvement of farming systems in North Amerika and Australia", In.: *Soil quality in semi-arid agriculture - Proceedings of an international conference,* Saskatchewan Institute of Pedology, Univerzity of Saskatchewan, Saskatoon, Canada, pp. 273 – 292

RISWC, Research Institute for Soil and Water Conservation; VÚMOP, Výzkumný ústav meliorací a ochrany půdy – BPEJ (ESEU), Praha, 2020, [Online] Available: https://bpej.vumop.cz/, [Accessed: 24 Apr, 2020]

Szturc, J., Karasek, P. and Podhrazska J. (2017), "Historical changes in the land use connected with appropriation of agricultural land – case study of cadastral area Dolni Vestonice and Modrice (Czech Republic)", *European Countryside*, vol. 9, no. 4, pp. 658–678. ISSN 1803-8417

Šarapatka, B., Novák, P. and Bednar, M. (2010), "Analysis of soil degradation in the Czech Republic: GIS approach", *Soil and water research*, vol. 5., no. 3, pp. 108-112, DOI 10.17221/487-SWR

Voltr, V. (2011), "Assessment of agricultural land fund in the Czech Republic, importance and future", *Agris On-line Papers in Economics and Informatics,* vol. 3, no. 4, pp. 13-22, ISSN 1804-1930

Vicente-Serrano, SM., McVicar, TR., Miralles, DG., Yang, Y. and Tomas-Burguera, M. (2020) "Unraveling the influence of atmospheric evaporative demand on drought and its response to climate change", *WIREs Clim Change*, vol. 11, no. 2, DOI 10.1002/wcc.632

CZECH FOOD RETAIL PRICES ANALYSIS (WITHIN THE EU MARKET)

Luboš Smutka[1], Michal Steininger[2] Mansoor Maitah[3] and Miroslav Svatoš[4]

[1, 2, 3, 4] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]smutka@pef.czu.cz, [2]steininger@pef.czu.cz, [3]maitah@pef.czu.cz, [4]svatos@pef.czu.cz

Annotation: The proposed paper is focused on Czech food price analyses at the level of individual retail chains operating in the Czech Republic. The main aim of the article is to specify the development of prices of selected food items within a ten-year period approximately. The idea is to examine the position of selected retail chains within the Czech food market and to identify price changes at the level of individual food items and selected food baskets. The food price development is also analysed and discussed with respect to global and EU food price development. The food price analyses are conducted through a unique data collection process. The authors of this paper have been collecting food price data in individual retail chains operating in the Czech Republic for last ten years. Individual retail chains examined include: Kaufland, Albert, Penny Market, Tesco, Lidl and Billa. More than twenty food items investigated are e.g. potatoes, rice, bananas, sugar, sunflower oil, flour, bread, yoghurt, edam 30%, butter, milk, eggs, chicken, etc. (individual data collection was carried in three-months intervals from 2010 up to 2019). For individual data analyses, the basic methods of statistical and comparative analyses are applied both at the level of primary and secondary data. Finally, the individual results showed a rather high level of long-term food price stability, on the other hand, as the Czech food market is operated by only a few dominant retailers, a significant price volatility was shown. Concerning Czech food-price sensitivity – it is possible to confirm much lower price sensitivity in relation to changes in the global market, but a significant price sensitivity and dependency was proven in relation to the EU market. Price variability analysis shows sufficient evidence to conclude that significant differences exist among individual food items which were analyzed. In one hand, significant oscillations are typical for seasonal food items e.g. potatoes, carrot, onion. On the other hand rather, stable prices were in cases of 30% edam, rice, bread, milk or sunflower (typical basic products). Based on price development characteristics (price dynamics and variation) - it is possible to divide individual items into two, respectively three groups. The group number one includes: bread, milk, semi-finished flour and edam 30% (separately is also pork chop (both with and without bone)). The second groups consists of: chicken, sugar, smooth flour, butter, yoghurt (Hollandia type), sunflower oil. The third groups encompasses: edam 45%, oranges, coffee Tchibo, potatoes, bananas, carrot, rice and onion.

Key words: Food prices, European Union, World, Czech Republic, retail chains, price development, interdependence and sensitivity.

JEL classification: E31, L81, Q11

1. Introduction

The globalization tendency in the world is constantly growing and the EU market is no exception in this respect (Matošková, 2011). If we focus on the EU retail market, it can be stated that this economic segment greatly benefits from a globally interconnected world. For example, according to a Deloitte study (2020), the revenues of European retail companies grew by 3.5% annually during the period 2013-2019. A price war has erupted between food chains in Europe under the onslaught of expanding discounts (especially from Lidl and Aldi) and tough competition in saturated markets is pushing retailers to adopt the omni-channel strategy (Deloitte, 2020). If we look at consumer behaviour in retail - specifically the share of European food expenditure in total expenditure - Eurostat (2020) declares that people in poorer EU countries spend more on food than in richer countries. Romanians (26.4%), Lithuanians (20.1%) and Estonians (18.7%) spend the most on food, while consumers pay the least in the United Kingdom (7.1%), Ireland (7.7%) and Luxembourg. (7.8%). The same is true after deducting expenses for soft drinks. The average Czech spends 35,100 CZK a year on food purchases and 3,800 CZK on soft drinks. Food itself is the second largest item (14.5%) of consumer spending in the Czech Republic after housing, while Czech food is the fifth cheapest in the European Union. The Czech Republic has a food price level of 84% of the EU28 average. Concerning Visegrad countries, all other members spend more on food than Czechs. Interestingly, Denmark (130% of the EU average), Luxembourg (125.2%) and Austria (125%) have the most expensive food and soft drinks in the EU (Eurostat, 2020). Although food prices in the Czech Republic are one of the lowest when compared with other EU countries, this fact has several reasons. It should be emphasized that employees in the EU receive an average of about 2.5 times higher remuneration per hour of work than employees in the Czech Republic, which has a significant impact on their food spending in retail chains in the Czech Republic (Makovský, 2018). Regarding Czech consumer behaviour in relation to food, it can be said that cereals, legumes, vegetables and fruits have grown in popularity in the last 30 years. On the other hand, the consumption of milk, meat, potatoes and sugar has decreased (Wang et al., 2018). Over the last 30 years in the Czech Republic, annual food consumption has fallen by about 17 kg per capita to about 790 kg. Since 1989, there has been a significant change in eating habits in the Czech Republic, especially for meat (previously 30.0 kg of beef per capita was consumed, now only 8.7 kg). On the other hand, consumption of poultry increased from 13.0 kg in 1989 to 28.4 kg in 2018. The structure of consumption of bakery products has also changed. In 1989, the consumption of bread reached 56.8 kg per capita and wheat bread 33.0 kg. This ratio reversed and the previously popular bread reached a consumption of 39.3 kg in 2018 and wheat bread 51.3 kg. Between 1989 and 2018, the consumption of cow's milk decreased by 33.5 l to 57.9 l per person in 2018. The structure of fat consumption also changed. In animal fats it decreased by 41.3%, on the contrary the consumption of vegetable fats increased by 41.6% (CZSO, 2020). From a macroeconomic point of view, in relation to primary food producers, the food industry and food in retail, we can talk about a significant correlation between the prices of individual food producers (Qin et al., 2020) and prices in the food retail network/chains in the Czech Republic. Rising demand for food widens the spread between consumer and producer food prices (Zhao and Liu, 2015). This trend can be observed in a number of food items in the Czech Republic. It can be stated that, from a macroeconomic point of view, the level of food demand in the Czech Republic significantly affects the dynamics of consumer food prices, and since 2016 this effect has been increasingly strong. Of course, the entire monetary policy of the central bank also participates in this situation (Wagan et al., 2018). The above aspects are well illustrated by the example of pork: Although its production prices per kilogram in 2018 visibly decreased year-on-year, in Czech shops, on the contrary, the price of pork increased slightly. The spread between consumer and producer prices thus widened significantly, probably reflecting strong demand. In 2019, the situation changed. Due to the African swine fever in China, world pork prices have risen sharply and the Czech market has not avoided an increase (Nather and Theuvsen, 2015). However, this cost pressure has resulted in a narrowing of the spread between consumer prices and producer prices. This indicates that traders have managed to pass on part of the rising costs to consumers. At present, the growth of food prices is strongly influenced by pro-inflationary demand pressures in the Czech domestic economy (CNB, 2020). It can be stated that the European / thus the Czech / retail food market is healthy, economically strong and its potential will be able to be used in the future not only by large retail chains at the global and local level. Based on Unibail-Rodamco-Westfield's interesting survey "How We Shop: The Next Decade" (2020), five key trends have been identified that will affect the retail sector across Europe in the coming decade: 1) online sales, 2) experiential economy, 3) sales techniques 4) the personalized offer of the future, 5) support of local brands (Unibail-Rodamco-Westfield, 2020).

2. Materials and Methods

This research is focused on Czech food price analyses at the level of individual retail chains operating in the Czech Republic. As the food price in the Czech Republic is heavily influenced by global and especially European market development, the food price analyses cover those retail chains which are a part of international retail groups. The food price development is affected by a range of factors.

This paper aims to specifically explore and examine the development of prices of selected food items within a ten-year period approximately. The goal is to identify price changes at the level of individual food items and divide them into several clusters in accordance with the identified specifics. Furthermore, the food price development is also analysed and discussed with respect to individual retail chains. The general food price of Czech food-price development is compared to World and EU countries' food-price development.

The food-price analyses are conducted through a unique data collection process. The researchers have been collecting lowest food price data in individual retail chains operating in the Czech Republic for the last ten years. Individual retail chains which are subject of this study include: Kaufland (owner: Schwarz-Gruppe), Albert (owner: Ahold), Penny Market (owner: REWE Group), Tesco, Lidl (owner: Schwarz-Gruppe) and Billa (owner: REWE Group). More than 20 food items are under investigation; the items include potatoes (unpacked), long-grain rice, bananas (unpacked), crystal sugar, sunflower oil, flour (smooth and semi-finished), bread (Šumava), edam (30% / 45% from the box), butter (82% fat), milk (durable semi-skimmed), eggs (medium size), chilled chicken (standard), Hollandia yoghurt white (3,5% fat), ground coffee (Tchibo Exclusive), carrot (packed), onion (packed), oranges, apples (unpacked), pork chop (with / without bone).

Each individual data collection was carried in all investigated retail stores at one point in time (within one day). Individual data collection was realized in three-month intervals from 2010 to the present.

The collected data is compared to aggregated data sets provided by the Czech Statistical Office and EUROSTAT and FAOSTAT. To compare Czech food-price development to the EU's and global food-price development, deflated prices were chosen.

For individual data analyses, the basic methods of statistical and comparative analyses are applied, both at the level of primary and secondary data. Particular analyzes were calculated mainly utilizing the softwares: Statistica and MS Excel.

The following analyzes were used in the article: correlation, sensitivity and cluster analysis.
To clarify, correlation describes the relationship between two processes or quantities. If one changes, the other changes correlate and vice versa. If a correlation is found between the two processes, they most likely are depended on each other, however, it cannot yet be concluded that one of them is the cause and the other the consequence. Correlation does not imply causality. In statistics, the term correlation means the mutual linear relationship between characters or quantities x and y. The degree of correlation is expressed by a correlation coefficient, which can take values from −1 to +1. The relationship between the characters or

quantities x and y can be positive, if (approximately) y = kx, or negative (y = -kx). The value of the correlation coefficient −1 indicates a completely indirect dependence, i.e. the more the values in the first group of characters increase, the more the values in the second group of characters decrease. The value of the correlation coefficient 1 indicates a completely direct dependence. If the correlation coefficient is equal to 0 (non-correlation), then there is no statistically detectable linear dependence between the characters. It is important to note that even with a zero-correlation coefficient, quantities can depend on each other, but this relationship cannot be expressed by a linear function (Forrester and Zhang, 2020).

In general, sensitivity analysis is a risk modelling and determination procedure in which changes to significant variables are made to determine the effects of those changes on the intended outcome. The analysis includes assumptions on a range of variables. Estimates for these variables will be subject to different types and degrees of risk. The sensitivity analysis therefore focuses on how the result will change if the estimation of the original variables changes (Kodric and Bregar, 2012). The sensitivity analysis is based on food price indices (world food price index published by FAO; EU food price index published by EUROSTAT; Czech food price index published by CZSO) analyses. We applied simple sensitivity analysis based on the analyses of relative year by year food price index differences. As such, the relations between World and Czech food price index as well as EU and Czech food price index was examined.

In general, cluster analysis is a multidimensional statistical method used to classify objects. It is used to sort units into groups (clusters) so that units belonging to the same group are more similar than objects from other groups. Cluster analysis can be performed both on a set of objects (each of which must be described by the same set of characters that it makes sense to follow in a given set) and on a set of characters that are characterized by a certain set of objects carrying these characters (Vogt and Linton, 2020). The authors of the article based this analysis on a modified BCG matrix, based on which clusters were created according to a common value in the growth dynamics and the intensity of fluctuations of the prices of the monitored food. Finally, hierarchical cluster analysis is applied to divide individual items under the analysis (Battaglia et al., 2015) into several clusters with respect to differences related to their price dynamics and price variability. The binary tree approach is chosen (data are merged into similar groups). The final tree is used to summarize data that are connected to form clusters based on their known distance (Euclidian distance). For better results, interpretation the final dendrogram is presented.

3. Results and Discussion

The world food market has undergone a major restructuring in recent years. Both the volume and the demand of the global supply are growing. The growth in the volume of turnover of agricultural and food goods on world markets is significantly driven by high population growth, which, in the period 2000-2020, increased from about 6 billion to more than 7.8 billion inhabitants. It is important, in this regard, to mention the growth of the purchasing power of the population, which has more than doubled over the period (in PPP per capita). The growth of demand, which directly determines the growth of food supply on the market, leads to the need to expand production capacity and at the same time leads to a greater intensification of production processes. This trend is connected to several significant challenges. One of these challenges is the ever-increasing cost of food. The growing demand for primarily processed or semi-processed food products with a higher degree of processing / added value and thus with higher unit prices also plays a role in this respect. In the last two decades (i.e. between 2000 and 2020) the price of food on the world market has risen significantly. Despite significant oscillations, the nominal price of food (according to the FAO) increased from 91.1 index points to 178.4 index points (the real price then increased by 91.8 index points to 135.3 index points). This development was also reflected in the development of prices in individual regions of the world. In the EU28 countries, the food price index rose from 73.07 index point to 105.42 index points in the same period. In the Czech Republic, food prices rose from 73 index points to 108.5 index points in the same period. It can be stated, in general, that the development of food prices on the Czech market is then very closely dependent on the development of food prices on the world market and thus on the markets of EU countries. The result of the correlation analysis (Table 1) shows that food prices within the Czech market are significantly dependent on the development of prices in the EU countries, and slightly less on the development of world prices. The results of the sensitivity analysis show a significantly higher dependence of the development of Czech food prices on prices in the EU countries compared to world market prices. If world market prices change by 1 index point, the Czech market price changes by 0.28 index points, while in the case of the EU market, a change in the price of food by 1 index point will result in a change in the price of food in the Czech Republic by 1.63 index points.

Table 1. World, EU, Czech Republic: Food price development – correlation matrix

	Correlation, p < ,05000 N=20				
Variable	AVG	Stan. Dev.	World	CR	EU
World	129,5424	23,26967	1,000000	0,653992	0,781144
CR	88,0900	12,22357	0,653992	1,000000	0,958221
EU	90,8045	10,28807	0,781144	0,958221	1,000000

Source: FAOSTAT, EUROSTAT, CZSO, own processing, 2020

If we focus on the Czech food market, it can be stated that retail prices are primarily determined by a few, usually multinational retail chains, which control almost four-fifths of food sales. Among these actors, the Schwarz, REWE and TESCO groups dominate. The results of a conducted analysis of the development of food prices on the Czech market (for details, please refer to Table 2) show that there are significant differences between individual retail chains on the Czech market in terms of setting price strategies. A random survey conducted between 2010 and 2019 (at the level of six retail chains focused on a basket of 22 selected food products) found relatively low food price inflation in the period under review. Long-term price analyses recorded only very limited inter-annual food-price growth (cc 1.4% per year). However, during the period under review individual prices surpassed the process of significant price oscillation and volatility, both upwards and downwards, which is confirmed by the relatively high value of the average deviation and variance. The results suggest that individual retail chains make very significant corrections, in the form of numerous discounts and adjustments to seasonal effects. Their pricing strategies are rather aggressive and their task is to strengthen the market's position in the market. The Czech retail market is very specific due to its concentration and degree of competition, which clearly demonstrates the decision of several retail chains to leave this market e.g. InterSpar, Carrefour, Delvita, and Julius Meinl.

The result of data collection and subsequent analysis also confirmed that there are certain differences between the individual retail chains in terms of price settings for selected food items (for details, please refer to Table 3), however, at the level of the selected food basket, the average price differed by only about 150 CZK. The price of the most expensive basket was identified in the case of the BILLA at the level of CZK 1,211, while the lowest price was recorded in the case of KAUFLAND and LIDL (both from the SCHWARZ group). However, it should be noted that, over time, the individual retail chains showed a tendency towards significantly high price corrections, which finally resulted in only a slight increase in the price of the analysed food basket during the period under review. However, we recorded only slow long-term food-price growth during the analysed time period that individual food items under the investigation passed through the significant price fluctuations and variance of prices of individual items in the shopping basket. In this respect, it is worth highlighting the extremely high price variability, especially in the case of retail chains such as BILLA and PENNY MARKET and in the case of LIDL.

Table 2. Survey: Food price characteristics

	The whole set of data							
	AVG	MEDI-AN	MAX	MIN	Avg. Dev.	St. Dev.	VAR	Growth rate
Carrot	18,31	15,82	29,90	11,57	4,33	5,37	29,24	1,021
Onion	15,35	14,90	24,23	9,23	3,15	3,96	18,69	1,018
Banana	27,34	28,57	33,90	17,07	4,26	4,98	25,94	1,005
Potatoes	15,92	15,90	27,90	7,02	4,49	5,52	30,95	1,008
Oranges	32,23	32,40	44,90	18,73	4,91	6,57	49,62	1,014
Apples	31,90	32,82	46,57	18,83	5,45	7,07	51,01	0,991
Edam 45 % box	166,36	165,23	218,35	107,96	20,87	28,44	844,53	1,020
Edam 30 % box	139,15	136,00	176,95	99,71	16,32	20,26	428,47	1,010
Bread	25,64	25,90	30,07	17,82	2,16	2,91	9,01	1,027
Sunflower Oil	34,78	35,73	40,90	25,40	3,91	4,77	24,81	0,990
CoffeeTchiboExlusive 250g	92,44	93,57	137,78	47,90	19,43	24,84	626,26	1,050
1 kg semi-finished. Flour	10,71	10,48	14,23	6,90	1,90	2,20	4,92	1,006
1 kg smooth Flour	10,61	10,32	13,07	6,74	1,87	2,11	4,50	1,006
1 kg Sugar	20,21	21,07	24,57	10,90	3,04	3,84	14,96	0,969
1 kg Rice	21,39	21,32	25,90	18,40	1,48	1,93	4,07	1,014
Chicken standard - 1 kg	68,05	69,48	91,42	42,23	11,61	13,74	193,68	1,003
Pork chop with bone - 1kg	119,08	120,29	148,59	89,86	11,79	15,24	262,61	1,019
Pork chop without bone1kg	157,25	163,91	184,96	104,25	19,58	23,49	630,23	1,006
Milk - 1l	14,74	14,73	19,07	9,50	2,22	2,75	7,67	1,003
Hollandia yoghurt - 500 g	18,91	18,57	23,40	12,90	2,05	2,60	6,87	1,019
Butter - 250 g	32,98	30,32	55,07	22,50	6,35	8,24	68,74	1,014
10 eggs M	30,76	30,15	50,07	19,73	5,65	7,43	55,56	1,020
Total	1110,69	1117,37	1249,19	940,71	65,98	83,09	7001,99	1,014

Sources: own processing, 2020

Although, a high degree of price volatility was demonstrated for individual retail chains in general and for individual food items investigated. It can be stated that this phenomenon was not reflected in long-term price development at the level of whole food basket examined, which resulted in an average year-on-year growth rate of food prices within the monitored basket of no more than two percent (for details, please refer to Table 4). With this being said, the price growth at the level of the whole basket is rather low, with some items recording significant price changes. Those changes are usually a result of some specific events or seasonality. According to the data provided, – the majority of food items examined, could be considered as low price sensitive. The analyses also recorded the effort of individual retail chains to follow each other. This trend analysis is not included in this paper. On the other hand, the significant portion of individual analysed records were affected by applied discount actions. During data collection process, the researchers recorded more than one hundred different price actions and discounts applied by individual retail chains in relation to food items under being examined.

Table 3. Survey: Individual retailers' food-price variation during the period 2010 – 2019

VARIATION	Albert	KAUF-LAND	BILLA	PENNY	TESCO	Lidl
Carrot	38,77	34,57	22,56	20,02	28,58	30,96
Onion	10,44	6,47	13,39	11,36	10,09	60,38
Banana	50,79	18,58	25,84	16,31	26,72	17,41
Potatoes	26,66	22,42	39,99	35,06	22,69	38,90
Oranges	25,52	18,36	43,16	48,00	22,88	139,79
Apples	71,38	42,60	42,36	52,03	67,67	30,00
Edam 45 % box	814,20	361,78	1413,53	542,34	935,00	1000,32
Edam 30 % box	790,03	366,58	530,32	224,15	316,17	343,57
Bread	2,47	13,78	7,79	10,89	13,16	5,99
Sunflower Oil	20,03	27,02	16,21	23,22	55,14	7,27
CoffeeTchiboExlusive 250g	507,04	843,43	425,47	819,17	575,58	586,86
1 kg semi-finished. Flour	3,59	5,96	3,58	5,06	7,19	4,16
1 kg smooth Flour	3,59	5,21	3,58	5,81	4,45	4,34
1 kg Sugar	9,65	13,16	21,21	15,02	18,00	12,73
1 kg Rice	0,73	2,44	6,31	4,65	6,65	3,66
Chicken standard - 1 kg	170,29	343,10	174,46	149,95	184,69	139,58
Pork chop with bone - 1kg	79,49	229,24	655,60	319,59	188,94	102,77
Pork chop without bone1kg	613,23	56,93	807,72	1365,59	504,60	433,34
Milk - 1l	10,66	7,58	8,72	6,21	8,06	4,77
Hollandia yoghurt - 500 g	5,85	10,46	5,25	6,27	7,65	5,75
Butter - 250 g	75,36	92,30	63,22	44,05	68,89	68,60
10 eggs M	41,00	68,99	56,10	57,50	54,02	55,75
Total	5577,02	5658,82	9107,46	9486,30	5341,17	6841,17

Sources: own processing, 2020

Table 4. Survey: Individual retailers' food-price growth rate during the period 2010 – 2019

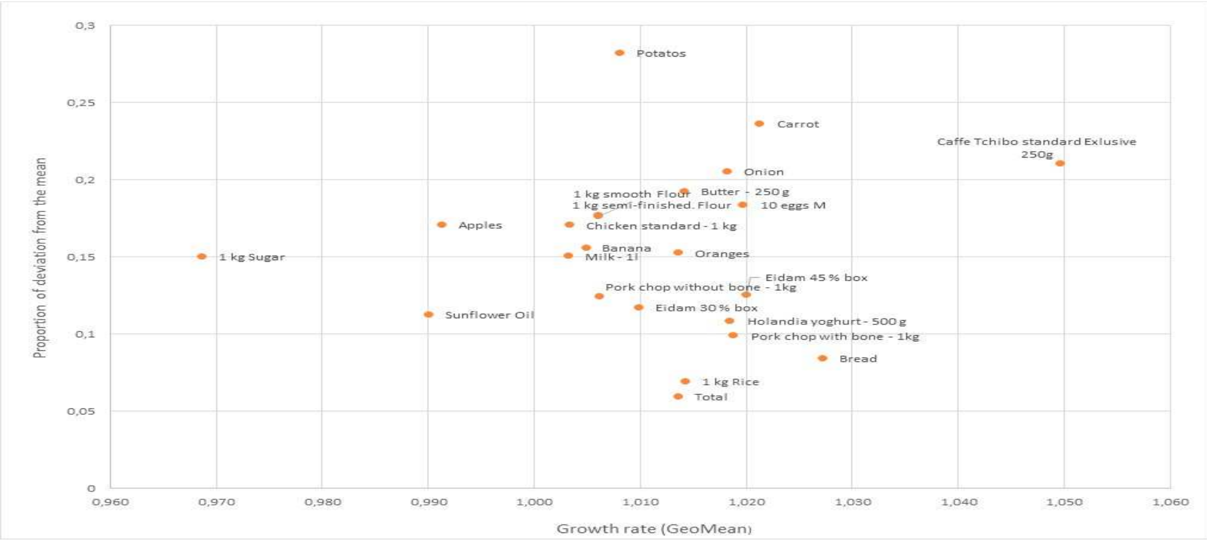
GEOMEAN	Albert	KAUF-LAND	BILLA	PENNY	TESCO	Lidl
Carrot	1,023	1,051	1,003	1,026	1,004	1,021
Onion	1,020	1,021	1,020	1,034	1,022	0,992
Banana	1,045	1,000	0,988	1,016	1,000	0,981
Potatoes	1,000	1,026	1,027	0,995	0,995	1,005
Oranges	1,025	1,000	1,000	1,040	0,991	1,026
Apples	1,007	1,011	0,976	1,000	0,960	0,994
Edam 45 % box	0,997	0,996	1,007	1,021	1,003	1,096
Edam 30 % box	1,015	1,009	1,012	1,019	1,000	1,004
Bread	1,007	1,039	1,016	1,043	1,049	1,009
Sunflower Oil	0,965	1,005	0,977	0,992	1,017	0,984
CoffeeTchiboExlusive 250g	1,067	1,051	1,037	1,062	1,059	1,023
1 kg semi-finished. Flour	0,993	1,024	0,976	1,024	1,024	0,993
1 kg smooth Flour	0,993	1,024	0,976	1,024	1,024	0,993
1 kg Sugar	0,968	0,983	0,941	0,978	0,978	0,963
1 kg Rice	1,003	1,013	1,013	1,023	1,020	1,014
Chicken standard - 1 kg	0,994	1,000	0,991	1,000	1,017	1,018
Pork chop with bone - 1kg	1,017	1,007	1,031	1,012	1,026	1,020
Pork chop without bone1kg	0,994	1,009	1,016	1,003	1,010	1,005
Milk - 1l	1,008	1,014	1,009	0,985	1,012	0,991
Hollandia yoghurt - 500 g	1,021	1,027	0,997	1,027	1,027	1,013
Butter - 250 g	1,030	1,021	1,010	1,021	0,980	1,023
10 eggs M	1,012	1,024	1,011	1,024	1,030	1,018
Total	1,010	1,012	1,010	1,020	1,013	1,016

Sources: own processing, 2020

From the above findings, it can be stated that the individual retail chains across the observed period showed, in terms of the monitored food basket, the significantly different price settings in the case of individual items. The results of the survey proved the following findings: PENNY MARKET is typical because of the highest price variability, followed by BILLA, LIDL, KAUFLAND, ALBERT and TESCO. On the contrary, in terms of the highest average price of the monitored basket, BILLA took first place, followed by TESCO, ALBERT, KAUFLAND, LIDL and PENNY MARKET.

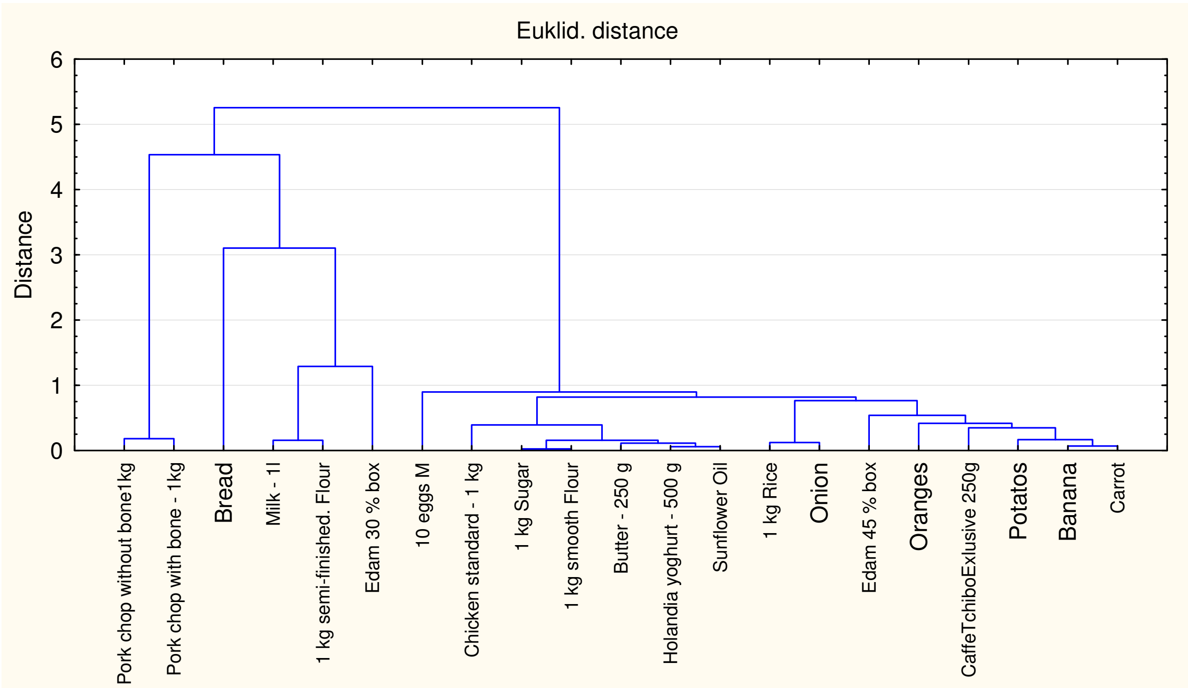
The final price of the analysis is focused on a deeper analysis of selected food items price characteristics development. Individual items are divided into several clusters based on their price dynamics and variability (for details, please refer to Figure 1 and Figure 2).

Figure 1. Survey: Selected item price-characteristic development (Price deviation vs. Growth rate)



Sources: own processing, 2020

Figure 2. Cluster analysis diagram



Sources: own processing, 2020

Looking at individual items within the monitored basket, in one hand a high degree of price variability can be stated in the context of relatively high dynamics of price development. For coffee, carrots, onions, oranges, potatoes, yoghurt, butter, eggs and cheese. On the other hand, apples, sunflower oil, rice, flour, chicken and pork remain price-stable over a long period. Sugar plays a specific role in this respect, experiencing extreme price fluctuations due to the removal of production regulation on the EU market. This phenomenon has taken place especially over the last three years, with a sharp price fall.

Based on the results of applied cluster analyses, while taking in consideration price dynamics and price variability – one can divide individual items into two, respectively three groups. Group one is composed of: bread, milk, semi-finished flour and edam 30% (separately is also pork chop (both with and without bone)). Group two consists of: chicken, sugar, smooth flour, butter, yoghurt (Hollandia type), sunflower oil. Group three includes: edam 45%, oranges, coffee Tchibo, potatoes, Banana, carrot, rice and onion.

4. Conclusion

The results of the analysis show that food prices on the Czech market are highly dependent on the development of market prices in EU countries. Furthermore, it follows that Czech food prices are much more sensitive to changes in prices on the EU market than to changes in global market prices. Furthermore, the analysis shows that the six dominant retail chains in the Czech market apply very different pricing strategies with a high degree of variability in connection with seasonality and also in connection with their efforts to fight for market position through various discounts. The results of data collection showed that almost 40% of all observations were affected by the declared discount action. The results of the analyses also revealed that the individual retail chains apply different pricing strategies, which is subsequently reflected in their position on the market. In general, a different pattern of extension prices can be traced in the case of discounts compared to other types of retail chains. Particularly aggressive behavior in this regard has been confirmed in relation to the REWE and SCHWARZ groups. If we focus on individual segments of basic foodstuffs, then the results of the analysis proved that it was possible to identify three groups of items due to the dynamics of price developments in 2010-2019 and then in relation to price dispersion. In general, it can be stated that the group with the highest degree of dynamics is represented by seasonal items with a high proportion of self-sufficiency, while the second segment is typical for items with a high degree of dependence of the Czech Republic on imports and a low level of food self-sufficiency. The third segment of items is then represented by especially basic food items with low unit prices which are price stable in the long run and their price growth is perceived as extremely sensitive (for consumers).

Acknowledgements

This paper is supported by a grant of National Agency for Agricultural Research (NAZV). The project title is "Dualita v českém zemědělství: výhoda nebo nevýhoda pro zemědělství nové generace?" (QK1920398).

References

Battaglia, O. R., Di Paola and B., Fazio, C., Cluster analysis of educational data: an example of quantitative study on the answers to an open-ended questionnaire, New York, 2015, [Online], Available: https://arxiv.org/ftp/arxiv/papers/1512/1512.08998.pdf, [Accessed: 17 Jun. 2020]

CNB, Czech National Bank, Zpráva o inflaci – příloha, Prague, 2020, [Online], Available: https://www.cnb.cz/cs/menova-politika/zpravy-o-inflaci/tematicke-prilohy-a-boxy/Co-hybe-cenami-potravin/, [Accessed: 20 Apr. 2020]

CZSO, Czech Statistical Office, Database, Prague, 2020, [Online], Available: https://vdb.czso.cz/vdbvo2/faces/cs/index.jsf?page=uziv-dotaz#, [Accessed: 17 Apr. 2020]

Deloitte Touche Tohmatsu Limited, Global Powers of Retailing, New York, 2020, [Online], Available: https://www2.deloitte.com/......./Report_GPR2020.pdf, [Accessed: 17 Apr. 2020]

Eurostat, European Statistical Office, Database, Luxembourg, 2020, [Online], Available: http://appsso.eurostat.ec.europa.eu/nui/show.do, [Accessed: 15 Apr. 2020]

Faostat, Food and Agriculture Organization Corporate Statistical Database, Rome, 2020, [Online], Available: http://www.fao.org/faostat/en/#data/CP, [Accessed: 15 Apr. 2020]

Forrester, P. and Zhang, J. (2020), "Parametrising correlation matrices", *Journal of Multivariate Analysis*, vol. 178, no. 104619, DOI 10.1016/j.jmva.2020.104619

Kodric, B. and Bregar, L. (2012), "The Sensitivity of Capital Services Index on Construction Price Indices", *Economic Research*, vol. 25, no. 3, pp. 666-689, DOI 10.1080/1331677X.2012.11517528

Makovský, P. (2018), "Does the minimum wage affect the rate of unemployment? The Czech Republic case", *Proceedings of 12th International Days of Statistics and Economics*, Prague, pp. 1133-1145, ISBN 978-80-87990-14-8

Matošková, D. (2011), "Volatility of agrarian markets aimed at the price development", *Agric. Econ. – Czech*, vol. 57, no. 1, pp. 34-40, DOI 10.17221/143/2010-AGRICECON

Nather, M. and Theuvsen, L. (2015), "Is African swine fever an economic threat to the EU?", *Proceedings of the Agrarian perspectives XXIV*, Prague, pp. 300-307, ISBN 978-80-213-2581-4

Qin, J., Ren, L., Xia, L., Wang, Z. and Chang, H. (2020), "Pricing strategies for dual-channel supply chains under a trade credit policy", *International transactions in operational research*, vol. 27, no. 5, pp. 2469-2508, DOI 10.1111/itor.12634

Unibail-Rodamco-Westfield, How We Shop: The Next Decade, Paris, 2020, [Online], Available: https://images-urw.azureedge.net/.........../20200113-WESTFIELD-How-we-shop-the-next-decade_onlyEN.ashx?la=en&revision=aaf28ea7-7919-4cda-9577-1cd1d0dd6893, [Accessed: 18 Apr. 2020]

Vogt, M. and Linton, O. (2020), "Multiscale clustering of nonparametric regression curves", *Journal of Econometrics*, vol. 216, no. 1, pp. 305-325, DOI 10.1016/j.jeconom.2020.01.020

Wagan, Z., Chen, Z., Seelro, H. and Shah, M. (2018), "Assessing the effect of monetary policy on agricultural growth and food prices", *Agric. Econ. – Czech*, vol. 64, no. 11, pp. 499-507, DOI 10.17221/295/2017-AGRICECON

Wang, X., Su, Ch., Tao, R. and Lobont, O. (2018), "When will food price bubbles burst?", *Agric. Econ. – Czech*, vol. 64, no. 12, pp. 566-573, DOI 10.17221/21/2018-AGRICECON

Zhao, D, Liu, Z. (2015), "Analysis of the agriculture trade openness impact on the rural household's food consumption in China", *Agric. Econ. – Czech*, vol. 61, no. 10, pp. 461-474, DOI 10.17221/188/2014-AGRICECON

LIFE SCENCE 4.0 – DATA PLATFORM

Michal Stočes[1], Jiří Vaněk[2], Edita Šilerová[3], Eva Kánská[4] and Miloš Ulman[5]

[1, 2, 3, 4, 5] Department of Information Technologies, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]stoces@pef.czu.cz, [2]vanek@pef.czu.cz, [3]silerova@pef.czu.cz, [4]kanska@pef.czu.cz, [5]ulman@pef.czu.cz

Annotation: The paper presents the current development of big data storage solution at the campus of the Czech University of Life Sciences Prague (CULS) (formerly Czech University of Agriculture Prague). The campus is quite large, attended by over 20,000 students and includes school forestry and agricultural businesses. The main goal of the solution is to create a platform for data integration within life sciences 4.0 framework. This includes the integration (collection, storage, normalization, presentation) of heterogeneous IoT data sources with distinct areas of focus such as remote sensing, hydrometeorology, operational and economic data. Modern sustainable development is based on various "smart" solutions based on the processing and utilization of large volumes of heterogeneous data, e.g. Industry 4.0.

Key words: data platform, smart agriculture, data storage, data integration, internet of things

JEL classification: L86

1. Introduction

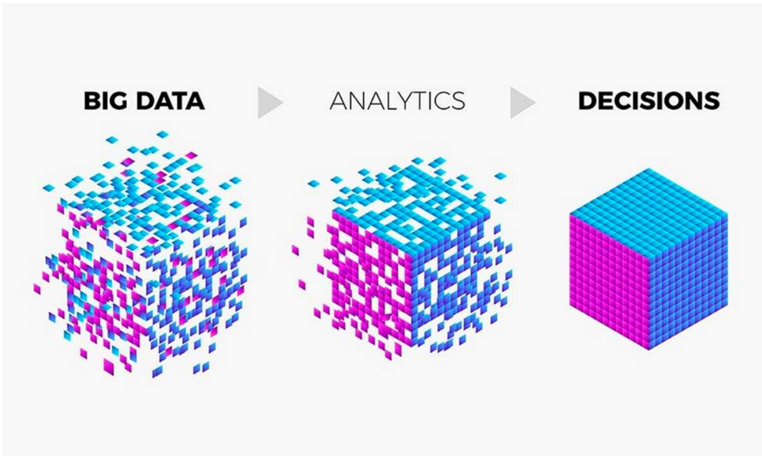
We live in a "period of data creation." Billions of sensors, cameras and other devices continuously monitor events on Earth and the activities of the human population. Within the Internet of Things (IoT) alone, according to (Seery, 2017), approximately 27 billion devices are connected to produce data and is expected to increase to 125 billion by 2030.Further, even more data are generated through weather and climate monitoring, remote sensing, social networks and a large number of autonomous research projects and monitoring of various activities and indicators. There are currently several dozen projects currently underway at the CULS in Prague alone, where data from drones, various sensors and measurements are produced. To effectively use all this data and search for possible synergistic effects, it is necessary to look for new approaches that will allow us to process and present them, ideally in real time for the needs of decision-making and process management, but also for further research. Data must be efficiently stored, processed and analyzed (Marjani et al., 2017). As it shows (Suciu, 2016), this area of "Big Data" is still hampered mainly by standardization. If IoT and Big Data are now being published, in most cases it is industry, smart homes and cities. In the field of Life Sciences, ie also the focus of the CULS in Prague, this area is solved mainly in Smart Farming (Precision Agriculture, Agriculture 4.0) and even here the issue of Big Data is not satisfactorily solved. (Kamilaris et al.,2017; Tzounis et al., 2017). Data processing for research and decision-making in other areas of Life Sciences (eg drought, climate change, sustainable ecosystems, but also rural development, etc.) often takes place separately without exploiting the potential of Big Data technologies. Expertise in the given profession and Big Data area is needed for efficient data extraction. In the field of data storage and processing with regard to the integration of various data sources into the Big Data environment of the computing cluster, especially in the field of Life Sciences there is a gap in current knowledge - it is necessary to move from "data creation period" to "data usage period". It is necessary to address the selection of appropriate standards and databases for the initial storage of data (Luo, 2018). Data from various sources are then stored in data warehouses, where one of the basic problems is the description of this data - semantics (di Martino et al., 2017; Stočes et al., 2018). It is necessary to combine data from various disparate sources that were not primarily intended to work together (Razzaque et al., 2016).

The contribution presents these global trends, is in line with the focus of the CULS in Prague and fills in an area that is not yet fully addressed - Smart Life Sciences (Life Sciences 4.0). It presents solutions that focus on the development of a technology platform for the integration of heterogeneous data (remote sensing, IoT, GIS, etc.) (Novák et al., 2019) and its publication. The solution is primarily expected to be used in the area of scientific activities at CULS (integration of partial solutions in various projects) and by other domestic and foreign partners. The research questions addressed in the research are such as: “What are the potential uses of current big data store in life science area?”

2. Materials and Methods

The methodical approach consists of analysis of existing and newly developed technologies for big data store for heterogenous data. The problem of today's systems is mainly that they generate a large amount of data, but their use, further analysis is not solved (Figure 1.).

Figure 1. Big Data Analytics



Source: towardsdatascience.com

The ecosystem of CULS in Prague is generated a number of data.The university's ecosystem is both in size and data flow and very similar to an rural region. These are administrative operational data and data as a result of various projects. These data are stored, but their usability is very weak, especially for single-purpose purposes. A Hackaton was held with CULS students last year, where areas and applications were sought for the use of data from existing data sources and data generated using the Internet of Things (IoT). The hackathon lasted two days and individual teams of students are looking for new ideas and innovations to improve the existing data and the environment on campus. Based on the results obtained by literary research and analysis of the results of the organized event (hackaton), the direction (partial projects) was defined, which will be solved within the big data platform under construction. During the hackathon, teams had the opportunity to communicate their questions with professional mentors. It assumes the possibility of using the hackaton results for other areas such as smart villages or rural development.

3. Results and Discussion

In general, a Hackathon can be defined as an action in which programmers, possibly in collaboration with graphics and web designers, work intensively on a given software project. Their function can be purely educational, but in many cases the goal is to create a specific IT application. The device or system on which it is being developed is also announced in advance. The main goal of the organized hackathon was to create and present a prototype of an imaginary application. The aim was to find the best possible use of data generated in the environment of university with an advantage for use in smart villages or rural development. A similar type of event is often used as a stage in the preparation of new and innovative projects in both the commercial and scientific spheres. During the preparation of projects, the teams consulted their intentions with professional mentors, which results in an increase in the quality of individual projects. Student teams presented the following projects.

The first project

MOEW (Management of Environmental Welfare). It was developed with regard to efficiency, simplicity, feasibility with a positive impact on the environment within the CULS. They focused on existing technologies used inside buildings - smart radiator heads, air conditioning, automatic window opening and more. With the help of the IoT world, it is possible to enrich these existing technologies and add more meaning to them - for example, with CO2 data in rooms. All these systems can be connected into one ecosystem, which would be automated with elements of machine learning and artificial intelligence thanks to the Big Data repository. The output would be a system with hierarchical layers of access showing clear data for individual layers of users from school management through maintenance to students. Thanks to this system, the quality of the environment within buildings should be improved, which should lead to better performance for all. As an added value, the project offers the use of all data in research and student work.

The second project

Greenhouse Monitor applies the Internet of Things to create a smart greenhouse. The application uses sensors to determine the current temperature or humidity in the greenhouse, soil pH and many other parameters. In addition to displaying information about the current state of the greenhouse, the application will allow the reservation of the flower bed, including modification of its layout, configuration of the substrate and watering or selection of specific sensors. Greenhouse Monitor provides a clear overview of the current state of the greenhouse even without a personal presence and simplifies the operation of flower beds by automating some activities. The application will also use artificial intelligence to evaluate increments or identify certain types of plant diseases.

The third project

It focuses on more convenient use of services at the University through greater use of mobile phones, and especially smart watches to communicate with smart devices at school. When turning on the application, it is possible to look at basic information about the study, the schedule, what our next lesson is, the topic of the lesson, the place or the weather from the University weather station. The main purpose of the application is to replace keys, tokens, bracelets, ISIC cards and crowns for locking cabinets and rooms using NFC technology. The application also allows navigation in the area both outside and inside buildings. Indoor navigation uses a Bluetooth beacon. The application allows you to register attendance using a phone or watch instead of an ISIC card. Another use of a smart watch could be to pay on the premises (eg in the canteen) using Google Pay or Apple Pay.

The fourth project

The main priority was to focus on the needs of students. The application thus displays the occupancy of individual places around the area, allows you to use area navigation, which would lead you to the selected room, booking classrooms, premium parking spaces, dormitory services (washing machines, gyms), etc. All these services would be fully integrated with UEP wallet and student UID.

The fifth project

The CULS Green project focuses on smart savings in CULS computer classrooms based on human detection. Furthermore, the use of a light sensor for street lamps in the area with the extension of WiFi. For students, it brings a new service of renting scooters for 10 minutes with an ISIC card, which will bring more flexible movement in the area. Last but not least, it presents a miniature game in the form of a quiz for student education based on IoT data from the campus, supplemented by historical beads.

The sixth project

The group dealt with applications for smartphones. Its aim was to help newcomers in school orientation and other students to find a suitable place, for example, to study or meet a larger number of people. The first goal was absolutely clear, the application must allow navigation around the university. To do this, they would use Bluetooth beacons, which allow you to determine the position with an accuracy of up to one meter. We would help our second target group to choose a suitable place so that the application would display free classrooms, the number of students connected to Wi-Fi in each corridor, as well as the noise level, the number of free tables or the temperature in the place. To obtain this data, we would use information from classroom schedules, Wi-Fi, shock, noise and temperature sensors.

According to the type of data is to create a platform for data integration from the life sciences environment. Data sources (data types, data behavior) can be divided

- remote sensing - satellites, aircraft, drones (large files - figures)
- sensors (micro data) => Big Data creation
- external data, eg CZSO, CHMI, legislation, stock exchange - purchase prices,
- internal administrative data

Furthermore, the following areas were defined, in which the processing and analysis of data can improve the quality of life in the CULS ecosystem. Preferred areas include:

- environment, energy saving
- monitoring of premises, resources and persons

4. Conclusion

The paper reflects the significant global trends of ICT development within the framework of the sustainable development of modern society, the so-called "smart solution 4.0", and shows advantages of combining it with the field of Life Sciences. It fills a knowledge gap that is not yet completely explored - analysis, methodology, and development of technology platform for integration and presentation of heterogeneous data from IoT and the surrounding big data environment. There is a considerable scientific potential with corresponding practical contributions in many areas. For example, it is likely that the solution can be used in the smart village or smart region concept.

The CULS ecosystem in Prague is in some respects very similar to the ecosystem of a small rural region or village. Therefore, it can be concluded that the procedures created experimentally within the kamus can be used under certain conditions in other areas

such as smart village development, rural development or large farm.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences in Prague, grant no. 2019B0009, "Life Science 4.0".

References

di Martino, B., Cretella, G. and Esposito. A. (2017), "Big Data, IoT and Semantics" In: Zomaya, A. Y. and S. Sakr *(eds.),* "*Handbook of Big Data Technologies*", Cham, Springer International, pp. 655-690, ISBN 978-3-319-49340-4, DOI 10.1007/978-3-319-49340-4_19

Kamilaris, A., Kartakoullis, A. and Prenafeta-Boldú, F. X. (2017), "A review on the practice of big data analysis in agriculture", *Computers and Electronics in Agriculture*, vol. 143, pp. 23-37, DOI 10.1016/j.compag.2017.09.037

Luo, L. (2018), "Data Acquisition and Analysis of Smart Campus Based on Wireless Sensor", *Wireless Pers Commun*, vol. 102, pp. 2897–2911, DOI 10.1007/s11277-018-5314-4

Marjani, M., Nasaruddin, F., Gani, A., Karim, A., Hashem, I. A. T., Siddiqa, A. and Yaqoob, I. (2017), "Big IoT Data Analytics: Architecture, Opportunities, and Open Research Challenges", *IEEE Access*, vol. 5, pp. 5247-5261, ISSN 2169-3536, DOI 10.1109/ACCESS.2017.2689040

Novák, V., Stočes, M., Kánská, E., Pavlík, J. and Jarolímek, J. (2019), "Monitoring of Movement on the Farm Using WiFi Technology", *AGRIS on-line Papers in Economics and Informatics*, vol. 11, No. 4, pp. 85-92. ISSN 1804-1930, DOI 10.7160/aol.2019.110408

Razzaque, M. A., Milojevic-Jevric,M., Palade, A. and Clarke, S. (2016), "Middleware for Internet of Things: A Survey", *IEEE Internet of Things Journal*, vol. 3, no. 1, pp. 70-95, DOI 10.1109/JIOT.2015.2498900

Stočes, M., Šilerová, E., Vaněk, J., Jarolímek, J., and Šimek, P. (2018), "Možnosti využití otevřených dat v sektoru cukr – cukrová řepa", *Listy cukrovarnické a řepařské*, vol. 134, no. 3, pp. 117-121. ISSN 1805-9708

Suciu G. (2016) "Big Data and Internet of Things—Challenges and Opportunities for Accelerated Business Development Beyond 2050!", In: Prasad R. and Dixit S. (eds.), *"Wireless World in 2050 and Beyond: A Window into the Future!"*, Cham, Cham, Springer International, pp. 111 - 128, ISBN 978-3-319-42141-4, DOI 10.1007/978-3-319-42141-4_10

Tzounis, A., Katsoulas, N. , Bartzanas, T., and Kittas C. (2017), "Internet of Things in agriculture, recent advances and future challenges", *Biosystems Engineering*, vol. 164, pp. 31-48, DOI 10.1016/j.biosystemseng.2017.09.007

CORPORATE SOCIAL RESPONSIBILITY AS A PREREQUISITE FOR LONG-TERM SUSTAINABLE SUCCESS

Daniela Šálková[1] and Olga Regnerová[2]

[1, 2] Department of Trade and Accounting, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]salkova@pef.czu.cz, [2]oregnerova@pef.czu.cz

Annotation: Every company should be responsible for its own behavior today. There is a prerequisite to address important CSR issues such as transparency, environmental protection, ethics, climatic change or resource constraints. The behavior of the company can be considered CSR only in the case of strategic interconnection of three areas – economic, social and environmental. Connecting all areas of CSR behavior and choosing the appropriate form of communication about responsible activities can bring significant benefits to companies. The essence of CSR is to define strategies aimed at eliminating negative phenomena. The main aim of the article is to show the current approach to CSR as one of the key prerequisites for sustainable growth in selected companies. The article shows the results of a pilot study mapping CSR of three selected entities operating on the Czech market. Data collection on the level of corporate social responsibility was carried out using a survey from October to November 2019. CSR evaluation of individual subjects was performed using the Triple Bottom Line / Three Pillars of CSR. For this purpose, each company has created its own criteria table with criteria evaluation. The parameters of the individual pillars were evaluated on the scale 1-5. The obtained data were analyzed and used to compare and determine links between CSR internationally and CSR in the Czech Republic.

Key words: social responsibility, sustainable development, behavior, company, Czech market

JEL classification: E21, D22, Q01, Q56

1. Introduction

Over the last two decades the public, governments, customers and other stakeholders have been demonstrating growing awareness of the social and environmental consequences of human activity in general, and business operations in particular. As a result, pointed out Grosbois (2012), the idea of sustainability and its three pillars of economic, environmental and social action gained popularity.

Corporate Social Responsibility (CSR) is the voluntary integration of social and environmental aspects into everyday corporate operations and interactions with corporate stakeholders (stakeholders include all persons and institutions that have anything to do with the company, i.e. suppliers, customers, employees, shareholders, region, non-profit organizations, etc.). The principle of including social and environmental aspects in the company's strategy (in addition to the primary focus on generating profit) is also called the triple responsibility. Socially responsible behavior of companies can be described as activities that go beyond not only legal, but also ethical, commercial and social expectations. When using corporate social responsibility in practice, it is a concept whose goal is the voluntary integration of social and environmental aspects into everyday corporate operations and interactions with stakeholders. The subject of business is not decisive for these companies.

CSR is often seen as a "missing link" in addressing the disjunction between economic growth in a market economy and its negative consequences (Šánová, 2013).

According to Regnerová, Navrátilová and Štáfek (2013) a large part of CSR's social responsibility also lies with companies. An important element of corporate social responsibility is the principle of voluntariness (Kuldová, 2012).

CSR has swept across the world and has become one of te buzzwords of the new millenium (Pedersen, 2006). In general, it is a matter of voluntarily integrating social and environmental considerations into day-to-day business operations and stakeholder interactions. The principle of including economic, social and environmental aspects in the company's strategy is also called the triple responsibility. CSR thus aims to facilitate the transition towards a socially and environmentally sustainable future.

The main aim of the article is to show the current approach to social responsibility as one of the key prerequisites for sustainable growth on the example of selected companies.

2. Materials and Methods

The article shows the results of a pilot study mapping the social responsibility of three selected entities operating on the Czech market. In the study, a total of six Czech and foreign business entities with different specializations were addressed with a request for cooperation. More detailed research will follow up on the study later.

Three entities operating in the Czech Republic agreed to participate in the pilot survey: IKEA Group, Sodexo Group and Bayer Group. These companies were selected because their business is carried out in another field. Furthermore, it is assumed for selected companies that their activity in the field of CSR is usually known to the public and that these entities not only apply but also develop the principles of CSR. Some of the companies were selected on the basis of long-term cooperation within other activities with the CZU (IKEA), others on the basis of personal contacts (SODEXO, Bayer). Persons responsible for the CSR area were contacted, at IKEA Environmental Coordinator, at SODEXO manager of internal processes, at HR Business Partner / HR Professional manager. The companies were contacted with a request for cooperation. Representatives of the companies commented on a set of pre-prepared questions in the field of CSR. Implemented projects and values of the company were discussed. Communication took place in the form of individual interviews in electronic and personal form. The data provided by the company's representatives were supplemented by independent information, various complaints in the Czech Republic and abroad, systemic imperfections or human factors, etc.

The collection of data on the level of corporate social responsibility using a research survey was carried out in the period October – November 2019. The evaluation of the social responsibility of individual subjects was performed using the Triple Bottom Line / Three Pillars of CSR. For this purpose, a separate criterion table with criterion evaluation was created for each company. Based on the information obtained, the parameters of the individual pillars were evaluated on a scale of 1-5. As all companies developed a large number of activities in virtually all sub-areas of the individual pillars, they were not rated worse than grade 4. They were further processed by one of the statistical characteristics of the position, namely the arithmetic mean.

The resulting data were displayed in a table providing information on the levels of each pillar of each company. The information obtained was analyzed and used to compare and determine the links between CSR on an international scale and CSR in the Czech Republic. Additional data for the evaluation of social responsibility of selected companies were obtained from interviews with representatives who work in the position of responsible managers in the company.

3. Results and Discussion

The concept of CSR has been developed and applied in the Czech Republic for several decades. In developed countries, a relatively high level of attention is paid to social responsibility; in the Czech Republic, this concept is often unknown to many entrepreneurs and the public. For this reason, this pilot study was carried out to verify the current level of individual parameters of social responsibility of entities operating in the Czech Republic.

Three business entities were selected to collaborate on the study. They do business in the Czech Republic: IKEA Group, Sodexo Group and Bayer Group. These entities not only apply the principles of CSR, but also develop them. Companies are therefore a suitable choice for obtaining and analyzing data on CSR principles abroad and in the Czech Republic.

IKEA

The IKEA Group was selected for cooperation mainly due to its system interconnection with the company IKEA Czech Republic. Its business activities at the national level allow interpretation of its activities in the field of CSR both abroad and in the Czech Republic. The company is constantly developing ideas that are both innovative and cost-effective.

Sodexo group

The Sodexo group was selected due to ties to the Czech company of the same name, Sodexo, with the parent company Sodexo, Société anonyme based in France. Available resources on the activities of the Sodexo business group on an international scale make it possible to analyze and interpret its activities in the field of social responsibility abroad and in the Czech Republic.

Bayer group

The Bayer Group was selected for its global operations in the areas of human health and agriculture. It was also chosen due to the system connection with Bayer, which operates in the Czech Republic. Company Bayer is constantly striving to improve the quality of life in its efforts to develop products and services that are created to serve the people and improve their quality of life. At the same time, Bayer aims to create value through innovation and growth. The company is also committed to the principles of sustainable development and social and ethical values.

Table 1. Criteria evaluation entity IKEA, Sodexo a Bayer

Parameters	Parameter evaluation **IKEA**	Parameter evaluation **Sodexo**	Parameter evaluation **Bayer**
Parameters of the economic pillar			
principles of good governance (corporate governance)	4.3	4.1	4.6
quality and safety of products / services	4.8	4.2	4.6
company code of business conduct (code of ethics)	4.8	4.9	4.9
customer relations	4.9	4.7	4.8
rejection of corruption	4.2	4	4.7
transparency	4.4	4.1	4.7
good investor relations	4.9	4.5	5
fair supplier / customer relationships (fair trade)	4.7	4.5	4.5
innovation and product sustainability	4.5	4.6	4.8
ethics of marketing and advertising	4.5	4.5	4.4
$\bar{x}$	4.6	4.41	4.7
Parameters of the social pillar			
health and safety of workers	4.2	4.5	4.9
quality employment policy	4.5	4.8	4.9
training and retraining of employees	4.2	4.6	5
employment of people with a deteriorating position on the labor market	4	4.5	4.7
corporate philanthropy and volunteering	5	4.6	4.9
respect for equal opportunities	4.8	4.8	4.7
rejection of child labor	4.6	4.8	4.8
Gender Equality	4.9	4.8	4
diversity in the workplace	4.7	4.7	4.9
listening and dialogue with stakeholders	4.7	4.6	4.8
$\bar{x}$	4.56	4.67	4.76
Parameters of ecological pillar			
environmentaly friendly corporate culture (recycling, energy savings, etc.)	4.9	4.5	4.6
reducing the negative impacts of the activity on the environment and the community	4.9	4.9	4.7

organic production, products and services	4.8	4.8	4.7
economical handling and protection of natural resources	4.9	4.7	4.6
investment in clean technologies (reduction of environmental impact, investment in the best available technologies - BAT)	4.8	4.6	4.6
protection of natural resources	4.8	4.4	4.4
$\bar{x}$	4.85	4.65	4.6

Source: Own research

The economic pillar should operate on the basis of a responsible and transparent method of management and supervision, the aim of which is to increase the company's value in the long term. Innovation should address greater security, the expansion of multicultural employment, resource conservation, the climatic protection, promotion of healthy lifestyles, waste recycling and energy recovery. In the case of the economic pillar, I recorded the largest variance in the evaluation of selected criteria for the monitored companies. The best rated company reached the value of 4.7, the worst rated value of 4.4.

At the level of the social pillar, the main criterion is the health and safety of employees. This needs to be ensured by implementing the relevant directives, constantly developing a safety culture, preventing accidents and building systems to reduce noise, improve machine safety, improve air quality, provide safety training or provide protective equipment. For the monitored companies, the best result was 4.75, the worst to 4.55.

The environmental pillar is the third of the basic elements of social responsibility. Minimizing negative impacts on the environment should be achieved by promoting a healthy lifestyle, product safety, waste recycling, energy recovery and reducing emissions of harmful substances. Every socially responsible company should also aspire to create its own waste prevention programs. For the monitored companies, the best result was 4.85, the worst the value 4.6.

4. Conclusion

The investigation revealed that CSR projects implemented in the Czech Republic in most cases follow examples from abroad and are initiated by foreign business entities.

According to Choi and La (2013) the results suggest that managers may need to be aware of perceived CSR as a key variable in restoring customer loyalty and that the results further suggest that perceived CSR has a direct and indirect positive effect on loyalty; perceived CSR has a direct impact on loyalty, but it also has an indirect influence on loyalty through customer trust.

In developed countries, the concerns of specific stakeholders, for example, regulators, shareholders, creditors, investors, environmentalists and the media are considered very important in disclosing CSR information (Waris, Jedrzej and Zeeshan, 2017). Moravec and Kukalová (2014), on the other hand, also show the influence and feedback of the tax environment on the socially responsible behavior of the company.

It was also confirmed that the involvement of Czech entrepreneurs in the field of social responsibility is relatively low. Czech business entities are either not interested in the concept of social responsibility at all, or are partially implemented in it only on specific occasions.

This is reinforced by the fact that all Czech subjects contacted either directly refused to participate in the study or did not react at all.

Some firms tend to act in a responsible way but some other firms are irresponsible (Yin, 2012). On the other hand if management becomes more familiar with specific activities falling under CSR, they will find that CSR is often unknowingly practiced (Stanislavská, 2009).

It is important to raise awareness of CSR. As confirmed by research Denga, Kang and Low (2013) overall, the results suggest that firms that integrate various stakeholders' interests in their business operation engage in investment activities that enhance their long-term profitability and efficiency, which ultimately increases shareholder wealth and corporate value, supporting the stakeholder value maximization view.

Perceived CSR directly affects positive emotions, negative emotions and customer–company identification. Positive emotions significantly influence customer–company identification. Positive emotions and customer–company identification partially mediate the relationship between perceived CSR and green consumer behavior (Su et al., 2017).

Further research should be focused on the evaluation of the level of social responsibility in Czech business entities in order to compare the results of individual parameters with foreign entities with a larger range of addressed companies.

References

Choi, B. and La, S. (2013), "The impact of corporate social responsibility (CSR) and customer trust on the restoration of loyalty after service failure and recovery", *Journal of Services Marketing*, vol. 27, no. 3, pp. 223 – 233, DOI 10.1108/08876041311330717

Denga, X., Kang, J. and Low, B. (2013), "Corporate social responsibility and stakeholder value maximization: Evidence from mergers", *Journal of Financial Economics*, vol. 110, no. 1, pp. 87 - 109, DOI 10.1016/j.jfineco.2013.04.014

Grosbois, D. (2012), "Corporate social responsibility reporting by the global hotel industry: Commitment, initiatives and performance", *International Journal of Hospitality Management*, vol. 31, no. 3, pp. 896 - 905, DOI 10.1016/j.ijhm.2011.10.008

Kuldová, L. (2012), "*Nový pohled na společenskou odpovědnost firem: Strategická CSR*", Plzeň, NAVA, ISBN 978-80-7211-408-5

Moravec, L. and Kukalová, G. (2014), "Investments Allocation Tax Factors in Pre-crisis Time", *Proceedings of the 11th International Scientific Conference on European Financial Systems,* pp. 396 - 402, Lednice, Czech Republic

Pedersen, E. R. (2006), "Making Corporate Social Responsibility (CSR) Operable: How Companies Translate Stakeholder Dialogue into Practice", *Business and Society review*, vol. 111, no. 2, pp. 137 - 163, DOI 10.1111/j.1467-8594.2006.00265.x

Regnerová, O., Navrátilová, M. and Štáfek, P.(2013), "Promotion of Fair Trade", *Proceedings of the Agrarian perspectives XXII*, Prague, pp. 361 - 368, ISBN 978-80-213-2419-0

Šánová, P. (2013), "GLOBAL G.A.P. as a possible tool of corporate social responsibility", *Proceedings of the Agrarian perspectives XXII*, Prague, pp.381-388, ISBN 978-80-213-2419-0

Stanislavská, L. (2009), "Corporate Social Responsibility", *Proceedings of the Agrarian perspectives XVIII*, Prague, pp 351 - 354, ISBN 978-80-213-1965-3

Stanislavská, L., Margarisová, K. and Šťastná, K. (2010), "International Standards of Corporate Social Responsibility", *Agris on-line Papers in Economics and Informatics*, vol. 2, no. 4, pp. 63 - 72, ISSN 1804-1930

Su, L., Swanson, S. R., Hsu, M. and Chen, X. (2017), "How does perceived corporate social responsibility contribute to green consumer behavior of Chinese tourists: A hotel context", *International Journal of Contemporary Hospitality Management*, vol. 29, no. 12, pp. 3157 – 3176, DOI 10.1108/IJCHM-10-2015-0580

Waris, A., Jedrzej, G. F. and Zeeshan, M., (2017), "Determinants of Corporate Social Responsibility (CSR) Disclosure in Developed and Developing Countries: A Literature Review", *Corporate Social Responsibility and Environmental Management*, vol. 24, no. 4, pp. 273 - 294, DOI 10.1002/csr.1410

Yin, J. and Zhang, Y. (2012), "Institutional Dynamics and Corporate Social Responsibility (CSR) in an Emerging Country Context: Evidence from China", *Journal Business Ethics*, vol. 111, pp. 301 - 316, DOI 10.1007/s10551-012-1243-4

THE IMPORTANCE OF KNOWLEDGE IN THE USE OF INFORMATION SYSTEMS TO INCREASE THE COMPETITIVENESS OF THE COMPANY

Edita Šilerová[1], Klára Hennyeyová[2], Vojtěch Rakovský[3] and Eva Kánská[4]

[1, 3, 4] Department of Information Technologies, Faculty of Economics and Management, CULS Prague, Czech Republic

[2] Faculty of Economics and Management, Slovak University of Agriculture in Nitra, Slovakia

[1]silerova@pef.czu.cz, [2]hennyeyova@uniag.sk, [3]rakovsky@pef.czu.cz, [4]kanska@pef.czu.cz

Annotation: Nowadays, the level of information and knowledge management is not fully controlled in most companies. Information systems create support for business processes in order to optimise them, based on experience from the processes within similar businesses. Today's information systems are used in data management or information management. Only a few of them manage information processing in the field of tactical and strategic planning, and almost none manage processing in the field of gathering, distributing, and sharing knowledge in a company. It can be said that investments in IT do not guarantee a successful way of managing information and knowledge in a company. The main task of management support applications is to analyse current data and, based on their analysis from different perspectives, give managers the opportunity to identify non-standard situations in a company. The process of obtaining data, information, and knowledge from large files is not only a technological problem but also a managerial problem. Therefore, the set technologies are being used as tools to fulfil the needs of information. From a managerial point of view, the goal of the process is to obtain as much relevant information and knowledge as possible to be able to solve the problem.

Keywords: information technology, communication technology, internet, information system, data, information, knowledge

JEL classification: Q19, Q13

1. Introduction

In present-day society, data, information, and, especially, knowledge play the most important roles in all decision-making processes. We come across information at every step. Society, companies, and people are saturated with information. Information surrounds and haunts us 24 hours a day, in the morning on the radio, on television, maybe in daily news, all day long on the Internet, on billboards, in streets, or at work after switching on the computer. It involves so much information that it becomes very difficult to process. In companies, data volumes are now annually growing in such quantities, which had in previous years been created in approximately ten years. However, we do not need such volumes of data to make the right decisions, what we need is the right data and information, which will be complemented by knowledge of the issues addressed. Without the correct knowledge, it is not possible to make a qualified decision. Knowledge is usually not stored anywhere (in any database or any literature). Most of the knowledge is owned by people - employees - and is acquired through practice or studies. The quality of knowledge is therefore strongly influenced by its user. At present, we can observe a huge "demand" for knowledge throughout society. The majority of people cannot make responsible decisions because a situation arises that does not find any starting point for their decisions, which would already exist. The Czech Republic is not self-sufficient in several food products as it currently does not have an adequate processing industry. There has been a huge shortage of seasonal workers, plus the influence of many other factors.

At present, there is no knowledge that could be used to make qualified decisions. "The agriculture information system reflects the interfaces and networks in the system and contributes to the management and administration of the system. In addition, the analysis of agricultural information systems can provide the identification of the basic components and networks of the system. It can be applied to any specific agricultural system in order to analyse the functioning of the information system. This approach is also useful for defining possible default values and for improving the management of information. Furthermore, the exchange of information (communication), via networks between system components, is critical for successful technology generation and information transfer. The theory of the agricultural information system helps us to understand the situation as a unit (i.e., to provide a holistic approach) and to identify the strengths and weaknesses of the studied system." (Demyriurek, 2010). Thus, knowledge plays an important role both in the selection of the information system as well as in the processing of data and information stored in the information system. "ERP" systems are defined as comprehensive software solutions aimed at integrating business and management processes through a holistic approach and a sole information system. ERP systems in agriculture help improve the enterprise performance and reduce and monitor costs. These systems are effective in decision making and can serve as a basis for precision agriculture. The main obstacles are insufficient staff skills and competences, lack of funding for ERP adoption, poorly developed or missing infrastructure, and difficulties in installing and adapting ERP systems to the agricultural business. Moreover, farm owners do not have confidence in high-tech solutions and poor knowledge of the above-mentioned systems." (Kulikov et al., 2020). Šilerová et al. (2017) also deal with the issue of using data and information from information systems and their influence on the quality of management. Nowadays, all managers are aware that without data and information, it is not possible to make qualified decisions, to model and to simulate situations that would affect the competitiveness of companies, their market position, and their progressiveness. The ability to make these decisions will be reinforced by the skills and knowledge of their employees–and stored data and information in the company's information systems. Information systems have become a strategic source of information. Today, almost all companies work with data and information, and also with knowledge. However, their influence on the quality of the decision-making process varies a lot. Companies' employees work with information systems daily, but obtaining reports from information systems depends on several factors; the systems are not often user-friendly. The quality of decisions depends on the source of data and information that is on the information system in the company. Most companies currently have information systems, which, however, are not very suitable for the possibility of obtaining quality reports daily, supporting the company's image improvements, competitiveness, increased productivity, and improved market position. The ability to make the right decision depends on the quality of the output of data, information and their connection with knowledge significantly affects the quality of decisions and the resulting position of the company in the society.

The aim of this article is to confirm or disprove these hypotheses:

H1 – Do you use information systems, which include knowledge, for decision making? It was hypothesised that 10% of the monitored companies also do store knowledge in company databases, which is later being used for draft decisions

H2 – Does your software solution allow you to work with integrated data such as production, economics, logistics, human resources, trade and more? It was hypothesised that 30% of the monitored companies use software that allows them to work with integrated data

2. Materials and Methods

The article was based on scientific methods, using a holistic methodology, analysis, synthesis, through both induction and deduction. The theoretical part is based on the study of secondary literary sources and the study of scientific and professional literature, all based on established hypotheses.

Information systems and information and communication technologies are an important source of competitiveness. The quality of each information system is determined by several factors and can be assessed according to measurable and non-measurable benefits. One of the immeasurable benefits is the quality of information and knowledge provided for the management. This indicator is derived from the ability of users to define requirements for their needs. The quality of the entire information system is fully dependent on the ability to manage the creation of an information strategy, the architecture of information systems, and the entire life cycle of an information system. It is fully dependent on the use of knowledge of the company's employees. The quality of the obtained data and the information in connection with the knowledge is influenced by the managers' ability to use them. The task or problem is methodically solved by migrating from data to information and knowledge with the possibility of use in information systems. The aim of the article is to confirm or disprove the established hypotheses based on the performed investigation. There was a survey, – based on the established hypotheses conducted in a selected sample of agricultural businesses, where a total of 64 selected enterprises were monitored. Enterprises with an area of more than 1000 ha were selected for the survey, where the use of software for data and information processing, i.e., information systems, can be assumed. The outputs from the questionnaire survey were used to process the conclusions of established hypotheses and proposals for optimal solutions supporting the development of companies.

3. Results and Discussion

All managers require quality information in order to make their decisions, which should be the most important assignment for each manager in the company. However, information obtained from an information system without ~~a~~ context has only ~~a~~ little value. The context is determined by a specific content or issue that requires an active intervention. For example, let us say that in the hypermarkets, the manager wants to get information about last week's meat products' sales and the subsidiary companies, which reached 60% of the expected sales. The context has three dimensions: topic (the volume of sales of meat products compared to the forecast), time (last week), and space (the situation on the Czech market and in Europe). As the example shows, such a manager must possess the access to information that will help him find answers to a number of ever-changing questions: is the situation due to a competitive approach.; have there been changes in customer habits; was the change due to rising prices or due to the sales techniques. From this example, it is clear that the manager needs information and knowledge embedded in the right consequences, as well as information and knowledge that goes beyond this area of consequences. The manager must be able to connect to both areas and find out solutions that keep the company at least at the competitiveness level. Gaining access to information in the right context is a necessary but not a sufficient enough condition/circumstance for undertaking the active action. Managers must be able to access the interactions with the information system, ask new questions and formulate new hypotheses. It requires the creation of such an information strategy that will allow to establish contacts with other managers, use additional expertise and co-work with those managers to formulate conclusions. Managers have diverse characters, they differ from each other in the way they access information, formulation of knowledge and finding solutions. Systems that support managerial decisions usually minimise these differences. With the effort to meet the requirements of managers, additional functions are incorporated, which make the system to become exceedingly difficult, less user-friendly, and in general not sufficient enough to the needs of managers. Managers also vary upon the level of their experience and knowledge of the subject. The administration of the same information system module can take one day for one manager and three days for another manager. It is obvious that an experienced manager can be very satisfied with the system as its functional spectrum does satisfy him or her. Another manager may not be happy with the system because he or she "cannot find anything" in there. Then, information systems, which require the active approach of managers, must take into account their different experiences and knowledge. Palmer and Waver (2000) address the need to manage data and information throughout the decision-making process. Data, information and knowledge gained throughout the decision-making process are a marginal source. "The proposed technical and economic parameters of digital farms meet the criteria for effective use of existing resources of the regional agro-industrial complex, reducing losses and improving the quality of agricultural products" state Bocharnikov et al. (2020).

If managers are to create value, they must be able to participate in a dialogue regarding a particular event. This means, naturally, that they must have access to information and knowledge about the new and best practical approaches. The system should support the contextual dialogue requirements. "Information is becoming a highly valued commodity of strategic importance in the period of globalization of trade, cooperation and mutual integration of companies" states Hallová, M. et al. (2019). Requirements may diverge from individual to individual just as well as from project to project. Managers must have access to information at various levels of detail. Different managers within the same organisation will have different information needs. Attention must be paid to the security of data and information in the company, as stated by Rodryčová and Staša (2000). To improve the competitiveness of the company, the most important factor is to ensure the security of all stored data in the company. There will be different needs for managers who decide to invest in the construction of new production facilities and those who ensure the day-to-day operation of production. However, supporting the general context of the event is crucial. One manager can engage in various activities at different times, once for day-to-day activities, once for resource optimisation, and once for planning. The system must allow the access into the system according to the managers' roles. One of the most important activities of every person is to ask new unusual questions. Yet, most of the information systems are designed in such a way so that they could provide answers to already known questions presented in a standardised form. If this experience should be the main focus of a person, he or she must be able to understand the context of events. Fountas et al. (2006) addresses the issue of the need for information from various sources for use in precision agriculture. A participatory methodology was developed in which farm managers decomposed their process of decision-making into brief decision statements along with associated information requirements. In their research, they describe information flows from data to managers' decisions, for strategic, tactical and operational decisions. If companies want to focus on experiences, their information systems must emphasize the needs of managers, and the companies should enhance their personal effectiveness as well as time creating value. Tummers et al. (2019) based on the published literature found that there is still a lack of standardized data and information for farm decision-making. There are FMIS only for selected areas of data and information processing, but there has been no significant shift.

The selected sample of agricultural businesses was surveyed based on established hypotheses: H1 – Do you use information systems, which include knowledge, for decision making? - was examined by several questions:

- 1st question – Do you use a software in your company to create predictions?
- 2nd Question – Is internal information used to create predictions?
- 3rd Question – Is external information used to create predictions?
- 4th Question - Knowledge is stored in the software used?

The answers to the chosen questions were almost identical. In the monitored 64 agricultural businesses, there does not exist a software that would allow making predictions. The internal information is being used for predictions in all monitored companies. It has shown that for 72% of the them, an Excel spreadsheet is used to process internal data. Of this 72%, only 21% of respondents make predictions directly in Excel and do model the situations of "what happens if" 28% of respondents said to be using simply just a pen and paper. Regarding the use of external information, the situation varies even more. Only 32% of respondents use external data to make predictions. Again, all monitored respondents use an Excel spreadsheet to process external data. It was fascinating to seek the answer of why the external information/data is being used to such a small extent, which can have a significant impact on the company's position in the market. The answer was once again very clear for all respondents - the market of suppliers and customers in agriculture is closed. Most companies have "their own" suppliers and customers. For instance, a supplier of fertiliser is being also a customer of the cultivated production. The situation is similar for commodities in animal production. It is rather difficult to predict further development of the situation. Likewise, the milk producers in the Czech Republic supply milk to dairies/creameries in Germany, where the price of milk is currently descending. To forecast these predictions would be very challenging, as the fact is that no monitored respondent has any regarded knowledge stored in information systems. In addition, the knowledge, which corresponds to current developments/evolutions would be very tricky to encounter at anyplace.

H1 was therefore not confirmed. H1 stated that 10% of the monitored respondents store knowledge in their company databases. For qualified decisions, managers must use their knowledge, which they have usually gained through many years of experience. It also majorly depends on interpersonal relationships and the transfer of skills/knowledge gained throughout many years of practise.

H2 – Does your software solution allow to work with integrated data - production, economics, logistics, human resources, trade and more? It was monitored whether there is an integrated software used in the respondents' companies. Within the 64 monitored companies, ERP software was used in 25% of them, that is to say, a software which is provided by one supplier and the same supplier ensures its regular upgrade. Users have the advantage of a unified user interface and have access to data and information according to their roles in the company. As shows the H1, unfortunately, knowledge cannot be used for predictions. Fifty-five percent of respondents have individual integrated applications. Unfortunately, these applications are from different vendors and therefore possess a different user interfaces. Various user interfaces are inconvenient for users as they have to pay additional attention to which application they are working with. For 20% of respondents, they have the use of individual applications, which are not integrated, and which come from different suppliers and thus are controlled differently. In these companies, the situation of collecting the data for making predictions is the worst, not to mention problems that can come along with data transfer between individual software.

H2 was therefore not confirmed either. H2 was determined that 30% of respondents use software that allows them to work with integrated data. However, if we also consider the possibility that companies use software from different suppliers and the individual modules are integrated, we can state that H2 has been met.

4. Conclusion

Knowledge is one of the most important factors in managers' decisions. Nowadays, more and more companies are using software that allows them to work with knowledge. Knowledge is stored in databases and is used to make predictions. The situation of agricultural holdings is currently focused mainly on the integration of internal data and information. This can be considered as another step to increase the competitiveness of agricultural holdings. Bouma et al. (2011) state that knowledge is very important and information systems enable their integration with internal and external data. In conclusion, the survey revealed a necessity of creation of an environment for storing knowledge and the need to gradually increase the use of stored knowledge in decision-making.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant: *Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2019B0009 – "Life Sciences 4.0"*.

References

Bocharnikov, V. S., Ivanova, I. V., Balashova, N. N., Ovchinnikov, M. A. and Tokarev, K. E. (2020), "Development of technical and economic parameters of experimental digital farms", *Journal of Physics: Conference Series*, vol. 1515, no. 3, DOI 10.1088/1742-6596/1515/3/032008

Bouma, J., van Altvorst, A. C., Eweg, R., Smeets, P. J. A. M. and van Latesteijn, H. C. (2011), "The role of knowledge when studying innovation and the associated wicked sustainability problems in agriculture", *Advances in Agronomy*, vol. 113, pp. 283 - 312, DOI 10.1016/B978-0-12-386473-4.00011-7

Demyriurek, K. (2010), "Information systems and communication networks for agriculture and rural people", *Agric. Econ. – Czech*, vol. 56, no. 5, pp. 209 - 214, DOI 10.17221/1/2010-AGRICECON

Fountas, S., Wulfsohn, D., Blackmore, B. S., Jacobsen, H. L. and Pedersen, S. M. (2006), "A model of decision-making and information flows for information-intensive agriculture". *Agricultural Systems*, vol. 87, no. 2, pp. 192 - 210, DOI 10.1016/j.agsy.2004.12.003

Hallová, M., Polakovič, P., Šilerová, E. and Slováková, I. (2019), "Data protection and security in SMEs under enterprise infrastructure", *Agris on-line Papers in Economics and Informatics,* vol. 11, no.1, pp. 27 - 33, ISSN 1804-1930, DOI 10.7160/aol.2019.110103

Kulikov, I., Semin, A., Skvortsov, E., Ziablitckaia, N. and Skvortsova, E. (2020), "Challenges of Enterprise Resource Planning (ERP) Implementation in Agriculture", *Entrepreneurship and Sustainability Issues*, vol. 7, no. 3, pp. 1847 - 1857, DOI 10.9770/jesi.2020.7.3(27)

Palmer, S. and Weaver, M. (2000), "*Úloha informací v manažerském rozhodování"*, Prague, Grada Publishing, ISBN 80-7169-940-3

Rodryčová, D. and Staša, P. (2000), "*Bezpečnost informací jako podmínka firmy"*, Prague, Grada Publishing, ISBN 80-7169-144-5

Šilerová, E., Hennyeyová, K., Michálek, R., Kánská, E. and Jarolímek, J. (2017), "Influence of the correct management of the IT department on the quality of data and information processing", *Agris on-line Papers in Economics and Informatics*, vol. 9, no. 4, pp. 91 - 98, ISSN 1804-1930, DOI 10.7160/aol.2017.090409

Tummers, J., Kassahun, A., and Tekinerdogan, B. (2019), "Obstacles and features of Farm Management Information Systems: A systematic literature review", *Computers and Electronics in Agriculture*, vol. 157, pp. 189 - 204, DOI 10.1016/j.compag.2018.12.044

TECHNICAL EFFICIENCY OF MILK PROCESSING COMPANIES

Marie Šimpachová Pechrová[1] and Zdeňka Náglová[2]

[1, 2] Institute of Agricultural Economics and Information, Mánesova 1453/75, 120 00 Prague 2

[1]simpachova.marie@uzei.cz, [2]naglova@pef.czu.cz

Annotation: The aim of this paper is to evaluate the technical efficiency of Czech milk processing companies that can be affected by sector changes. During last ten years there are large fluctuations in profits due to increase of costs and decrease of revenues. A parametric method Stochastic Frontier Analysis was used to calculate the technical efficiency by True Fixed-effects model with half normal distribution of technical inefficiency term. There were 613 observations per 53 milk processing firms for years 2004 to 2017. Results showed that technical efficiency of sample of milk processing companies is on 65.7% level. Median was higher, half of the firms were more or less efficient than 71.5%. There was none firm that would be 100% efficient in all years. The most efficient firm had average efficiency 93.82%. On the other hand, minimum was only 19.49% that points out on the firm that produces too small output with too many resources. In comparison to other studies it is very low efficiency. One of the reasons can be the situation in this sector and price fluctuations. The sample consist mainly of small and medium enterprises for which it is harder adapt to sectoral changes and price fluctuations can affect their economic situation. Therefore, the data must be subjected to further analysis to find the part of milk processors with such lower efficiency.

Key words: technical efficiency, milk industry, food industry, stochastic frontier analysis

JEL classification: L66, D22, C02

1. Introduction

Milk processors belong to important part of Czech food processing industry. Czech sector is also influenced by the situation on the European and world market. Exports of milk and dairy products is 42.1% of the volume of milk production, imports of 32.4% in 2008. In this year production in the Czech Republic reached 3 079.4 mil. l. A large volume of dairy is produced abroad (23%) and 24.2% is sold through sales organization to foreign countries (MoA, 2019a). In last years this sector was influenced by abolition of milk quotas (end in 2015) and Russian food embargo (from 2014). These restrictions relate to overproduction and price decreases. To be competitive in European market play a more important role in current food industry. The aim of this paper is to evaluate the technical efficiency of Czech milk processing companies which can be affected by sector changes. Share of milk processors on whole food processing companies is quite low, 1.9%, but they had important share on sales (14.7%) and employment (9.2%) in 2018. But during last ten years there are large fluctuations in profits due to increase of costs and decrease of revenues. In this sector in 2018 there were 150 firms with total 8 402 workers. The number of companies decreases in time, so the number of employees. Labour productivity is very fluctuating (MoA, 2019b).

Milk sector was affected by economic crisis with decline of cow population. The concentration is high with leading firms on milk market Špička (2013). There were some analysis dealing with Czech milk industry. For example, Špička et al. (2015) analyzed the innovations in this sector because this sector is important recipient of subsidies. Náglová et al. (2017) dealt with factors influencing economy of milk industry companies. There were found differences in economy with respect to subsidies drawing, size of the firm, ownership structure. Other study by Náglová et al. (2016) evaluated the effect of investment support on economic indicators.

National subsidies have greater impact on economy than investment from Rural Development Programme. Some studies are focused on dairy farms and their profitability, which have positive trend in time and is higher in specialized farms then in mixed farms (Žáková Kroupová, 2016). Many studies also use stochastic frontier analysis (SFA) to assess technical efficiency. For example, Čechura et al. (2014) analyzed the differences in efficiency between Czech and Slovak milk processors and did not find any significant differences. Similarly, Pechrová and Šimpach (2015) analyzed differences in efficiency between male or female farmers using SFA. This parametric method is used because of its "ability to show the reasons for deviations in a production function such as random effect and measurement error, which contributes to inefficiency" (Attipoe et al., 2020). Messen and van den Broeck (1977) and Aigner et al. (1977) were the first who divided the error term into two parts – noise v_i and inefficiency u_i. This later enabled to derive the firm specific inefficiency u_i from the composed error term $\varepsilon_i = v_i - u_i$. Based on this finding it is possible to assess the technical efficiency of firms and compare it. SFA has also an advantage that it can respect panel nature of the data. Besides, explanatory variables can be introduced in the function of mean or variance or the inefficiency.

2. Materials and Methods

A parametric method Stochastic Frontier Analysis was used to calculate the technical efficiency. It was because we had panel data for which SFA is more suitable than alternative Data envelopment Analysis. The efficiency is estimated in one step for all years. A model was estimated as True Fixed-Effects which was introduced by Greene (2005). We considered Cobb-Douglas type of production function (1) because it is easy to be estimated, coefficients can be interpreted as elasticities and can be linearized by natural logarithms (2).

$$y_{it} = x_{1,it}^{\beta_1}.x_{2,it}^{\beta_2}.x_{3,it}^{\beta_3}.x_{4,it}^{\beta_4}.e^{v_{it}-u_{it}} \tag{1}$$

$$\ln y_{it} = \beta_1 \ln x_{1,it} + \beta_2 \ln x_{2,it} + \beta_3 \ln x_{3,it} + \beta_4 \ln x_{4,it} + v_{it} - u_{it} \tag{2}$$

where y_{it} denotes the production of firm i (i = 1, 2, ..., N, where N is total number of firms) in time t (t = 1, 2, ..., T, where T stays for a time). $x_{k,it}$ (k = 1, 2, ..., K, where K is total number of production factors) stands for the input k of firm i in time t; β_k are the estimated parameters of explanatory variables. v_{it} is stochastic term (noise) and u_{it} stays for inefficiency term – they compose synthetic error $\varepsilon_{it} = v_{it} - u_{it}$. The inefficiency term was assumed to have half normal distribution $u_{it} \sim N(0,\sigma_u^2)$, stochastic noise is normally distributed $v_{it} \sim N(0,\sigma_v^2)$.

The parameters of production function are estimated by the maximum likelihood method. After that, the efficiency is estimated using Jondrow et al. (1982) JLMS method that measures the contribution of u_{it} to ε_{it} as (3).

$$E\left[u_{it} \middle| \varepsilon_{it}\right]. \tag{3}$$

Technical efficiency takes values between 0 and 1 (or 0% to 100%) where 100% efficient firms lie on the frontier and produce given output with minimum inputs. Firms with lower efficiency use too many resources to produce their output and are therefore inefficient. Its distribution is skewed to the left. Shapiro-Wilk W test proved that the probability that the distribution is normal is zero, hence, for further testing of hypothesis have to be used non-parametric tests.

The production function had following inputs: x_1 – consumption of material and energy, x_2 – equity, x_3 – liabilities, x_4 – personal costs. Production was approximated by y – sales of own products and services. From originally 627 observations, only 613 could be used due to inability to calculate the technical efficiency (e.g. due to null values). The panel was unbalanced. There were 613 observations per 53 milk processing firms (11.4 on average) for years 2004 to 2017 in the results. The data were obtained from Albertina database. In this database accounting data from financial statements can be found. We selected companies dealing with branch according to CZ-NACE 10.5 Manufacture of dairy products. This sample can be considered as representative, because the analyses cover more than 30 % of enterprises in Czech Republic. Description of the sample is displayed in Table 1.

Table 1. Statistical description of the variables (in thous. CZK)

	Mean	**Median**	**Std. dev.**	**Min**	**Max**
y – sales of own products and services	687 296	390 409	971 435	0	6 090 181
x1 – material	525 574	244 859	781 458	0	4 759 803
x2 – equity	135 217	57 141	216 810	-119 718	1 655 230
x3 – liabilities	194 288	108 226	274 156	0	1 910 446
x4 – personal costs	52 647	31 120	77 183	0	550 852

Source: own elaboration (2020) based on Albertina data (2019)

Sample was divided according to the year of observation, size of the firm, region where the firm operates and type of the ownership (foreign of Czech[19]). Differences were tested by non-parametric Kruskal-Wallis equality-of-populations rank test (medians of more groups) and Two-sample Wilcoxon rank-sum (Mann-Whitney) test (means of two groups) with null hypothesis H_0: There are no statistically significant differences in medians between groups. When the null hypothesis is rejected, we can conclude that there are statistically significant differences in technical efficiency between various groups of firms. Calculations were done in StataIC 15.1.

3. Results and Discussion

We estimated true fixed-effects model with half-normal distribution of the inefficiency term. Results are displayed in Table 2. Model as a whole was statistically significant, because p-value of Wald $\chi^{2[4]} = 892.50$ was 0.00 (H_0 was rejected and the model is significant). But there is only one significant parameter, so the results cannot be generalized for whole population. Nevertheless, more important is that all coefficients are in line with economic theory. Increase of material and energy consumption by 1% cause the increase of production by 0.029%. Increase of equity has higher impact, the production would increase by 0.004%. Increase of liabilities by 1% caused increase of production by 0.169%. The highest elasticity is in case of personal costs (that is the proxy for employment in the firms). Its increase by 1% cause increase of the production by 0.641%.

Table 2. Results of true fixed-effects model

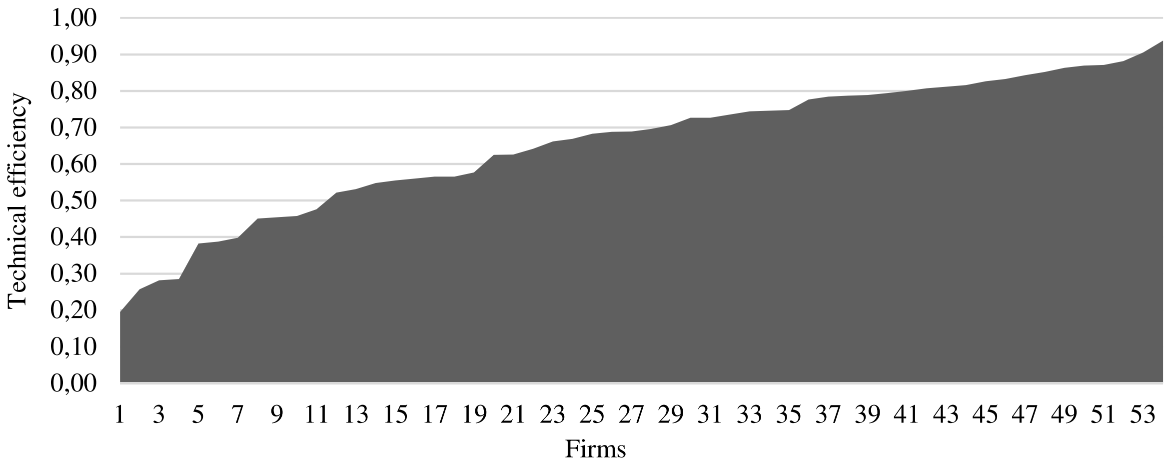
Parameter	**Coefficient**	**Standard error**	**t-value**	**p-value**	**95% confidence interval**	
lx1	0.0292	0.0155	1.8800	0.0600	-0.0012	0.0596
lx2	0.0037	0.1158	0.0300	0.9750	-0.2233	0.2306
lx3	0.1693	0.1145	1.4800	0.1390	-0.0551	0.3936
lx4	0.6411	0.0264	24.2800	0.0000	0.5894	0.6929

Source: own elaboration (2020) based on Albertina data (2019)

[19] As foreign were marked businesses with foreign capital higher than 50%.

Average technical efficiency was relatively low, only 65.66%. Median was higher, half of the firms were more or less efficient than 71.54%. One quarter of observations was less efficient than 49.11% and one quarter more than 86.88%. Each of 49 firms was 100% efficient at least in one year. There was none firm that would be 100% efficient in all years. The best firm was efficient from 93.82%. On the other hand, minimum was only 19.49% that points out on the firm that produces too small output with too many resources. Figure 1 shows the average efficiency for each firm in all years. In comparison to other studies that deal with very similar issue, Špička (2013) identified higher efficiency of Czech dairy industry, above 90%. It was analyzed in 2007-2010. Čechura et al. (2015) also analyzed this sector and identified efficiency 92.1% in years 2004-2011. We have different time series, longer (2004–2017) and used different method. While Špička (2013) estimated the technical efficiency by non-parametric method – data envelopment analysis with variable returns to scale, we use parametric method. For this reason, the results differ.

Figure 1. Average technical efficiency of each firm



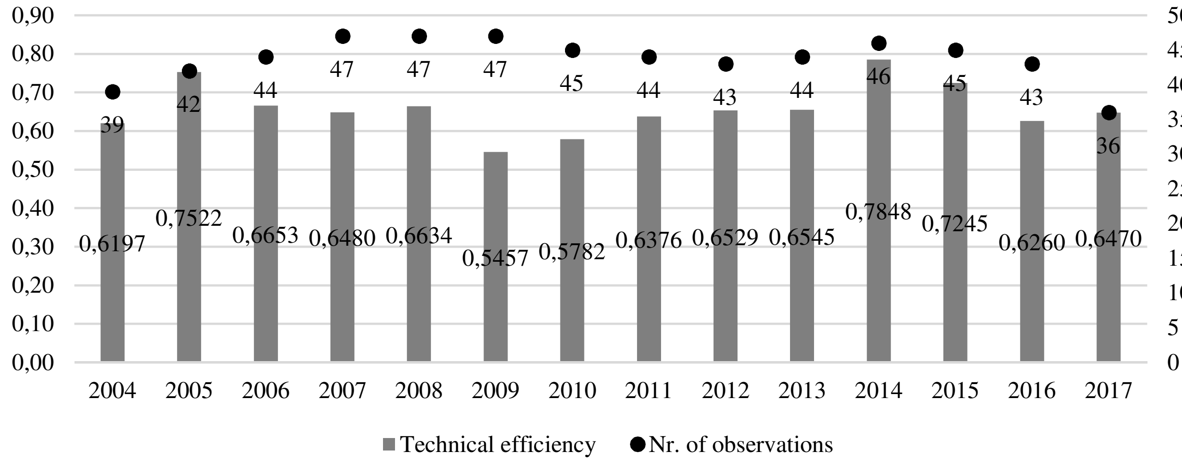
Source: own elaboration

The development of the technical efficiency follows the overall economic situation in the country. After the entrance to the EU, the technical efficiency was one of the highest (75.22% on average) in year 2005 (Figure 2). Then it decreased to 54.57% in 2009 due to economic crisis. But it was increasing again until 2014. The companies started to get well slowly after the crisis and their technical efficiency increased on 78.48% in that year. However, it did not improve much after that. There was decrease on 62.60% in 2016 than increase on 64.70% in 2017.

Overall the best situation was in year 2014. After this year there were some changes, that influenced milk market. Dairy sector is sensitive to changes also with relation to milk prices, their crash and overproduction (Klopčič et al., 2019). There are also some problems with milk quotas abolishment (Silva, Almeida and Marta-Costa, 2018). Some authors find relation between milk quotas and efficiency (Areal, Tiffin and Balcombe, 2012). Other factor that may influenced the milk situation was Russian embargo (from 2014 probably to 2020) imposed also on milk and milk products.

There are statistically significant differences in medians of technical efficiency in various years because probability in Kruskall-Walis test that the technical efficiency is equal is almost 0 ($\chi^{2[14]}$ = 42.556, p-value = 0.0001).

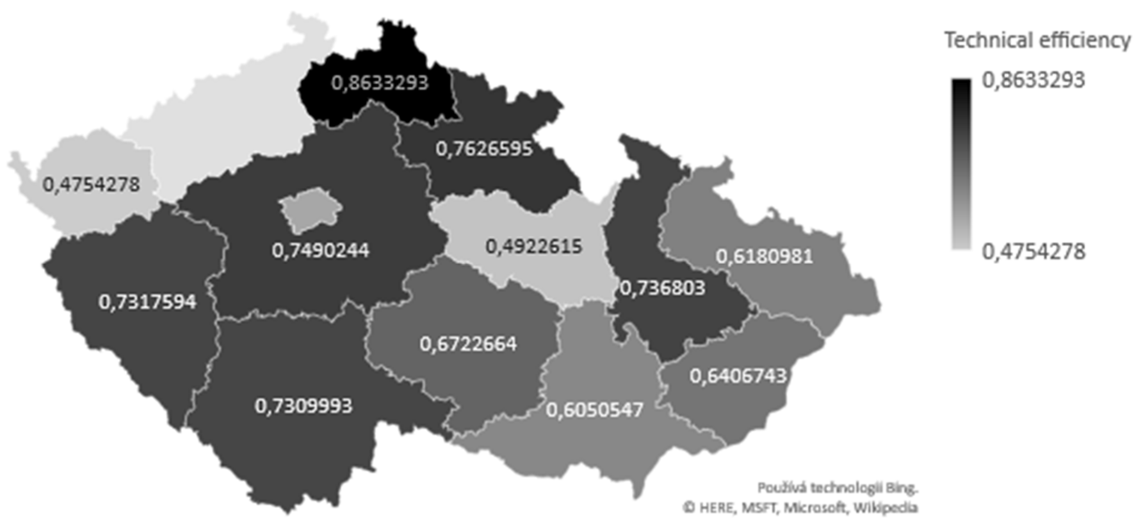
Figure 2. Development of technical efficiency in various years



Source: own elaboration

The highest technical efficiency was noted in Liberecký region (86.33%), as is described Figure 3. Then high efficiency was noted also in Královéhradecký region (76.27% on average) and in Středočeský region (74.90%). On the other hand, the lowest was in Karlovarský region (47.54%) and Pardubický region (49.23%). Also, in regions that contain two the largest cities in the Czech Republic was the efficiency low – Prague (only 54.52%) and in South Moravian region (60.51%). Based on the Kruskall-Walis test results ($\chi^{2[13]} = 72.290$ (p-value 0.0001 is lower than 0.05). Differences in technical efficiency of milk producers according to region was also find by Alem et al. (2019). Region can by assumed as a criterion that may affect the efficiency of firm.

Figure 3. Technical efficiency in Czech regions



Source: own elaboration

Regarding the size of the firm[20] the most technically efficient were on average middle-sized companies (70.67%) and only then large (65.99%). Not surprisingly the smallest firms were the least technically efficient - small from 58.43% and micro only from 50.04%.

[20] Firm size was defined according to the number of employees (particularly respect the definition of Commission. Small firms employ less than 50 persons, medium less than 250.

The differences were tested by Kruskal-Wallis test. Based on the $\chi^{2[3]}$ = 12.676 (p-value 0.005 is lower than 0.05). There are statistically significant differences in technical efficiency according to the size of the companies. Náglová and Šimpachová Pechrová (2019) analyzed also technical efficiency of food processors (production of other product) with respect to size. They did not find any significant differences between firm size. The firm size seems to be important criterion of milk industry efficiency (because of its significant differences). Lower efficiency of small firms can be also affected by firm specialization. In our sample, a lot of smaller companies deal with cheese production, that can be considered as handicraft production with high intensity of labor. So, their efficiency cannot be compared with large, industrial companies in milk industry and reach such scale effect as they do. According to Vokoun et al. (2015) that stability of food industry is thanks to the medium and large firms because they have experiences with supports and utilize increasing return to scale.

Slightly higher technical efficiency was in the companies that were owned by foreign (66.32%) than by Czech owners (65.51%). However, Wilcoxon rank-sum test revealed no statistically significant differences among both groups. Probability that the technical efficiency in both groups is equal is 58.69% (z-value = 0.543, p-value = 0.587). That means that there are no statistically significant differences between both groups.

4. Conclusion

Results showed that the technical efficiency of sample of milk processing companies is on 65.7% level. Median was higher, half of the firms were more or less efficient than 71.5%. In comparison to other studies it is low efficiency. One of the reasons can be the situation in this sector and price fluctuations. It is important to conduct deeper analysis. There was none firm that would be 100% efficient in all years. The most efficient firm had average efficiency 93.82%. On the other hand, minimum was only 19.5% that points out on the firm that produces too small output with too many resources. There were statistically significant differences in efficiency among different years. Overall the best situation was in year 2014 when the farms were efficient from 78.5%. The most technically efficient were on average middle-sized companies (70.67%) and only then large (65.99%). The highest technical efficiency was noted in Liberecký region (86.33%) and the lowest was in Karlovarský region (47.54%). Slightly higher technical efficiency was in the companies that were owned by foreign (66.32%) than by Czech owners (65.51%), but the differences were not statistically significantly different. The sample consist mainly of small and medium enterprises which can harder adapt to sectoral changes and price fluctuations can affect their economic situation. Therefore, the data must be subjected to further analysis and evaluated according to other criteria to find the part of milk processors with lower efficiency.

Acknowledgements

Supported by the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0918, project 1130/2019 Technical efficiency of food industry.

References

Aigner, D., Lovell, C. A. K. and Schmidt, P. (1977), "Formulation and estimation of stochastic frontier production function models", *Journal of Econometrics,* vol. 6, no. 1, pp. 21 - 37, ISSN 0304-4076, DOI 10.1016/0304-4076(77)90052-5

Alem, H., Lien, G., Hardaker, B. and Guttormsen, A. (2019), "Regional differences in technical efficiency and technological gap of Norwegian dairy farms: a stochastic metafrontier model", *Applied Economics*, vol. 51, no. 4, pp. 409 - 421, ISSN 1466-4283, DOI 10.1080/00036846.2018.1502867

Areal, F. J., Tiffin, R. and Balcombe, K. (2012), "Farm technical efficiency under a tradable milk quota system", *Journal of Dairy Science*, vol. 95, no. 1, pp. 50 - 62, ISSN 0022-0302, DOI 10.3168/jds.2011-4638

Attipoe, S. G., Jianmin, C., Opoku-Kwanowaa, Y. and Ohne-Sef, F. (2020), "The determinants of technical efficiency of cocoa production in Ghana: An analysis of the role of rural and community banks", *Sustainable Production and Consumption,* vol. 23, pp. 11 - 20, ISSN 2352-5509, DOI 10.1016/j.spc.2020.04.001

Čechura, L., Hockmann, H., Malá, Z. and Malý, M. (2014), "Productivity and efficiency differences between Czech and Slovak milk producers", *Review of Agricultural and Applied Economics*, vol. 17, no. 2, pp. 17-21, ISSN 1336-9261, DOI 10.15414/raae.2014.17.02.17-21

Čechura, L., Kroupová, Z. and Rudinskaya, T. (2015), "Factors determining TFP changes in Czech agriculture", *Agric. Econ. – Czech*, vol. 61, no. 12, pp. 543 - 551, ISSN 1805-9295, DOI 10.17221/14/2015-AGRICECON

Greene, W. (2005), "Reconsidering heterogeneity in panel data estimators of the stochastic frontier model", *Journal of Econometrics*, vol. 126, no. 2, pp. 269 - 303, ISSN 0304-4076, DOI 10.1016/j.jeconom.2004.05.003

Jondrow, J., Lovell, C. K., Materov, I. S. and Schmidt, P. (1982), "On the estimation of technical inefficiency in the stochastic frontier production function model", *Journal of Econometrics*, vol. 19, no. 2-3, pp. 233 - 238, ISSN 0304-4076, DOI 10.1016/0304-4076(82)90004-5

Klopčič, M., Kuipers, A., Malak-Rawlikowska, A., Stalgiene, A., Ule, A. and Erjavec, K. (2019), "Dairy farmers' strategies in four European countries before and after abolition of the milk quota", *Land Use Policy*, vol. 88, pp. 1 - 9, ISSN 0264-8377, DOI 10.1016/j.landusepol.2019.104169

Meeusen, W., and van den Broeck, J. (1977), "Technical efficiency and dimension of the firm: Some results on the use of frontier production functions", *Empirical Economics*, vol. 2, no. 2, pp. 109 - 122, ISSN 0377-7332, DOI 10.1007/BF01767476

Ministry of Agriculture, Agriculture 2018, Prague, 2019a, [Online], Available: http://eagri.cz/public/web/file/627472/Zemedelstvi_2018_brozura_pro_web.pdf, [Accessed: 16 Apr. 2020]

Ministry of Agriculture, Panorama of food industry 2018, Prague, 2019b, [Online], Available: http://eagri.cz/public/web/file/642629/panorama_potravinarskeho_prumyslu_2018_web.pdf, [Accessed: 12 Mar. 2020]

Náglová, Z., Boberová, B., Horáková, T. and Smutka, L. (2017), "Statistical analysis of factors influencing the results of enterprises in dairy industry", *Agric. Econ. – Czech,* vol. 63, no. 6, pp. 259 - 270, ISSN 1805-9295, DOI 10.17221/353/2015-AGRICECON

Náglová, Z. and Šimpachová Pechrová, M. (2019), “Technical and scale efficiency of food processing companies”, *Proceedings of the Agrarian perspectives XXVIII*, Prague, pp. 181 - 188, ISBN 978-80-213-2973-7

Náglová, Z., Špička, J. and Gürtler, M. (2016), “Evaluation of effects of investment support in the Czech dairy industry”, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 64, no. 4, pp. 1345 - 1351, DOI 10.11118/actaun201664041345

Silva, E., Almeida, B. and Marta-Costa, A. A. (2018), “Efficiency of the dairy farms: a study from Azores (Portugal)”, *European Countryside*, vol. 10, no. 4, pp. 725-734, ISSN 1803-8417, DOI 10.2478/euco-2018-0040

Pechrová, M. and Šimpach, O. (2015), “Are there any differences in efficiency between Czech agricultural holdings managed by male or female farmers?”, *Proceedings of the Agrarian perspectives XXIV*, Prague, pp. 340 - 346, ISBN 978-80-213-2581-4

Špička, J. (2013), ”The competitive environment in the dairy industry and its impact of the food industry”, *Agris on-line Papers in Economics and Informatics*, vol. 5, no. 2, pp. 89 - 102, ISSN 1804-1930, DOI 10.22004/ag.econ.152693

Špička, J., Smutka, L. and Selby, R. (2015), “Recent areas of innovation activities in the Czech dairy industry”, *Agric. Econ. – Czech*, vol. 61, no. 6, pp. 249 - 264, ISSN 1805-9295, DOI 10.17221/128/2014-AGRICECON

Vokoun, M., Polanecký, L. and Stellner, F. (2015), “The impact of the recent economic crisis on the food industry in the Czech and Slovak Republic”, *Procedia Economics and Finance*, vol. 34, pp. 142 - 148, ISSN 2212-5671, DOI 10.1016/S2212-5671(15)01612-3

Žáková Kroupová, Z. (2016), “Profitability development of Czech dairy farms”, *Agric. Econ. – Czech*, vol. 62, no. 6, pp. 269-279, ISSN 1805-9295, DOI 10.17221/131/2015-AGRICECON

THE ECONOMIC EFFICIENCY OF ORANGE CULTIVATION AND ITS CHALLENGES TOWARDS SUSTAINABLE DEVELOPMENT OF SMALL HOUSEHOLDS IN TUYEN QUANG PROVINCE, VIETNAM

Thu Trang Tran Nguyen[1], Thi Minh Hop Ho[2], Philippe Burny[3], Thi Nga Bui[4] and Philippe Lebailly[5]

[1] Economics & Rural Development, Gembloux Agro-Bio Tech, University of Liege, 5030 Gembloux, Belgium and Faculty of Economic and Business Management, Tan Trao University, Tuyen Quang 300000, Vietnam

[2, 3, 5] Economics & Rural Development, Gembloux Agro-Bio Tech, University of Liege, 5030 Gembloux, Belgium

[4] Faculty of Accounting and Business Management, Vietnam National University of Agriculture, Hanoi 100000, Vietnam

[1]thutrang027@gmail.com, [2]thiminhhop.ho@uliege.be, [3]philippe.burny@uliege.be, [4]hieu0306@gmail.com, [5]philippe.lebailly@uliege.be

Annotation: This paper focuses on the orange cultivation of farm holders to analyze their production costs to understand which challenges and issues they should face getting higher profits. The analysis results reveal that from 2014 to 2018 the orange cultivation areas and production in Tuyen Quang Province increase 1.58 and 1.83 times, respectively. Its average yield gets 22.02 tonnes/ha/year. This cultivation brings a surplus profit to farm holders. Results of the economic analysis also show that fertilizer, pesticide, and outsourced labor costs count the most in the total orange production (27%, 27%, and 40%, respectively). The study suggests that the farm's holders should think about cost optimization toward sustainable development by using more organic fertilizer and integrated pest management as well as reducing the outsourced labor cost by mechanizing harvesting. Locality government also should take necessary solutions to improve the knowledge of orange farm holders to the organic cultivation technique.

Key words: Input costs, orange cultivation, production cost, Vietnam

JEL classification: Q12

1. Introduction

Orange is one of the most popular fruits in Vietnam that consumers prefer thanks to its taste and high vitamin value. In 2016, worldwide produced approximately 67 000 million tonnes of orange, of which Vietnam contributed 520 million tonnes (FAO, 2017). Orange trees are widely grown in several southern and northern provinces of Vietnam including Tuyen Quang due to its suitable climate and natural conditions for cultivation. The orange tree cultivation plays an important role in the agricultural development of rural households and their livelihoods in Tuyen Quang, one of fourteen provinces in the Northern Midlands and Mountain Areas of Vietnam where is known as a poor region of the country (Prime minister of Socialist, 2013). Area and production of this crop have quickly increased for ten years

Orange fruit cultivation plays an important role in agricultural development of rural households in Tuyen Quang. The area and production of this crop have quickly increased for about ten years (People's Committee of Ham Yen District, 2015, 2016, 2017, 2018, 2019) which raises questions about the economic efficiency and the sustainability of this evolution. The objectives of this paper therefore aim to assess farm holders' orange cultivation for analysing their production costs in order to understand which challenges and issues they should face to get higher profits.

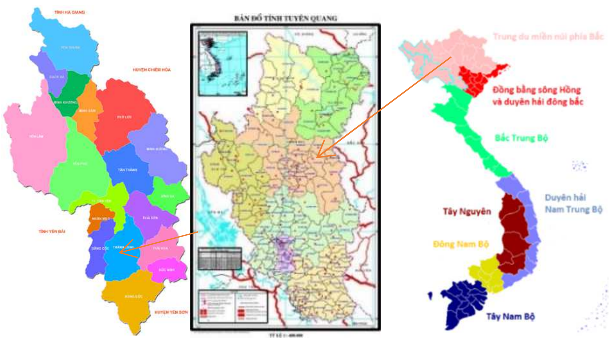
2. Materials and Methods

Study site, sample size and sampling methods

Tuyen Quang consists six districts and one city of which orange cultivation dominates in Ham Yen district with more than 90% of the orange production of the province (Tuyen Quang Statistic Office, 2018, 2019). Ham Yen district was therefore chosen as the study site.

Located about 40 kilometres from Tuyen Quang city (Figure 1), Ham Yen district has the total natural area of 90 thousand hectares, of which agricultural land is 11.4 thousand hectares, accounting for 13%. Hilly land is about 61 thousand hectares, suitable for industrial crops such as tea, citronella; food crops as maize, cassava; and fruits crops like orange, pineapple (Ham Yen District information portal, 2019). The annual rainfall presents from 1 600 mm to 1 800 mm with an annual average rainy days of 150 (People's Committee of Tuyen Quang Province, 2014). This climate is very favourable for orange cultivation.

Figure 1. Location of the study site



Source: (Department of Survey and Mapping Vietnam, 2019; Tuyen Quang Portal, 2019)

Both secondary and primary data have been used in this research. The secondary data were collected from the Office of statistics of Tuyen Quang to illustrate the evolution of area and production of orange cultivation in the province from 2014-2018. Primary data were taken from selected orange farms.

As mentioned above, objective of the research is accessing farm holders' orange cultivation activity to analyse their production costs, the target group of the study is, therefore, professional orange farms. According to the definition of Vietnam government, a farm met two conditions of a minimum of 2.1 ha of cultivation area, and annual production value at least of 700 million VND will be considered as a professional (Ministry of Agriculture and Rural Development of Vietnam, 2011).

It is ideal to study if all the farms chosen, but due to the limitations of time and cost, the minimum number of samples was adopted (Aday & Cornelius, 2006):

$$n = \frac{z^2pq}{e^2} \qquad \textbf{(1)}$$

Here, n is the minimum sample volume, z is distribution value corresponding to the selected reliability, p is estimated percentage of certified farms in the total of farms met the criteria of farm certificate, q = 1 - p, e is allowed error. Using p = 0.93 from the pilot survey, 95%

confidence interval, 5% of allowed error, the minimum sample volume determined by formula (1) was approximately 100 observations.

The study applied the random sample method to choose observations (Kothari, 2004). A structured questionnaire was built after an in-depth review of the literature and six trial interviews based on the method (Cooper & Schindler, 2011). Official survey was conducted from April to June 2019 with a result of 107 collected valid observations. Primary data were analysed by Excel and SPSS 20 software.

Models and variables

The Cobb-Douglas model was applied in order to determine the relation between the production value obtained and the inputs used and to indicate production efficiency (Hossain et al., 2015; Moghaddasi & Pour, 2016; Mohammadshirazi et al., 2015; Qasemi-Kordkheili et al., 2013). The original Cobb-Douglas production function was given as follows:

$$Y = AL^{\alpha}K^{\beta} \qquad \textbf{(2)}$$

Here, Y is total annual production, L is labour input, K is capital input, A is total factor productivity, α and β are the output elasticities of capital and labour, respectively.

To estimate the parameters, the Equation (2) is transformed into log linear form. The model used in this study was given in Equation (3):

$$\ln(Y_i) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(X_{ji}) + e_i \qquad \textbf{(3)}$$

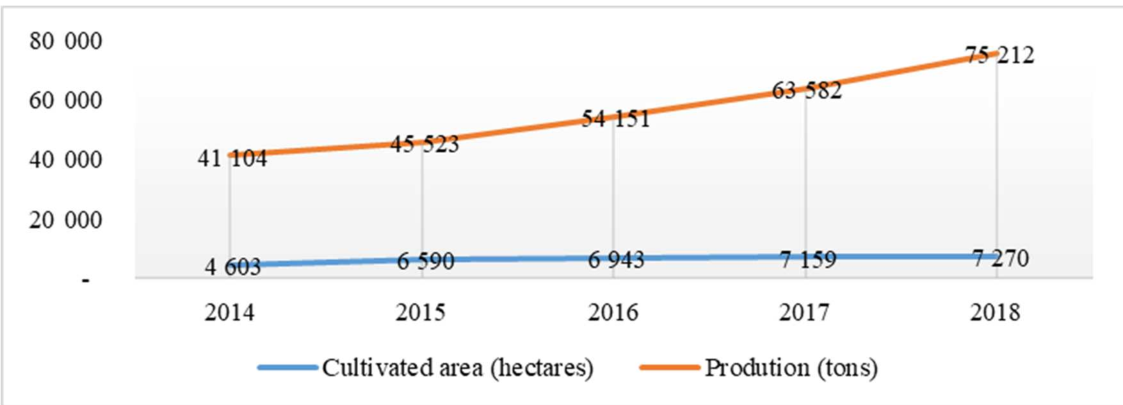
Here, i denotes the i-th orange farm in the sample; Y_i is the value of orange production of the i-th farm; X_{ji} is the j-th annual cost of the i-th farm; β_j with j = 1, 2, 3, ..., k are unknown parameters of the production function; e_i represents the random error.

3. Results and Discussion

Evolution of orange cultivation in Tuyen Quang province

The orange cultivated area and the production during the 2014-2018 period has flourished, the production increased by 1.83 times while the cultivated area augmented by 1.58 times. The results described in Figure 2.

Figure 2. Area cultivation and annual production of oranges in Tuyen Quang Province



Source: Tuyen Quang Statistic Office (2018, 2019)

Characteristics of farm holders

In the interviews with farm holders, the information on demography characteristics of farms' holders and the general information of orange production were collected. Such characteristics were given in Table 1.

Table 1. Characteristics of orange farm holders

Characteristics	**Minimum**	**Maximum**	**Mean**
Age (years)	31	64	47.75
Education (years)	3	12	8.76
Number of family members	2	10	4.73
Farming experience (years)	7	36	19.79

Source: Surveyed data (2019)

The age of the farm's holders varies from 31 to 64 years old with an average of 48. Their education level also changes from minimum 3 years to the end of high school with 12 years. These figures show that in terms of quantity, the intellectual level of orange farm holders in Ham Yen is almost the same as other remote areas of Vietnam. The farm holders are likely experienced in orange cultivation with an average of about 20 years.

Orange production of farm holders

Table 2 shows the information on orange production of farm holders. Each holder may own one or several orchards. Their average total orchard area was 5.6 ha. In the crop 2018-2019, the average orange production gained 109 tonnes/farm. In 2018, the average yield obtained 22 tonnes/ha that was higher than average Vietnamese national orange yield of 13.54 tonnes/ha (General Statistics Office of Vietnam, 2019) and was approximately the one in the United States of America of 21.7 tonnes/ha (USDA, 2018).

Table 2. Orange production of farm holders

Indicator	Minimum	Maximum	Mean
Number of orchards	1	4	2.10
Farm area (hectare)	2.20	20.00	5.59
Yield (tonne/hectare)	2.50	36.67	22.02
Production (tonne)	25.00	290.00	108.95
Selling price at farm gate (Mil. VND/tonne)	4.30	13.00	5.96

Source: Surveyed data (2019)

Only fresh orange was sold to collectors at the average price of 5.96 Mil.VND/tonne. Due to the lack of warehouse for post-harvest preservation and no local orange juice factories, farm holders therefore often face to "price pressures" created by collectors. 66 of 107 interviewed farm holders said that it should be diversified orange products instead of only fresh form to get a better selling price. At the same time, 97 of them desired a larger market for more stable orange price. Constructing the stable consumption market and diversifying orange products are also challenges for orange farms in Tuyen Quang.

In the functional analysis of the orange production in Tuyen Quang province, the description of the variables in the relation between the output value and the inputs used by the average and the standard deviations of the variables are presented in Table 3.

Table 3. Description of variables

Variables		Mean (Mil. VND)	Std. Dev.	Proportion (%)
Y	Gross production value	642.36	297.79	
	Inputs costs			
X1	Fertilizer	76. 24	39.32	26.61
X2	Pesticide	77.35	37.96	26.99
X3	Outsourced labour	115.10	59.62	40.17
	Interest	7.21	21.15	2.52
	Tools	5.54	3.56	1.93
	Energy	5.10	4.68	1.78
	Total cost	**286.54**		**100.0**

Source: Surveyed data (2019)

The surveyed data show that fertilizer, pesticide, and outsourced labor costs were the three biggest costs of orange farms in Tuyen Quang province, with an occupation of 27%, 27% and 40% of the total input costs, respectively. The big share of these costs in total production cost causes a negative impact of farm holders' profit from orange cultivation as indicated in the argument (Strzelecka et al., 2019).

Fertilizer cost contains purchases of organic and inorganic one. The farm holders confirmed that they used popularly inorganic fertilizer because of its fast effect. Each farm spent an average of 76 million VND on fertilizer cost for the crop 2018-2019.

Pesticide cost includes the purchases of pesticides and herbicides on the Vietnamese government permitted use list. In the crop 2018-2019, each observed farms spent 77 million VND in average on pesticides and herbicides purchases.

Outsourced labour costs accounted for 40% of total production cost. This expense is used to hire fixed workers to take care of the orchards year-round and to hire seasonal workers to harvest and transport oranges to the selling point at the harvest time. The average cost to hire fixed labourer was 17.5-22.5 million VND/person/year (People's Committee of Ham Yen District, 2019); The cost of hiring seasonal workers to collect and transport oranges to the selling point is about 600-1200VND/kg of orange. In the crop 2018-2019, the average value of outsourced labour cost per farm was about 115 million VND.

Above mentioned shows that for the improvement of the operation of orange farms in Tuyen Quang, farm holders should pay attention to the impact of three cost factors: fertilizer cost, pesticide cost, and outsourced labour cost. As fertilizer, pesticide and outsourced labour costs were the majority of total production cost, these had been chosen to be the explanatory variables of the Cobb-Douglas production function. The results were presented in Table 4.

Table 4. The coefficient estimates of variables

Variables	Estimated value	t-value
(Constant)	4.16	6.28
Ln (X1)	0.29	3.09
Ln (X2)	0.31	3.60
Ln (X3)	0.21	3.18
R^2	0.65	
F	64.55	

Source: Surveyed data (2019)

Hence, for 95% confidence interval, the orange production function of the orange farm in Tuyen Quang was given as below:

$$ln(Y_i) = 4.16 + 0.29\, ln(X_{1i}) + 0.31\, ln(X_{2i}) + 0.21\, ln(X_{3i}) + e_i$$

Using one sample t-test on the fertilizer cost per hectare of orange farm in Tuyen Quang, the results also showed that the average value of this cost was less than 16 million VND/ha/year. Scientific documents argue that the use of inorganic fertilizers is also a challenge for sustainable production. A reasonable combination of organic and inorganic fertilizers is a solution for well-growing plants without harm to crops, soil and the environment (Pretty, 2018; Purbajanti et al., 2019).

The average pesticide cost per hectare was less than 16 million VND/ha/year. It was lower than in a neighbour locality Van Chan district where pesticide cost accounted for 24 million VND/ha/crop (Phan, 2018). Nevertheless, the use of chemicals in agriculture needs to be very careful to avoid drug resistance as well as biological imbalances. The use of essential oils as plant protection drugs (Blázquez, 2014; Isman et al., 2011) and integrated pest management (IPM) (Berk, 2016; Dubey et al., 2010; European Commission, 2019) are suggestions for Tuyen Quang orange farm holders to achieve sustainable development.

For the outsourced labour cost, the orange harvest has been carried out entirely manually. The lack of mechanization has led farm holders to pay more for seasonal workers. So, farm holders could save a significant part of this cost if machines could apply to the orange harvesting and transportation to the selling point.

4. Conclusion

Based on the results of the survey of 107 orange farms in Tuyen Quang province, the study pointed out the positive aspects on farm holders' economic development and creating jobs for rural labourers. In the crop of 2018-2019, the average yield of oranges in Tuyen Quang was 22.02 tonne/ha, higher than the national average. During the period of 2014-2018, the orange production and cultivation area have been increasing 1.83 times and 1.58 times, respectively.

Fertilizer costs, pesticide costs, and outsourced labour costs are the three main components of input costs that account for 94% of the total production cost of the farm. Farm holders could achieve higher income by saving these costs.

Good control of the use of chemicals and inorganic fertilizers in orange cultivation is essential for sustainable agricultural development. Local governments and policymakers need more efficient solutions to stabilize oranges prices, to build product brand and larger consumer markets.

Due to limited resources, this study has not provided specific quantitative solutions. Further studies are needed to address this issue.

References

Aday, L. A. and Cornelius, L. J. (2006), "*Designing and Conducting Health surveys: A Comprehensive Guide (Third edition ed.)*", Hoboken, John Wiley & Son, ISBN 9780787975609

Berk, Z. (2016), “Chapter 4 - Agricultural production practice”, In: Berk, Z. (ed.), “*Citrus Fruit Processing*”, San Diego, Academic Press, pp. 65 - 82, , ISBN 978-0-12-803133-9, DOI 10.1016/B978-0-12-803133-9.00004-7

Blázquez, M. (2014), “Role of Natural Essential Oils in Sustainable Agriculture and Food Preservation”, *Journal of Scientific Research and Reports*, vol. 3, no. 14, pp. 1843 - 1860, DOI 10.9734/JSRR/2014/11376

Cooper, D. R. and Schindler, P. S. (2011), “*Business research methods (Twelve edition)*”, New York, The McGraw-Hill, ISBN: 9780073521503

Department of Survey and Mapping Vietnam, Administrative map of Socialist Republic of Vietnam, Hanoi, 2019, [Online], Available: https://www.bandovn.vn/vi/page/mau-ban-do-hanh-chinh-nuoc-cong-hoa-xa-hoi-chu-nghia-viet-nam-181?AspxAutoDetectCookieSupport=1, [Accessed: 31 Aug. 2019]

Dubey, N., Shukla, R., Kumar, A., Singh, P. and Prakash, B. (2010), “Prospects of botanical pesticides in sustainable agriculture”, *Current Science*, vol. 98, no. 4., pp. 479 - 480, ISSN 0011-3891

European Commission, Integrated Pest Management (IPM), Brussels, 2019, [Online], Available: https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/ipm_en?fbclid=IwAR23xIj_2GW6f9S4JijShijKfhCcfq2umfclOH2D5DPda5YSlEiy5X1wnoE, [Accessed: 10 Mar. 2020]

FAO, Food and Agriculture Organization of the United Nations, Citrus fruit fresh and processed statistical bulletin 2016, Rome, 2017, [Online], Available: http://www.fao.org/3/a-i8092e.pdf, [Accessed: 31 Aug. 2019]

General Statistics Office of Vietnam (2019), “*Agriculture, Forestry and Fishing”,* In: *“Statistical Yearbook 2018*”, Hanoi, Statistical Publishing House, pp. 542

Ham Yen District information portal, Natural conditions of Ham Yen District, Ham Yen, 2019, [Online], Available: http://hamyen.org.vn/gioi-thieu/dieu-kien-tu-nhien.html, [Accessed: 20 Sep. 2019]

Hossain, M., Alam, M. and Uddin, M. (2015), “Application of Stochastic Frontier Production Function on Small Banana Growers of Kushtia District in Bangladesh”, *Journal of Statistics Applications & Probability*, vol. 4, no. 2, pp. 337 - 342, DOI 10.12785/jsap/040218

Isman, M. B., Miresmailli, S. and Machial, C. (2011), “Commercial opportunities for pesticides based on plant essential oils in agriculture, industry and consumer products”, *Phytochemistry Reviews*, vol. 10, no. 2, pp. 197 - 204, DOI 10.1007/s11101-010-9170-4

Kothari, C. R. (2004), “*Research methodology Methods and Techniques (Second revised edition)*”, New Delhi, New Age International limited, ISBN 978-81-224-2488-1

Ministry of Agriculture and Rural Development of Vietnam (2011) “*Circulars: Provisions on criteria and procedures for certification of farm economy*”, (27/2011/TT-BNNPTNT), Hanoy, Vietnam

Moghaddasi, R. and Pour, A. A. (2016), "Energy consumption and total factor productivity growth in Iranian agriculture", *Energy Reports*, vol. 2, pp. 218 - 220, DOI 10.1016/j.egyr.2016.08.004

Mohammadshirazi, A., Akram, A., Rafiee, S. and Bagheri Kalhor, E. (2015), "On the study of energy and cost analyses of orange production in Mazandaran province", *Sustainable Energy Technologies and Assessments*, vol. 10, pp. 22 - 28, DOI 10.1016/j.seta.2015.01.007

People's Committee of Ham Yen District (2015), "*Report: Evaluate the results of production and business of farms 2014*", (12/BC-UBND), Tuyen Quang, Vietnam

People's Committee of Ham Yen District (2016), "*Report: Evaluate the results of production and business of farms 2015*", (09/BC-UBND), Tuyen Quang, Vietnam

People's Committee of Ham Yen District (2018), "*Report: Implementation results in 2017, plan for implementation in 2018 a number of contents in the field of cooperative and farm economy*", (79/BC-HDND), Tuyen Quang, Vietnam

People's Committee of Ham Yen District (2019), "*Report: Implementation results in 2018, plan for implementation in 2019 a number of contents in the field of cooperative and farm economy*", Tuyen Quang, Vietnam

People's Committee of Ham Yen District. (2017), "*Report: Evaluate the results of production and business of farms 2016*" (11/BC-UBND), Tuyen Quang, Vietnam

People's Committee of Tuyen Quang Province (2014), "*Decision: Approving the Scheme of Development of Sanh orange production areas in Tuyen Quang province, period 2014-2020*", (338/QĐ-UBND), Tuyen Quang, Vietnam

Phan, D. T. (2018), "*Citrus market research aimed at reviewing current status of citrus production and consumption to identify production and income improvement opportunities for the local people of Thuong Bang La commune, Van Chan district, Yen Bai province*", Hanoi, Vietnam

Pretty, J. (2018), "Intensification for redesigned and sustainable agricultural systems". *Science*, vol. 362, no. 6417, pp. 1 - 7, DOI 10.1126/science.aav0294

Prime minister of Socialist, R. o. V. (2013), "*Approving the master Plan on socio-economic development of the Northern Midland and Mountains region up to 2020*", (1064/QĐ-TTg), Vietnam

Purbajanti, E. D., Slamet, W., Fuskhah, E. and Rosyida. (2019), "Effects of organic and inorganic fertilizers on growth, activity of nitrate reductase and chlorophyll contents of peanuts (Arachis hypogaea L.)", *IOP Conference Series: Earth and Environmental Science*, vol. 250, no. 1, DOI 10.1088/1755-1315/250/1/012048

Qasemi-Kordkheili, P., Asoodar, M. and Kazemi, N. (2013), "Orange production assessment and analysis of the relationship between energy input and yield in the sari region of Iran", *Elixir Agriculture*, vol. 64, pp. 18871 - 18879, ISSN 2229-712X

Strzelecka, A., Zawadzka, D. and Kurdyś-Kujawska, A. (2019), "Factors affecting incomes of small agricultural holdings in Poland", *Procedings of the 28th International Scientific Conference Agrarian Perspectives XXVIII*, Prague, pp. 289 - 295, ISBN 978-80-213-2973-7

Tuyen Quang Portal, Administrative map of Tuyen Quang, Tuyen Quang, 2019, [Online], Available: https://tuyenquang.gov.vn/Pages/gioi-thieu.aspx?ItemID=6&l=Gioithieu&fbclid =IwAR3FV_BJ_841e2WfJwSHxmN8c1FcbMliX12ZbjxwwbqSwGhrsfENxUVCS0o, [Accessed: 01 Aug. 2019]

Tuyen Quang Statistic Office (2018), "*Tuyen Quang Statistical Yearbook 2017*". Vietnam: Statistical Publishing House

Tuyen Quang Statistic Office. (2019), "*Tuyen Quang Statistical Yearbook 2018*", Vietnam, Statistical Publishing House

USDA, N. A. S. S., United States Department of Agriculture, National Agricultural Statistics Service, Citrus fruits 2018 summary (1948-9048), Washington D.C., 2018, [Online], Available: https://www.nass.usda.gov/Publications/Todays_Reports/reports/cfrt0818.pdf, [Accessed: 01 Aug. 2019]

POSITION OF MARKETING TRADE SUBSYSTEM AND ITS FUNCTIONS IN ORGANIZATIONAL SYSTEMS WITH TANGIBLE, MIXED, INTANGIBLE AND AGRICULTURAL PRODUCTION

Arnošt Traxler[1], Monika Jadrná[2], Marek Dvořák[3] and Pavla Hošková[4]

[1, 2, 3] Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic
[4] Department of Statistics, Faculty of Economics and Management, CULS Prague, Czech Republic

[1]traxler@pef.czu.cz, [2]jadrnam@pef.czu.cz, [3]dvorakmarek@pef.czu.cz, [4]hoskova@pef.czu.cz

Annotation: This paper deals with the position of the Marketing Trade Subsystem (MTS) and its functions in the organizational system (OS). The term OS represents the systemic concept of enterprises with tangible, intangible and mixed production. The OS is defined by elements (tangible, human and mixed) and links (tangible energetic, informational and mixed). Through these elements and links, it is possible to define subsystems of the 1st order, by increasing the distinguishing level also subsystems of higher orders. The MTS is defined by human elements and mixed links. It is one of the important supporting subsystems. Its task is to increase the business success of the company. The systemic approach is consistently applied in the research. The conclusions are confirmed by the evaluation of a questionnaire survey involving 561 managers. Then two sets have been created for this research. The first set represents all 561 managers of tangible, mixed and intangible production enterprises, the second includes 106 managers of agricultural enterprises only. For a closer determination of the MTS function, the distinguishing level was increased, which made it possible to define the 2nd order subsystems, i.e. subsystem marketing, trade and services and describe their basic functions

Key words: Management, organizational system, manager, control subsystem, marketing trade subsystem, productional subsystem, tangible, mixed, intangible and agricultural production

JEL classification: E19, M11, L20

1. Introduction

The organizational system (OS), in our conception, represents an abstraction of the company, in which a system approach is consistently applied. It was replaced in the 1980s by the empirical and marketing-strategic approach represented by (Drucker, 2002; Kotler 2001; Porter, 1994) and the procedural approach represented by Steve Jobs (Elliot and Simon, 2012). The return to the systemic approach is evident in Hieronymi´s (2013), which considers systemic thinking to be very important for a better understanding of the complexity of the world in the context of its growing interconnection. Boulding (2009) deals with the hierarchy of systems and ranks among the main earth-physical, biological and social systems, each of which includes its own subsystems. Karpavicius, Cvilikas and Gatautis (2007) argue that the development of the concept of systemic management requires a new understanding of the management of the organization. One of the new theories is the systemic aspect of the management and economic processes. From the point of view of the system, it is necessary to first characterize the structure of each organization. This is the basis for the further development of systems theory in the field of management. By analyzing different approaches, it was found that the system can be considered as a unit of elements that are interdependent and that functions as a separate environment object. According to the systems theory, the management of the organization can be considered as a complex information process. Katz and Khan got the furthest in this direction. Based on their research, they defined the basic subsystems of the open system, and their work served other authors in more detailed research. Meyer (2010) modified their theories and defined the following subsystems OS: Control (integration and coordination), support (input processing), production (energy conversion), management structure scheme (management and social position of employees), adaptive (monitoring and response to changes). Similarly, based again on the theory of Katz and Kahn, the OS was conceived by Gareth Morgan (1986), who defined five basic subsystems: strategic, technological, socio-cultural, structural and managerial. He understands the system's inputs as sources: human, financial, information and material, which powers the OS. Outputs of the OS are products and services that retroactively affect the sufficiency and quality of inputs. Authors who deal with a systemic approach do not address the issue of marketing and trade, authors who deal with marketing and trade do not apply the systemic approach. The Theory of Management of Organizational Systems (TMOS) (Hron and Traxler, 2017) is used for the definition, position and function of the marketing-trading subsystem. It defines nine basic subsystems of the 1st order: Control (CSS), Organizational (OSS) and Production (PSS) as the main subsystems and Technological (TS1), Technical (TS2), Ecological Ergonomic (EES), Economic Information (EIS), Labour (LSS) and Marketing Trade (MTS) as supporting subsystems. The use of the distinguishing level allows to define even the subsystems of higher orders, i.e. examine the processes and relationships in these subsystems in more detail. This option is used to examine the position and function of the MTS.

2. Materials and Methods

Two sets have been created for this research. The first set represents all 561 managers of Tangible Production (TP), Intangible Production (NP) and Mixed Production (MP) enterprises. The first file of managers has the following structure: men 82.0 %, women 18.0 %, ownership share 25.5 % of managers. A lower level of management is held by 32.1 % of managers, middle 21.5 %, higher by 22.8 %, a member of the Board of Directors is 11.4 %, staff positions are 12.2 %, Secondary vocational education 23.4 %, Secondary general education 7.0 %, College of Humanities branch 7.0 %, College of Technical branch 29.9 %, College of Economics 28.9 %. Age structure: from 20 to 30 years – 11.1 %, from 31 to 40 years – 23.1 %, from 41 to 50 years – 34.2 %, from 51 to 60 years – 26.1 %, from 61 5.9 %. As a member of the select (non-formal) management is considered 65.0 %. The second set includes 106 managers of agricultural enterprises only. The file of managers has the following structure: men 83.0 %, women 17.0 %, ownership share 39.0 % of managers. A lower level of management is held by 24.6 % of managers, middle 12.7 %, higher by 29.1 %, a member of the Board of Directors is 22.4 %, staff positions are 11.2 %, Secondary vocational education 23.3 %, Secondary general education 1.8 %, College of Humanities branch 3.6 %, College of Technical branch 36.6 %, College of Economics 27.7 %. Age structure: from 20 to 30 years – 11.8 %, from 31 to 40 years – 20.6 %, from 41 to 50 years – 25.2 %, from 51 to 60 years – 30.4 %, from 61 11.8 %. As a member of the select (non-formal) management is considered 76.2 %.

Due to the size and structure of the files, it is possible to consider the files to be representative and allow to make comparisons. A questionnaire method was used to obtain the data which are then statistically processed.

The absolute frequency indicates how many times given category exists in the file. The sum must be equal to the range of file *n*, i.e.:

$$n_1 + n_2 + n_3 + \ldots + n_k = \sum_{i=1}^{k} n_i = n \tag{1}$$

The relative frequency of the *fi* reflects the proportion of number of occurrences of the given category in the total range of the file, i.e.:

$$f_i = \frac{n_i}{n} \tag{2}$$

If the relative frequency is multiplied by 100, it can be expressed as a percentage. Variable *n* may not match the number of respondents because some respondents did not have to answer the question or have identified multiple answers. Therefore, the concept of checksum has been introduced, which is understood to be *n*. The checksum can also be larger and smaller than the number of respondents (someone selects two answers, someone skips the question). If the variable can have multiple values, then the frequency method is not appropriate. In this case, the values are sorted into intervals and the frequency of the values at each interval is determined, allowing their order to be determined. The processed data demonstrate or refute the correctness of the presented conclusions concerning the position and function of the Marketing-Trading Subsystem of OS. Analytical and synthetic thinking, logical deductions and induction were used to formulate the presented conclusions. Furthermore, aggregation and desaggregation methods were used because it is necessary to compare subsystems at the same distinguishing level.

3. Results and Discussion

The Marketing Trade Subsystem is subsystem of the 1st order and belongs among the supporting subsystems of the OS. It consists of a set of Human Elements (HE) and Mixed Links (ML). Mixed Links are made up of Tangible Energetic Links and Informational Links (TEL, IL), see Scheme 1.

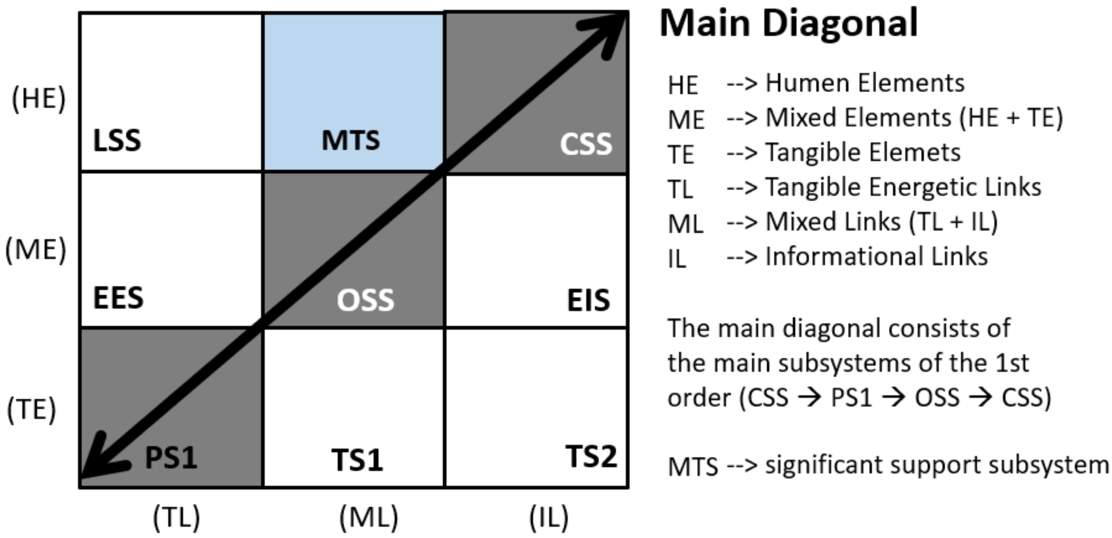
Symbolic notation:

$$MTS = \{[HE], [\ ML]\} \tag{3}$$

3.1 Position of MTS (marketing and trade) resulting from a consistently applied

Marketing and trade are carried out by people (HE), so it is necessary to explain them as a mixed link (ML).

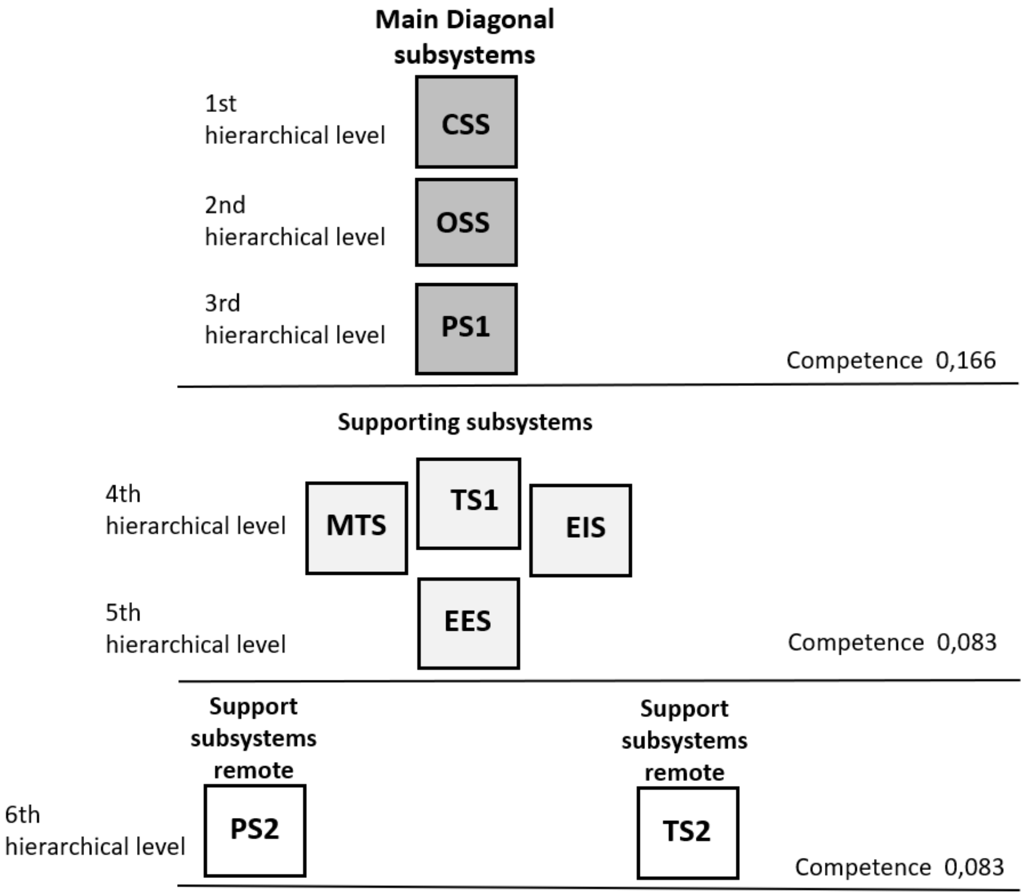
Scheme 1. Subsystems of the 1st order of the OS



Source: Authors (2020)

Marketing and business activities are intangible, but in order to be successful, it is also necessary to link to the product, which in most cases is tangible or mixed. Own trade and marketing activities represents an informational type of links, a connection to the product represents a tangible links. At present, when the marketing and strategic approach to management prevails (Kotler and Porter mentioned above), the position and importance of marketing are strongly overestimated. It can be expressed by the often used statement, that it is not an art to produce, but to sell. Many people believe that marketing is at the top of the hierarchy of importance for the proper functioning of an enterprise. The systemic approach refutes this claim. The hierarchy of the 1st order subsystems can be illustrated by Scheme 2.

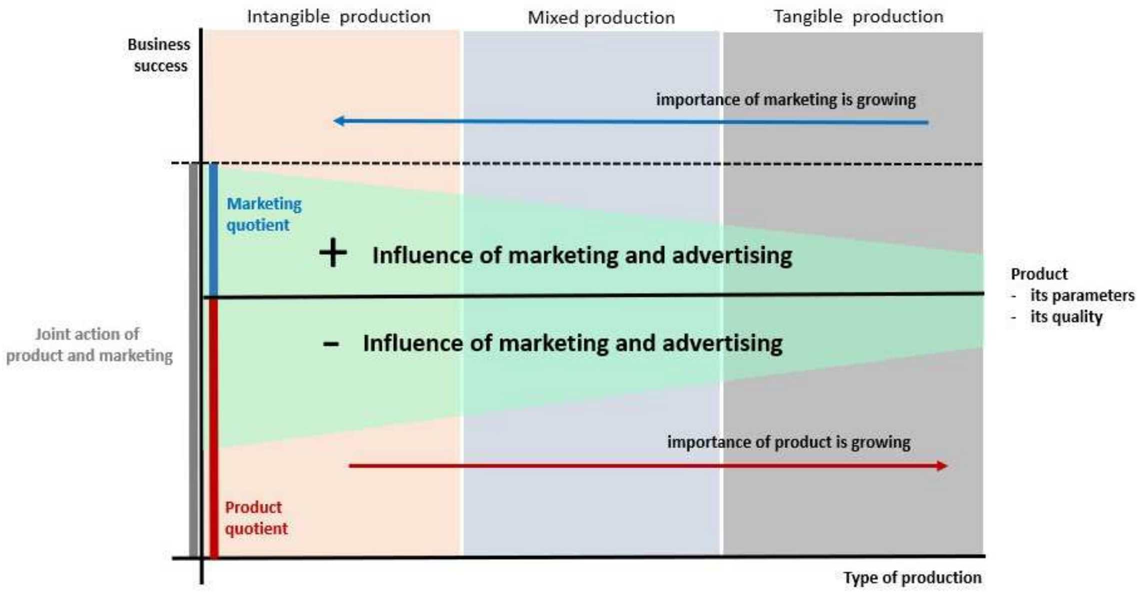
Scheme 2. Hierarchy of the Subsystems of the 1st order of the OS



Source: *Authors (2020)*

The CSS must identify the vision and strategy. It determines the production. Production affects the technology used, which requires the allocation and subsequent optimization of resources. Resource allocation creates organizational units (OU) where production is carried out. Human resources, tangible resources, financial resources, spatial and temporal resources must be allocated. Then the head of OU is appointed. This cycle takes place on the main diagonal. The MTS is a very important subsystem, but only supportive. The relationship between the product and marketing is expressed in Scheme 3.

Scheme 3. Product and marketing impact on business success



Source: Authors (2020)

The natural interest in the product is determined by its utility value, its quality and its price. The utility value is determined by the correct strategy. The CSS has selected and decided on the implementation of the product that is (or is not) of interest. Quality, especially for tangible products, is determined by technology. The price is determined by the cost of production and the level of profit that the CSS wants to achieve. If the market does not accept a set price, it is necessary to reduce the required profit rate. This is the task of marketing and trade, but the limit of price reduction remains the costs that are associated with production.

The scheme shows that:

- marketing and trade can significantly improve or deteriorate business success, but it lies (MTS) at the lower stage of the hierarchy of subsystems
- the influence of marketing and advertising has a downward trend on business success from intangible production, through mixed production to tangible production

3.2 Statistical data confirming the conclusions of the preceding point

Confirmation that the CSS is more important to the success of the business than the MTS, confirming the hierarchy of these subsystems:

- The managers confirmed that the success of the company is decided by the CSS (correct/bad business management) from 73.3 % for TP enterprises, 70.8 % for MP enterprises and 64.6 % for enterprises with IP, vs the MTS (good/bad marketing and trade activities) 24.7 % for enterprises with TP, 29.2% for enterprises with MP and 35.4 % for enterprises with IP.
- Managers are clearly aware and confirm the theory (TMOS), which is not subject to fashion trends, that the decisive factor for the success of the business is the CSS, not the MTS, as many claim. The MTS is important, but only the supporting subsystem of the OS. In the case of agricultural enterprises, the managers confirmed even more significantly the influence of the CSS on the success of the enterprise. According

to them, 80.9 % of the company's success is decided by the CSS, marketing and business (MTS) activities by 19.1 %.

Confirmation that the MTS is a support subsystem, not the main one:

- 78.4 % of management staff with TP, 88. 3 % of management staff with MP and 90.3 % of management staff with IP identified marketing and trade activities as support activities for efficiency.
- Separate marketing department has 50.0 % of TP enterprises, 68.0 % of enterprises with MP and 72.0 % of enterprises with IP.

These results confirm that even managers in practice consider MTS (without knowing the terminology given by us) as a support subsystem or support activities. In the case of agriculture, this claim is confirmed even more significantly, since 84.8 % of managers identified the business as a supportive activity, only 23.2 % of enterprises have a separate marketing department.

Confirmation of the importance of PS1 (products) in relation to the economic (business) success of the product and the enterprise:

- Managers said that the quality of their products was decided by 60.2 % for TP enterprises, 40.1 % for MP enterprises and 35.8 % for IP enterprises, the quality of their marketing and trade activities management staff said in 39.8 % for TP enterprises, 59.9 % for MP enterprises and 64.2 % for IP enterprises.
- Managers said that the economic success of the company is decided by 1/ selection of the right product (interest in the product on the market), 2 /product quality, 3/ appropriate way of selling and advertising. The same order was determined by both TP enterprise managers and managers of enterprises with MP and IP. This is even more true for agricultural enterprises, as managers said that the quality of their products is 64.1 % of economic success. 35.9 % of managers stated that the quality of business activity is decisive. They also confirmed the above order decides 1/the choice of the right product, followed by 2/the quality of the product and then 3/the appropriate way of sales and advertising.

Confirm the importance of binding to a product:

- Managers have confirmed the importance of the link between marketing and trade (MTS) to the product (PS1). They stated that the business success depends on the correct product structure of 25 % for TP enterprises, from 18.8 % for MP enterprises and 17.6 % for IP enterprises.
- Managers confirmed that the success rate of marketing and trade depends on the high quality of products from 35.9 % for TP enterprises, 23.0% for MP enterprises and 34.4 % for IP enterprises.
- Managers confirmed that the success of the marketing and trade depends on their own business policy (price selling, marketing and advertising) from 39.1 % for TP enterprises, 58.2 % for MP enterprises and 48.0 % for IP enterprises.

Since the link to the product is characterized by the structure of the products and the quality of the products, it is necessary to add the data for the structure and quality.

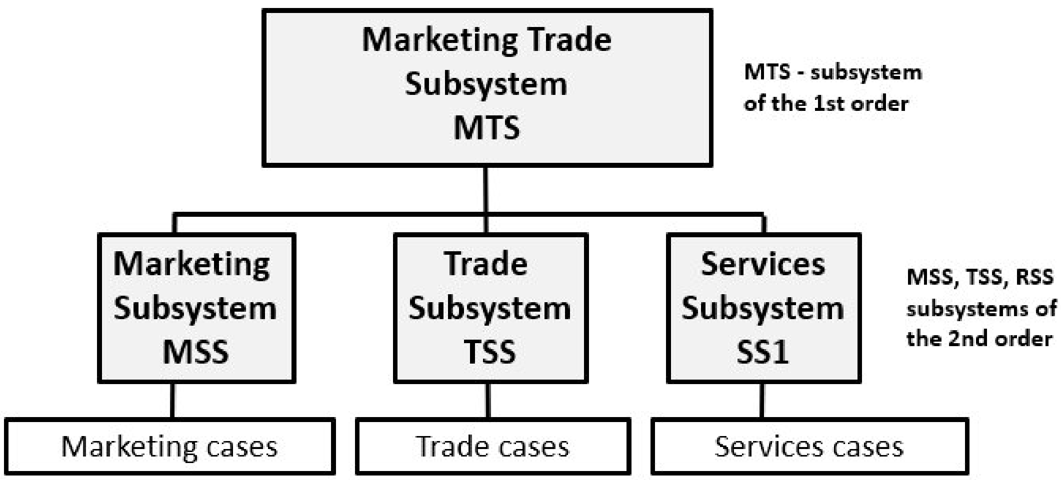
Then the product-to-trade policy comparison looks like this: (60.9 % x 39.1 %) for enterprises with TP, (41.8 % x 58.2 %) for enterprises with MP and (52.0 % x 48.0 %) for enterprises with IP. These data confirm the importance of the MTS binding to the product. This is even more true for agricultural enterprises, with answers for the structure and quality of products being 65.8 % (product structure 28.21 % + product quality 37.6 %). 34.2 % of respondents were in favor of their own trade policy. The data also confirm the indicated trend in Scheme 3 that the importance of the product is growing and marketing is declining towards TP.

3.3 Features of the Marketing-Trade Subsystem (MTS) of the OS

Although the systemic approach evaluates the MTS only as a supporting subsystem and the managers confirmed this in the questionnaire survey, this does not mean that the MTS does not have a significant impact on the behaviour of the OS and its success. The MTS function is determined by the functioning of the higher order subsystem, which captures Scheme 4.

The task of marketing is to create trade opportunities, the task of the trade is to realize the business opportunity, i.e. the conclusion of a commercial contract. The task of services is to create an added value – care for the client, in a more demanding type of trade, the implementation of the solution (e.g. sw), care for existing customers, training and etc. In addition to carrying out these tasks, they can become a useful source of information for the CSS.

Scheme 4. Desagregation of the MTS

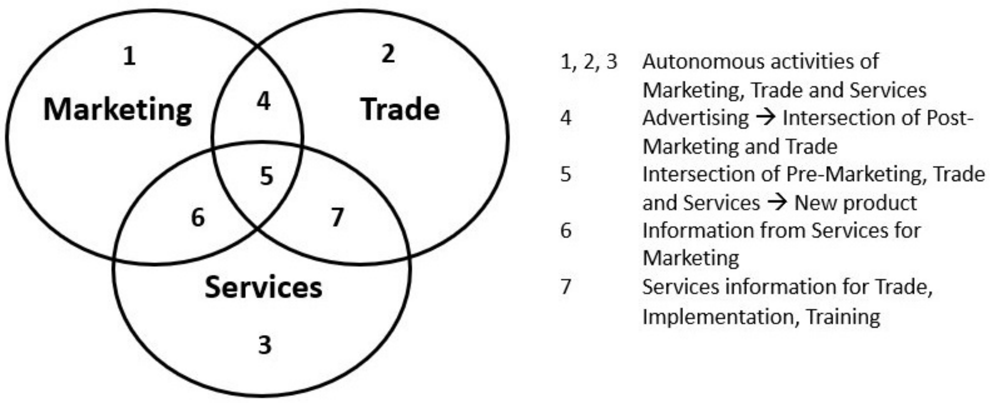


Source: Authors (2020)

It is important that the subsystems operate in symbiosis and support each other. The scheme 5 illustrates the interaction and influence.

The functions and tasks of marketing, trade and services are outlined below. The penetration marked by number 4 represents the interaction of advertising as a marketing tool and its own trade, which aims to increase sales, especially for consumer goods. Penetration marked by number 6 represents the use of information from the services to the marketing. The services provide to marketing information about the strengths and weaknesses of products obtained from clients who use the products. The penetration marked by number 7 represents the use of the services information for the trade activities. The information can be used to argue in business negotiations. The intersection of marked by number 5 represents the point of intersection of information from all MTS subsystems and can be an important source of information for reflection on a new product or a major innovation of an existing product. In terms of marketing and as an information source, services (SS1) are underappreciated. In the case of agriculture, the role of service has not been examined because the production of agricultural primary production ends with the sale of products. In the case of self-processing by selling a food product. Also, advertising for agricultural products is zero or minimal. In the case of food products, it is used by chain stores.

Scheme 5. Interaction of the 2nd order MTS subsystems



Source: Authors (2020)

4. Conclusion

This paper summarizes the results of the MTS examination, its position and functions in the OS. The systemic approach is consistently applied when examining. Its conclusions are confirmed by an evaluation of the questionnaire survey involving 561 managers in companies with TP, MP, IP and 106 managers of agricultural enterprises.

The conclusions are:

- The MTS is a support subsystem of the 1st order of the OS.
- From the point of view of the hierarchy, the MTS is at the fourth hierarchical level.
- Mixed links ensures the interconnection of the MTS to the product.
- The structure of the products and their quality is more important for business success, in the long term.
- When subsystems of the 2nd order of the MTS work in symbiosis, the efficiency of the entire MTS increases.

These conclusions are also valid for agricultural enterprises.

Managers realize that product quality represents the long-term success of the business in the market, that marketing and trade activities can increase the success of the product, but without the required quality only in the short term. The quality is ensured (especially in the case of TP) level of technology. This means that in the long term, and especially for TP, it stands higher in the subsystem hierarchy. In the long term confirmed by the managers, the most important to the success of the whole company are the correctly selected products (PS1), their quality (TS1) and only then the appropriate way of selling and advertising (MTS). This is more pronounced for TP businesses.

Acknowledgements
This research article was supported by IGA PEF CZU (CULS) 2019B0006 - Atributy řízení alternativních business modelů v produkci potravin.

References

APPLE, Produkty společnosti Apple a český zákon o ochraně spotřebitele, [Online], 2020, Available: https://www.apple.com/cz/legal/statutory-warranty/, [Accessed: 9 Apr. 2020]

Boulding, K. E. (2009), "Systems Research and the Hierarchy of World Systems: General Systems in Special Chaos", *Systems Research And Behavioral Science*, vol. 26, no. 5, pp 505 - 509, DOI 10.1002/sres.994

Drucker, P. F. (2000), "*Výzvy managementu pro 21. století*", Praha, Management Press, ISBN 80-7261-021-X

Hieronymi, A. (2013), "Understanding Systems Science: A Visualand Integrative Approach", *Systems Research and Behavioral Science*, vol. 30, no. 5, pp. 580 - 595, DOI 10.1002/sres.2215

Hron, J. and Traxler, A. (2017), "*Teorie řízení organizačních systémů*", Praha, Česká zemědělská univerzita v Praze, ISBN 978-80-213-2768-9

Karpavicius, T., Cvilikas, A. and Gatautis, R. (2007), "Application of Systemic Management Conception to Organization's Management Decisions Structuring", Inzinerine Ekonomika-Engineering Economics, vol. 54, no. 4, pp. 44 - 52, ISSN 1392-2785

Kotler, P. (2001), "*Marketing Management*", Praha, Grada Publishing, ISBN 80-247-0016-6

Meyer, J. W. (2010), "*World Society: The Writings of John W. Meyer*", Oxford, Oxford University Press, ISBN 9780199593439

Morgan, G. (1997), "*Images of organization. 2nd ed*", Thousand Oaks, Sage Publications, ISBN 0761906320

Porter, M. E. (1993), "*Konkurenční strategie*", Praha: Management Victoria Publishing, ISBN 80-85605-11-2

Titan Web Marketing Solutions, Powerful Ps You Need to Know About Apple's Marketing Mix, Murfreesboro, 2020, [Online], Available: https://titanwebmarketingsolutions.com/4-powerful-ps-need-know-apples-marketing-mix/, [Accessed 10 Apr. 2020]

Traxler, A., Dvořák, M., Jadrná, M., Hošková, P. and Platilová Vorlíčková, L. (2019), "Ifluence of Control Subsystem on Production-Technical Area of Organizational System", *Proceedings – of the 28th International Scientific Conference Agrarian Perspectives XXVIII*, Prague, pp. 312 - 320, ISBN 978-80-213-2973-7

Tyson, S. (2017) "*Organizační chování*". Praha: Grada Publishing, ISBN 80-716-9296-4

CONSUMER BEHAVIOUR ON THE FOOD SUPPLEMENT MARKET

Kamila Veselá[1], Linda Pudilová[2] and Lucie Severová[3]

[1, 2, 3] Department of Economic Theories, Faculty of Economics and Management, CULS Prague, Czech Republic

[1] kvprofin@gmail.com, [2] linda.pudilova@gmail.com, [3]severova@pef.czu.cz

Annotation: Food supplements have practically always been part of the Czech market, though they did not experience a boom until the 1990s, when the emerging market gave rise to a whole range of food supplement producers and distributors. Since then, market competition has been increasing. Currently, the food supplement market is primarily characterized by intense competition, the existence of fraudulent companies (especially online retailers of weight loss products), the tendency to establish ever stricter criteria and regulation by the European Union. At the same time, the knowledge base and awareness have been on the rise among consumers. This article presents the results of a survey of Czech people's attitudes and consumer behaviour with respect to healthy lifestyle and food supplements. The survey focused on respondents with at least secondary education due to the considerable size of this educational group, which is likely to continue increasing further in the future. The following facts form the basis of the survey: the number of secondary and tertiary school graduates is growing, as are both the level of food supplement consumption and the demand for health products and healthy living. The survey was conducted among a total of 324 respondents. A total of 200 respondents admitted to using food supplements, with 33 % of respondents (108) spending up to CZK 200 per month on food supplements, while only 2.5 % (8) claimed to spend over CZK 1,000 per month on these products.

Key words: food supplements, consumption, active ingredient, consumer behaviour, health, vitamins, minerals

JEL classification: H75, D49

1. Introduction

High-quality food with plenty of vitamins, minerals and other vital nutrients is essential for the proper development of the human body and a healthy lifestyle. However, the development of sustainable food consumption habits can be hindered by economic, time, organizational and social barriers (Gorynska-Goldmann, 2019). Many people compensate for the lack of quality food and key nutrients by improving their diets with various food supplements. Food supplements fall under a special food category whose aim – according to Act No. 110/1997 Coll., on Food and Tobacco Products – is to supplement a normal diet and provide a concentrated source of vitamins and minerals. Regulation of the food supplement market is currently under the purview of the Ministry of Agriculture, which oversees and approves the introduction of new products on the market (Ministry of Agriculture, 2018). The food supplement market has seen significant development since the 1990s. Thanks to growing consumer awareness, both consumption and competition levels in relation to food supplements have increased exponentially. As stated in the 2019 press release issued by the Czech Statistical Office, "Czechs spend CZK 2,400 a year on pharmaceutical drugs on average", which coincides with the continuing rise in medicament consumption and spending. In the period between 2013 and 2017 alone, the level of spending on over-the-counter medicines in pharmacies grew by 29 % (Institute for Politics and Society, 2019). The Internet and the opportunity to purchase food supplements as well as to obtain relevant information about active ingredients in food supplements online have also contributed to the development of the food supplement market (Czeh Statistical Office, 2019).

As stated by the Ministry of Health in the “Health 2020” program, the efficiency of health care and economic performance are closely interrelated. Accordingly, the Ministry of Health considers it essential to use all available means to support national health policies and, thereby, the economy.

The objective of this paper is to assess consumer behaviour on the food supplement market. The introduction presents background information and the focus of the research. The methodology section describes the way in which primary data have been analysed and research results evaluated. The final results of the research are presented in the Results and Discussion section, where they are compared to other studies carried out by different authors. The presented text aims to evaluate consumer behaviour of Czech consumers on the food supplement market by analysis of the primary data obtained through a questionnaire survey conducted among people with at least secondary education, who form a dominant group of the Czech population.

2. Materials and Methods

All background information relating to the article was processed by the analysis and subsequent synthesis of secondary sources. The primary data that form the basis of this article were obtained from a questionnaire survey. The participating respondents are Czech nationals with at least secondary education. The total number of respondents amounted to 324. The questionnaire survey was conducted in 2019. See the following table for respondent classification based on the criteria being evaluated.

Table 1. Basic respondent group information

Criteria	Respondent group	Number of respondents	Percentage of respondents
Gender	Female	150	46.3 %
	Male	174	53.7 %
Age	0-20	10	3.1 %
	21-30	146	45.1 %
	31-40	88	27.2 %
	41-50	58	17.9 %
	51-60	18	5.6 %
	over 60	4	1.2 %
Education	Completed upper secondary	294	90.7 %
	Advanced vocational	10	3.1 %
	University	20	6.2 %
Monthly income	0-15,000	86	26.5 %
	15,001-20,000	40	12.3 %
	20,001-30,000	60	18.5 %
	30,001-40,000	62	19.1 %
	41,001-50,000	64	19.8 %
	over 50,000	12	3.7 %

Source: Own research, 2019

The questionnaire survey results were obtained via descriptive methods using both absolute and relative statistics. The results were presented in contingency tables subsequently tested by Pearson's chi-squared test. The significance level was set at 0.05. In cases where the $\chi 2$ test value was equal to or greater than the critical $\chi 2$ test value at the significance level of 0.05, the null hypothesis of independence was rejected. Cramer's V was subsequently determined in all cases where the null hypothesis was rejected (Abbot and McKinney, 2013). The following hypotheses were tested:

$H0_1$: The use of food supplements is independent of gender.
$H0_2$: The use of food supplements is independent of age.
$H0_3$: The use of food supplements is independent of income.
$H0_4$: There is no correlation between the amount of investment in food supplements and gender.
$H0_5$: There is no correlation between the amount of investment in food supplements and age.
$H0_6$: There is no correlation between the amount of investment in food supplements and income.

3. Results and Discussion

The questionnaire survey involved a total of 324 respondents, consisting of 174 men and 150 women. 45 % of all respondents fell into the 21-30 years of age category. 91 % of the respondents had secondary education, while 9 % held advanced vocational or university degrees. A total of 16 % admitted to using food supplements on a regular basis; 45.7 % claimed to use food supplements occasionally, and 34 % stated they did not believe in or use any food supplements.

H01: The use of food supplements is independent of gender.

Table 2. Food supplement consumption based on gender

Gender	"Yes, I use food supplements regularly"	"Yes, I use food supplements occasionally"	"No, I don't believe in food supplements"	Total
Women	39	72	46	157
Men	17	81	69	167
Total	**56**	**153**	**115**	**324**

Source: own research, 2019

The obtained $\chi 2$ value (13.47) is higher than the critical $\chi 2$ value of distribution for 2 degrees of freedom at a probability level of 0.95 (5.99). Therefore, the null hypothesis can be rejected. The use of food supplements is dependent on gender. Cramer's V is low, amounting to 0.20. Women can be said to use food supplements more frequently than men. This was also corroborated by Ruprich et al. (2006) in a study on individual food consumption.

Another monitored variable focused on determining whether the use of food supplements is related to the age of respondents. The highest number of food supplement users fall in the 21-30 years of age category (96), while the lowest number of supplement users is in the over 60 category (4). In this instance, the low number food supplement users can be attributed to the low income of respondents at retirement age, as the average monthly pension income amounted to just CZK 14,377 per month in 2018 (ČSSZ, 2019).

H02: The use of food supplements is independent of age.

Table 3. Food supplement consumption based on age

Age	"Yes, I use food supplements regularly"	"Yes, I use food supplements occasionally"	"No, I don't believe in food supplements"	Total
0-20 years of age	2	6	2	10
21-30 years of age	32	64	50	146
31-40 years of age	6	49	33	88
41-50 years of age	8	26	24	58
51-60 years of age	4	8	6	18
Over 60	4	0	0	4
Total	**56**	**153**	**115**	**324**

Source: own research, 2019

The obtained $\chi2$ value (30.80) is higher than the critical $\chi2$ value of distribution for 8 degrees of freedom at a probability level of 0.95 (15.51). Therefore, the null hypothesis can be rejected. The use of food supplements is dependent on age. Cramer's V amounts to 0.22. The level of food supplement consumption relative to age was determined in a similar manner by Ruprich at al. (2006).

The following table shows the correlation between the use of food supplements and the level of income. The highest number of food supplement users fall in the 20-30 thousand CZK category (93). In relative terms, the highest number of food supplement users are in the 15-20 thousand CZK category. By contrast, the lowest percentage of food supplement users belong to the over 50 thousand CZK category.

H03: The use of food supplements is independent of income.

Table 4. Food supplement consumption based on income

Income	"Yes, I use food supplements regularly"	"Yes, I use food supplements occasionally"	"No, I don't believe in food supplements"	Total
CZK 0-15,000	1	16	12	29
CZK 15,001-20,000	17	28	20	65
CZK 20,001-30,000	24	69	44	137
CZK 30,001-40,000	10	31	22	63
CZK 40,001-50,000	1	5	7	13
Over CZK 50,000	3	4	10	17
Total	**56**	**153**	**115**	**324**

Source: own research, 2019

The obtained $\chi2$ value (15.36) is lower than the critical $\chi2$ value of distribution for 8 degrees of freedom at a probability level of 0.95 (15.51). Therefore, the null hypothesis cannot be rejected; the use of food supplements is independent of the income level.

The following text focuses on analysing the impact that the gender, age and income criteria have on monthly investment in food supplements. The proposed null hypothesis was $H0_4$: There is no correlation between the amount of investment in food supplements and gender.

Table 5. Monthly investment in food supplements based on gender

Gender	CZK 0-200	CZK 201-350	CZK 351-500	CZK 501-1,000	Over CZK 1,000	Total
Women	62	40	30	26	16	174
Men	64	35	27	17	7	150
Total	**126**	**75**	**57**	**43**	**23**	**324**

Source: own research, 2019

The obtained χ2 value (4.17) is lower than the critical χ2 value of distribution for 6 degrees of freedom at a probability level of 0.95 (12.59). Therefore, the null hypothesis cannot be rejected; the amount of monthly investment in food supplements is independent of gender.

Research into the impact of age on the amount of investment in food supplements revealed that most respondents (108) spend up to CZK 200 per month on food supplements, 54 of whom belong to the 21-30 years of age category. The proposed null hypothesis was $H0_5$: There is no correlation between the amount of investment in food supplements and age.

Table 6. Monthly investment in food supplements based on age

Age	CZK 0-200	CZK 201-350	CZK 351-500	CZK 501-1,000	Over CZK 1,000	Total
0-20	3	6	3	1	1	14
21-30	60	24	30	20	8	142
31-40	28	26	12	14	8	88
41-50	33	13	3	6	3	58
51-60	3	8	5	1	1	18
Over 60	0	2	2	0	0	4
Total	**127**	**79**	**55**	**42**	**21**	**324**

Source: own research, 2019

The obtained χ2 value (36.50) is higher than the critical χ2 value of distribution for 10 degrees of freedom at a probability level of 0.95 (18.31). Therefore, the null hypothesis can be rejected. The monthly amount invested in food supplements is dependent on age. Cramer's V amounts to 0.17.

$H0_6$: There is no correlation between the amount of investment in food supplements and the level of income

Table 7. Monthly investment in food supplements based on the level of income

Income	CZK 0-200	CZK 201-350	CZK 351-500	CZK 501-1,000	Over CZK 1,000	Total
0-15,000	21	2	4	2	0	29
15,001-20,000	18	21	14	8	4	65
20,001-30,000	59	33	19	16	10	137
30,001-40,000	24	14	13	6	6	63
40,001-50,000	2	5	5	3	2	17
Over 50,000	2	2	3	6	0	13
Total	**126**	**77**	**58**	**41**	**22**	**324**

Source: own research, 2019

The obtained χ2 value (43.50) is higher than the critical χ2 value of distribution for 10 degrees of freedom at a probability level of 0.95 (18.31). Therefore, the null hypothesis can be rejected.

The monthly amount invested in food supplements is dependent on the level of income. Cramer's V amounts to 0.18.

A whole range of studies have shown how consumer interest in quality foods, organic foods and the overall nutritional composition of foods is growing (Kozior et al., 2020). This is especially evident among athletes, as documented by Coufalová (2016), who points out the increased interest of athletes in the nutritional composition of food and food supplements, however, with increasing awareness of diseases of civilization, the interest in food supplements is growing significantly, even in the non-sports population. The findings also fully correspond to the conclusions of Sundgot (2003), which points out the importance of the use of dietary supplements by Norwegian athletes. Maughan (2010) states that approximately 85% of athletes use some type of dietary supplement, and in the research by Braun et al. (2009) was concluded that more than 80% of German athletes use dietary supplements. The fact that food supplements are a large part of life for an increasing part of the population is clearly evidenced by statistics on the consumption of these goods.

4. Conclusion

The principal objective of this article was to present the results of research carried out in 2019 via a questionnaire survey. The selective sample included individuals with at least secondary education, in which secondary school leavers made up 91 % (294) of all respondents. The results revealed that 64.5 % of all respondents (209) admitted to using food supplements. In addition, more women than men were found to use food supplements (111:98). The purpose of the questionnaire survey was to identify the factors involved in the use of food supplements. The research has shown that gender and age also play a role in the use of food supplements. Furthermore, it demonstrated a correlation between the proportion of monthly income invested in food supplements and age, and between the amount invested monthly in food supplements and the respondents' level of income. By contrast, it did not establish any correlation between the level of income and the use of food supplements, or between the amount spent on food supplements and gender.

In the future, it is possible to focus, for example, on research into consumer behaviour when buying organic food and how consumers invest in health.

Acknowledgements

This work was supported by the Faculty of Economics and Management, Czech University of Life Sciences in Prague under Grant “The impacts of climate change on the economic performance of viticulture and wine production in the Czech Republic”, number 2020B0002.

References

Abbott, M. and McKinney, J. (2013), “*Understanding and applying research design*”, Hoboken, John Wiley & Sons, ISBN 97811118096482

Braun, H., Koehler, K., Geyer, H., Kleinert, J., Mester, J. and Schänzer, W. (2009), “Dietary supplement use among elite young German athletes”, *International journal of sport nutrition and exercise metabolism*, vol. 19, no. 1, pp. 97-109, DOI 10.1123/ijsnem.19.1.97

Coufalová, K. (2016), “Eating habits of Czech athletes with a focus on the use of food supplements”, *Czech Kinanthropology*, vol. 20, no. 4, pp. 39 - 49, ISSN 1211-9261

ČSSZ (2019), "*Statistical Yearbook of Pension Insurance – 2018*", Prague, The Czech Social Security Administration, ISBN 978-80-87039-54-0

Czech Statistical Office, Results of health accounts of the Czech Republic in the years2010-2018, Prague, 2020, [Online], Available: https://www.czso.cz/csu/czso/vysledky-zdravotnickych-uctu-cr-2010-2018, [Accessed: 29 Mar. 2020]

Czech Statistical Office, Using the Internet to Search for Health Information in the Czech Republic – 2018, Prague, 2019, [Online], Available: https://www.czso.cz/csu/czso/cri/vyuzivani-internetu -to-search-information-about-health-in-the-czech-republic-2018, [Accessed: 29 Mar. 2020]

Czech Statistical Office, We pay an average of 2,400 crowns a year for medicines, Prague, 2019, [Online], Available: https://www.czso.cz/csu/czso/za-leky-prumerne-platime-2-400-korun-rocne, [Accessed: 29 Mar. 2020]

Czechia, Act No. 110/1997 Coll. on Food and Tobacco Products and on Available and Supplementary Legislation, Prague, 2020, [Online], Available: https://www.zakonyprolidi.cz/cs/1997-110, [Accessed: 30 Mar. 2020]

Gorynska-Goldmann, E. (2019), "Barriers to the Development of Consumption Sustainability: the Consumers' Perspective on the Food Markets", *Hradec Economic days*, vol. 9, no. 1, pp. 243 - 251, DOI 10.36689/uhk/hed/2019-01-024

Institute for Health Economics and Technology Assessment, Structure of costs in Czech health care and mechanisms of their allocation, Prague, 2019, [Online], Available: https://www.politikaspolecnost.cz/wp-content/uploads/2020/01/Struktura-n%C3%A1klad%C5%AF-v-%C4%8Desk%C3%A9m-zdravotnictv%C3%AD-a-mechanismy-jejich-alokace-IPPS.pdf, [Accessed: 29 Mar. 2020]

Kozior, M., Jakeman, P.M. and Norton, C. (2020), "Peri-training nutrition methods: advancements to dietary assessment in an athletic population", *Applied Physiology, Nutrition, and Metabolism*, vol. 45, no. 5, pp. 564 - 568, DOI https://doi.org/10.1139/apnm-2019-0622

Maughan, R.J., Depiesse, F. and Geyer, H. (2010), "Dieting to win or to be thin? A study of dieting and disordered eating among adolescent elite athletes and non-athlete controls", *British Journal of Sports Medicine*, vol. 44, no. 1, pp. 70 - 76, DOI 10.1136/bjsm.2009.068668

Ministry of Agriculture, Decree No. 58/2018 Coll., on food supplements and food composition, Prague, 2018, [Online], Available: http://eagri.cz/public/web/mze/potraviny/aktualni-temata/doplnky-stravy/, [Accessed: 29 Mar. 2020]

Ministry of Health of the Czech Republic (2014), "*Health 2020 – National strategy for health Protection and Promotion and Disease Prevention*", Prague, Geoprint, ISBN 978-80-85047-47-9

Ruprich, J., Dofkova, M., Rehurkova, I., Slamenikova, E. and Resova, D. (2006), "*Individual Food Consumption – National Study SISP04*", Prague, CHFCH NIPH in Prague

Sundgot-Borgen, J., Berglund, B. and Torstveit, M. K. (2003), "Nutritional supplements in Norwegian elite athletes – impact of international ranking and advisors", *Scandinavian journal of medicine & science in sports,* vol. 13, no. 2, pp. 138 - 144, DOI 10.1034/j.1600-0838.2003.10288.x

SUSTAINABILITY ASSESSMENT OF AGRICULTURAL SYSTEMS IN ALBANIA: A MULTI-CRITERIA APPROACH

Orhan Zaganjori[1], Vladimír Krepl[2], Maitah Mansoor[3] and Seth Nana Kwame Appiah-Kubi[4]

[1, 3, 4] Department of Economics, Faculty of Economics and Management, CULS Prague, Czech Republic
[2] Department of Sustainable Technologies, Faculty of Tropical AgriSciences, CULS Prague, Czech Republic

[1]zaganjori@pef.czu.cz, [2]krepl@ftz.czu.cz, [3]maitah@pef.czu.cz, [4]appiah-kubi@pef.czu.cz

Annotation: The objective of this paper is to assess the sustainability of agricultural systems in Albania based on a multi-criteria approach. For this purpose, TOPSIS methodology is applied. Considering that there is no single widely accepted sustainability framework, in this study a set of 9 indicators are selected based on country-specific suitability as well as availability and reliability of data found on official statistical data sets. In addition, judgment-based statistical analysis conducted by four experts is used as a technique for validating, interpreting, and integrating data aiming at high-accuracy results. The results are presented in two different spatial scales, county and regional. Based on results from this paper, Kukës, Dibër, and Gjirokastër are top three counties having the most sustainable agriculture systems while Fier, Tiranë, and Elbasan represent bottom three counties. On the regional scale, amongst three regions, the Northern and the Southern regions have almost the same levels of sustainability of agricultural systems while the Central Albania is ranked as the region having the least sustainable agriculture system.

Key words: Sustainability, Agricultural Systems, Environment, Development, TOPSIS.

JEL classification: Q01, Q56.

1. Introduction

Agriculture is an all-inclusive word used to describe numerous ways in which crop plants and domestic animals sustain the global human population by producing food and other products (Harris and Fuller, 2014). In addition, agriculture provides non-commodity goods and services, shapes the environment, affects social and cultural systems, and contributes to economic growth (Huylenbroeck et al., 2007). However, there are long-lasting concerns regarding agriculture activities and their impact on the environment, economy and society. Molden (2007) stated that agriculture accounts for 70 percent of the freshwater withdrawals from rivers and groundwater. Springmann et al. (2016) claimed that the food system is responsible for more than a quarter of all greenhouse gas emissions. Kanianska (2016) noted that land-cover changes are responsible for vegetation modifications that impact regional climate, carbon sequestration, and biodiversity losses. Also, Kanianska (2016) added that intensive management practices lead to land degradation, soil and water deterioration. Similarly, Clark and Tilman (2017) pointed out that agriculture is a major cause of environmental degradation. Kołodziejczak (2018) described the utilization of capital, yields, productivity, labor force, and their economic implications in agriculture. Bekele and Bekele (2017) emphasized the importance of social aspects in terms of poverty alleviation, improvement of farmers' livelihood, access to education and training, as well as the attraction of youth to agriculture, and strengthening of women's position.

Sustainable development and sustainable agriculture have been a dominant theme in addressing such concerns. Sterling (2010) defined sustainable development as a reconciliation between economy and environment that would sustain human progress on the entire planet and for a long future. Marin et al. (2012) described sustainable development more as a synthesis between economy and ecology rather than a doctrine or theory. Milne and Gray (2013) added that defining sustainability requires the subordination of traditional economic criteria to criteria based not only on ecological but social values too. Similarly, the authors of this study consider the sustainability concept based on the three-pillars model; environmental, economic, and social. Meanwhile, sustainable agriculture was defined by Hill and MacRae (1988) as a philosophy and system of farming that involves benign designs and management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, prevent problems, as well as promote agroecosystem resilience and self-regulation and sustain production for the nourishment of all people. In other words, sustainable agriculture is in contrast with conventional agriculture which was described as "*capital-intensive, large-scale, highly mechanized agriculture with monocultures of crops and extensive use of artificial fertilizers, herbicides and pesticides, with intensive animal husbandry*" (Knorr and Watkins, 1984).

In this context, assessing sustainability is of utmost importance because it encompasses growth based on environmental protection, human and ecological health, as well as economic and social development. Thus, this study aims to assess the sustainability of agriculture systems. Albania is selected as the case country and a multi-criteria approach is applied.

2. Materials and Methods

In this study, TOPSIS multi-criteria decision method is applied. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a mathematical method used for the selection of all feasible alternatives through distance measures and rank them from positive-ideal to the negative-ideal solution. TOPSIS to the fuzzy environment method proposed by Chen (2000) is applied for the purpose of this study. A multi-criteria decision-making problem is expressed as:

$$D = \begin{array}{c c} & \begin{array}{cccc} W_1 & W_2 & \cdots & W_n \\ C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} & \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \qquad \mathbf{(1)}$$

From matrix (**1**), D represents the decision-makers, $\{A_1, A_2, \cdots, A_m\}$ refers to available alternatives, $\{C_1, C_2, \cdots, C_n\}$ expresses criteria. In addition, X_{mn} signifies the evaluation value of A_m alternative with respect to criterion C_n by decision-maker D. Also, $\{W_1, W_2, \cdots, W_n\}$ indicates the weight of criterion C_n.

Linguistic variables are used to assess attributes of criterion C_n for alternative A_m by decision-maker D. Table 1 shows linguistic variables:

Table 1. Linguistic Variables and Fuzzy Numbers

Linguistic Variables	Very Good (VG)	Good (G)	Medium (M)	Poor (P)	Very Poor (VP)
Fuzzy Number	(8, 10, 10)	(6, 8, 10)	(3, 5, 7)	(0, 2, 4)	(0, 0, 2)

Source: Chen, 2000

The criteria and sub-criteria weights are calculated as shown in equation **(2)** and **(3)**:

$$\widetilde{X}_{ij} = \frac{1}{K}\left[\tilde{x}_{ij}^{1}(+)\tilde{x}_{ij}^{2}\,(+)\cdots(+)\tilde{x}_{ij}^{K}\right] \quad (2)$$

$$\widetilde{W}_{j} = \frac{1}{K}\left[\widetilde{w}_{j}^{1}(+)\widetilde{w}_{j}^{2}\,(+)\cdots(+)\widetilde{w}_{j}^{K}\right] \quad (3)$$

K refers to the decision-makers. Normalized fuzzy decision matrix (**1**) can be formed as $\tilde{R} = \left[\tilde{r}_{ij}\right]_{mxn}$ (**4**), where B and C represent benefit and cost criteria as follows $\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), j \in$ B and $\tilde{r}_{ij} = \left(\frac{a_j^-}{a_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{c_{ij}}\right), j \in$ C where $c_j^* = \max c_{ij}$ if $j \in$ B, and $a_j^- = \min a_{ij}$ if $j \in$ C. Chen (2000) constructed the weighted fuzzy decision matrix as $\tilde{V} = \left[\tilde{v}_{ij}\right]_{mxn}$ (**5**), i= 1, 2, …, m, j = 1, 2, …,n where $\tilde{v}_{ij} = \tilde{r}_{ij} x \widetilde{w}_j$. Variables $\tilde{v}_{ij}$, $\forall i,j$ are normalized positive triangular fuzzy numbers ranging between 0 and 1. As such, fuzzy positive-ideal solution (FPIS, A^*) and fuzzy negative-ideal solution (FNIS, A^-) can be expressed as $A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \cdots, \tilde{v}_n^*)$ and $A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \cdots, \tilde{v}_n^-)$ where $\tilde{v}_1^* =(1, 1, 1)$ and $\tilde{v}_1^- = (0, 0, 0)$, j = 1, 2, ...,n.

Positive ideal solution (D^*) and negative ideal solution (D^-) are calculated using formula **(6)** and **(7)**:

$$D_i^* = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^*\right), i = 1, 2, \dots, m. \quad (6)$$

$$D_i^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), i = 1, 2, \dots, m. \quad (7)$$

D_i^* and D_i^- indicates the positive and negative distance between fuzzy numbers. Finally, the ranking order of alternatives A_m is performed by calculating the closeness coefficient (CC).

$$CC_i = \frac{D_i^-}{D_i^* + D_i^-}, i = 1, 2, \dots, m. \quad (8)$$

Values closest to 1 are the closest to the positive-ideal solution (the best) and values closest to 0 are the closest to the negative-ideal solution (the worst).

3. Results and Discussion

Albania is divided into twelve counties and three regions. As such, a set of 12 alternatives (A) was applied in this study. List of counties and regions is given in Table 2:

Table. 2 Counties and Regions in Albania

Region	**County**				
Northern	Shkodër	Lezhë	Kukës	Dibër	Durrës
Central	Tiranë	Elbasan			
Southern	Vlorë	Fier	Korçë	Gjirokastër	Berat

Source: Authors' own table based on data from INSTAT (2014)

Regarding indicators or criteria (C) there is not a generally accepted set of indicators for sustainability assessment of agriculture systems. Dong and Hauschild (2017) stated abundant sustainability indicators for different decision problems. Dahl (2012) noted that good indicators can be considered as such only if the data behind them is reliable. Similarly, Dizdaroglu (2017) added that the major issue in assessing sustainability is reliable and accessible data. For the purpose of addressing such concerns, a three-step procedure was followed. In the first step, prior research was conducted regarding the determination of criteria and their applicability in the local context of Albania. In the second step, aiming at addressing data accessibility and reliability concerns, a thorough check of available data sets from public and official sources at the national and international levels has been carried out. It must be highlighted that all data analyzed in this study is from years 2017 and 2018. In the third step, four experts in the field of statistics (D) were asked to assess criteria and alternatives relying on given data as well as their judgment. Expert judgment was applied because is commonly regarded as an adequate technique for validating, integrating and interpreting data. This is considered particularly important in Albanian case.

A list of nine criteria was selected. Table 3 shows the list and statistical information source:

Table 3. List of criteria used to assess the sustainability of agriculture systems in Albania

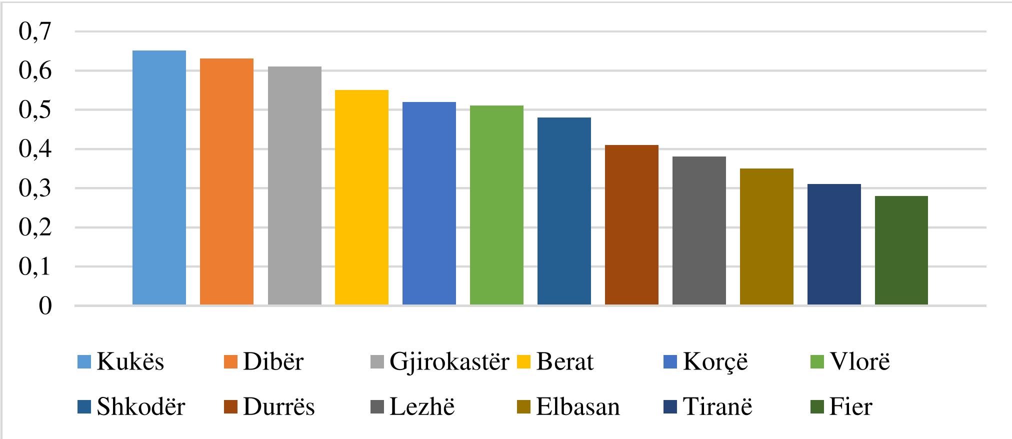
Criterion	**Aspect**	**Source**
	Environmental	
C_{11}	*Soil Quality*	(NEA, 2019*a*; NEA, 2019*b*; NEA, 2018*a*; NEA, 2018*b*)
C_{12}	*Surface Water Quality*	(NEA, 2019*a*; NEA, 2019*b*; NEA, 2018*a*; NEA, 2018*b*)
C_{13}	*Underground Water Quality*	(NEA, 2019*a*; NEA, 2019*b*; NEA, 2018*a*; NEA, 2018*b*)
	Economic	
C_{21}	*Number of cattle*	(INSTAT, 2019; INSTAT, 2018)
C_{22}	*Milk production*	(INSTAT, 2019; INSTAT, 2018)
C_{23}	*Arable Cereal Crops*	((INSTAT, 2019; INSTAT, 2018)
C_{24}	*Yields of Cereal Crops*	(INSTAT, 2019; INSTAT, 2018)
	Social	
C_{31}	*Workforce in Agriculture Sector*	(INSTAT, 2019; INSTAT, 2018)
C_{32}	*Gender Equality*	(INSTAT, 2019; INSTAT, 2018)

Source: Authors' selection based on their own research

In the analysis for criterion C_{11} *Soil Quality* was taken into consideration the concentration of copper (Cu), manganese (Mn), zinc (Zn), and iron (Fe). For criterion C_{12} *Surface Water Quality* was analyzed magnesium (Mg), calcium (Ca) and pH scale. While for criterion C_{13} *Underground Water Quality* phosphorus (P), nitrate-nitrogen (NO2-NO3) and oxygen levels. In the analysis for criteria C_{21} *Number of Cattle* and C_{22} *Milk Production* were considered cows, sheep, and goats. For criteria C_{23} *Arable Cereal Crops* and C_{24} *Yields of Cereal Crops* were considered wheat, maize, barley, rye, and oats. Criterion C_{31} *Workforce in Agriculture Sector* was analyzed as the percentage of the working force employed in agriculture sector out total working force employed. While criterion C_{32} *Gender Equality* was analyzed as the percentage of women farmers heading the farms out of all farmers.

Alternatives are rated by decision-makers using linguistic and triangular fuzzy variables from Table 1. Formula **(4)** is applied to construct a normalized decision matrix, while the weighted normalized fuzzy decision matrix is calculated according to formula **(5)**. Fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FNIS) is calculated based on the formula **(6)** and **(7)**. The closeness coefficient is calculated using formula **(8)**. The results of closeness coefficient are given in Chart 1:

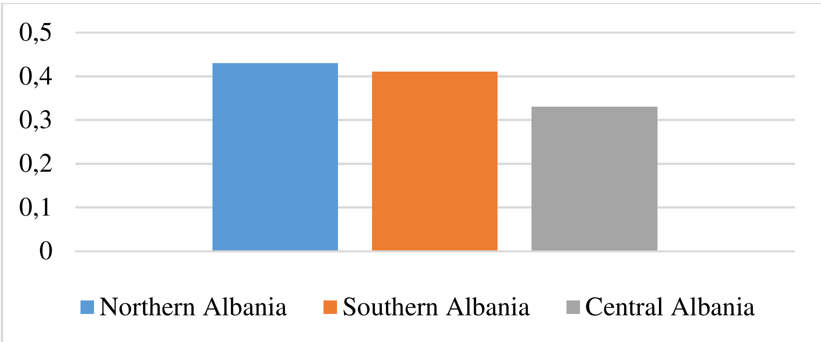
Chart 1. Sustainability Assessment of Counties in Albania



Source: Authors' own results

The findings from Chart 1 indicate that alternatives (A) are in the following ranking order Kukës < Dibër < Gjirokastër < Berat < Korçë < Vlorë < Shkodër < Durrës < Lezhë < Elbasan < Tiranë < Fier. In value terms, the closeness coefficient for Kukës is 0.65, Dibër 0.63, Gjirokastër 0.61, Berat 0.55, Korçë 0.52, Vlorë 0.51, Shkodër 0.48, Durrës 0.41, Lezhë 0.38, Elbasan 0.35, Tiranë 0.31, and Fier 0.28.

Chart 2. Sustainability Assessment of Regions in Albania



Source: Authors' own results

As shown in Chart 2, the following ranking order on the regional scale is Northern Albania < Southern Albania < Central Albania. The closeness coefficient for each region is Northern Albania 0.43, Southern Albania 0.41, and Central Albania 0.33.

4. Conclusion

The results of this study suggest that county having the best sustainable agricultural system in Albania is Kukës followed by Dibër while county having the worst sustainable agricultural system in Albania is Fier and then Tiranë. On the regional scale, the Northern region appears to be leading in terms of sustainability, however, it must be pointed out that it shares a very slight difference of 0.02 with the Southern region. The same could not be said for Central Albania. In contrast with the Northern and the Southern regions, the Central region has a difference of 0.10 with the Northern region, and 0.08 with the Southern region. None of the regions seems to be above 0.50. In other words, neither Northern Albania nor Southern Albania and Central Albania scored more than half of what is the ideal level of sustainability (equal to 1). On the county scale, it may be worth mentioning that from the four most densely populated counties in Albania (Tiranë, Durrës, Fier, Elbasan) three of them are ranked as the three least sustainable counties (Fier, Tiranë, Elbasan).

Milovanovic and Smutka (2017) when assessing the competitiveness of the South Asian agriculture sector considered fertilizer and pesticide application. Because of the very low reliability of available data concerning the use of fertilizers and pesticides in Albanian case, in this study soil and water quality was analyzed instead. Rovný et al. (2017) when investigating challenges faced by farmers considered soil and water quality as one of the main issues. Similarly, Gebeltová and Malec (2018) added that rich soil is necessary for sustainable agriculture. From the economic and social aspect, Flores et al. (2018) examined the yields and distribution of employees. In this study, such indicators were analyzed considering livestock and crop production. In the social aspect, the working force employed in agriculture, as well as equal opportunities for women in leading farms, were considered.

Also, the study has some limitations which should be addressed. Analyzes and calculations were performed based on public and official data, however, Eurostat (2019) noted that the official data provided by INSTAT are not in line with European requirements and do not represent the real situation. As such, expert judgment technique was used. Even though the judgment-based statistical analysis was applied to achieve high-accuracy results, there is a risk for subjective biases in process and metrics analyses. Furthermore, in order to gain a deeper insight into the sustainability of agricultural systems, a longitudinal study considering similar and/or other indicators can be proposed.

Acknowledgements
The authors would like to thank the Institute of Statistics (INSTAT) and the National Environment Agency (NEA) of Albania for their cooperation. “”

References

Bekele, F., and Bekele, I. (2017), “Social and Environmental Impacts on Agricultural Development”, In: Ganpat, W. G., Dyer, R. and Isaac, W. A. P. (eds.), “*Agricultural Development and food security in developing nations*” Hershey, IGI Global, pp. 21-56, DOI 10.4018/978-1-5225-0942-4.ch002

Chen, C. T. (2000), “Extensions of the TOPSIS for Group Decision-Making Under Fuzzy Environment”, *Fuzzy Sets and Systems*, vol. 114, no. 1, pp. 1-9, DOI 10.1016/S0165-0114(97)00377-1

Clark, M. and Tilman, D. (2017), “Comparative Analysis of Environmental Impacts of Agricultural Production Systems, Agricultural Input Efficiency, and Food Choice”, *Environmental Research Letters*, vol. 12, no. 6, 064016, DOI 10.1088/1748-9326/aa6cd5

Dahl, A. L. (2012), “Achievements and Gaps in Indicators for Sustainability”, *Ecological Indicators*, vol. 17, pp. 14-19, DOI 10.1016/j.ecolind.2011.04.032

Dizdaroglu, D. (2017), “The Role of Indicator-Based Sustainability Assessment in Policy and the Decision-Making Process: A Review and Outlook” *Sustainability*, vol. 9, no. 6, 1018, DOI 10.3390/su9061018

Dong, Y., and Hauschild, M. Z. (2017), “Indicators for Environmental Sustainability”, *Procedia CIRP*, vol. 61, pp. 697-702, DOI 10.1016/j.procir.2016.11.173

Eurostat (2019), "*A Sector Review of Agriculture Statistics of the Republic of Albania: Final Report*", Brussels, European Commission

Flores, J. A., Konrad, O., Flores, C. R. and Teresinha, N. S. (2018), "Sustainability Indicators for Bioenergy Generation from Amazon's Non-Woody Native Biomass Sources", *Data in Brief*, vol. 21, pp. 1900-1908, DOI 10.1016/j.dib.2018.11.022

Gebeltová, Z. and Malec, K. (2018), "Analysis of Selected Factors Affecting Official Land Prices in Czech Agriculture (2009-2018)", *Proceedings of Agrarian Perspectives XXVII*, Prague, pp. 51 - 57, ISBN 978-80-213-2890-7

Harris D.R. and Fuller D. Q. (2014), "Agriculture: Definition and Overview", In: Smith C. (ed.) "*Encyclopedia of Global Archaeology*" New York, Springer, DOI 10.1007/978-1-4419-0465-2_64

Hill, S. and MacRae, R. J. (1988), "Developing Sustainable Agriculture education in Canada", *Agriculture and Human Values*, vol. 5, no. 4, pp. 92-95, DOI 10.1007/BF02217652

Huylenbroeck, G. V., Vandermeulen, V., Mettepenningen, E. and Verspecht, A. (2007), "Multifunctionality of Agriculture: A Review of Definitions, Evidence and Instruments", *Living Reviews: Landscape Research*, vol. 1, no. 3, pp. 1-43, DOI: 10.12942/lrlr-2007-3

INSTAT, Institute of Statistics, Ndarja Administrative, 2014, [Online], Available: http://www.instat.gov.al/al/dokumentimi/klasifikimet/version/?verId=3488, [Accessed: 2 Apr. 2020]

INSTAT, Institute of Statistics, Vjetari Statistikor Rajonal, 2018, [Online], Available: http://www.instat.gov.al/media/4938/vjetari-statistikor-rajonal-2018.pdf, [Accessed: 3 Apr. 2020]

INSTAT, Institute of Statistics, Vjetari Statistikor Rajonal, 2019, [Online], Available: http://www.instat.gov.al/media/6558/vsr-alb.pdf, [Accessed: 3 Apr. 2020]

Kanianska, R. (2016), "Agriculture and Its Impact on Land-Use, Environment, and Ecosystem Services", In: Almusaed, A. (ed.), "*Landscape Ecology"*, London, IntechOpen, pp. 3 - 26, DOI: 10.5772/63719

Knorr, D. and Watkins, T. R. (1984), "*Alterations in Food Production*". New York, Van Nostrand Reinhold, ISBN 9780442248604

Kołodziejczak, W. (2018), "Reduction of Employment as the Way to Balance Production Processes in the Polish Agriculture", *Proceedings of the Agrarian Perspectives XXVII*, Prague, pp. 128 - 135, ISBN 978-80-213-2890-7

Marin, C., Dorobantu, R., Codreanu, D. and Mihaela, R. (2012), "The Fruit of Collaboration Between Local Government and Private Partners in the Sustainable Development Community Case Study: County Valcea", *Economy Transdisciplinarity Cognition*, vol. 15, no. 2, pp. 93-98, ISSN 2067-5046

Milne, M. J. and Gray, R. (2013), "W(t)ither Ecology? The Triple Bottom Line, the Global Reporting Initiative, and Corporate Sustainability Reporting", *Journal of Business Ethics*, vol. 118, pp. 13-29, DOI 10.1007/s10551-012-1543-8

Milovanovic, V. and Smutka, L. (2017), “Competitiveness of South Asian Agriculture: A Critical Assessment”, *Proceedings of the Agrarian Perspectives XXVI*, Prague, pp. 233 - 240, ISBN 978-80-213-2787-0

Molden, D. J. (2007), “*Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*”. London: International Water Management Institute, ISBN 978-1-84407-397-9

NEA, National Environment Agency, Raporti i Gjëndjes Në Mjedis 2017, Tirane, 2018a, [Online], Available: http://akm.gov.al/assets/raporti-akm-2017_preview_09052018.pdf-ardhur-nga-shtepia-botuese.pdf, [Accessed: 3 Apr. 2020]

NEA, National Environment Agency, Programi Kombëtar i Monitorimit të Mjedisit Për Vitin 2017, Tirane, 2018b, [Online], Available: http://www.akm.gov.al/assets/pkmm-2017.pdf, [Accessed: 3 Apr. 2020]

NEA, National Environment Agency, Raporti i Gjëndjes Në Mjedis 2018, Tirane, 2019a [Online], Available: http://www.akm.gov.al/assets/raporti-i-gjendjes-ne-mjedis-2018.pdf, [Accessed: 3 Apr. 2020]

NEA, National Environment Agency, Programi Kombëtar i Monitorimit të Mjedisit Për Vitin 2018, Tirane, 2019b [Online], Available: http://www.akm.gov.al/assets/pkmm-2018.doc-pdf.pdf, [Accessed: 3 Apr. 2020]

Rovný, P., Dobák, D., Kádeková, Z., Kubicová, L. and Smutka, L. (2017), “Minimum Land Requirements for Average Family Income Produced in the Slovak Agriculture”, *Proceedings of the Agrarian Perspectives XXVI*, pp. 327 - 334, ISBN 978-80-213-2787-0

Springmann, M., Godfray, H. J., Rayner, M. and Scarborough, P. (2016), “Analysis and Valuation of the Health and Climate Change Cobenefits of Dietary Change”, *Proceedings of the National Academy of Sciences of the United States of America*, Minnesota, pp. 4146 - 4151, DOI 10.1073/pnas.1523119113

Sterling, S. (2010), “Learning for Resilience, or the Resilient Learner? Towards a Necessary Reconciliation in a Paradigm of Sustainable Education”, *Environmental Education Research*, vol. 16, no. 5-6, pp. 511 - 528, DOI 10.1080/13504622.2010.505427

ASSESSING THE AGRICULTURAL TRADE COMPLEMENTARITY OF MERCOSUR AND THE EUROPEAN UNION

Ivo Zdráhal[1], Martin Hrabálek[2] and Věra Bečvářová[3]

[1, 3] Department of Regional and Business Economics, [2] Department of Territorial Studies, Faculty of Regional Development and International Studies, Mendel university in Brno, Czech Republic

[1]ivo.zdrahal@mendelu.cz, [2]martin.hrabalek@mendelu.cz, [3]vera.becvarova@mendelu.cz

Annotation: This article aims to assess the level and changes in agri-food trade complementarity of MERCOSUR and EU by employing 3 different methods when interrogating the nature and pattern of trade between MERCOSUR and EU. The Trade complementarity index, the Export similarity index and the Spearman' rank correlation coefficients of the competitiveness indicators were used to assess the agri-food trade complementarity of MERCOSUR and EU. The analysis of the complementarity is concentrated on the period from 1999 to 2018. The agri-food trade is defined broadly as 59 products / sectors by SITC classification. The data for analysis came from UNCTAD. The analysis was done at aggregated level (the bilateral trade relations of specific countries are not assessed). The scores of the export similarity index and the association between trade competitiveness indices imply that the MERCOSUR and EU28 (as a blocks) are weakly complementary in agriculture trade in the world market. Also, the decreases of scores indicate that MERCOSUR and EU are getting less substitutable (less competing) on the world market. The results of the trade complementarity index indicate the weak complementarity of the MERCOSUR's export specialization and EU's import specialization when compared to the import specialization typical for the world market. From the EU's perspective, the results of the trade complementarity index indicate that the export and import specializations are similar to the world economy. The result provides relevant policy-related information that contributes to regional and inter-regional integration programs.

Key words: Liberalization, Balassa index, Export similarity index, Trade complementary index, Spearman correlation

JEL classification: Q17, F14, F15

1. Introduction

The increase in regionalism and the growing number of preferential trade agreements between individual regional integration groups are examples of the changes in the world economy in the past decades (Cihelková, 2012). The European Union (as the most advanced bloc) has already established preferential agreements with a number of third countries (or groupings of countries) to define the institutional framework for mutual trade, investments and other interactions (EC, 2020). Currently, the EU negotiates agreements with other countries and integration groupings and one of the reginal blocs with which the EU has been negotiating the new form of mutual economic relations is the MERCOSUR (Mercado Común del Sur) group of countries (Hrabálek and Machačová, 2015). MERCOSUR includes the South American states of Argentina, Paraguay, Uruguay and Brazil, that is the leading economy in the bloc. After two decades of consultations and negotiations, a final document on a future trade agreement was reached in June 2019.

The main controversial topic is the liberalization of agrarian markets, where the EU is very protective and the counterparty is significantly competitive (Hrabálek, 2015). In this context, it is important to mention that Brazil has actively developed its comparative advantage in agri-food production and trade, has become a global agri-food powerhouse and serious competitor to the global market dominance of the world's leading agricultural exporters (Zdráhal, 2019a). Therefore, regarding the liberalization of agrarian markets, the final document on a future trade agreement was immediately criticized by a number of EU organizations and EU member states and can be expected to be the subject of political discussions and probably disputes within the EU itself. That is why it is reasonable to shed light on the level and changes in agri-food trade complementarity of MERCOSUR and EU as a part of ongoing debate on trade liberalization.

This article aims to assess the level and changes in agri-food trade complementarity of MERCOSUR and EU by employing 3 different methods when interrogating the nature and pattern of trade between MERCOSUR and EU.

2. Materials and Methods

The analysis of the changes in agrarian foreign trade between MERCOSUR and the European Union (EU 28) is based on the UNCTAD data. The analyzed time series covers the period 1998-2018. For the purpose of analyzing the commodity structure of agrarian foreign trade, the individual sectors (product groups) are defined according to the Standard International Trade Classification (SITC) Revision 3. The analysis was carried out at the level of 3-digit code, i.e. for 59 different commodity groups of agrarian foreign trade (SITC 0 + 1 + 2 + 4 - 232 - 251 - 266 - 267 - 269 - 27 - 28). The sum of these is the total agrarian trade. The nominal values of the trade flows are in current prices in USD. The dynamics of agrarian trade of MERCOSUR and EU was described by looking at the trends in the value of agrarian exports, imports and balance. Also, the Trade balance index (Smutka et al., 2018) to analyses whether a bloc has specialization in export (as net-exporter) or import (as net-importer).

The Trade complementarity index, the Export similarity index and the Spearman' rank correlation coefficients of the competitiveness indicators were used to assess the agri-food trade complementarity of MERCOSUR and EU. These procedures and indices are the traditional and recognized tools (Jayawickrama and Thangavelu, 2010; Yu and Qi, 2015; Hoang, 2018) used in empirical trade analysis.

Export similarity index (ESI) was proposed by Finger and Kreinin (Finger and Kreinin, 1979) and is used to measure the similarity of exported products between two countries in the world market. The computation formula is as follows:

$$ESI(ab,w) = 100 \times \left\{\sum_j^n \min\left(\frac{x_a^j}{x_a}, \frac{x_b^j}{x_b}\right)\right\} \quad \mathbf{(1)}$$

where *ESI(ab,w)* represents the product similarity index of exports of country *a* and country *b* to the market *w*. The $x_a^j \,/\, x_a$ represents the ratio of the commodity *j* exported by the country *a* to the world (*w*) to the total agrarian export of country *a* to market *w*. The $x_b^j \,/\, x_b$ represents the ratio of the commodity *j* exported by the country *b* to the world (*w*) to the total agrarian export of country *b* to market *w*. The value of index ranges from 0 to 100. In the case the two countries export exactly the same products, the index is 100 (countries are competing in the world market); if they export completely different products, then the index is 0 (it indicates division of labor and natural possibilities to trade).

Trade complementarity index (TCI) was proposed by Drysdale (Drysdale, 1969) and the main idea is to measure the extent to which one country's export structure matches another country's import structure more closely that it matches the structure of the world imports. The computation formula is as follows:

$$TCI_{ab} = \sum_j^n \left(\frac{X_a^j}{X_a} \times \frac{M_w - M_a}{M_w^j - M_a^j} \times \frac{M_b^j}{M_b} \right) \quad (2)$$

where M_a^j and M_b^j are imports of commodity *j* by the countries *a* resp. *b*, M_a and M_b are total agrarian imports of countries a resp. b, M_a^j is the world import of commodity j and M_w is the total world agrarian import. The TCI value of unity indicates that the export and import specializations are similar to the world economy specialization and the existence of comparative advantage cannot explain the bilateral trade (Hoang, 2018). The value of TCI grater then (smaller) than unity points to the existence of strong (weak) complementarity between the export specializations of country *a* and the import specialization of country *b*.

The level of association between trade competitiveness indices of two countries (group of countries) is a respectable instrument to measure the complementarity between them (Jayawickrama and Thangavelu 2010; Hoang 2018). To capture the degree of trade specialization (competitiveness) of a group of countries, we assessed the revealed comparative advantages of the sectors included in the total agrarian trade. To achieve this, Balassa (1965, 1977) suggested the following index of revealed comparative advantage:

$$BI_{ij} = \frac{\frac{x_{ij}}{X_i}}{\frac{x_{wj}}{X_w}} \quad (3)$$

In this calculation *x* represents exports, *i* is a country, *j* is a product and *w* is a set of countries (world). The Balassa index varies between 0 and infinity. The values between 0 and 1 indicating that the country reveals comparative disadvantage and the values between 1 and infinity signals that the country has a comparative advantage in that specific sector.

When calculating the BI scores for each product for both MERCOSUR and EU, the Spearman's rank correlation was useful to assess the degree and nature of the association between trade competitiveness indicators. The computation formula for Spearman's rank correlation coefficient is as follows:

$$\rho_s = 1 - \left\{ \frac{6 \sum_j^n d_j^2}{n(n^2-1)} \right\} \quad (4)$$

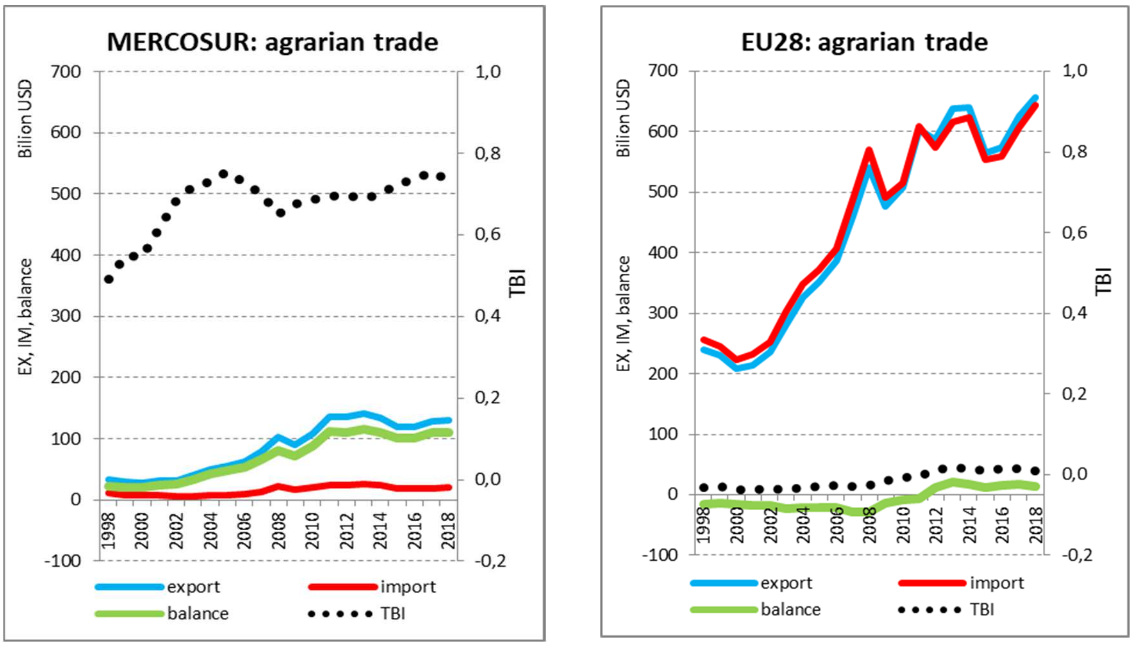
The score ranges from -1 to +1. A positive (negative) score indicates that the two countries are substitutable on the world market. A negative score indicates that the two countries are complementary on the world market.

3. Results and Discussion

The value of agri-food trade has significantly increased in the case of MERCOSUR as well as EU28 (fig. 1). MERCOSUR's total agrarian export value increased 4.4 times between 1999 and 2018 to 130.6 billion USD. The value of total agrarian import to MERCOSUR states also rose, but only 2.3 times and reached 20.2 billion USD in 2018. The MERCOSUR shows a position of a net-exporter (TBI value increased from 0.49 to 0.73 in 1999 resp. 2018) and the balance of agrarian trade reached 110.4 billion USD in 2018. Especially Brazil plays a dominant role in this trade. The EU28's total agri-food trade shows higher values in comparison to MERCOSUR and the export and import values increased 4.8 resp. 2.6 times between 1999 and 2018 and reached values of 657.0 and 643.5 billion USD. The EU28 is currently also in a position of a net-exporter (TBI value increased from -0.03 to 0.01 in 1999 resp. 2018) and the balance of agrarian trade reached 13.5 billion USD in 2018.

The dynamics of agri-food trade of both, the MERCOSUR and EU28, has increased especially in the early 2000s. Such an increase occurred in the new millennium and can be linked to the implementation of the Uruguay Round Agreement on Agriculture (URAA) and to compulsory 36% cut in average bound tariffs at the end of 2000 for developed countries and 2004 for developing ones (Bureau et al., 2017). Together with the decrease in unilaterally applied tariffs levels and preferential applied tariffs levels, both groups of countries increased its integration in global agribusiness. In the case of EU28, accession of new Member States (2004 and further) has boosted agricultural trade, especially within the EU's internal market. The 75% of the value of agrarian trade is traded intra-regionally; the rest is traded between EU and non-EU member states.

Figure 1. Change in the value of agrarian trade



Source: UNCTAD, own calculations

The MERCOSUR countries are the world´s leading exporter of soy-based products (soybeans, oilcakes, feed stuffs, fats and oils), sugarcane products (sugar and bioethanol), meat, coffee and cereals. The EU exports a wide range of products from all parts of the value chain which demonstrates the competitiveness of the EU agri-food sector in a variety of product classes reaching from commodities to highly processed food industry products. Notably, the share of final products in exports increased slightly over the last 10 years, up to 42.1% in 2018. EU imports, on the other hand, are clearly dominated by agricultural food and feed products; the share of imports of final agricultural products was 17.8% in 2018 (European Commission, 2018). This shows the strength of the EU agri-food sector in producing high value added quality produce.

The value of bilateral agrarian trade between MERCOSUR and EU28 countries has increased from 12.6 to 24.2 billion USD in 1999 resp. 2018. MERCOSUR's export to EU28 reached 21.4 billion USD in 2018, the imports from EU28 were around 2.9 billion USD in 2018. Despite the increase in the values of traded agri-foods, the European Union is gradually losing its share in the structure of export of MERCOSUR's countries (certain exception is the EU's share in MERCOSUR's countries imports). More detailed trade analyses can be found in Zdráhal et al. (2019a) and Zdráhal et al. (2019b).

The agricultural trade complementarity of MERCOSUR and the European Union was assessed by employing export similarity index (ESI), the Spearman' rank correlation coefficients of the association between agrarian trade competitiveness indices (Scorrelation) and trade complementarity index (TCI shows complementarity both ways - MERCOSUR to EU28 and EU28 to MERCOSUR). The following table (tab. 1) presents the average scores of mentioned indices in four sub-periods. The first sub-period (1999-2003) is the one before the agrarian trade of MERCOSUR countries started to expand. Also, it was a time before the new member state has joint the EU. For the second one (2004-2008) is typical that the agrarian trade of both groups was significantly increasing (in the case of EU it was mainly intra-regional trade), but lately affected by the Great Recession. The next period (2009-2013) represents the time of Great Recession and recovery. The last one (2014-2018) represents the current state after the recovery period.

Table 1. The agricultural trade complementarity of MERCOSUR and the European Union

	1999-2003	2004-2008	2009-2013	2014-2018	1999-2018
ESI	43.0	42.5	41.4	38.9	41.4
Scorrelation	-0.270	-0.186	-0.190	-0.257	-0.226
$TCI_{MERCOSUR \rightarrow EU28}$	0.917	0.886	0.844	0.793	0.860
$TCI_{EU28 \rightarrow MERCOSUR}$	1.106	1.056	1.089	1.059	1.078

Source: UNCTAD, own calculations

The score of export similarity index indicates the degree of similarity of agrarian exports between MERCOSUR and EU28 countries on the world market. In other words, it shows the trade complementarity of both countries by comparing its export patterns on the world market. The score of ESI was 43.0 at the beginning of the analyzed period and decreased to 38.9 at the end of the analyzed period. In general, this indicates weak degree of difference of complementarity (100 would signal identical structure of exports) of MERCOSUR's and EU28's agricultural exports on the world market and in the same time, the decrease indicates that MERCOSUR and EU28 are getting less substitutable (less competing) on the world market. In other words, the complementarity of MERCOSUR's and EU28's agricultural exports on the world market has increased. The complementarity increased especially in the second half of the analyzed period (2009-2018).

The Spearman' rank correlation coefficients of the Balassa scores shows the level of association between agrarian trade competitiveness indices (on the world market) of MERCOSUR and EU28. The coefficients were -0.270, -0.186, -0.190 and -0.257 in particular periods. This indicates weak complementarity of MERCOSUR and EU28 on the world market (-1 would signal opposite to identical structure of exports). The change in coefficients shows firstly the decrease in complementarity (increase of competition between both groups) between

1999 and 2009, but in the second half of the analyzed period, the trend changed and the complementarity of MERCOSUR and EU28 on the world market is increasing again.

Trade complementarity index measures the extent to which MERCOSUR's (EU's) agrarian export pattern matches EU's (MERCOSUR's) agrarian import pattern more closely than it matches the pattern of world imports. The TCI score of unity means that the export and import specializations are similar to the world market. The scores of TCI (0.917, 0.886, 0.844 and 0.793) are smaller than unity. That indicates the weak complementarity of the MERCOSUR's export specialization and EU's import specialization when compared to the import specialization typical for the world market. The decreased in the scores indicate that the complementarity is becoming weaker. In other words, the structure of MERCOSUR's supply is becoming more and more in line with the structure of demand on the world market (in general), then with the EU's import specialization. The scores of TCI (1.106, 1.056, 1.089 and 1.059) indicate that EU's agricultural export specialization and MERCOSUR's import specialization show (during the analyzed period) existence of rather stronger complementarity, but the scores are close to unity. The scores are fluctuating, but the trend is decreasing. The closer the scores will be to unity, the more the EU's export specialization would match to MERCOSUR's import specialization in the same way as to the pattern of world imports.

4. Conclusion

This article aimed to assess the level and changes in agri-food trade complementarity of MERCOSUR and EU. Based on the above analyses, we can conclude the following. The results of ESI and the association between trade competitiveness indices imply that the MERCOSUR and EU28 (as a blocks) are weakly complementary in agriculture trade in the world market. In addition, both methods indicate that the complementarity is slightly increasing. In other words, MERCOSUR and EU are getting less substitutable (less competing) on the world market. The results of TCI indicate the weak complementarity of the MERCOSUR's export specialization and EU's import specialization when compared to the import specialization typical for the world market. Also, the decrease in the scores indicate that the MERCOSUR's export specialization is matching more and more with the needs of the world market rather than with the EU's import specialization. From the EU's perspective, the results of TCI indicate that the export and import specializations are similar to the world economy. Generally, the results support the ongoing liberalization process and the rationale for the cooperation and taking advantage of existing economic resources exists in the segment of agrarian products (at least at the level of entire blocks trading). However, gains and losses from trade liberalization can differ within both blocks. Therefore, further research and evaluations, especially at the bilateral level (country to country) and from an angle of specific industries, need to be done.

Acknowledgements

This work was supported by Internal Grant Agency of Faculty of Regional Development and International Studies, Mendel University in Brno, under no.: FRRMS_IGA_2020/012

References

Balassa, B. (1965), "Trade Liberalisation and Revealed Comparative Advantage", *The Manchester school*, vol. 33, no. 2, pp. 99 - 123, ISSN 1467-9957, DOI 10.1111/j.1467-9957.1965.tb00050.x

Balassa, B. (1977), “Revealed' Comparative Advantage Revisited: an Analysis of Relative Export Shares of the Industrial Countries, 1953-1971”, *The Manchester school*, vol. 45, no. 4, pp. 327 - 344, ISSN 1467-9957, DOI 10.1111/j.1467-9957.1977.tb00701.x

Cihelková, E. (2012), *“Aktuální otázky světové ekonomiky: proměny a governance”*, Prague, Professional Publishing, ISBN 978-80-7431-104-8

Drysdale, P. (1969), “Japan, Australia, New Zealand: the prospect for western pacific economic integration”, *Economic Record*, vol. 45, no. 3, pp. 321-342, ISSN 1475-4932, DOI 10.1111/j.1475-4932.1969.tb00174.x

EC, European Commission: Agri-food trade in 2018, Brussels, 2020, [Online], Available: https://1url.cz/RzBDC [Accessed: 20 Apr. 2020]

EC, European Commission: Economic partnerships, 2020, Brussels, [Online], Available: https://1url.cz/WzBDu [Accessed: 15 Apr. 2020]

Finger, J. M. and Kreinin, M. E. (1979), “A Measure of `Export Similarity' and Its Possible Uses”, *The Economic Journal*, vol. 89, no. 356, pp. 905 - 912, ISSN 0013-0133, DOI 10.2307/2231506

Hoang, V. (2018), “Assessing the agricultural trade complementarity of the Association of Southeast Asian Nations countries”, *Agric. Econ. – Czech*, vol. 64, no. 10, pp. 464 - 475, ISSN 1805-9295, DOI 10.17221/253/2017-AGRICECON

Hrabálek, M. (2015), “European Union and Liberalization of Global Trade: The Case of Agriculture”, *Proceedings of 12th International Scientific Conference: Economic Policy in the European Union Member Countries*, Karviná, pp. 236 - 242, ISBN 978-80-7510-114-3

Hrabálek, M. and Machačová, L. (2015), “Interregional Cooperation between EU and Mercosur: The Prospect of a Free Trade Agreement?”, *Proceedings of X. International Conference on Applied Business Research ICABR*, Brno, pp. 344 - 350, ISBN 978-80-7509-379-0

Jayawickrama, A., Thangavelu, M. (2010), “Trade linkages between China, India and Singapore: Changing comparative advantage of industrial products”, *Journal of Economic Studies*, vol. 37, no. 3, pp. 248 - 266, ISSN 0144-3585, DOI 10.1108/01443581011061267

Smutka L., Maitah M., Svatoš M. (2018), “Changes in the Czech agrarian foreign trade competitiveness – different groups of partners’ specifics”. *Agric. Econ. – Czech*, vol. 64, no. 9, pp. 399 - 411, ISSN 1805-9295, DOI 10.17221/399/2016-AGRICECON

UNCTAD, United Nations Conference on Trade and Development, World statistical database, Geneve, 2020, [Online], Available: https://bit.ly/21GbfKX, [Accessed: 20 Jan. 2020]

Yu, C. and Qi, C. (2015), “Research on the Complementarity and Comparative Advantages of Agricultural Product Trade between China and CEE Countries”, *Journal of Service Science and Management*, vol. 8, no. 2, pp. 201 - 208, ISSN 1940-9907, DOI 10.4236/jssm.2015.82022

Zdráhal, I., Daňková, B., Hrabálek, M., Juráňová, L. and Vašíčková, D. (2019a), “Agri-food Trade Patterns of Brazil: the Role of European Union and China”. *Proceedings of the 28th International Scientific Conference Agrarian Perspectives XXVIII*, Prague, pp. 371 - 378, ISBN 978-80-213-2973-7

Zdráhal, I., Chmelíková, G., Juráňová, L., Minaříková, V. and Bečvářová, V. (2019b), "Agri-food Trade Patterns of Argentina". *Proceedings of the 13th International Scientific Conference INPROFORUM*, České Budějovice, pp. 163 - 171, ISBN 978-80-7394-776-7

METHODS FOR CATEGORICAL DATA ANALYSIS: ILLUSTRATING CONSUMER BEHAVIOUR WITH RELATION TO ORGANIC PRODUCE

Martina Zámková[1], Stanislav Rojík[2], Martin Prokop[3], Radek Stolín[4] and Luboš Střelec[5]

[1, 3, 4] College of Polytechnics Jihlava, Tolstého 16, 586 01, Czech Republic,

[2] Department of Management, Faculty of Economics and Management, CULS Prague, Czech Republic,

[5] Department of Statistics and Operation Analysis, Faculty of Business and Economics, Mendel University in Brno, Czech Republic

[1]martina.zamkova@vspj.cz, [2]rojiks@pef.czu.cz, [3]martin.prokop@vspj.cz, [4]radek.stolin@vspj.cz, [5]lubos.strelec@mendelu.cz

Annotation: A description of consumers' shopping habits based on categorical data interpretation and modelling (source of data: an extensive survey), with special focus on different groups of consumers (age, gender, income, and education etc. specific) purchasing organic products. The survey outcomes were analysed using the contingency tables analysis, including the Pearson's chi-square test. Correspondence analysis enabled graphic representations of the resulting dependencies. Correspondence analysis represents a popular method often employed in order to analyse the associations between individual categories of variable(s) in contingency tables. The correspondence analysis mechanisms allow for the description of the associations between nominal or ordinal variables and their graphical presentation in multidimensional space. The influence of several predictors on one predicted variable was tested through logistic regression; the model parameters were estimated by the Maximum Likelihood Estimation. Relevant methods for categorical data processing indicated the dependency of organic produce purchase frequency on age, income, gender, household size and municipality of respondent.

Key Words: Correspondence Analysis, Logistic Regression, Pearson's Chi-Squared Test, Consumer Behaviour, Organic Food.

JEL Classification: C30, Q13

1. Introduction

Organic (especially grocery) products are on the rise. (Bioeco actual, 2020) The organic food market has been experiencing the largest boom in 1997-2006, when its value augmented by 80% (Ditschun, 2010). Globally speaking, the largest organic market share in 2018 has been maintained by the US (42%), followed by Germany (11%) and France (9%) (Statista US Market of organic products, 2020). With the US clearly dominating the organic produce market, Europe proves to be a strong second. In 2009, the organic produce market in the Czech Republic was negligible (Janssen and Hamm, 2012), whereas currently (2019) its value reaches 3.73 billion CZK (approx. 150 mil USD), (Yearbook-Organic farming in the Czech Republic, e.agri.cz, 2017). Pilař et al. (2018) concluded that there were two general underlying levels to organic produce shopping: Egoistic and Altruistic. The driving force behind the Egoistic motivation is the perception of higher quality of organic food and the belief, that it is healthier, more nutritional, and more beneficial than standard (non-organic) products. Altruistic motivation is driven by environmental reasons, animal welfare consideration, and consciousness of the impact on rural and regional areas. The same driving factors were identified for example by Kareklas, Carson, and Muehlingl (2014) or Yadav (2016). Looking at the Czech organic market, a substantial research has been carried out by Živělová and Crhová (2012), confirming increasing interest on the side of Czech consumers, notwithstanding the relatively significant price difference, that stands out when compared to the Western Europe. There the common price difference between organic and conventional food items is approx. 20-30 %, while the Czech Republic in 2012 reports about four times higher differentiation. Still, the 2012 organic food market in the Czech Republic may be called somewhat developed compared to the remaining central and Eastern European countries (Živělová and Crhová, 2013). The relations between organic products and consumers' behaviours (with regard to different consumer categories based on gender, age, income etc.) were further explored by Zámková and Prokop (2014). The motivation and objective of this paper is to compare the research results published in 2014 with the up-to-date consumer behaviour and to identify a market trend that would be of some use and guidance to Czech farms and holdings.

2. Materials and Methods

A large survey mapping shopping preferences of Czech consumers has been used as a source of data. The quota sampling questionnaire has been sent out in 2018/2019. Overall, 2,033 respondents participated. The vast majority of the data is categorical and to process them we therefore used exclusively statistical methods suitable for work with qualitative variables.

Where the response variable proves to be categorical, logistic regression is used. Explanatory variables may be continuous as well as categorical. In a binary logistic regression, the response variable Y is dichotomous with the values of 1 and 0, indicating the presence or absence of an event A. The probability of the A's occurrence is $p = P(Y = 1)$. The probability of A occurring in certain conditions defined by X is $p(X) = P(Y = 1|X)$, and at the same time equals the mean value $E(Y|X)$. The probability is defined as the odds ratio of A occurrence and non-occurrence, i.e. $odds = p/(1-p)$. The logarithm of the odds (logit) defined by $logit = ln(p/(1-p))$ is therefore linearly dependent on the conditions given by X. Regression model parameters are estimated by the Maximum Likelihood Estimation. The Wald statistics tests the statistical significance of regression coefficients (Hosmer and Lemeshow, 2000).

The data were analysed using the contingency tables analysis, including the Pearson's chi-square test (Agresti, 2002; Anděl, 2005; Pilař, 2019). Correspondence analysis represents a popular graphical method often employed in order to analyse the associations between individual categories of one or more variables in contingency tables. The correspondence analysis mechanisms allow for the description of the associations between nominal or ordinal variables and their graphical presentation in multidimensional space (Greenacre, 1984).

3. Results and Discussion

As for the response variable (Do you buy organic food?), answers "I don't know" were filtered out, leaving only Yes and No answers for further consideration. We were interested in the driving factors behind a consumer's decision to purchase organic products. This has led to the establishment of the binary response variable. The explanatory variables (gender, age, education, income, members of the household, children, and municipality size) were considered as categorical, the values of the variables were coded. Regression model parameter estimates including the Wald statistics values, significance of individual coefficients and the reliability of 95% confidence intervals are listed in Table 1, indicating clear association between organic produce purchases and gender, age, income, household, and municipality size.

Table 1. Regression Model Parameters

	Coefficient	**Standard Error**	**Wald Statistics**	**Significance**	**Lower 95%**	**Upper 95%**
Constant	-0.6585	0.3423	3.701	0.0544	-1.3293	0.0124
Gender	0.2973	0.1094	7.381	0.0066	0.0828	0.5118
Age	0.4035	0.0802	25.298	< 0.0001	0.2463	0.5607
Education	0.0698	0.1195	0.341	0.5591	-0.1644	0.3039
Monthly Household Income	0.2338	0.0401	33.774	< 0.0001	0.1543	0.3113
Household Members	-0.1411	0.0618	5.217	0.0224	-0.2623	-0.0200
Number of Children	-0.0266	0.0583	0.207	0.6487	-0.1408	0.0877
Municipality Size	0.0569	0.0288	3.917	0.0478	0.0006	0.1133

Source: own research

In order to provide a detailed description of individual sub-dependencies, there is a contingency table representing every one of them. The Pearson's chi-square test confirms the dependence. The dependence intensity identified via the Pearson's Contingency Coefficient and the relations between individual categories of pairs of variables are indicated through the correspondence analysis.

Table 2. Contingency table: Do you buy organic food? & Gender
(Pearson's coefficient = 0.158, chi-square = 72.20, p-value is less than 0.001, degrees of freedom = 2)

Column %	men	women
yes	47.62%	57.11%
no	27.91%	30.91%
I don't know	24.47%	11.98%

Source: own research

The survey results show that women tend to buy organic food more frequently than men, namely by 10 percentage points. More often than not, men do not know, or inquire, whether the purchased food is organic, see Table 2.

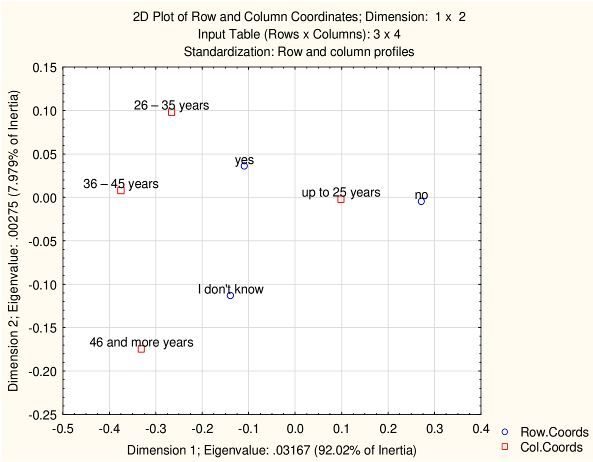
Table 3. Contingency table: Do you buy organic food? & Age
(Pearson's coefficient = 0.182, chi-square = 97.43, p-value is less than 0.001, degrees of freedom = 6)

Column %	under 25 years	26 – 35 years	36 – 45 years	46 or more
yes	50.72%	66.56%	66.82%	58.60%
no	34.48%	17.53%	12.80%	15.29%
I don't know	14.80%	15.91%	20.38%	26.11%

Source: own research

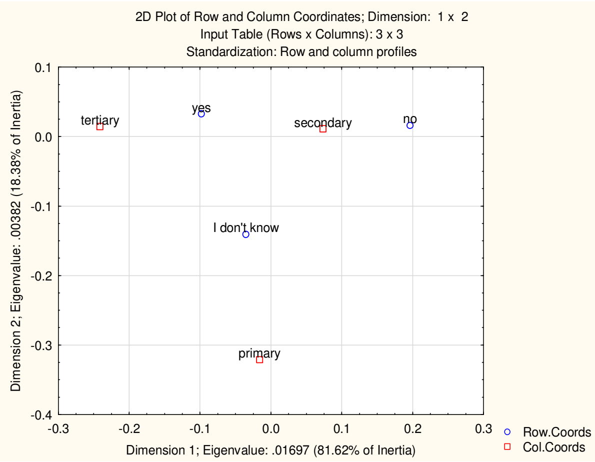
Organic produce is most frequently purchased by 26-45 years old consumers (this age group being two thirds of the total number of respondents). Older people seem to buy organic produce less often, and the respondents under 25 reported the lowest frequency, only around 50%, see Table 3. The higher the age of the respondent, the lower the certainty about the organic origin of purchased food. The correspondence map (Figure 1) shows similar results, see the rather significant share of positive responses manifested by the age groups between 26 and 45.

Figure 1. Do you buy organic food? & Age



Source: own research

Figure 2. Do you buy organic food? & Education



Source: own research

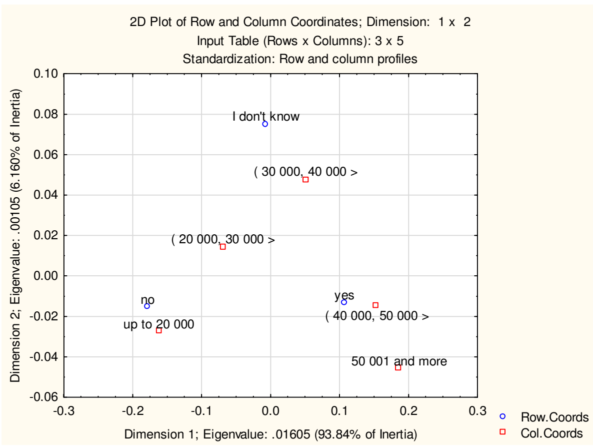
As per the frequency table (Table 4), clearly the share of respondents purchasing organic produce rises with their education. The correspondence map (Figure 2) indicates a high number of respondents with primary education unaware of the fact if they are buying organic produce or not.

Table 4. Contingency table: Do you buy organic food? & Education
(Pearson's coefficient = 0.143, chi-square = 58.86, p-value is less than 0.001, degrees of freedom = 4)

Column %	Primary	Secondary	Tertiary
yes	45.54%	51.41%	64.34%
no	26.73%	33.35%	19.18%
I don't know	27.72%	15.25%	16.48%

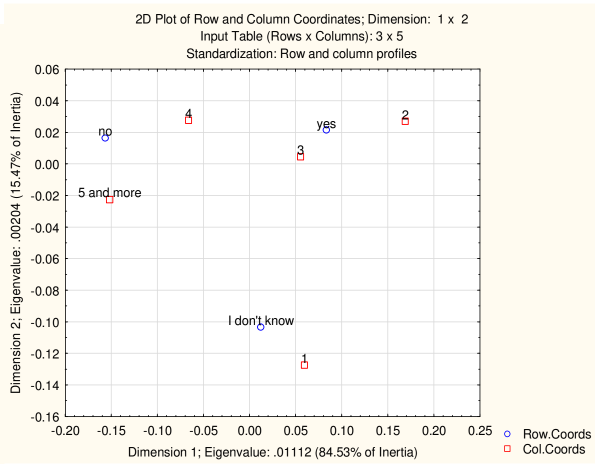
Source: own research

Figure 3. Do you buy organic food? & Income



Source: own research

Figure 4. Do you buy organic food? & Household Members



Source: own research

See the table of relative frequencies (Table 5), which outlines the growing number of organic produce consumers as the household income increases. Also, as detailed in the correspondence map (Figure 3), there is a higher frequency of negative responses in the lowest income group, while at the same time the group with income over 40,000 CZK reported more frequently positive answers.

Table 5. Contingency table: Do you buy organic food? & Monthly Household Income
(Pearson's coefficient = 0.123, chi-square = 41.28, p-value is less than 0.001, degrees of freedom = 8)

Column %	under 20,000 CZK	(20,000; 30,000 >	(30,000; 40,000 >	(40,000; 50,000 >	50,001 CZK and more
yes	46.31%	49.59%	54.23%	60.17%	62.34%
no	38.76%	34.04%	28.29%	24.71%	23.70%
I don't know	14.93%	16.37%	17.48%	15.12%	13.96%

Source: own research

The highest number of respondents who buy organic produce comes from two-member families, while the more numerous family, the lower the number of respondents who purchase organic food see Table 6. At the same time, the number is rather low, when it comes to single-member households. The correspondence map (Figure 4) also shows that respondents who live alone are often not certain if what they buy is organic.

Table 6. Contingency table: Do you buy organic food? & Household Members
(Pearson's coefficient = 0.114, chi-square = 37.26, p-value is less than 0.001, degrees of freedom = 8)

Column %	1	2	3	4	5
yes	53.33%	61.97%	56.56%	51.96%	47.02%
no	25.93%	22.74%	27.54%	33.20%	36.47%
I don't know	20.74%	15.29%	15.90%	14.83%	16.51%

Source: own research

We observe the same trend when it comes to the number of children in the household as in the case of other household members. Single-child families tend to buy organic products the most. Families with more than 4 children and childless families buy organic food with similar frequency. This trend is confirmed by the correspondence map, where +4 families disrupt the decreasing share of positive answers reported by families with children; see Table 7 and Figure 5.

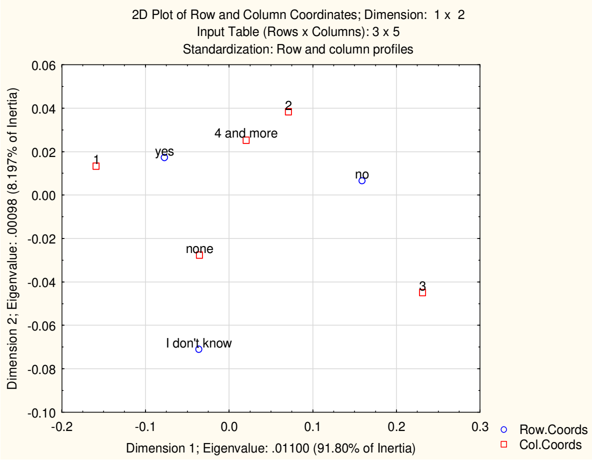
Table 7. Contingency table: Do you buy organic food? & Number of Children
(Pearson's coefficient = 0.108, chi-square = 33.92, p-value is less than 0.001, degrees of freedom = 8

Column %	none	1	2	3	4 and more
yes	54.67%	60.81%	52.40%	43.51%	54.02%
no	28.17%	22.83%	33.41%	40.17%	31.03%
I don't know	17.17%	16.36%	14.19%	16.32%	14.94%

Source: own research

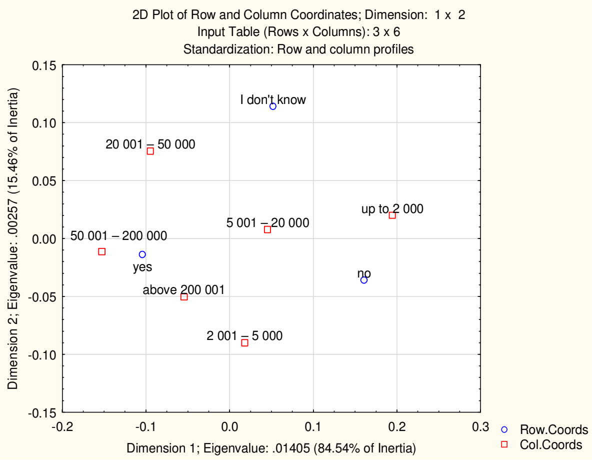
The frequency table illustrates how the share of respondents purchasing organic food grows along with the size of their municipality, see Table 8. Additionally, the correspondence map shows that people living in municipalities of less than 2,000 residents tend to purchase organic food least often. They are more likely to grow organic products themselves, see Figure 6.

Figure 5. Do you buy organic food? & Number of Children



Source: own research

Figure 6. Do you buy organic food? & Municipality Size



Source: own research

Interestingly, the organic produce market has been growing since 2013 - the larger share of organic purchases is the evidence. It may be concluded that respondents with the highest income have been getting more interested in organic food, which disproves the trend recorded in 2013, when the highest income families showed the least interest, and the same change of trend applies to the youngest group of respondents (Zámková, Prokop, 2014).

Table 8. Contingency table: Do you buy organic food? & Municipality Size
(Pearson's coefficient = 0.128, chi-square = 47.03, p-value is less than 0.001, degrees of freedom = 10)

Column %	under 2 000 citizens	2,001 – 5,000 citizens	5,001 – 20,000 citizens	20,001 – 50,000 citizens	50,001 – 200,000 citizens	over 200 001 citizens
yes	44.52%	54.55%	51.80%	57.48%	61.52%	57.42%
no	37.44%	32.60%	31.63%	24.50%	23.99%	28.81%
I don't know	18.04%	12.85%	16.56%	18.02%	14.49%	13.77%

Source: own research

The price differences between organic and non-organic products have been decreasing (compared to 2012) and that clearly plays a major role in the trend development. There have also been a major improvements as to the available selection and distribution of organic produce, not to mention the increasing number of organic farms, organic food processing facilities, and people interested in purchases of organic produce (Živělová and Crhová, 2013), (Yearbook-Organic farming in the Czech republic, e.agri.cz, 2017). Another trend is in area of healthier food products is increasing purchase of local products - because of quality and shorter distance from producers to consumers (Balcarová et al., 2018; Chalupová and Prokop, 2016).

4. Conclusion

We have analysed the behaviour of different groups of customers when it comes to purchasing organic produce. The segmentation of consumers and identification of their profiles implied the use of statistical methods for categorical data processing. All the data come from an extensive questionnaire survey. Taking into consideration all factors at once, logistic regression revealed a significant dependence between the organic food purchases and gender, age, income, household members, and municipality size of the respondent. Other statistical methods (Pearson's test of independence, correspondence analysis) confirmed sub-dependencies as for the number of children in the household and respondents' education.

Analysis of these sub-dependencies suggested that women tend to buy organic food more often than men, and that men are not likely to be interested in the origin of purchased food. Organic produce is most frequently purchased by 26-45 years old consumers, while younger respondents purchase organic food the least often. The higher education, income, and population in the place of residence, the higher the frequency of organic food purchases. People with elementary education often do not know where their food comes from. Childless persons in single-households often do not pay special attention to the quality and label information on the packaging; the share of respondents who do not buy organic food tend to be reduced as the number of children in the household increases. Organic produce is most frequently sought by two-member or one-child families.

Acknowledgements

This research was supported by the College of Polytechnics, Jihlava, under Grant no. 1170/4/2006 "Využití vícerozměrných statistických metod ve statistickém výzkumu" and by IGA PEF CZU (CULS) 2019B0006 "Atributy řízení alternativních business modelů v produkci potravin."

References

Agresti, A. (2002), "*Categorial Data Analysis*", New York, Wiley, ISBN 9780471458760

Anděl, J. (2005), "*Mathematical statistics*", Praha, Matfyzpress, ISBN 8086732401

Balcarová, T., Pilař, L., Pitrová, J. and Petkov, R. (2018) "How Local is Local: Case Study of Prague Farmers' Market." *Proceedings of the Agrarian perspectives XXVII. Food Safety – Food Security,* Prague, pp. 7 - 13, ISBN 9788021328907

Bioeco actual, Organic market worldwide: observed trends in the last few years, Barcelona, 2020, [Online], Available at https://www.bioecoactual.com/en/2020/03/10/organic-market-worldwide-observed-trends-in-the-last-few-years, [Accessed 25 Apr. 2020]

Chalupová, M. and Prokop, M. (2016), "Awareness of the Vysočina Regional Food Labels With Context of Their Media Presence" *Acta Universitate Agriculturae at Silviculturae Mendelianae Brunensis*, vol. 64, no. 1, pp. 223 – 234, DOI 10.11118/actaun201664010223

Czech Ministry of Agriculture, Market of organic products, Prague, 2019, [Online], Available: http://eagri.cz/public/web/en/mze/organic-production-and-organic-food/the-market-and-trade-in-organic-food/, [Accessed: 22 Apr. 2020]

Ditschun, T. L. (2010), "Nurturing and Preserving the Sensory Qualities of Nature", In: Dubé, L., Bechara, A., Dagher, A., Drewnowski, A., LeBel, J., James, P. and Rickey Y. (eds.), "*Obesity Prevention. The Role of Brain and Society on Individual Behavior"*, London, Academic Press, pp. 555 - 566, DOI 10.1016/B978-0-12-374387-9.00045-3

Greenacre, M. J. (1984), "*Theory and Applications of Correspondence Analysis*", London, Academic Press, ISBN 0122990501

Hosmer, D. W. and Lemeshow, S. (2000), "*Applied Logistic Regression*", New York, Wiley, ISBN 9780471356325

Jansenn, M. and Hamm, U. (2012), "Product labelling in the market for organic food: Consumer preferences and willingness-to-pay for different organic certification logos", *Food Quality and Preference,* vol. 25. no 1. pp. 9 - 22, DOI 10.1016/j.foodqual.2011.12.004

Kareklas, I., Carlson, J. R. and Muehling, D. D. (2014). “I eat organic for my benefit and yours: Egoistic and altruistic considerations for purchasing organic food and their implications for advertising strategists”, *Journal of Advertising*, vol. 43, no. 1, pp. 18 - 32, DOI 10.1080/00913367.2013.799450

Ministry of Agriculture of the Czech Republic, Yearbook-Organic farming in the Czech Republic, Prague, 2017, [Online], Available: http://eagri.cz/public/web/file/616968/Rocenka_Ekologickeho_zemedelstvi_2017_k_zverejneni.pdf, [Accessed: 24 Apr. 2020]

Pilař, L., Kvasničková Stanislavská, L., Pitrová, J., Krejčí, I., Tichá, I. and Chalupová, M. (2019), “Twitter Analysis of Global Communication in the Field of Sustainability.” *Sustainability*, vol. 11, no. 24, 6958, DOI 10.3390/su11246958

Pilař, L., Kvasničková Stanislavská, L., Rojík, S., Kvasnička, R., Poláková, J. and Grasham, G. (2018), “Customer experience with organic food: global view “, *Emirates Journal of Food and Agriculture*, vol. 30, no. 11, pp. 918 - 926, DOI 10.9755/ejfa.2018.v30.i11.185

Statista, Retail sales share of organic food worldwide in 2018, by country, New York, 2020, [Online], Available: https://www.statista.com/statistics/262347/worldwide-spending-on-organic-products-by-country, [Accessed 22 Apr. 2020]

Yadav, R. (2016), “Altruistic or egoistic: Which value promotes organic food consumption among young consumers? A study in the context of a developing nation.“ *Journal of Retailing and Consumer Services,* vol. 33, no. C, pp. 92-97, DOI 10.1016/j.jretconser.2016.08.008

Zámková, M. and Blašková, V. (2013), “The differences in the marketability of organic products in Greece and the Czech Republic”, *Agricultural Economics - Czech*, vol. 59, no. 5, pp. 219 - 226, DOI 10.17221/93/2012-AGRICECON

Zámková, M. and Prokop, M. (2013), “Consumer behaviour of students when shopping for organic food in the Czech Republic”, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, vol. 61, no. 4, pp. 1191 - 1201, DOI 10.11118/actaun201361041191

Zámková, M. and Prokop, M. (2014), “Comparison of Consumer Behavior of Slovaks and Czechs in the Market of Organic Products by Using Correspondence Analysis“. *Acta UniversitatisAgriculturae et Silviculturae Mendelianae Brunensis,* vol. 62, no. 4, pp. 783 – 795, DOI 10.11118/actaun201462040783

Živělová, I. and Crhová, M. (2013), “Organic Food Market in the Czech republic“, *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* vol. 61, no. 2, pp. 539 – 546, DOI 10.11118/actaun201361020539

CONTENT

JEL Classification System / EconLit Subject Descriptors
Basic classification and detailed classification you can find on a web page:
https://www.aeaweb.org/econlit/jelCodes.php

A. General Economics and Teaching
A1 General Economics
A2 Economic Education and Teaching of Economics
A3 Collective Works

B. History of Economic Thought, Methodology, and Heterodox Approaches
B1 History of Economic Thought through 1925
B2 History of Economic Thought since 1925
B3 History of Economic Thought: Individuals
B4 Economic Methodology
B5 Current Heterodox Approaches

C. Mathematical and Quantitative Methods
C1 Econometric and Statistical Methods and Methodology: General
C2 Single Equation Models • Single Variables
C3 Multiple or Simultaneous Equation Models • Multiple Variables
C4 Econometric and Statistical Methods: Special Topics
C5 Econometric Modeling
C6 Mathematical Methods • Programming Models • Mathematical and Simulation Modeling
C7 Game Theory and Bargaining Theory
C8 Data Collection and Data Estimation Methodology • Computer Programs
C9 Design of Experiments

D. Microeconomics
D1 Household Behavior and Family Economics
D2 Production and Organizations
D3 Distribution
D4 Market Structure, Pricing, and Design†
D5 General Equilibrium and Disequilibrium
D6 Welfare Economics
D7 Analysis of Collective Decision-Making
D8 Information, Knowledge, and Uncertainty
D9 Intertemporal Choice

E. Macroeconomics and Monetary Economics
E1 General Aggregative Models
E2 Consumption, Saving, Production, Investment, Labor Markets, and Informal Economy
E3 Prices, Business Fluctuations, and Cycles
E4 Money and Interest Rates
E5 Monetary Policy, Central Banking, and the Supply of Money and Credit
E6 Macroeconomic Policy, Macroeconomic Aspects of Public Finance, and General Outlook

F. International Economics
F1 Trade
F2 International Factor Movements and International Business
F3 International Finance
F4 Macroeconomic Aspects of International Trade and Finance
F5 International Relations, National Security, and International Political Economy
F6 Economic Impacts of Globalization

G. Financial Economics
G1 General Financial Markets
G2 Financial Institutions and Services
G3 Corporate Finance and Governance

H. Public Economics
H1 Structure and Scope of Government
H2 Taxation, Subsidies, and Revenue
H3 Fiscal Policies and Behavior of Economic Agents
H4 Publicly Provided Goods
H5 National Government Expenditures and Related Policies
H6 National Budget, Deficit, and Debt
H7 State and Local Government • Intergovernmental Relations
H8 Miscellaneous Issues

I. Health, Education, and Welfare
I1 Health
I2 Education and Research Institutions
I3 Welfare, Well-Being, and Poverty

J. Labor and Demographic Economics
J1 Demographic Economics
J2 Demand and Supply of Labor
J3 Wages, Compensation, and Labor Costs
J4 Particular Labor Markets
J5 Labor–Management Relations, Trade Unions, and Collective Bargaining
J6 Mobility, Unemployment, Vacancies, and Immigrant Workers
J7 Labor Discrimination
J8 Labor Standards: National and International

K. Law and Economics
K1 Basic Areas of Law
K2 Regulation and Business Law
K3 Other Substantive Areas of Law
K4 Legal Procedure, the Legal System, and Illegal Behavior

L. Industrial Organization
L1 Market Structure, Firm Strategy, and Market Performance
L2 Firm Objectives, Organization, and Behavior
L3 Nonprofit Organizations and Public Enterprise
L4 Antitrust Issues and Policies
L5 Regulation and Industrial Policy
L6 Industry Studies: Manufacturing
L7 Industry Studies: Primary Products and Construction
L8 Industry Studies: Services
L9 Industry Studies: Transportation and Utilities

M. Business Administration and Business Economics • Marketing • Accounting • Personnel Economics†
M1 Business Administration
M2 Business Economics
M3 Marketing and Advertising
M4 Accounting and Auditing
M5 Personnel Economics

N. Economic History
N1 Macroeconomics and Monetary Economics • Industrial Structure • Growth • Fluctuations
N2 Financial Markets and Institutions
N3 Labor and Consumers, Demography, Education, Health, Welfare, Income, Wealth, Religion, and Philanthropy
N4 Government, War, Law, International Relations, and Regulation
N5 Agriculture, Natural Resources, Environment, and Extractive Industries
N6 Manufacturing and Construction
N7 Transport, Trade, Energy, Technology, and Other Services
N8 Micro-Business History
N9 Regional and Urban History

O. Economic Development, Innovation, Technological Change, and Growth†
O1 Economic Development
O2 Development Planning and Policy
O3 Innovation • Research and Development • Technological Change • Intellectual Property Rights†
O4 Economic Growth and Aggregate Productivity
O5 Economywide Country Studies

P. Economic Systems
P1 Capitalist Systems
P2 Socialist Systems and Transitional Economies
P3 Socialist Institutions and Their Transitions
P4 Other Economic Systems
P5 Comparative Economic Systems

Q. Agricultural and Natural Resource Economics • Environmental and Ecological Economics
Q1 Agriculture
Q2 Renewable Resources and Conservation
Q3 Nonrenewable Resources and Conservation
Q4 Energy
Q5 Environmental Economics

R. Urban, Rural, Regional, Real Estate, and Transportation Economics
R1 General Regional Economics
R2 Household Analysis
R3 Real Estate Markets, Spatial Production Analysis, and Firm Location
R4 Transportation Economics
R5 Regional Government Analysis

Y. Miscellaneous Categories
Y1 Data: Tables and Charts
Y2 Introductory Material
Y3 Book Reviews (unclassified)
Y4 Dissertations (unclassified)
Y5 Further Reading (unclassified)
Y6 Excerpts
Y7 No Author General Discussions
Y8 Related Disciplines
Y9 Other

Z. Other Special Topics
Z1 Cultural Economics • Economic Sociology • Economic Anthropology
Z2 Sports Economics
Z3 Tourism Economics