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**FACULTY OF ECONOMICS AND MANAGEMENT**

Czech University Of Life Sciences Prague

Faculty of Economics and Management

# AGRARIAN PERSPECTIVES XXX.

# SOURCES OF COMPETITIVENESS UNDER PANDEMIC AND ENVIRONMENTAL SHOCKS

## PROCEEDINGS

**of the 30th International Scientific Conference**

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**PROCEEDINGS - of the 30th International Scientific Conference Agrarian Perspectives XXX. Sources of Competitiveness under Pandemic and Environmental Shocks**

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

# Agrarian perspectives XXX. Sources of Competitiveness under Pandemic and Environmental Shocks


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# FOREWORD

The tradition of organizing annual international conferences is now a firmly established part of our long history. In connection with this tradition the jubilee 30th Agrarian Perspectives conference will take place at the Faculty of Economics and Management of the Czech University of Life Sciences Prague during the period of 15 to 16 September 2021. Unfortunately, the conference will not be held in its traditional format due to the current pandemic situation. But our experience gained from organizing other online conferences give us a strong hope that our conference will be interesting and successful.

The topic of this year's conference is Sources of Competitiveness under pandemic and Environmental Shocks. It has been almost two years that we have been facing a huge worldwide pandemic crisis. It has changed many aspects of our lives. We can see problems in areas of production, processing, packaging, delivery and more. But we can't stay knocked down. Every such situation must be taken as a challenge and an opportunity to discover new solutions and new ways to create a better future.

The wide scope of the conference provides space for authors in many research areas ranging from Economics, Management, and Rural development to Informatics and Systems Engineering. The conference generates not only a platform for discussing theoretical issues, but also for sharing experience and finding new partners for the future cooperation in the field of research.

We are looking forward to listening to the representative keynote speakers from the Czech Republic, the United Kingdom and Hungary, who will address the plenary meeting of the conference on 15 September 2021. Derek Shepherd - Academic Lead – Teaching and Quality in the Plymouth Business School, University of Plymouth, Lukáš Čechura – a professor at the Czech University of Life Sciences Prague, Matthew Gorton - a professor of Marketing at Newcastle University Business School and Deputy Director of the National Innovation Centre for Rural Enterprise and Imre Fertő - a director general at the Centre for Economics and Regional Studies in Budapest will provide a good starting point of the conference. They will also, undoubtedly, spark interesting debates and experience sharing which will continue in parallel sessions in the afternoon and the following day.

In conclusion, I would like to express my strong belief that the jubilee 30th Agrarian Perspectives Conference will create an inspirational framework for all participants and will contribute to the further development of our research areas.

Ing. Martin Pelikán, Ph.D.

Dean FEM CZU Prague

# ASSESSMENT OF EMPLOYMENT GROWTH IN BIOECONOMY SECTORS IN THE VISEGRAD GROUP COUNTRIES

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**Annotation:** The paper's topic is dedicated to actual and major economic and government priorities. The bioeconomy is a new direction of economic development, encompasses almost all sectors related to the production, processing and use of renewable resources. The emergence and development of new biotechnologies contribute to increasing the demand for a well-educated, high-skilled and productive workforce, and as a result will lead to the creation of new green jobs and activities. That is why very important to analyse employment growth in bioeconomy as a driving force for extension of bioeconomy sectors. Employment growth in bioeconomy can lead to successful development and support of domestic sectors and implementation of national bioeconomy strategies. Which in turn will contribute to the transformation and creation of quality employment and income opportunities. This is important condition of balanced, inclusive, and sustainable economic growth of the V4 group countries' bioeconomy. The main aim of the paper is to evaluate the development of employment in various sectors of the bioeconomy in V4 countries using shift-share analysis in 2008-2018. Shift-share analysis enables a quantitative assessment of the dynamics of the sectoral structure of employment in the bioeconomy sectors and the breakdown of employment growth based on a mixed sectoral effect, a competitive effect and a residual effect. Based on the results of analysis, we identify that in V4 countries the main competitive sectors of the bioeconomy that have a high potential for employment growth are agriculture (54.6%), food industry (22.01%), wood and furniture production (11.36%) in 2018 year. In this biomass producing and high labour productive sectors are generating EUR 55855.31 million of value added and employed 3.4 million people. Shift-share analyse show that competitive and sectoral-mix effect affect employment growth in the same bioeconomy sectors at V4 level (corelation coefficients are 93.63% and 85.99%). We can summarise, that sectoral structure of employment and the differences between sectoral growth in the bioeconomy have a large impact on the overall rate of employment growth in the V4 countries.

**Key words:** bioeconomy, employment growth, jobs, shift-share analysis, Visegrad countries

**JEL classification:** J21, C21, Q57, R11

## 1. Introduction

In the context of the challenges of our time, such as changing weather due to greenhouse gas emissions, preserving biological variability, food security and the availability of materials and energy, the bioeconomy is evolving in the direction of a new economic and industrial revolution. The bioeconomy consists of producing and transforming biomass for the provision of food, feed, materials, energy, and related services to European citizens (Ronzon et al., 2020). The bioeconomy creates conditions for multiple, cyclical use of resources, ensures GDP growth, creating employment growth and improve the socio-economic development of the country. Bioeconomy is associated with the transition from non-renewable to renewable sources and the improvement of livestock systems. Converting agricultural products into renewable materials and energy gives countries the opportunity to increase the potential of the food system, as well as accelerate their economic development, while improving food security and nutrition. The transition to bio-based technology and the development of bioeconomy is viewed by the European Commission as a strategic economic orientation, as it has the potential to reduce the burden on the environment while strengthening green innovation, markets and jobs in the EU (Ronzon et al., 2020). That is why today the building of a new bioeconomy is becoming an increasingly important and strategic direction of the country's development. Biotechnology has led to innovations in many branches of industry and agricultural, played a significant role in supporting economic growth, employment, energy supply and the production of bio-products (Wózniak and Twardowski, 2018). There are different economic effects associated with the activities of the industrial biotechnology sector in Europe: the direct effect, i.e. the employment related from core IB sector activities; upstream effects – employment generated by the suppliers to the IB sector; downstream effects – employment involved with processing and integrating IB outputs; and induced effects – resulting from the spending of employees from the aforementioned categories (Debergh, Bilsen and Van de Velde, 2016). Addressing economic performance through a labour productivity measure gives further insights into the growth potential of bioeconomy sectors, which is of particular importance from the perspective of the EU and its various policies (Ronzon and M'Barek, 2018).

Human capital is a basic development factor in the field of bioeconomy created by a workforce that directly implements investments and by qualified employees with specialized skills and knowledge; leads to increase in the competitiveness of a region as well as to achieving profits (Wózniak, Tyczewska and Twardowski, 2021). Increasing Europe's competitiveness and new job creation is one of the main policy goals for the bioeconomy. It also means increasing the ability of countries to translate opportunities from all types of innovation into new products and services on the marketplace, creating new jobs at the local level. This requires investments, innovation, strategy development and systemic change in different sectors (agriculture, forestry, fisheries, food, biobased industry and services) (European Commission, 2018). The EU, through a number of policies, such as Common Agricultural Policy (CAP), Common Fisheries Policy (CFP) and other policies related to the bioeconomy sectors, aims to stimulate the knowledge, research and actions towards supporting and strengthening bioeconomy (Loizou et al., 2019). In Poland, Slovakia and Czech Republic dedicated Bioeconomy Strategy at national level under development. In Hungary, at the moment, there are only other political initiatives, programs and strategies dedicated to bioeconomy. They are focused on protection of environment, enhancing the use of biomass production potential and development research, knowledge transfer and improving social sustainability. Also, in the V4 countries exist Bioeconomic Clusters that are engaged in the development of a regional bioeconomic strategy, monitoring bioeconomic indicators, promoting innovation and cooperation between stakeholders in bioeconomy, and strengthening and developing competitiveness of the regional bioeconomy sectors. We can state, that V4 countries: Poland, Slovakia, Czech Republic and Hungary are countries with great potential in the production and use of biomass. Biomass requires more processing steps with a higher cost and labour requirements (Popp et al., 2021). This in turn provides increasing demand for bioproducts, a high potential for inclusive economic development and job creation, including in rural areas.

## 2. Materials and Methods

Based on the theory, we can state that not only natural and biological, but also human resources are very important for the development and ensuring the competitiveness of the country's bioeconomy. Increasing employment in bioeconomy sectors becomes a priority task for states. In turn, employment growth depends on the sectoral structure of growth, labour productivity and labour intensity of growth within individual sectors. In this paper we use data "Jobs and wealth in the EU bioeconomy" obtained from European Commission, Joint Research Centre (JRC). The shift-share analysis enables to identify the driving forces of employment growth and analyse the dynamics of the total and sectoral employment in the V4 countries (Bielik and Rajčániová, 2008). We applied the method of shift-share analysis of employment growth in bioeconomy of the Visegrad Group Countries in 2008-2018 years to quantify sectoral contributions to employment growth, and its structural decomposition into sectoral-mix effect, competitive effect, and residual effect. Shift-share analysis is a method which examines growth (or decline) rates of a variable such as GVA or employment in a region by splitting it into three additive components (Oguz and Knight, 2010). Employment growth reflects labour demand shifters in sectors. The dynamics and intensity of sectors economic growth, its nature and structure reflect changes in labour productivity, new conditions for job opportunity creation, development and transformation of the labour market and employment. Shift-share analysis provides comprehensive assessment of the link between the sectoral-mix of employment and international differences in employment growth (Ray and Harvey, 1995). The effects of shift-share analysis can be calculated using the following formulas and measures (OECD, 2000; Batóg and Batóg, 2007; Bielik and Rajčániová, 2008):

- Annualised employment growth ($\overline{EG}$) in total sample:

$$\overline{EG} = \left(\sum_{i=1}^{n}\sum_{j=1}^{s}(N_{ijt} - N_{ij0})\right)/\sum_{i=1}^{n}\sum_{j=1}^{s}N_{ij0} \tag{1}$$

where: $s$ – number of sectors; $n$ – number of countries; $N_{ijt}$ – employment in country $i$, sector $j$ and time $t$; $N_{ij0}$ – employment in country $i$, sector $j$ and time $0$.

- Relative annualised employment growth ($REG_i$) in country $i$:

$$REG_i = EG_i - \overline{EG} = \sum_{j=1}^{s}\left(N_{ijt} - N_{ij0}\right)/\sum_{j=1}^{s}N_{ij0} - \overline{EG} \tag{2}$$

where: $EG_i$ – annualised net employment growth in country $i$.

- Sectoral contribution ($SC_{ij}$) to annualised employment growth of sector $j$ in country $i$:

$$SC_{ij} = EG_{ij} * w_{ij0} = \left[\left(N_{ijt} - N_{ij0}\right)/N_{ij0}\right] * \left(N_{ij0}/\sum_{j=1}^{s}N_{ij0}\right) \tag{3}$$

where: $EG_{ij}$ – employment growth in country $i$ and sector $j$; $w_{ij0}$ – share of sector $j$ in total employment in country $i$ at time $0$.

- Competitive effect ($CE_i$) in country $i$:

$$CE_i = CID_i - \overline{EG} = \sum_{j=1}^{s}\left(EG_{ij}\right) * \overline{w_{j0}} - \overline{EG} \tag{4}$$

where: $CID_i$ – employment growth in country $i$ assuming a common initial distribution of sectors and $\overline{w_{j0}}$– employment share of sector $j$ in total sample at time $0$:

$$\overline{w_{j0}} = \sum_{i=1}^{n} N_{ij0} \, / \sum_{i=1}^{n} \sum_{j=1}^{s} N_{ij0} \tag{5}$$

- Sectoral-mix effect ($SE_i$) in country i:

$$SE_i = CSG_i - \overline{EG} = \sum_{j=1}^{n} \overline{EG_j} * w_{ij0} - \overline{EG} \tag{6}$$

where: $CSG_i$ – employment growth in country $i$ assuming common sectoral growth rates and $\overline{EG_j}$ – annualised employment growth of sector $j$ in the overall sample:

$$\overline{EG_j} = \sum_{i=1}^{n} (N_{ijt} - N_{ij0}) / \sum_{i=1}^{n} N_{ij0} \tag{7}$$

- Residual effect ($RE_i$) in country $i$:

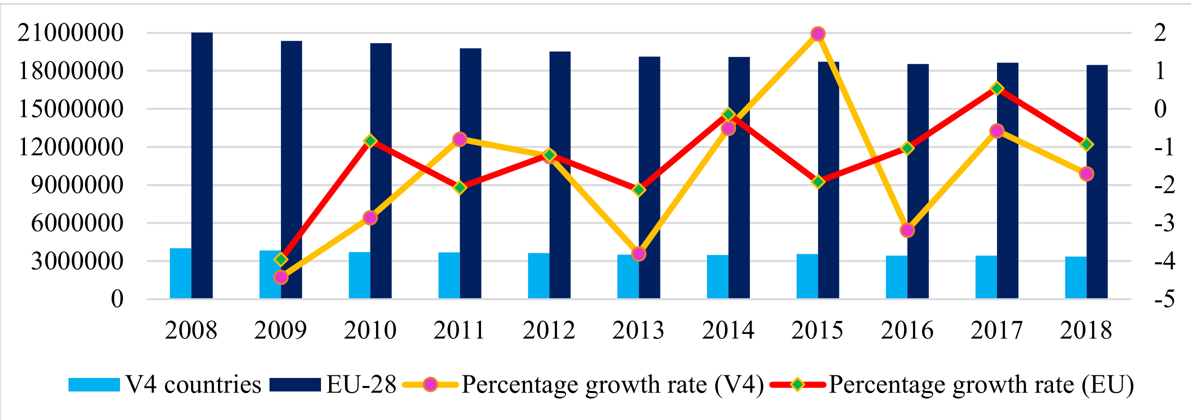
$$RE_i = REG_i - CE_i - SE_i \tag{8}$$

The difference in the total growth of employment between a country $i$ and average growth for the total sample of countries can be divided into three effects (OECD, 2000; Batóg and Batóg, 2007). The sectoral-mix effect, which measures the impact of differences between the initial sectoral structure of employment in country $i$ and the structure of total sample. The competitive effect, which measures the impact of differences between the sector specific growth rates in country $i$ and the sector specific rates averaged over all countries, explains cross country variation in employment growth. The residual effect, which measures whether the employment growth of country $i$ tends to be higher, relative to all countries, in the sectors in which the country $i$ is specialised (Ray and Harvey, 1995). The shift-share analysis was carried out as a useful tool for identify sectors of bioeconomy with a high potential for increasing employment, and in order to determine efficiency, sustainability, competitiveness of sectors.

## 3. Results and Discussion

The impact of employment on economic growth and poverty reduction maximizes the benefits of bioeconomy growth, ensuring it is sustainable and inclusive. The bioeconomy employed approximately 18.5 million people in the EU-28 in 2018, generating turnover EUR 2417.9 billion (Figure 1). The bioeconomy created up to EUR 669.4 billion of value added in the EU- 27. Employment in the European Union's bioeconomy declined between 2008 and 2018, resulting in the loss of nearly 2.7 million people, even though bioeconomy creates new green jobs. Only in 2017 there is an increase in the number of people employed 0.55%.

Figure 1. Changes of number of people employed in bioeconomy in 2008-2018 in EU-28 and V4 countries.

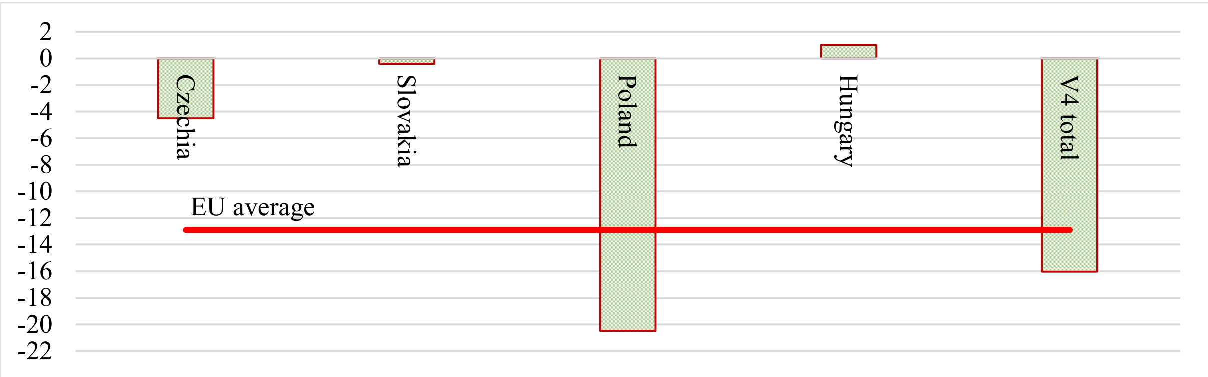



*Source: Authors own calculations based on data JRC – Bioeconomics*

In 2018 in the V4 countries, the bioeconomy generated turnover of EUR 214.7 billion (8.88% of EU turnover) and value added around EUR 55.85 billion (8.4% of EU value added) and employed 3.4 million people (18.21% of the EU labour force). This means that the bioeconomy represents about 11.67% of all sectors of the economy in terms of employment in the V4 countries. We saw employment growth in 2009-2011, and in 2013-2015, when it peaked at 1.98% in 2015. We can state that for 2008-2018 years number of persons employed in the V4 countries gradually decreasing. Compared to 2008, employment reduced by 0.6 million people, mainly due to the ongoing restructuring of the agricultural sector and low labour productivity. In the V4 countries the agricultural sector employs 54.66% of all workers employed in the V4 bioeconomy, but it generates only 36.39% of value added. At the same time, the food sector employed only 22.01% and generates 32.94% of value added, this indicating that higher labour productivity compared to agriculture.

On the next Figure 2 we can see annualised total employment growth during 2008-2018 years in V4 countries and employment in the bioeconomy tends to decline. For Slovakia, Poland, Czechia employment growth was negative, mainly due to a decrease in employment in the agricultural and food industry. In V4 countries the annualized total employment growth (- 16.03%) is higher than the approximate in the EU. Negative employment growth (-20.48%) in Poland observed mainly due to the agricultural sector share reduction (Loizou et al., 2019). Slovakia had the smallest negative employment growth only 0.42% among the V4 countries. Only Hungary represents positive increasing of employment growth (0.99%), because of agriculture sector as a main sector of bioeconomy.

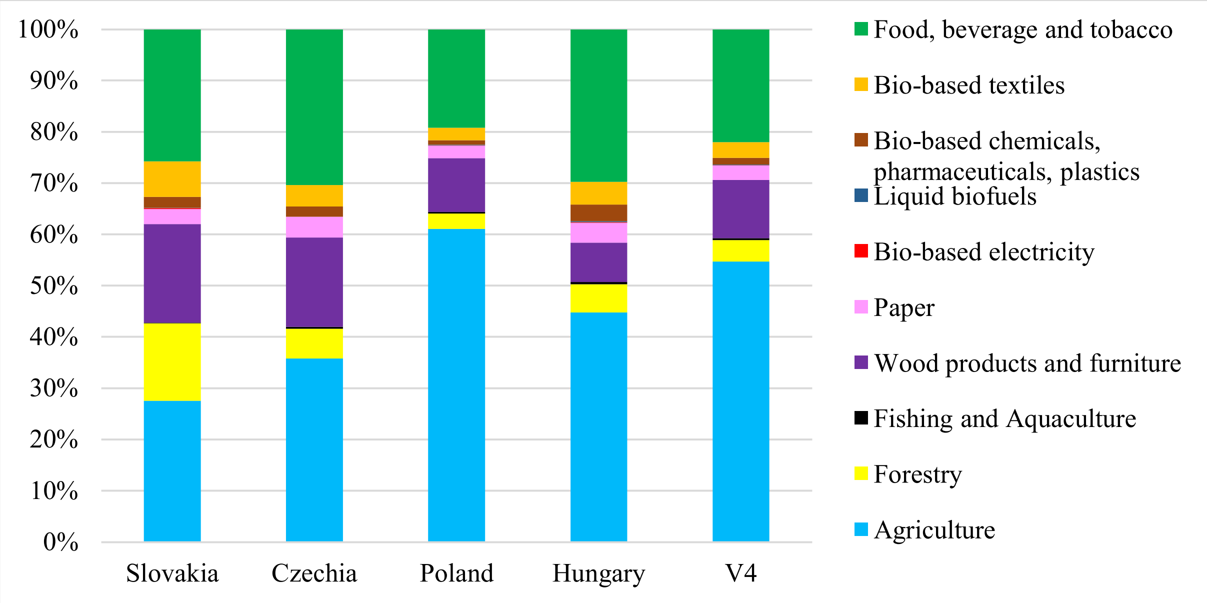
Figure 2. The annualised total employment growth in V4 countries in 2008-2018, %




*Source: Authors own calculations based on data JRC – Bioeconomics*

As we can see on figure 3, agriculture (54.66%), wood products and furniture (11.36%), food, beverages and tobacco manufacture (22.01%), and forestry (4.21%) are four major sectors providers of the jobs in the bioeconomy of V4 countries. Biomass production sectors were the most labour productive and intensive sectors of the bioeconomy. And these sectors employ the largest number of people, because Slovakia, Czechia, Poland and Hungary are considered as biomass providers and countries with strong agrarian economies.

Figure 3. The share of number of people employed in the bioeconomy sectors in V4 countries in 2018 year, %




*Source: Authors own calculations based on data JRC – Bioeconomics*

In Slovakia bioeconomy employed 168.69 thousand people (5.02% of total V4 bioeconomy employees) and generating EUR 3936.3 million of value added in 2018. There are the main five productive sectors of the bioeconomy (account for more than 90% of bioeconomy turnover in the country) in terms of employees and economic yields, which are the food production, the agriculture, the forestry, the wood and furniture industry and the pulp and paper industry (POWER4BIO, 2020). Bio-based agriculture (27.54% of people employed in bioeconomy) and food industry (25.75%), forest and wood industry (15.10% and 19.24%) and biofuel production are the priority sectors of bioeconomy in Slovakia. Sectoral contribution to annualised employment growth of agriculture was -5.4%, food, beverage and tobacco was 2%, and forest and wood industry was 4.4%. RIS3 strategy, Rural Development Programme of the SR 2014-2020 and Greener Slovakia strategy until 2030 contribute to the development of the bioeconomy in Slovakia, support the development of innovation and research, increase the competitiveness of the agri-food sector, forest industry, bio-based plastics for automotive industry through the creation of higher added value from own products, stimulate the rural bioeconomy through investments in enterprises, human resources through training and advisory services. Slovakia is interested in creating jobs with high added value, jobs in services, jobs that contribute to climate change mitigation, in green jobs that are friendly to natural and limited resources (The Ministry of Labour, Social Affairs and Family of the SR, 2014).

In Czech Republic regional bioeconomy strategy focused on forestry (5.79%), wood products and furniture (17.39%), agriculture (35.79%), biogas station, food industry (30.41%) and waste. Bioeconomy employed 383.31 thousand people (11.4% of total persons V4 bioeconomy) and generating EUR 9453.08 million of value added in 2018. Sectoral contribution to annualised employment growth of food, beverage and tobacco was -2.16%, agriculture was -0.32%, and wood products and furniture was 0.32% in Czech Republic. Country counts with institutions dedicated to R&D fields in bioeconomy relevant subjects, as well as high-level education and vocational training in the field of residues (POWER4BIO, 2021). Bioeconomy platform of the Czech Republic, Regional RIS3 strategy, CR national strategy "CR for 2030" are the main documents that, at the national and regional level, contribute to the development of the bioeconomy, and the achievement of the goals in the field of sustainable development. In 2019 the Ministry of Agriculture has developed the Bioeconomy Concept in the CR (2019-2024). The main goal is to support the development of the bioeconomy in CR; together with the V4 states, strive to support the development of the bioeconomy at the macro-regional level; ensure effective investment of public funds in research and education in the field of bioeconomy (The Ministry of Agriculture of the CR, 2019). This Concept will encompass the development of the bioeconomy in the economic, environmental and social area, in each will be creating new job opportunities based on digital technologies and innovative business solutions.

In Poland bioeconomy is the biggest one among the V4 countries, employed 2433.7 thousand people (72.38% of persons employed in V4 bioeconomy) and generating EUR 33409 million of value added in 2018 (60% of value added in V4). Poland's bioeconomy focuses on the agriculture (61.05% of total of total bioeconomy employment), forestry, wood products and furniture (13.44%), food and beverage sectors (19.23%), but also on pharmaceutical and chemical sector, innovative technologies and industrial biotechnological processes. Sectoral contribution to annualised employment growth of agriculture was negative (-21.02%), food industry was 0,74%, forestry, wood and paper sector was 1.04%. In Poland, there is no single, complex and strategic document dedicated to bioeconomy, but Poland placed bioeconomy as a smart specialisation strategy (Wózniak and Twardowski, 2018). Smart Specialisation Strategy, The National Development Strategy 2020, Strategy for Innovation and Economic Efficiency “Dynamic Poland” are related to the Poland bioeconomy. The general strategic goals and objectives are as follows: increasing productivity, competitiveness and innovativeness of the economy; effective use and rational management of resources, levelling imbalances in regional development and social disparities, and improving the quality of life in rural areas for sustainable development of the country.

The regional level recommendations for bioeconomy developed by Hungarian Bioeconomy Cluster. The bioeconomy related policies also should follow the goals and policies of CAP (POWER4BIO, 2021). The National Rural Development Strategy (2012-2020) are oriented on increasing rural employment, balanced and varied agriculture and forestry, the strengthening of local energy production, improvement of the standard of living, and the conservation of ecosystems and biodiversity. Bioeconomy employed 376.85 thousand people (11.21% of workers in V4) and generating EUR 9056.9 million of value added in 2018. Agricultural is the biggest supply sector providing approximately 90% of the biomass, that is why agricultural wastes and by-products in bioeconomy are significant and important (POWER4BIO, 2020). Agriculture sector (44.75% of the total number of persons employed in the Hungarian bioeconomy) and food, beverage and tobacco (29.75% of person worked in bioeconomy) are the two main providers of bioeconomy jobs in Hungary. Sectoral contribution to annualised employment growth of food, beverage and tobacco was 0.22%, contribution of agriculture was 1.2%, and forestry was 1.8%. The goal of strategy should be to create agricultural products with high added value, which will contribute to the emergence of jobs with higher added value.

Table 1. Shift-share decompositions of employment growth in V4 countries in 2008-2018 years, %

| V4 | $REG_i$ | $SE_i$ | $CE_i$ | $RE_i$ |
|---|---|---|---|---|
| Slovakia | 15.60777 | 7.592551 | 10.12186 | -2.10664 |
| Czechia | 11.51159 | 8.054188 | 13.04659 | -9.58919 |
| Poland | -4.44909 | -2.04648 | -1.91865 | -0.48396 |
| Hungary | 17.02074 | 4.664646 | 17.39649 | -5.04039 |
| **Correlation coefficient** | | 0.85993 | 0.93631 | -0.47399 |

*Source: Authors own calculations based on data JRC – Bioeconomics*

Table 1 present the shift-share decomposition of employment growth in V4 countries. A positive sectoral-mix effect implies that Slovakia, Czechia and Hungary have a favourable distribution of high-growth industries. In Czechia the value of sectoral mix-effect is the highest (8.05%) and means that economy is made up of sectors with faster employment growth rates than the V4 growth. In Slovakia the value of sectoral mix-effect means, that there 7.59% more jobs were created than would have been created if the structure of the bioeconomy sectors in the country was identical to the structure of the bioeconomy in the V4 countries. In Poland a negative sectoral-mix effect indicates that industries would have grown slower, than the V4 countries average. The corelation between the annualised regional employment growth and sectoral-mix effect is high and positive (85.99%) and confirms a strong relationship between structure of the bioeconomy sectors in each country and the structure of the bioeconomy in the V4 group. The positive competitive effect reflects cross-country variation and also sectors of bioeconomy in Slovakia, Hungary and Czechia are growing faster than those same sectors in the total sample. In the case of Hungary, the high value of the competitive effect (17.4%) was due to the fact that employment growth in country assuming a common initial distribution of sectors was positive (1.4%). In Poland negative competitive effect indicates that the sectors of the Polish bioeconomy are growing slower than in the V4 countries. The same results, that the largest negative values of sectoral-mix and competitive effects are associated with Poland, have Batóg and Batóg (2007). Correlation coefficient is positive and statistically significant (93.63%), so countries employment growth rate affects employment growth in the same bioeconomy sectors at V4 countries level. Bielik and Rajčániová (2008) have the similar statistically significant values of coefficient of correlation, positive values of sectoral mix-effect and residual effect, and negative sectoral-mix and competitive effects for Poland. The last residual effect is negative in all V4 countries, and this means that they have a low measure of a country's degree of specialization in bioeconomy sectors in which they have a competitive advantage and growth potential. The correlation between residual effect and regional employment growth are negative (–47.39%) and dependence was relatively weak. Relative annualised employment growth was again positive in Hungary (17.02%), Slovakia (15.6%) and Czechia (11.5%) and higher than the V4 countries average. Poland has a negative value $REG_i$, but it relates to fact that jobs in bioeconomy sectors more concentrated in the country than in the rest of the V4 on average. Poland also has the great potential of biomass, which can be used to produce energy, or conversion into biofuels and raw industrial materials (Wózniak and Twardowski, 2018). The shift-share analysis allowed to assess the prospects and competitiveness of bioeconomy sectors in V4 countries. To improve the general bioeconomic situation in the agricultural, forestry and food sectors governments of the countries should continue to develop bioeconomy strategies at the national and regional levels in order to support and develop promising sectors of the bioeconomy, increase their competitiveness, improve the professional competence of employees, implement scientific research work and innovative biotechnologies, and, as a result, build a strong bioeconomy in the country that will ensure a sustainable, green and inclusive economic growth.

## 4. Conclusion

The bioeconomy employed approximately 3,362,561 thousand people in V4 countries in 2018. The growth rate of employment in 2008-2018 was -15.97%. In general, we can state a negative tendency towards a decrease in the number of employed. This is due to structural changes and restructuring in the agricultural sectors. In addition, this is determined by working conditions, income level, and the hazardous nature of the work in these sectors of bioeconomy. In Slovakia bioeconomy employed 168.69 thousand people (5.02% of V4 bioeconomy), in Czech Republic employed 383.31 thousand people (11.4% of V4 bioeconomy), in Poland employed 2433.7 thousand people (72.38% of V4 bioeconomy), in Hungary employed 376.85 thousand people (11.21% of V4 bioeconomy). Agriculture (55%), food, beverage and tobacco (22%), and wood products and furniture (12%) are the three sectors of the bioeconomy in which the largest percentage of people work in the V4 countries, and which are the main current producers and potential users of biomass. Sectoral contribution of agriculture to annualised employment growth were negative in Slovakia (-5.4%), Czech Republic (-0.32%) and Poland (-21%), only Hungary has positive contribution of agriculture (1.2%). Using shift-share analysis, we analysed employment growth in V4 countries considering three impacts effects. The sectoral-mix effect, the competitive effect and the residual effect show the influence of the national factor, sectoral structure and sector competitiveness on employment in the V4 countries. Positive sectoral mix-effect mean that in Czechia (8.05%), Slovakia (7.59%) and Hungary (4.67%) were created jobs more, on the contrary in Poland (-2.05% jobs) – fewer, than could be created if the structure of the bioeconomy sectors in these countries was the same as the structure of the bioeconomy in the V4 countries. The positive values of competitive effect in the Czech Republic, Hungary and Slovakia indicate that sectoral employment is growing faster than total employment in all sectors of the bioeconomy in V4 countries. On the contrary, the effect values are negative in Poland, this means that the rate of bioeconomy employment growth are more slowly than in V4 countries as whole. We can state, that in Slovakia, Poland, Czechia and Hungary due to the negative residual effect, employment in sectors of the bioeconomy is growing slower compared to the employment growth rate of these sectors in the total bioeconomy in the V4 countries. Correlation analysis showed that there is a rather strong positive relationship between regional employment growth and the competitive effect, and sectoral-mix effect (the correlation coefficient is 0.94 and 0.86, respectively). This means that the sectoral structure of employment and the differences between sectoral growth in the bioeconomy have a large impact on the overall rate of employment growth in V4 countries. The correlation between relative employment growth and the residual effect is negative and low (– 0.47), which indicates the presence of convergent processes in V4 countries. We can state, that V4 countries: Poland, Slovakia, Czech Republic and Hungary are countries rich on biomass and with big potential of bio-based production. The transition to a bioeconomy helps the Visegrad group countries to innovate and develop new bio-based sustainability products and improve its competitiveness in EU markets. The bioeconomy during the economic crisis and the COVID-19 crisis can be important in reducing unemployment, because the reduction of workers in the main bio-based production sectors as agriculture, forestry and food was the lowest of all sectors of the country's economy.

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# INCREASING TOTAL FACTOR PRODUCTIVITY AS A CONDITION FOR ENHANCING COMPETITIVENESS OF THE RUSSIAN AGRICULTURE: REGIONAL FEATURES

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**Annotation:** The aim of the paper is to analyse the dynamics of total factor productivity of agriculture (TFP) in Russia as a whole and in the regional context as the basis for increasing competitiveness of the industry in the context of a pandemic and environmental shocks. As a result of the calculations, it was revealed that the basic index of agricultural growth in Russia for the period from 2005 to 2019 was 1.62, TFP growth occurred with an increase in the output of agricultural products and a decrease in the volume of resources for its production. Against the background of TFP growth, the foreign trade competitiveness of the Russian agriculture increased. The export of agricultural products increased 5.5 times over this period, the country became a net exporter. In 2020, during the COVID-19 pandemic, agricultural production increased by 1.5%, and exports grew by 20% in both volume and value. In the federal subjects of Russia, dynamics of output, resources growth vary markedly. Such dynamics lead to big regional differences in agricultural TFP dynamics. Based on the calculations performed for 2005–2019 (2005 is the base year), the authors reveal a significant unevenness of TFP dynamics in the regions of Russia. The first group with the highest TFP rates includes 17 regions from the Central (9 regions), Privolzhsky (3 regions), Northwest (2 regions), Southern (2 regions), North Caucasian (1 region) Federal Districts. In Kursk, Oryol, Belgorod and Lipetsk Oblast, TFP more than doubled over the period under review (2.69; 2.57; 2.37; 2.35, respectively), in the remaining 13 regions of the first group the TFP growth is from 1.65 up to 1.99. The second group consists of regions with cumulative TFP growth values which are less than 1.61, but more than 1.00. It is the most numerous group. It includes 43 regions from all federal districts of the Russian Federation. In 18 regions, the value of TFP growth over the period ranges from 1.31 to 1.61. And in the remaining 25 regions, the values are very low: from 1.00 to 1.31. The third group contains 12 regions, five of which are in the Far Eastern Federal District. The growth of the total factor productivity in the regions that are currently lagging behind in this indicator will contribute to the growth of competitiveness of the Russian agriculture.

**Key words:** agriculture, total factor productivity, Cobb-Douglas production function, output, resources, competitiveness, regions.

**JEL classification:** Q10, Q16, Q18.

## 1. Introduction

Economic science pays much attention to the problems of increasing competitiveness of agriculture both in the world and in Russia. However, in the works of foreign and domestic researchers, this problem is not widely considered in the context of total factor productivity (TFP). Most researchers in the study of competitiveness rely on indicators of international trade to determine the absence or presence of comparative advantages. In our opinion, it is necessary to pay more attention to total factor productivity in order to identify the long-term aspects of agricultural competitiveness (DeBoe, 2020).

Since labour, capital, natural resources are the main factors of agricultural production, which over time lose their productive qualities and need to be updated, a necessary condition for competitiveness of agricultural production is the timely replacement of retired resources.

Improving the efficiency of resource use acts as an economic tool to ensure the reproduction of the resource base and to raise total factor productivity.

(U.S. Department of Agriculture, 2014) regularly calculates TFP and publishes the results for countries and regions of the world. The Department has currently published data for the period from 1962 until 2016. Thus, the accumulated TFP in agriculture in Russia for the period from 2005 to 2016 was equal to 1.42 (U.S. Department of Agriculture, 2014).

Different countries also conduct their own studies of TFP dynamics, which is calculated considering national specifics, according to refined methods, peculiarities and possibilities of national statistical accounting. These studies emphasize the importance of studying national characteristics and the relationship between competitiveness and total factor productivity (Hupková et al., 2010), (Dilip, 2014), (Sendhil et al., 2017), (Kloss, 2017).

Insufficient level of total factor productivity is the most significant problem that hinders competitiveness of the Russian agricultural organizations and farmers' households. Total factor productivity has a significant impact on the profitability of production, production volumes in most federal subjects of the Russian Federation (Bokusheva, 2012). Total factor productivity reflects the impact of technological and non-technological innovation, and weak TFP growth indicates a low degree of innovation in the given sector of an economy. Russia lags significantly behind the developed countries in terms of production efficiency. There is also a hypothetical explanation for this (Bokusheva, 2012): a large scale of costs does not always guarantee production growth, since factors that are not always taken into account by other researchers, for example, total factor productivity, play an important role. Chekansky (2003) notes that the "Solow residual" reflects the influence of all other factors, along with changes in the volumes of used factors of production (labour and capital). To a large extent, we can also determine this by the influence of natural and climatic factors. Meanwhile, Chekansky (2003) recommends recognizing that the dominant role among other factors is assigned to technical progress. And the latter just contributes to the growth of competitiveness of agriculture in the long term.

The problems of total factor productivity in agriculture in Russia are disclosed in the scientific works of Rada et al. (2020), OECD (2020). A study by Rada et al. (2020) is devoted to TFP in agriculture of Russia in a regional context. They estimate total factor productivity growth from 1994 to 2013 for the country as a whole and for the regions. They substantiate that the regional development of agriculture in the country was extremely uneven. The authors conclude that until 2013, the most sustained productivity growth occurred in the Southern Federal District, which became the most important agricultural region in Russia. The South significantly outstripped the Central District and the country in terms of total factor productivity. The Central Federal District also showed an increase in TFP in the XXI century (Rada et al., 2020).

The aim of this work is to assess the TFP dynamics in agriculture in Russia as a whole and in the regional context for the period from 2005 to 2019. We consider TFP as an important condition for the growth of competitiveness of national agriculture in the context of the pandemic and environmental shocks. We intend to use a methodology that takes into account the specifics of the Russian agriculture and features of regional statistics.

## 2. Materials and Methods

In this study, cumulative factor productivity ("Solow residual") is determined using the "Growth accounting approach" based on the Cobb-Douglas production function. The "Solow residual" from the Cobb-Douglas function is a part of the increase in production, which is explained not by the contribution of capital and labour, but by the contribution of any other unaccounted factors (first of all, innovations, technological progress, improvement of human capital, as well as the influence of natural and climatic conditions). These factors are difficult to quantify, so in practice it is necessary to calculate only the TFP growth rate, and not the TFP value itself. TFP helps to understand how innovations, technological progress, new knowledge affect competitiveness. In this study, we carry out the calculations of the TFP dynamics in the Russian agriculture as a whole and in the regional context.

To determine the dynamics of TFP, we first calculate the output growth rates in agriculture, as well as the growth rates of volumes of used resources in this industry at the regional level in Russia. Then, we find the difference between the growth rates of output and used resources. The obtained values are total factor productivity growth rates. We preliminarily clear all indicators of the influence of inflation.

A feature of agricultural statistics in Russia is that in statistical accounting, there are three groups of agricultural producers: agricultural enterprises, farm enterprises and households. Households of the population are small non-entrepreneurial households that produce products mainly for personal consumption and sell part of the products. In 2020, households in Russia produced 27.4% of the Russian gross agricultural output. Farm enterprises are predominantly family-owned, private subjects of an entrepreneurial type. In 2020, they produced 14.3% of gross agricultural output. The share of agricultural organizations was 58.3% (Rosstat, 2021). The three types of manufacturers considered above have different equipment with resources, use different technologies, and are characterized by different levels of resource efficiency. This study analyses the dynamics of total factor productivity in general for all categories of farms.

The calculations are based on the improved Methodology for Measuring International Agricultural Total Factor Productivity (TFP) Growth, used by the (U.S. Department of Agriculture, 2014). This methodology was adapted to the Russian specifics of statistical accounting. So, we take into account those factors of production which are better reflected in open sources of the Russian statistical information. An important criterion is also that the data cover not only agricultural organizations, but all other categories of farms in Russia.

We use the index of the volume of gross agricultural products in Russia as a whole and in the regional context as the production index. Rosstat publishes this indicator. It is a weighted average index for various types of agricultural products, and it is calculated for all categories of farms.

We consider the following resources: land, labour, energy capacity, mineral fertilizers, feed and farm animals.

We determine the dynamics of used land resources based on data on the sum of arable land (including irrigated), perennial plantations, and forage lands (Rosreestr, 2021). We adjust each type of agricultural land by its own coefficient, accordingly with the USDA methodology (U.S. Department of Agriculture, 2014).

We reveal changes in the volume of labour resources use based on the average number of people employed in agriculture. For this, indicator “Average annual number of employees” (Rosstat, 2021) was cleared from the number of people employed in forestry, hunting, fishing and fish farming. This indicator reflects employment in agricultural organizations, farms enterprises and households.

Instead of the USDA’s indicator characterizing the availability of tractors and combines (U.S. Department of Agriculture, 2014), we use "Energy capacity per 100 hectares of sown area" (hp) (UISIS, 2021). The latter indicator characterizes the level of technical equipment in agriculture more adequately.

We consider the dynamics of the volumes of applied mineral fertilizers based on indicator "Arrivals of mineral fertilizers" (Agro-industrial complex ..., 2020), in contrast to the indicator of the volumes of mineral fertilizers applied by agricultural organizations used in the USDA calculations (U.S. Department of Agriculture, 2014).

We analyse the contribution of feed based on data on their consumption in all categories of farms based on indicator "Consumption of feed for livestock and poultry in farms of all categories" (UISIS, 2021). Consumption of feed is expressed in feed units to ensure comparability of different feed types. The USDA calculations use the Total Metabolic Energy in Animal Feed (Mcal) metric (U.S. Department of Agriculture, 2014).

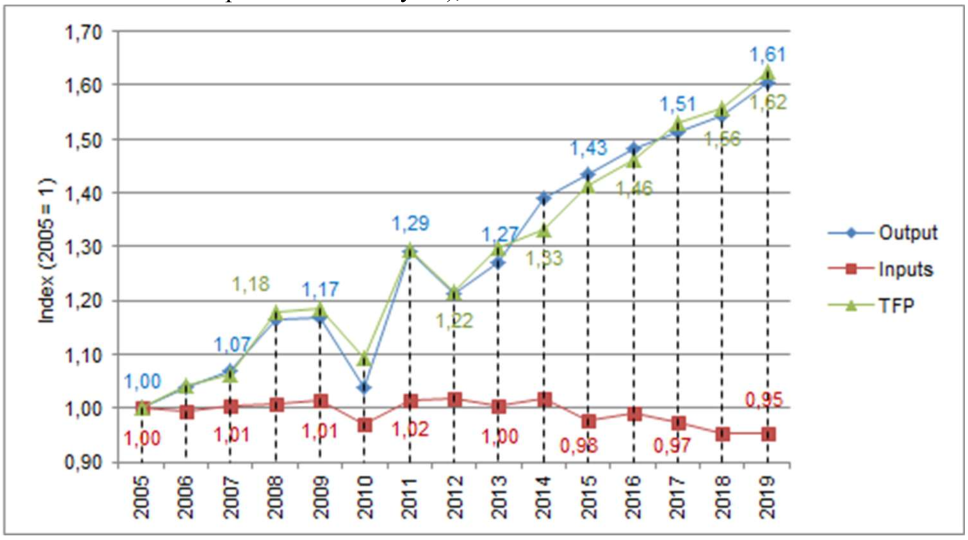
We analyse the index of the dynamics of livestock based on the number of livestock for its various types (Rosstat, 2021) by recalculating into standard heads.

We determine the total index for production factors as a weighted average of indices for all types of resources: land, labour, energy capacity, mineral fertilizers, feed and farm animals. To determine the weights of production factors, we apply a regression analysis based on the federal subjects of the Russian Federation in 2005–2019. We take the Cobb-Douglas production function as the regression equation. To eliminate outliers, we exclude a number of subjects of the Russian Federation from the calculations: Murmansk Oblast, Chechen Republic, Republic of Ingushetia, Magadan Oblast, Chukotka Autonomous Okrug, Crimea, federal cities, autonomous okrugs within krais (to avoid double counting). As a result, 73 regions remain in the sample, instead of 85.

## 3. Results and Discussion

Based on the methodology described above, we calculate the indicators of the dynamics of total factor productivity both for the Russian Federation as a whole and for the regions for the period of 2005–2019.

Figure 1. Total factor productivity, output and resources in agriculture in Russia in 2006–2019 (2005 was adopted as the base year), basic indices in unit fractions

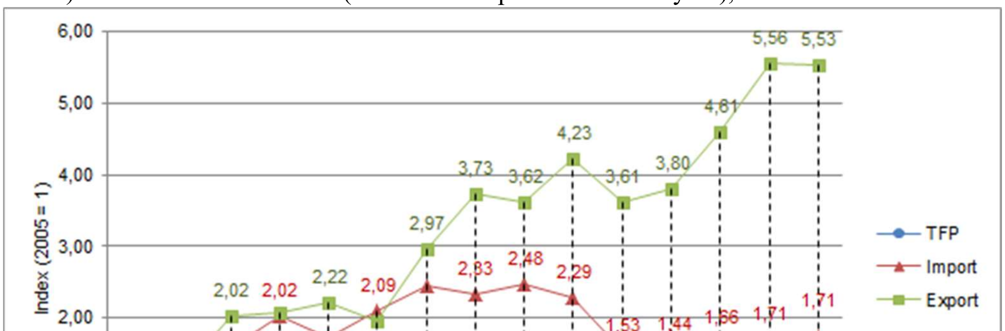



*Source: compiled by the authors*

Figure 1 shows the dynamics of total factor productivity growth in Russia compared to the base period (2005). As can be seen from the graphs, for the indicated period TFP growth amounts to 1.62. This growth can be explained by a significant increase in agricultural output and decreasing volumes of used resources. The growth in total factor productivity is due to the improvement of production technologies and management. In addition, the dynamics of total factor productivity was influenced by weather and climatic conditions. They are especially noticeable in the drop in total factor productivity in lean years in Russia (2010 and 2012).

The growth of total factor productivity makes it possible to compete more successfully in world markets. Figure 2 shows the dynamics of growth of total factor productivity, exports and imports of agricultural products and food in the Russian Federation. During the period under review, the growth rate of exports significantly outstripped the growth rate of imports, the country turned into a net exporter of agricultural products.

Figure 2. Total factor productivity, exports and imports of food products and agricultural raw materials (except for textiles) of Russia in 2006–2019 (2005 was adopted as the base year), basic indices in unit fractions




*Source: compiled by the authors based on (Rosstat, 2021)*

The results obtained in the Russian agriculture in 2020, when the COVID-19 pandemic swept the whole world and Russia, deserve special attention. The volume of agricultural production in 2020 increased by 1.5% compared to 2019: crop production by 1%, livestock by 2% (Rosstat, 2021). The most impressive was the growth rate of the export of agricultural products in Russia. Compared to 2019, the export of agricultural products, both in monetary and physical terms, increased by 20% and amounted to $30.7 billion (Agroexport, 2021).

As shown above, the growth in agricultural production in the country during the period under review was achieved thanks for the more efficient use of resources, while the situation in different regions of the country is significantly different. Based on our calculations, we identify three groups of the Russian regions. These are the regions with TFP growth rates for the period from 2005 to 2019 higher than the national average (1.62); regions with TFP growth rates from 1.00 to 1.61; and regions with TFP less than 1.00 (Table 1).

Table 1. Total factor productivity in agriculture of the Russian regions in 2019 (relative to the base year – 2005), basic indices in unit fractions

| TFP growth over the period | Regions included in the group |
|---|---|
| More than the average Russian value (1,62) | Kursk Oblast, Oryol Oblast, Belgorod Oblast, Lipetsk Oblast, Pskov Oblast, Tambov Oblast, Tula Oblast, Voronezh Oblast, Kaliningrad Oblast, Astrakhan Oblast, Tver Oblast, Ulyanovsk Oblast, Krasnodar Krai, Ryazan Oblast, Republic of Dagestan, Samara Oblast, Penza Oblast |
| From 1,00 to 1,61 | Republic of Bashkortostan, Rostov Oblast, Leningrad Oblast, Volgograd Oblast, Udmurt Republic, Sverdlovsk Oblast, Komi Republic, Saratov Oblast, Smolensk Oblast, Chuvash Republic, Vladimir Oblast, Primorsky Krai, Moscow Oblast, Republic of Altai, Kurgan Oblast, Republic of Kalmykia, Novgorod Oblast, Kaluga Oblast, Republic of Mordovia, Perm Krai, Republic of Karelia, Republic of Adygea, Kirov Oblast, Republic of Tatarstan, Orenburg Oblast, Yaroslavl Oblast, Ivanovo Oblast, Nizhny Novgorod Oblast, Tyumen Oblast, Republic of North Ossetia – Alania, Stavropol Krai, Tomsk Oblast, Altai Krai, Republic of Sakha (Yakutia), Krasnoyarsk Krai, Irkutsk Oblast, Omsk Oblast, Republic of Tyva, Republic of Mari El, Novosibirsk Oblast, Kemerovo Oblast, Amur Oblast, Vologda Oblast |
| Less than 1,00 | Bryansk Oblast, Kostroma Oblast, Zabaykalsky Krai, Khabarovsk Krai, Republic of Buryatia, Republic of Khakassia, Karachay-Cherkess Republic, Arkhangelsk Oblast, Chelyabinsk Oblast, Sakhalin Oblast, Jewish Autonomous Oblast, Kamchatka Krai, Kabardino-Balkarian Republic |

*Source: compiled by the authors*

The first group covers 17 regions from the Central (9 regions), Privolzhsky (3 regions), Northwest (2 regions), Southern (2 regions), North Caucasian (1 region) Federal Districts. In Kursk, Oryol, Belgorod and Lipetsk Oblast – the regions of the Central Federal District – TFP over the period under review more than doubled (2.69; 2.57; 2.37; 2.35, respectively). In the remaining 13 regions, TFP growth ranged from 1.65 to 1.99.

The second group of regions with cumulative TFP growth values that are less than 1.61, but more than 1.00, is the most numerous. It includes 43 regions from all districts of the Russian Federation. In 18 regions, the value of TFP growth over the period ranged from 1.31 to 1.61, and in the remaining 25 regions, the values are very low: from 1.00 to 1.31.

The third group encompasses 12 regions, 5 of which are in the Far Eastern Federal District. The group includes 6 regions in which during the period under review there was a decrease in the output of agricultural products. These are such regions, as Kostroma Oblast, Khabarovsk Krai, Republic of Buryatia, Arkhangelsk Oblast, Murmansk Oblast, Jewish Autonomous Oblast (Table 2).

The third group also includes Bryansk Oblast – one of the leaders in the growth of agricultural production (2.76), in which the negative TFP value was the result of a significant increase in the volume of used resources, in particular fertilizers. This is a result of the intensive development of crop and livestock production in the region since 2014. Positive values of output growth were also achieved in the Karachay-Cherkess Republic (1.46), Chelyabinsk Oblast (1.38), Sakhalin Oblast (1.25), and the Republic of Khakassia (1.05). In these regions, the growth in output was accompanied by a more intensive use of resources for agricultural production.

Table 2 shows the groups of regions that differ in the dynamics of agricultural output. The first group contains regions with output growth values exceeding the national average of 1.61. This group consists of 21 regions of the Russian Federation from all federal districts, except for the Ural and Siberian. This group includes 13 regions with TFP growth that are above the national average. The rest of the regions, despite a significant increase in output, concerning the outstripping growth in the volume of used resources, have lower TFP growth rates.

Table 2. Dynamics of output in agriculture of the Russian regions in 2019 (relative to the base year – 2005), basic indices in unit fractions

| **Output growth over the period** | **Regions included in the group** |
|---|---|
| More than the average Russian value (1,61) | Belgorod Oblast, Kursk Oblast, Lipetsk Oblast, Pskov Oblast, Tambov Oblast, Bryansk Oblast, Astrakhan Oblast, Voronezh Oblast, Republic of Mari El, Penza Oblast, Oryol Oblast, Kabardino-Balkarian Republic, Kaliningrad Oblast, Novgorod Oblast, Amur Oblast, Republic of Adygea, Republic of Dagestan, Tula Oblast, Republic of Mordovia, Kaluga Oblast, Ulyanovsk Oblast |
| From 1,00 to 1,60 | Tver Oblast, Ryazan Oblast, Samara Oblast, Krasnodar Krai, Republic of Kalmykia, Rostov Oblast, Altai Krai, Karachay-Cherkess Republic, Tomsk Oblast, Yaroslavl Oblast, Saratov Oblast, Orenburg Oblast, Volgograd Oblast, Leningrad Oblast, Chelyabinsk Oblast, Republic of Altai, Primorsky Krai, Republic of Tatarstan, Republic of North Ossetia – Alania, Stavropol Krai, Sverdlovsk Oblast, Sakhalin Oblast, Chuvash Republic, Novosibirsk Oblast, Tyumen Oblast, Kamchatka Krai, Udmurt Republic, Zabaykalsky Krai, Kemerovo Oblast, Moscow Oblast, Republic of Bashkortostan, Vladimir Oblast, Krasnoyarsk Krai, Kurgan Oblast, Smolensk Oblast, Irkutsk Oblast, Nizhny Novgorod Oblast, Republic of Tyva, Republic of Khakassia, Omsk Oblast, Komi Republic, Republic of Buryatia |
| Less than 1,00 | Perm Krai, Kirov Oblast, Republic of Sakha (Yakutia), Ivanovo Oblast, Vologda Oblast, Kostroma Oblast, Republic of Karelia, Khabarovsk Krai, Arkhangelsk Oblast, Jewish Autonomous Oblast |

*Source: compiled by the authors*

The second group consists of regions with growth rates in agricultural output of more than 1.00, but below the national average. It encompasses 42 regions from all federal districts. The group presents 4 regions with TFP growth rates exceeding the national average. In these regions, high TFP values were achieved thanks for the outstripping production output compared to the volume of resource use.

The third group is the regions in which the production of agricultural products has decreased. It includes 10 regions, a significant part of which is in zones unfavorable for agriculture.

Table 3 demonstrates the groups of regions according to the dynamics of the volume of used resources for agricultural production.

Table 3. Dynamics of the use of resources in agriculture of the regions of Russia in 2019 (relative to the base year – 2005), basic indices in unit fractions

| Growth in total resources over the period | Regions included in the group |
|---|---|
| More than the average Russian value (0,95) | Kabardino-Balkarian Republic, Bryansk Oblast, Kamchatka Krai, Sakhalin Oblast, Republic of Mari El, Belgorod Oblast, Chelyabinsk Oblast, Tambov Oblast, Amur Oblast, Novgorod Oblast, Pskov Oblast, Karachay-Cherkess Republic, Republic of Adygea, Astrakhan Oblast, Kaluga Oblast, Republic of Mordovia, Voronezh Oblast, Penza Oblast, Tomsk Oblast, Kursk Oblast, Lipetsk Oblast, Republic of Tyva, Kaliningrad Oblast, Orenburg Oblast, Yaroslavl Oblast, Altai Krai, Republic of Khakassia, Republic of Kalmykia, Stavropol Krai, Republic of Altai, Novosibirsk Oblast, Republic of Tatarstan, Primorsky Krai, Zabaykalsky Krai, Irkutsk Oblast, Kemerovo Oblast, Republic of Dagestan, Saratov Oblast, Tyumen Oblast, Republic of North Ossetia – Alania, Tula Oblast, Rostov Oblast, Leningrad Oblast, Republic of Buryatia, Krasnoyarsk Krai, Volgograd Oblast, Ryazan Oblast, Ulyanovsk Oblast |
| From 0,80 to 0,94 | Sverdlovsk Oblast, Chuvash Republic, Omsk Oblast, Tver Oblast, Krasnodar Krai, Udmurt Republic, Samara Oblast, Oryol Oblast, Nizhny Novgorod Oblast, Vladimir Oblast, Vologda Oblast, Moscow Oblast, Kostroma Oblast, Jewish Autonomous Oblast, Kurgan Oblast, Smolensk Oblast |
| Less than 0,80 | Republic of Sakha (Yakutia), Ivanovo Oblast, Republic of Bashkortostan, Perm Krai, Komi Republic, Kirov Oblast, Khabarovsk Oblast, Arkhangelsk Oblast, Republic of Karelia |

*Source: compiled by the authors*

The average Russian value of the basic index in 2019 compared to 2005 was equal to 0.95 (Table 3). The regions are divided into three groups. The first group has regions with index values greater than 1.61, that is, regions in which the volume of used resources grew faster than the average Russian value of the output growth index. The second group cover regions with indices from 0.95 to 1.60. The third group shows regions with indices less than 0.95. The first group shows 10 regions, the second – 38 regions, and the third – 25 regions. In 29 regions of Russia, the resources usage decreased (the index value is less than 1.00) during the period under consideration.

## 4. Conclusion

Total factor productivity in Russia increased 1.62 times over the period of 2005–2019. This was achieved as a result of increased output and declining dynamics of resource use. The growth in total factor productivity increases competitiveness of the Russian agriculture. This is evidenced by the growth of exports in comparison with the base period (2005) by 5.5 times and the increase in imports by 1.7 times. In 2020, the country became a net exporter of agricultural products and food. TFP growth contributes to greater resilience of the Russian agriculture to external shocks. So, in 2020, when the whole world was covered by the COVID-19 pandemic, the volume of agricultural production in Russia increased by 1.5% (Rosstat, 2021), the export of agricultural products and food increased by 20% compared to 2019 (Agroexport, 2021).

At the same time, TFP dynamics are noticeably different in the regions of Russia. Based on the calculated values of the cumulative TFP growth for the period from 2005 to 2019, the regions of the country were divided into 3 groups: regions with TFP growth indicators for the period from 2005 to 2019 higher than the national average (1.62); regions with TFP growth rates from 1.00 to 1.61; and regions with TFP less than 1.00. The first group with outstripping TFP growth (compared to the national average) includes 17 regions, 9 of which are in the Central Federal District, 3 in the Privolzhsky Federal District, 2 in the Northwest, 2 in the Southern, and 1 in the North Caucasian Federal District. Whereas, in accordance with previous calculations for the period up to 2013, (Rada et al., 2017; Rada et al., 2020) observe an outstripping TFP growth in the regions of the Southern Federal District. The second group (growth from 1.00 to 1.61) includes 43 regions, of which, in 18 regions, the cumulative TFP growth ranges from 1.31 to 1.61. TFP growth in 12 regions of Russia does not exceed 1.00.

A further increase in competitiveness of agriculture in the Russian Federation can be ensured by an increase in total factor productivity not only in successful regions. This also applies to those regions showing insignificant TFP growth.

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# USABILITY STUDY OF THE DECISION-MAKING SUPPORT TOOL IN VIRTUAL REALITY ENVIRONMENTS

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**Annotation:** The paper deals with the usability and User experience analysis results of a developed software prototype combining VR technology with standardized questionnaires. The required result of the proposed prototype is to develop a decision-making support tool in virtual reality environments. The purpose is to support and streamline the decision-making process where, with the help of implemented interactions and functions, Virtual reality minimizes the knowledge gaps of responders. As a result, it is possible to effectively obtain and evaluate well-informed automatic user feedback from VR environments regarding the given topic, but only if the presented technology is usable by its users and for this reason, usability analysis is necessary.

To verify our prototype in terms of the usability and User experience perspective, we prepared a fictional case study focusing on a simple urban planning topic, which is the expected ordinary use of our prototype. Following the given scenario, participants filled in a prepared questionnaire in a VR environment. We recorded each participant's overall behavior in both real and virtual environments. Then we have evaluated the findings using standard methods for usability studies, which consisted of the System Usability Scale (SUS), Heuristic evaluation, Cognitive think-aloud protocol, and semi-structured interviews with users.

The combination of Heuristic testing and the Cognitive think-aloud methods identified the possible shortcomings which the SUS method does not fully reflect. The evaluation of the results highlights the possible shortcomings of the methodologies concerning VR technology and User experience (UX). It determines the need to use more precise usability methods, which may need to be modified specifically for the VR technology environment.

The realized usability study results provided us with significant confidence that the developed prototype can support decision-making in urban planning and that we can expand and continue the research concerning the VR questionnaires.

**Key words:** Virtual Reality, VR; usability, decision-making process, questionnaire, UX

**JEL classification:** M15, L86, O32

## 1. Introduction

Virtual Reality (VR) has become a significant technology in recent years not only for research purposes but mainly, thanks to relatively recent advances in IT, for their actual applications. Making VR hardware available to average consumers leaves room for this technology even in smaller companies or households. Stereoscopic VR imaging allows users to process the visual-spatial information by placing them into a real-size 3D environment (Kang, Shin and Ponto, 2020). Users can manipulate objects or perform various actions feeling that they are physically present in the mentioned environment. Consumer acceptance of VR technology is still in its first stages, but as innovation accelerates, more and more businesses are identifying ways to use this technology in various industries (Abidi et al., 2016). The ability to "immerse" a user in a 3D virtual world and let him interact with virtual engineering models is an essential, though often overlooked, ability. With the rise of affordable, high-quality VR devices and monitoring solutions, 3D design data can be visualized relatively quickly in VR using only minimal or no programming knowledge (Wolfartsberger, Zenisek and Sievi, 2018).

Regarding the fast evolution of VR technologies, there is a possible lack of standard methods for creating and evaluating VR experiences to achieve the desired immersive effect. Also, there are missing comprehensive guidelines for satisfying user experience (UX) in VR. Immersion and good UX can be vital for proper decision-making in virtual environments. The VR prototype must be entirely usable and accessible for the given target group or individual. If users make the most effort to orient themselves in the environment, the prototype loses effectiveness. Conversely, it can contribute to negative results and misunderstanding of the presented issues (Sameeh El Halabi et al., 2019). Besides, most of the already implemented software applications are for one purpose only, with limited tools to measure and evaluate user feedback and UX.

Due to the current Covid-19 situation, it is necessary to look for new solutions that minimize or eliminate the negative pandemic effects (Siani and Marley, 2021; Ekmeil et al., 2021 Schiopu et al., 2021; Lee and Kim, 2021).

Our efforts aim to create satisfied users that can "stay at home" and still make well-informed decisions regarding the relevant fields (such as urban planning, real estate market, or architecture). This effect may represent a significant competitive advantage for countless industries in the future.

The study we conducted was focused on developing a prototype software tool that integrates virtual reality technologies into existing survey management systems. The second part of the study dealt with the testing and evaluation of such prototype in terms of usability and UX.

The key objective of this paper is to present the second part of our study, i.e. the usability and UX analysis results of a developed prototype combining VR technology with standardized questionnaires. The required result of the proposed prototype is the support and streamlining of the decision-making process where, with the help of implemented interactions and functions, virtual reality minimizes the respondents' knowledge gaps. The VR questionnaire responses can be processed and evaluated by the existing questionnaire system using its standard methods. As a result, it is possible to effectively obtain and evaluate well-informed automatic user feedback from VR environments regarding the given topic, but only if the presented technology is usable by its users.

Before the prototype development, it was necessary to answer whether Virtual reality can provide a comparable experience as in the real world. So, the developed prototype could provide the correct data considering the decision-making process. The experiment from the "Immersive environment for improving the understanding of architectural 3D models: Comparing user spatial perception between immersive and traditional virtual reality systems" (Paes, Arantes and Irizarry, 2017) deals with differences in spatial perception in immersive and "classical" 3D environments. The experiment consists of asking participants to identify spatial aspects and virtual space elements (such as dimensions, proportions, openings) in both immersive and non-immersive ("classical") 3D environments. The results prove that users using an immersive environment have a better spatial perception of virtual space as opposed to spatial perception using a conventional workstation ("classic" 3D display on a 2D monitor). The immersive environment allowed users to perceive spatial elements more accurately than through conventional 3D display. Higher accuracy in determining certain spatial aspects and distances using an immersive platform means a better understanding of the spatial arrangement of the 3D model. Better spatial perception can be understood as a better interpretation of spatial elements, concluding that the spatial geometric information displayed in an immersive environment "makes more sense", and the user processes it better. In short, presentation and communication using this type of image information are better with the support of an immersive environment than traditional 3D displays (Liu, Shimizu and Ando, 2021; Li et al., 2021; Paes, Arantes and Irizarry, 2017). Kang, Shin and Ponto (2020) and Cowan et al. (2021) performed similar experiments to evaluate the influence of immersive VR on product purchasing decisions. The results confirmed that interactivity and visual-spatial orientation had a significant effect on product awareness. Interactivity, which allows shoppers to move and manipulate the product freely, significantly increases the perceived level of product awareness in the shopping interface (Kang, Shin and Ponto, 2020; Cowan et al., 2021).

In addition to visual stimuli, VR also provides sound stimuli. Maffei et al. (2016) looked at the credibility of simulated sound stimuli within VR. This study aimed to understand whether the simulated acoustic and visual stimuli were sufficiently identical with their corresponding elements in the real natural world. The results suggest that the acoustically and visually impressive virtual reconstruction made the participants feel like in the real world. In other words, the virtual world is perceived as a believable world, where action, movement and perception can be directed appropriately to the environment's complexity. Thus, immersive VR has a potentially significant advantage for integrating all sensory information over other 3D displays. In summary, a good level of compliance achieved with modern multisensory immersive VR technologies can be an intelligent and innovative tool for enhancing planning and predicting the impact on the community and their complex environment (Maffei et al., 2016).

## 2. Materials and Methods

The development resulted in the creation of the functional prototype as an add-on for the Unity engine (convenient development engine for VR environments), integrating data from the Google Forms survey management system into the VR environment. The developed prototype uses form data from Google Forms (Table 1), based on which it generates the same form content in the 3D virtual environment of the Unity engine. The form prepared in this manner can be filled in using the VR in the mentioned environment, and its results can be exported back to Google forms for standard evaluation.

According to Sameeh El Halabi (2019), the VR tool must be entirely usable and accessible for the given target group or individual. We needed to determine whether the overall VR experience within our prototype is user-friendly to verify that it can effectively serve as a decision-making support tool. During the VR experience, participants should not encounter any obstacles that could negatively affect their ability to make decisions. They should be concentrating only on the questionnaire given topic.

To verify our prototype in terms of the usability and User experience perspective, we have prepared a fictional case study focusing on a simple urban planning topic, which is the expected ordinary use of the prototype. Following the given scenario, participants filled in a prepared questionnaire in a VR environment. We recorded each participant's overall behavior in both real and virtual environments. Then we have evaluated the findings using standard methods for usability studies, which consisted of the System Usability Scale (SUS), Heuristic evaluation, Cognitive think-aloud protocol, and semi-structured interviews with users.

Table 1. VR supported items from the Google Forms service

| Google Forms item | VR prototype support |
|---|---|
| **Short Answer** | yes |
| **Paragraph** | yes |
| **Multiple Choice** | yes |
| **Checkboxes** | yes |
| **Dropdown** | yes |
| **Linear Scale** | yes |
| **Multiple Choice Grid** | yes |
| **Date** | yes |
| **Time** | yes |
| **Image** | no |
| **Page-break** | no |
| **Video** | no |

The *System Usability Scale (SUS)* uses an internationally standardized questionnaire to determine the level of usability, which consists of a set of ten questions with which the respondent expresses the degree of agreement on a scale of 1-5, specifically from "Strongly agree" to "Strongly disagree" (Bangor, Kortum and Miller, 2008).

The *Heuristic evaluation* is one of the basic usability testing methods, which consists of browsing and evaluating websites and applications by experts. The UX and usability expert evaluates the examined element by comparing the element's current state with the generally given rules of usability of the application (Nielsen, 1994). Regarding the given problem, we used the 10 Usability Heuristics for User Interface Design (Nielsen, 2020).

The *Cognitive think-aloud protocol* is often taught in UX courses (Fan, Shi and Truong, 2020) and is considered the "gold standard" for usability assessment (Hornbæk, 2010). Participants verbalize their thoughts during testing while completing a given scenario. Thanks to this, it is possible to gain insight into their thought processes, which is difficult to obtain by mere observation (Fan, Shi and Truong, 2020). This method has been used in many studies that seek to understand the user's cognitive processes during interaction with technology (Tawfik et al., 2021). It is recommended to perform testing only in the presence of the user and the moderator. The user proceeds through the specified scenario, and the moderator intervenes only if the user could not or would not be able to complete the scenario successfully.

*Semi-structured interviews* were conducted as a short interview with each participant to discover the overall VR experience's main pros and cons.

With the help of our prototype, we prepared a fictitious case study dedicated to constructing a future relaxation area for students. The area location was situated between the old and the new faculty buildings, and all faculty students well know it. For this case study, we created a simple questionnaire using Google Forms, which contained questions about the equipment of individual parts of the relaxation area, including the amount of greenery or water features. Subsequently, the developed VR prototype imported the questionnaire data into the Unity engine prepared VR environment, which has processed them into a usable form. The chosen case study aimed to demonstrate the expected most common use of the developed prototype: "*To assist in deciding on the shape or location of elements in 3D space using VR technology, where the user is provided with an immersive experience from the perspective of their own eyes on a 1:1 scale*". The user should then have a better understanding of the presented issues and thus make decisions easier.

Due to the topic of the case study, the only criterion for selecting testing participants was the existing relationship with the Faculty of Economics and Management. So, the participants were motivated for the correct completion of the questionnaire. Respondents were informed about the case study's fictitiousness only after the end of testing. A total of 6 participants (three women and three men) with no or minimal experience with VR technology participated in the testing. According to Nielsen (2012) and Virzi (1992), it takes five testers to identify 80% of system errors. The number of six participants is, therefore, sufficient to test the main usability issues. The usability testing took place at the Human Behaviour Research Unit laboratory at the Faculty of Economics and Management, Czech University of Life Sciences Prague (Fig. 1).

Figure 2. Usability testing

## 3. Results and Discussion

Based on the chosen SUS methodology, each participant evaluated the statements in the questionnaire (Table 2).

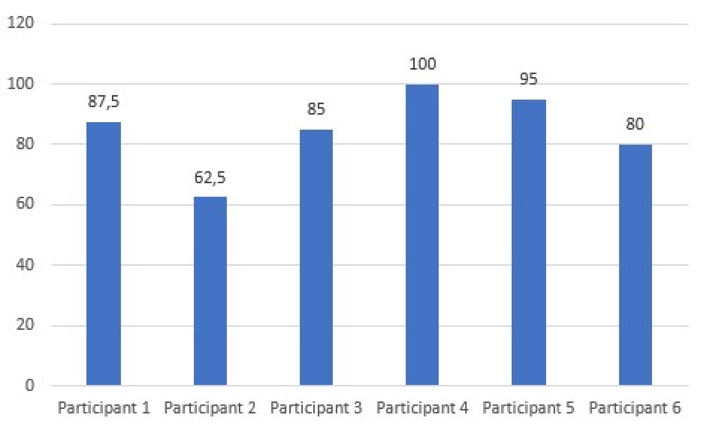
Table 2. SUS questionnaire

| | Statement |
|---|---|
| **1.** | I think that I would like to use this application frequently. |
| **2.** | I found the application unnecessarily complex. |
| **3.** | I thought the application was easy to use. |
| **4.** | I think that I would need the support of a technical person to be able to use this application. |
| **5.** | I found the various functions in this application were well integrated. |
| **6.** | I thought there was too much inconsistency in this application. |
| **7.** | I would imagine that most people would learn to use this application very quickly. |
| **8.** | I found the application very cumbersome to use. |
| **9.** | I felt very confident using the application. |
| **10.** | I needed to learn a lot of things before I could get going with this system. |

*Source: Bangor, Kortum and Miller (2008)*

The SUS value can take values in the range 0 (worst) - 100 (best), and we can, in a simplified form, interpret them as meaning that values below 68 are below average and above 68 points above average (Bangor, Kortum and Miller, 2008). In our case (see Fig. 2), the arithmetic mean of the SUS values of all participants is 85 and indicates a significantly above-average score. Within each SUS, only one case did not meet the selected limit of 68. Overall, the prototype can be described as above average in terms of user experience within the SUS methodology.

Figure 2. Individual SUS chart




Results of the SUS method were cross-verified with other mentioned methods for usability evaluation. The verification led to the identification of the following usability issues. We set the following scale for scoring: 1- not a usability problem / 4 - a critical problem (see Table 3).

Table 3. Discovered issues

| Score | Issue | VR connected issue |
|---|---|---|
| **3** | Absence of reply confirmation. | No |
| **3** | Absence of visual distinction of already answered questions. | No |
| **2** | Absence of more noticeable feedback (sound, vibration, highlighting) when pointing and clicking on a menu item or questionnaire. | Yes |
| **2** | The individual questionnaire items are not sufficiently visible in the virtual environment. | Yes |
| **2** | Absence of VR control help system. | Yes |

Each identified problem will be addressed and solved accordingly in future software releases to achieve a better user experience. For the completeness of the results, it is also necessary to mention the identified positives concerning the VR prototype, which support the right direction of development. None of the participants had problems with orientation in the VR and none of them experienced cybernetic disease (Lim et al., 2021; McCauley et al., 1992) characterized by nausea and headache. Five respondents stated that they felt as if they were completing a questionnaire in the real world and that filling in the questionnaire was fun (necessary for increasing the motivation for survey participation). Also, they would repeat the completion of the VR questionnaire. Four respondents were very interested in the environment and would welcome more interactive elements.

From the information analysis obtained mainly by the Cognitive think-aloud protocol (Fan, Shi and Truong, 2020) and an additional interview with each participant, we identified other shortcomings and recommendations, especially from the point of view of the VR, which heuristics (Nielsen 2020) and SUS do not fully address. For example, the size of the placed objects from the participant or the user menu generation at a certain distance from the eyes. The problem also arises when we have tried to define the corrections for these shortcomings because each participant proposes completely different values. Other findings suggest that participants need more than visual feedback and better navigation around the survey items, which is not standard compared to a "classic" web survey. The findings show the need to extend the prototype's usability testing with more appropriate and accurate methods (such as Eye-tracking, Click-tracking and Keyboard tracking adapted for VR) or design new methods exclusively for usability testing VR environments.

## 4. Conclusion

The paper presents the usability and UX analysis results of a developed prototype combining VR technology with standardized questionnaires. According to the achieved results, the prototype was evaluated as above average and very promising as the decision-making support tool.

The combination of Heuristic testing and the Cognitive think-aloud methods identified the possible shortcomings which the SUS method does not fully reflect. The evaluation of the results highlights the possible shortcomings of the methodologies concerning VR technology and User experience (UX). It determines the need to use more precise usability methods, which may need to be modified specifically for the VR technology environment. We will use this information in the implementation of further tests. Based on the obtained findings, the existing prototype will be modified to eliminate the identified shortcomings and implement new recommended functionalities. We are planning further tests, especially considering the types of questions in the questionnaire and their effectiveness in VR environments.

Subsequently, we will perform a comparison of our VR questionnaire with a typical online one to measure the costs for survey preparations and their individual impact on decision-making. The realized usability study results provided us with significant confidence that the developed prototype can support decision-making in urban planning and that we can expand and continue the research concerning the VR questionnaires.

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# POTENTIAL FOR USING FINANCIAL LEVERAGE TO INCREASE PROFITABILITY – CASE OF AGRICULTURE COMPANIES IN CROATIA

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**Annotation:** The coronavirus pandemic has emphasized the strategic importance of the domestic agriculture sector, by disrupting the usual food chains and forcing countries to turn to domestic producers. Croatia has a great potential, but issues such as the size of farms, land ownership and lack of financing opportunities have led to a constant increase in imports of agricultural products and decrease in the percentage of cultivated land. The focus of this paper is on financing opportunities of agriculture companies in Croatia. Companies can benefit from using financial leverage if they have high enough return on assets to be able to borrow funds at interest rates that are lower than return on assets. Successful using of financial leverage will result in increasing return on equity above the level of return on assets. The main objectives of the paper are to investigate: 1) the level of profitability of agriculture companies in Croatia, 2) if companies are successful at using financial leverage, 3) if the size of the company is an important factor when it comes to using financial leverage, 4) if there is a difference between the potential of agriculture companies to use financial leverage when compared to other non-financial sectors. By analyzing the period 2015-2019, research results showed that a certain number of agricultural companies in Croatia is limited from expanding their operations due to low profitability and unfavorable borrowing. A positive aspect is that small agriculture companies are generally not in a disadvantage when compared to medium and large companies. However, a negative aspect is that companies from other non-financial sectors are in a more favorable position due to higher return on assets, making it easier for them to use financial leverage successfully.

**Key words:** agriculture companies, Croatia, financial leverage, profitability, return on assets, return on equity.

**JEL classification:** M41

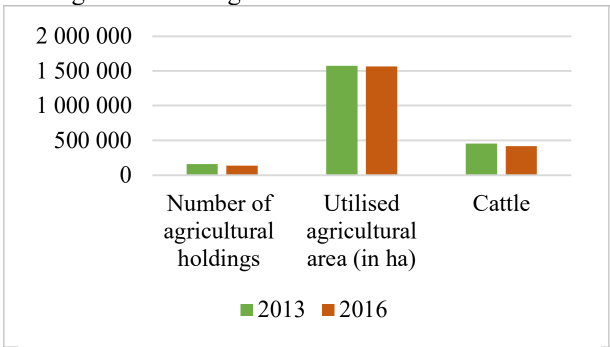
## 1. Introduction

Countries around the world have recognized the importance of the agriculture sector for the well-being of its inhabitants. In addition to food production, agricultural sector has many other benefits. It offers raw resources necessary to produce other products, adds to the economic progress through exports to other countries, provides employment, etc. “Providing livelihoods and jobs for 40 % of today’s global population, agriculture is the single largest employer in the world” (Franić, Jurišić and Gelo, 2014). These are the main reasons why countries constantly desire to enlarge and recover their agricultural sectors (Sarwar, 2014). The challenges faced by agriculture entities are numerous, but many of them are related to financing. “Financial constrains in agriculture remain pervasive, and they are costly and inequitably distributed, severely limiting smallholders’ ability to compete. Financial constrains originate in the lack of asset ownership to serve as collateral (wealth rationing) and in reticence to put assets at risk as collateral when they are vital to livelihoods (risk rationing)” (World Bank, 2008). Without financial resources, agricultural entities are not able to grow in size and take advantages from the economy of scale.

In addition to the ongoing issues that the agriculture sector has faced for years, new challenges have emerged with the COVID-19 pandemic. Although there may be benefits for national agriculture sectors in the short-run, due to closed borders and turning consumers to domestic products for caution, OECD analysis predicts negative effects to agricultural markets over the next decade. The explanation is that lower economic growth will reduce overall food consumption. Lower demand will then result in price decreases, putting a downward pressure on agricultural revenues, which will consequently lead to a reduction in agricultural production. It is expected that the animal production will decline more substantially than cereal production, because in times of economic crisis high-value products are more affected (OECD, 2020).

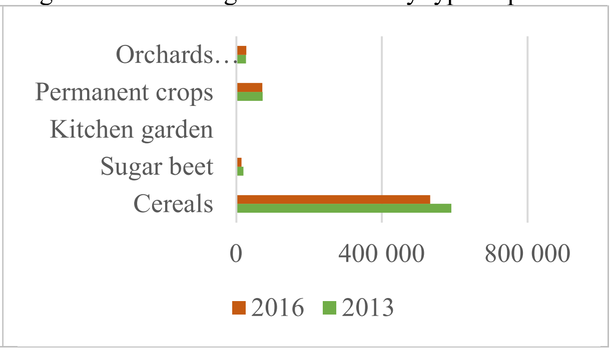
Croatia, as an EU Member State, has many competitive advantages that could be used to encourage growth and development. Some of the advantages are: unrestricted access to EU markets, access to investment support under the EU common agricultural policy, diverse agro-ecological conditions, water resources and quality land, good roads infrastructure, growing domestic tourism industry, etc. (World Bank Group, 2019). Sector of agriculture, forestry, hunting and fishing contributes 6.5 % to the GDP, which rises to 10 % when the food industry is included (FAO, n.a.). When considering forward and backward linkages, the broad agri-food sector currently contributes close to 15 % to the Croatian economy (World Bank Group, 2019). Croatia devotes a lot of public resources to agriculture, which is evident from the fact that the public support in Croatia is around 1.3 % of GDP (double than on average in EU-28), with the share of EU funding at around 65 % (World Bank Group, 2019). Some of the other indicators related to the agricultural sector are presented in Figures 1 and 2.

Figure 1. Main agricultural indicators in Croatia




*Source: Croatian Bureau of Statistics, n.a. (c)*

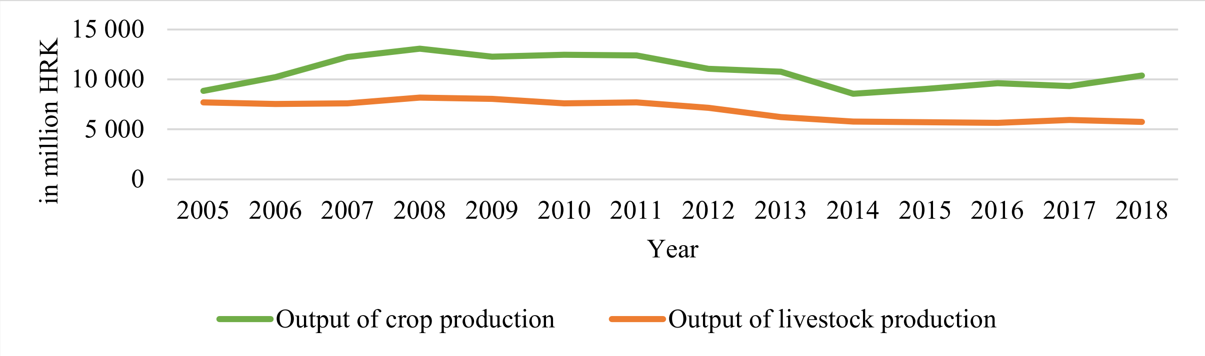
Figure 2. Utilised agricultural area by type of produce




*Source: Croatian Bureau of Statistics, n.a. (c)*

All the indicators presented in Figure 1 have decreased in 2016 when compared to 2013. Family farms and livestock farms have been especially affected, leading to a severe reduction in the number of agricultural holdings over the years. For example, number of family farms in 2007 was 180,120, reducing to 130,264 in 2016. Livestock farms have decreased from 162,260 in 2007 to 88,131 in 2016 (Croatian Bureau of Statistics, n.a. (a)). A reduction in the number of agricultural holdings over the years consequently affected the output in agricultural production (Figure 3). Output of the livestock production has been especially reduced, which is alarming, since the animal products are usually higher-valued than cereal products. Results in the recent years have, however, been slightly improved. Chain index for the total agricultural production is above 100 in 2018 (104) and 2019 (103) when compared to the previous year (Croatian Bureau of Statistics, 2020).

Figure 3. Output of agricultural production in Croatia for the period 2005-2018




*Source: Croatian Bureau of Statistics, n.a. (b)*

One of the issues in Croatian agriculture sector is that large agri-food systems have relatively good access to capital at subsidized rates, while smaller producers and business remain excluded. The demand side is characterized by a high number of small-scale farmers growing low value crops, creating scale problems for banks. Their access to capital markets is additionally limited by limited knowledge of modern value chains, their financing or management requirements. On the supply side, the problem is a lack of information about agriculture among commercial banks and other financial service providers (World Bank Group, n.a.). In addition, Franić, Jurišić and Gelo (2014) stress out the negative impact of inadequate production structure (low profit sector prevail), low yields in most farms, high production costs (due to small and fragmented production area) and problems with products sale (small quantities, non-standardized supply, long supply chains, lack of product brands, etc.). A survey conducted among family farms and crafts showed the most important issues from the standpoint of agriculture producers. They singled out high level of input prices, slow administration, low market price and problem of debt collection. Inability to obtain credit and low yield were rated with the lowest score (Lončarić, Lončarić and Tolušić, 2016).

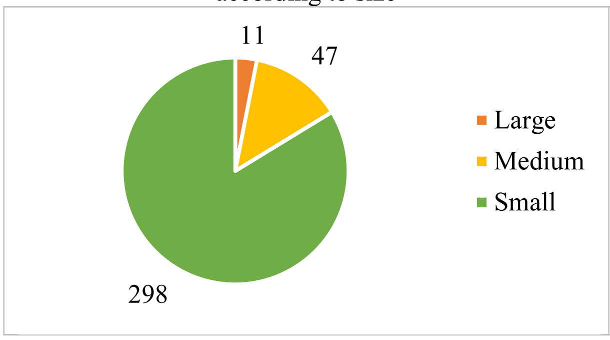
Ability of an entity to grow in size significantly depends on its possibility to favorably borrow funds. Entities with higher profitability ratios, primarily return on assets (ROA), have more possibilities of obtaining loan, since the main condition for favorable borrowing is that the interest rate must be bellow ROA. When making strategic decisions such as financing, DuPont model serves as one of the best tools that helps stakeholders by providing an overview of different aspects such as profitability, capital structure, leverage, operational efficiency, etc. (Sur, Mitra and Maji, 2014). When developed, DuPont model focused on increasing ROA, "but the first modification of the DuPont model shifted the focus from ROA to ROE, incorporating debt or leverage as a third area of attention" (Doorasamy, 2016). The modified or extended DuPont model therefore focuses on ROE as the most important financial ratio, and identifies entity's strengths and weaknesses, covering the following areas: profitability, operating efficiency, and leverage. "ROE shows whether management is growing the company's value at an acceptable rate" (Herciu, Ogrean and Belascu, 2011). Basically, if you multiply net profit margin (net profit / revenues) with total assets turnover (total assets / revenues) and the leverage multiplier (total assets / equity), you will get ROE. Leverage ratio or multiplier shows a degree to which an entity uses debt (Kharatyan, Nunes and Lopes, 2016). The correlation between the debt ratio and profitability can be positive (e.g., Bhagyalaskshmi & Saraswathi, 2019; Kharatyan, Nunes and Lopes, 2016; Adenugba, Ige and Kesinro, 2016) and negative (Kim, 2016; Ali, 2020; Ahmad, Salman and Shamsi, 2015), depending on the circumstances, as shown by previous research results. In other words, not every debt will lead to an increase in profitability. If an entity can borrow funds at interest rates that are lower than ROA, borrowed funds can be invested by achieving a return that is high enough to pay back the interest and make additional profit for the owners, i.e., increasing ROE. Therefore, by comparing the ROA and ROE, it can be concluded whether the entity uses the positive effects of financial leverage (Žager, Sever Mališ and Brozović, 2019). In the opposite case, when the interest rate is higher than ROA, it is not recommended to borrow funds, because it will lead to a decrease in ROE. As is the case in other sectors, successful farm business managers must understand the determinants of profitability. A research conducted by testing an e-learning tool based on DuPont model with graduate students and farm producers showed "that the computer software was effective for teaching of profitability analysis contained within the DuPont profitability model" (Melvin, Boehlje, Dobbins and Gray, 2004). This is one way to raise awareness and improve knowledge regarding financing and other decision-making.

Literature analysis showed the issues of agriculture sector in Croatia, suggesting low yields, fragmentation and unequal conditions for agriculture companies depending on their size. The purpose of this paper is to further analyze the profitability of agriculture companies in Croatia, focusing on the following research objectives: 1) the level of profitability of agriculture companies in Croatia, 2) if companies are successful at using financial leverage, 3) if the size of the company is an important factor when it comes to using financial leverage, 4) if there is a difference between the potential of agriculture companies to use financial leverage when compared to other non-financial sectors in Croatia.

## 2. Materials and Methods

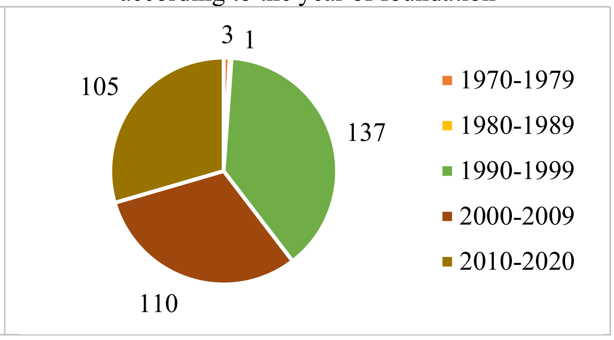
Initial research population consisted of companies active in the period 2015-2019 whose primary section of activity is *Agriculture, forestry and fishing*, with micro companies excluded from the research. Population size was 356 (Figure 1), dominated by small companies (84 %), mostly founded after 1990 (Figure 2).

Figure 1. Distribution of agriculture companies according to size




*Source: author*

Figure 2. Distribution of agriculture companies according to the year of foundation




*Source: author*

Table 1. contains distribution of agriculture companies according to the group of activity they primarily operate in, which is a more detailed classification of agriculture section. The most represented groups of activities are growing annual crops (26 %) and raising animals (21 %).

Table 1. Distribution of agriculture companies according to group of activity

| **Group of activity (3-digit numerical code)** | **Number of companies** | **%** | **Group of activity (3-digit numerical code)** | **Number of companies** | **%** |
|---|---|---|---|---|---|
| Silviculture and other forestry activities related to it | 7 | 2 % | Cultivation of perennial crops | 40 | 11 % |
| Mixed production | 50 | 14 % | Fishing | 20 | 6 % |
| Growing annual crops | 92 | 26 % | Ancillary services in forestry | 7 | 2 % |
| Raising of livestock, poultry, and other animals | 76 | 21 % | Logging | 11 | 3 % |
| Aquaculture | 21 | 6 % | Hunting, trapping and related service activities | 4 | 1 % |
| Growing of planting material and ornamental plants | 18 | 5 % | Collection of forest fruits and products, except forest assortments | 1 | 0 % |
| Ancillary activities in agriculture and post-harvest activities | 9 | 3 % | **Total** | **356** | **100 %** |

*Source: author*

Financial data for the analyzed companies were collected from the service of the Financial agency Info.BIZ and were taken from the annual financial statements for the period 2015-2019. The analysis is based on profitability ratios, namely return on assets (ROA) and return on equity (ROE). Since some companies in certain years did not have available all financial information necessary for calculating profitability ratios or they had negative capital due to accumulated losses, number of analyzed companies per year is below 356 (Table 2). A total number of observations (pooled sample) in the period 2015-2019 is 1,482.

Table 2. Number of agriculture companies analyzed by year

| **Year** | **Number of companies** | **Year** | **Number of companies** |
|---|---|---|---|
| 2015 | 298 | 2018 | 295 |
| 2016 | 293 | 2019 | 296 |
| 2017 | 300 | **Total** | **1,482** |

*Source: author*

After calculating profitability ratios, median was used as a middle value to generalize conclusions. Companies with ROE higher than ROA in a specific year were marked as successful at using financial leverage. For those companies that were able to use financial leverage, an additional indicator was calculated as a ratio of ROE and ROA – financial leverage index. One of the aims of the research was to investigate if the size of the agriculture company is an important distinguishing factor when using financial leverage. Therefore, a Pearson correlation coefficient was calculated to explore the correlation between financial leverage index and two variables that were used as proxies for size: total assets and total revenues.

Another aim of the research was to compare the agricultural companies with companies that operate in other sections of activities in terms of using financial leverage. Companies used for the comparison belong to the non-financial sections of activity (Table 3), are medium or large in size, have available financial information for the period 2015-2019 and do not have a negative capital. A total sample contains 1,667 companies and 8,130 observations in the analyzed 5-year period.

Table 3. Distribution of companies that operate in other non-financial sections of activities

| Section of activity (alphabetical code) | Number of companies | % | Section of activity (alphabetical code) | Number of companies | % |
|---|---|---|---|---|---|
| Manufacturing | 550 | 33 % | Transport and storage | 111 | 7 % |
| Electricity, gas, steam supply and air conditioning | 33 | 2 % | Mining and quarrying | 11 | 1 % |
| Information and communications | 60 | 4 % | Professional, scientific, and technical activities | 69 | 4 % |
| Wholesale and retail trade; repair of motor vehicles and motorcycles | 451 | 27 % | Administrative and support service activities | 43 | 3 % |
| Construction | 133 | 8 % | Other service activities | 3 | 0 % |
| Water supply; wastewater disposal, lord. Waste and active environmental rehabilitation | 89 | 5 % | Real estate business | 15 | 1 % |
| Accommodation products and food preparation and service | 99 | 6 % | **Total** | **1,667** | **100 %** |

*Source: author*

A sample of non-financial large and medium companies was compared to the sample of previously analyzed agricultural large and medium companies (58 companies and 270 observations in the 5-year period). After comparing medians of their profitability ratios, the one-way ANOVA test was performed. The purpose was to test if the means of ROA, ROE and financial leverage index are statistically significantly different between the two analyzed samples.

## 3. Results and Discussion

Out of 1482 company-year observations related to the sample of agriculture companies, in 72 % of the cases ROE was higher than ROA, which indicates a positive effect of financial leverage. As may be seen from Table 4, there is an upward trend and 2019 is the most successful year with 74 % of the companies that benefit from using financial leverage. However, the remaining 26 % of the companies are not able to yield positive effects from borrowing additional funds. Some of them operate with a loss, while some of them have a positive but very low ROA. For companies that do not use debt but are financed strictly from equity, ROE would be equal to ROA. Out of 1,060 companies that have ROE higher than ROA, 50 % of them have financial leverage index above 1.96 (Table 4). This means that half of the companies were able to double ROE (when compared to what they would realize if they were financed only through own funds) by borrowing additional funds at the interest rate that is below ROA.

Table 4. Comparison of profitability ratios for analyzed agricultural companies – analysis by years

| Year | ROE > ROA | | ROE < ROA | | Total | Median of financial leverage index* |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | | |
| 2015 | 200 | 67 % | 98 | 33 % | 298 | 2.07 |
| 2016 | 206 | 70 % | 87 | 30 % | 293 | 1.96 |
| 2017 | 221 | 74 % | 79 | 26 % | 300 | 1.86 |
| 2018 | 214 | 73 % | 81 | 27 % | 295 | 1.92 |
| 2019 | 219 | 74 % | 77 | 26 % | 296 | 2.03 |
| **Total** | **1,060** | **72 %** | **422** | **28 %** | **1,482** | **1.96** |

** for companies with ROE > ROA*

*Source: author*

When it comes to size, it appears that small agriculture companies are better at using financial leverage, since the percentage of small companies (74 %) that have ROE higher than ROA is significantly higher than for medium and large companies (62 %). In addition to higher percentage, median of financial leverage index suggest that small companies that are successfull at using financial leverage generally were able to increse their ROE above ROA more than it was the case with medium and large companies. It is usully perceived that larger companies have better and more favorable financing opportunities, which is why the oposite research resutls were expected.

Table 5. Comparison of profitability ratios for analyzed agricultural companies – analysis by company size

| Size of company | ROE>ROA | | ROE<ROA | | Total | Median of financial leverage index* |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | | |
| Small | 893 | 74 % | 319 | 26 % | 1,212 | 1.97 |
| Medium and large | 167 | 62 % | 103 | 38 % | 270 | 1.84 |
| **Total** | **1,060** | **72 %** | **422** | **28 %** | **1,482** | **1.96** |

** for companies with ROE > ROA*

*Source: author*

Median of profitability indicators confirms that small agriculture companies are not in unfavorable position when compared to large and medium agriculture companies. On the contrary, their median ROA is 4.39 %, suggesting that median company would have to borrow funds at the interest rate that is lower than 4.39 %. At the level of medium and large companies, median is only 3.68 %, which limits posibilities for favorable borroring and using financial leverage. As a result, median ROE is significantly lower for medium and large companies than for small companies in the agriculture sector.

Table 6. Median of profitability ratios for analyzed agricultural companies

| Financial ratio | Small | Medium and large | All |
|---|---|---|---|
| Median of ROE | 9.83 % | 5.86 % | 8.92 % |
| Median of ROA | 4.39 % | 3.68 % | 4.11 % |

*Source: author*

To futher analyze if the size of the company is an important factor in using financial leverage to increase profitability, a correlation analysis was conducted an a sample of companies that have ROE higher than ROA. Pearson correlation coefficient showed that there is a negative correlation between the financial leverage index and variables that were used as proxies for size – total assets and total revenues. However, the result is not significant at $p < 0.05$. Therefore, the definite conclusion is that small agriculture companies are not in a disadvantage when compared to medium and large companies, suggesting that companies of all sizes have equal opportunities for growth.

Table 7. Correlation analysis for agriculture companies with ROE > ROA (n = 1,060)

| Variables | Pearson correlation coefficient | P-value |
|---|---|---|
| Total assets vs. Financial leverage index | -0.0332 | 0.2831 |
| Total revenues vs. Financial leverage index | -0.0408 | 0.1823 |

*Source: author*

Another research aim is related to comparison of agriculture companies to other non-financial companies in terms of using financial leverage. This is why the second part of the research concentrates on comparing medium and large companies that operate in section of activity *Agriculture, forestry and fishing* with medium and large companies from other 13 non-financial sections of activities (primarily manufacturing, as may be seen from Table 3). The results for other non-financial companies are presented in Table 8. It is evident that 75 % of other non-financial companies are successfull in using financial leverage, which is a higher percentage than for agriculture medium and large companies (62 %).

Table 8. Comparison of profitability ratios for companies from other sections of activities (pooled sample of medium and large companies, 2015-2019)

| **Year** | **ROE > ROA** | | **ROE < ROA** | | **Total** |
|---|---|---|---|---|---|
| | **No.** | **%** | **No.** | **%** | |
| 2015 | 1,135 | 72 % | 441 | 28 % | 1,576 |
| 2016 | 1,210 | 75 % | 403 | 25 % | 1,613 |
| 2017 | 1,208 | 74 % | 414 | 26 % | 1,622 |
| 2018 | 1,276 | 77 % | 376 | 23 % | 1,652 |
| 2019 | 1,276 | 77 % | 391 | 23 % | 1,667 |
| **Total** | **6,105** | **75 %** | **2,025** | **25 %** | **8,130** |

*Source: author*

Such results may be partially explained by lower ROA in case of agriculture companies when compared to other non-financial companies, since the median is lower by almost 2 percentage points (Table 9). However, when comparing only companies that have ROE higher than ROA, agriculture companies have higher median financial leverage index.

Table 9. Median of profitability ratios for agriculture companies and companies from other non-financial sections of activities (pooled sample of medium and large companies, 2015-2019)

| **Financial ratio** | **Agriculture companies** | **Companies from other section of activities** |
|---|---|---|
| ROA | 3.68 % (n = 270) | 5.79 % (n = 8,130) |
| ROE | 5.86 % (n = 270) | 10.61 % (n = 8,130) |
| Financial leverage index for companies with ROE > ROA | 1.84 (n = 167) | 1.78 (n = 6,105) |

*Source: author*

One-way ANOVA test confirmed that the means of ROA between the two samples of companies are statistically significantly different at $p = 0.05$. On the other hand, the results indicate that means of ROE and financial leverage index are not sigificantly different using the same level of significance. It can be concluded that other non-financial companies on average have higher ROA and therefore more options for favorable borrowing of additional funds. Although median of ROE is also higher for other non-financial companies, the dispersion between the companies within the sample is to high to be able to confirm the significance of this difference.

Table 10. Results of the one-way ANOVA (two independent samples; variables: ROA, ROE, Financial leverage index)

| **ROA** | | | | | | |
|---|---|---|---|---|---|---|
| Source of Variation | SS | df | MS | F | P-value | F crit |
| Between Groups | 0.261213 | 1 | 0.2612 | 26.3996 | 0.0000 | 3.8426 |
| Within Groups | 83.09466 | 8,398 | 0.0099 | | | |
| Total | 83.35587 | 8,399 | | | | |
| **ROE** | | | | | | |
| Source of Variation | SS | df | MS | F | P-value | F crit |
| Between Groups | 0.652559 | 1 | 0.6526 | 0.1629 | 0.6865 | 3.8426 |
| Within Groups | 33,641.04 | 8,398 | 4.0058 | | | |
| Total | 33641.69 | 8399 | | | | |
| **Financial leverage index** | | | | | | |
| Source of Variation | SS | df | MS | F | P-value | F crit |
| Between Groups | 983.5791 | 1 | 983.5791 | 0.1065 | 0.7442 | 3.8429 |
| Within Groups | 57,900,041 | 6,270 | 9,234.4564 | | | |
| Total | 57,901,025 | 6,271 | | | | |

*Source: author*

## 4. Conclusion

Despite the fact that it is not the most productive sector, past experiences have shown that countries must focus on strengthening their agriculture sector, which plays an important role especially in times of crisis such as the ongoing pandemic. Croatia has many competitive advantages that should encourage agriculture production. However, development of the agricultural sector is burdened with numerous issues: inadequate production structure, low yields, high production costs due to small and fragmented production area, long supply chains, etc. Literature review has shown that agriculture entities have limited access to capital markets, caused by both the demand and the supply side of those markets. Limited financing opportunities are a serious constraint on further growth. If entities are not profitable enough to borrow funds at interest rates that are lower than ROA, then they do not have options to gather additional external funds. In other words, they are unable to take advantage of the positive effects of financial leverage. Empirical research conducted on agriculture companies in Croatia showed that three quarters of companies have ROE higher than ROA, meaning that they are successful at using financial leverage, while the remaining one quarter are not. Contrary to expectations, small agriculture companies have higher median ROA and ROE, are better at using financial leverage and have higher financial leverage indexes. Although the negative correlation between the size of the agriculture company and financial leverage index proved to be not significant, at least the conclusion is that small agriculture companies are not in a disadvantage when compared to medium and large companies. However, results related to profitability and using financial leverage are better in other sectors when compared to agriculture, especially ROA, which in the end demonstrates that low yields are an important issue in agriculture.

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# DRIVERS OF FARMERS' SUCCESS DURING THE FIRST WAVE OF COVID-19

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**Annotation:** The paper deals with the analysis of the sources of competitiveness in the group of small farmers during the first wave of COVID-19. The aim is to reveal the drivers of farmer's success under introduced institutional measures. In particular, the paper addresses the following research questions: Does the group of small farmers catch up the opportunity to enhance their business? What are the sources of farmers' success? The results show that almost two third of interviewees were affected by the first wave of COVID-19 in the production and sale. The farmers faced problems with delivery of inputs, hiring labour inputs, increased sanitary requirements, limited or functionless some marketing channels and the ban on foreign trade. On the other hand, the analysis revealed that the costumers increased their demand on local and higher quality food. Moreover, farmers introduced several business innovations, such as the introduction of online payment methods and online technologies in the sale. Furthermore, they were pushed to speed up the prepared investments projects. These activities helped to increase the sales during the first wave of the COVID-19 and might represent drivers of success in their future business.

**Key words:** competitiveness, farmers, COVID-19 pandemy, Logit model, success drivers

**JEL classification:** Q18

## 1. Introduction

COVID-19 has brought about diverse institutional reactions on a global scale, with significant impacts on economic growth, human life and the activities of economic entities. Such impacts differ greatly depending on the extent to which COVID-19 has spread, the type of measures taken, and the structure of the national economy. In the same way there have been differences between individual sectors, industries, and size classes of economic entities within a particular country.

According to OECD (2020), lower economic growth will reduce overall food consumption; lower consumer demand and subsequent price decreases lead to a reduction in agricultural production. As the supply side reaction to this lower demand will lag, agricultural prices will fall, at least in the short run, putting additional pressure on farm revenues.

Expert studies present a range of problems associated with the COVID-19 pandemic, which are generally divided into several sub-categories (Ker and Cardwell, 2020; Laborde et al., 2020): food supply, food demand, food safety and security, trade. As Laborde et al. (2020) mentioned, agriculture and food markets are facing disruptions because of labour shortages created by restrictions on movements of people and shifts in food demand resulting from closure of restaurants, schools as well as from income losses. The strength and intensity of individual influences differ, however, depending on the nature of activity of the enterprise, the size of the enterprise, the type of product made, the level of mechanisation and robotisation of production, the location, or the forms of product distribution. Seleiman et al. (2020) stated, that the most critical factors with impact on crop production as a result of the COVID-19 are: soil fertility, availability of fertilizers, sowing and harvest dates, water availability and pests or diseases (all concerning with agricultural machinery, laborers and international fertilizers and pesticides trade). Laborde et al. (2020) contend in their study that COVID-19 will probably have smaller direct impact on agricultural production which is highly mechanised (e.g. cereals), because the most of farms deploy large-scale machinery with low labour input e.g. for land preparation, sowing, harvesting. On the other hand, using large-scale mechanization is more difficult for production as fruit or vegetable. These production uses usually seasonal farm workers.

Based on FAO's survey (FAO, 2019), usually small-scale producers are facing the problems of accessing inputs (e.g. seeds, fertilizers), because of higher prices, lower income or lack of inputs availability in the market.

Rohit et al. (2020) confirmed many risks in the agricultural supply chains during the COVID-19 pandemic - demand risks, financial risks, logistics and infrastructure risks (based on research in India, namely, in micro, small, medium, and multi-national enterprises). Other authors indicated following risks concerning agricultural production during the pandemic:

On the supply-side

- labour shortages (Hobbs, 2020; Brewin, 2020; Seleiman, 2020; Cortignani et al., 2020);
- declines in incomes (OECD, 2020);
- international trade – accessibility of inputs, fertilizers and pesticides (Seleiman, 2020; Gurbuz et al., 2020; Jámbor et al., 2020);
- perishability of the products (Jámbor et al., 2020);

On the demand-side

- panic buying behaviour (Hobbs, 2020; Kerr, 2020);
- changes in consumption patterns (Hobbs, 2020);
- income instability (Jámbor et al., 2020).

The Coronavirus outbreak caused supply and demand shocks as well as a high fluctuation in financial markets (Gurbuz and Ozkan, 2020) and could also lead to a food security crisis if proper measures are not supported (Hossain, 2020). Also, Siche (2020) confirms, that the COVID-19 pandemy has an impact on agriculture and the food supply chain (affecting food demand). The agriculture faced not only the COVID-19 pandemic, but also other factors influencing agricultural production as soil and water resources, climate changes and human labor demand. The negative impact of COVID-19 on agriculture can be minimized through enhancing local production and short food supply chains (Seleiman et al., 2020). Also, governments collaboration in terms of international trade of inputs, using digital and farm management technologies can be helpful for minimising risks resulting from COVID-19.

The impacts of the pandemic have been projected, inter alia, in a range of government measures and support schemes across individual sectors of the national economy. Such measures were designed to act as a supportive and effective tool to moderate the negative impacts on individuals and small, medium-sized and large enterprises alike. The fundamental government measures in the Czech Republic can essentially be summarised under the following areas: (I) tax allowances, (ii) support for the self-employed, (iii) support to maintain employment levels, (iv) free use of data boxes, (v) support for farmers, foresters, and food producers, (vi) measures for employees. The nature of the measures taken are both financial and administrative-organisational in nature (connected, for example, with extending the deadline for submitting applications, reports, etc.). Measures have also been projected in domestic and international business relations at the level of regulating foreign trade.

The paper addresses the following research questions: Does the group of small farmers catch up the opportunity to enhance their business? What are the problems and sources of farmers' success?

## 2. Materials and Methods

The paper deals with the analysis of the sources of competitiveness in the group of small farmers during the first wave of COVID-19. The primary objective of the paper is to analyse and evaluate possible and effective ways of dealing with problems associated with the occurrence of the COVID-19 pandemic within the selected group of small enterprises - family farms.

The analysis is based on the dataset that was collected in a questionnaire survey, conducted as an electronic questionnaire during the first week of June, 2020. The questionnaire was intended for agricultural entities - family farms - working in the Czech Republic and falling within the category of small enterprises. The questionnaire contained closed and open questions, which were sectioned into several parts: identification of the entity and of its activity (products produced), the impacts of the COVID-19 pandemic on production, on processing products, sales and the distribution of products. The selection of enterprises and the categorisation of production, and the formulation of the individual questions in the questionnaire, were set out in accordance with the requirement of planned future international comparison within selected countries of the EU.

The target group of respondents was reached in cooperation with Asociace soukromého zemědělství ČR (Association of Private Farming of the Czech Republic) and Společnost mladých agrárníků ČR (Young Agrarians´ Society of the Czech Republic). The questionnaire was completed by a total of 147 respondents, who can be characterised by both socio-economic and production characteristics.

As far as the age structure is concerned, the representatives of family farms can be divided into the following groups: young farmers to the age of 40 (22.64 % of respondents), respondents of between 41 and 50 years of age (45.28 % of respondents), and respondents aged 51 years and older (32.08 % of respondents). Vocational secondary-school education (58.93%) and university education (35.71 %) were prevalent among the respondents.

The dataset consists of the following production categories: 14.6 % fruit and vegetables, 7.5 % eggs and poultry, 27 % raw meat and processed meat products, 8 % cheeses and dairy products, 3,5 % herbs, lavender, spices and nuts, 7.5 % honey, 1.3 % grapes and wine, 3.1 % processed products (jam, spirits, cordials, gherkins, oil, and other), 12.4 % milk and 15 % other. As for product aggregation, the farms can be characterised as follows: fresh foods (fruit and vegetables, bakery products) account for 24.3 %, durable foods (for example, honey, wine, jam, etc.) account for 11.1 %, flexible foods (sold either unprocessed, processed, or non-perishable - such as milk and meat) account for 57.7 %, and others represent almost 7 %.

The size structure of respondents is described based on annual turnover, in that 57.8 % of respondents stated annual turnover from farming activity up to CZK 1.2 million, 23.1 % achieve turnover between CZK 1.2 million and CZK 5 million, and almost 20 % of those asked have turnover of more than CZK 5 million.

Although generalisation of the results is not possible on account of the unrepresentative nature of the selection in the true sense, such methods are commonly used in similar research and the investigation carried out brings a number of findings which make it possible to clarify the main features of the problem under consideration. In spite of the fact that we are not dealing with a representative sample in the statistical sense of the word, it is possible to assume the broader validity of the results achieved.

The empirical part uses Logistic regression to find the main factors determining economic activity. In particular, we aim to relate the probability of the decrease in production and problems occurrence in production, processing, sales and logistic with the following factors (regressors): food category (fresh and durable), income, contractual relationships, labour, seasonal labour and drop in the price.

Logit model can be formally written as (Green, 2003):

$$Prob(Y = 1|\boldsymbol{x}) = \frac{e^{x'\beta}}{1+e^{x'\beta}} = \Lambda(\boldsymbol{x}'\boldsymbol{\beta}) \qquad \textbf{(1)}$$

where y is binary variable (1 = the decrease in production or the problem occurrence), **x** is a vector of regressors and **β** is a vector of parameters to be estimated. Λ(.) stands for the logistic cumulative distribution function.

## 3. Results and Discussion

We start our analysis with the characterisation of changes in the use of marketing channels. It emerges from the answers provided by respondents that the most commonly used marketing channel is a sale directly from a farm/house/own farm shop. This provides a certain advantage, and resilience to crisis situations like COVID-19. The results also show that there was a significant decline in the role of the market, restaurants and catering, public institutions and festivals. The role of the market, restaurants and catering, and public institutions mainly decreased in terms of fresh foods. For non-perishable products, it was the market and other categories (wholesale, mobile sales, foreign trade). The category of flexible foods did not register any fundamental (statistically significant) change in the use of marketing channels.

Overall production, or sales, of agricultural products fell for 62.1 % of respondents, was entirely transformed at 13.1 %, and the situation was used by farmers to increase production, or sales, in 24.8 % of cases. At the same time, 64 % of those asked stated that contractual relationships and the conditions of sale had changed in consequence of the epidemic. The price of agricultural products remained unchanged for approximately two-thirds (64.7 %) of respondents, but 30 % reported a drop in their prices. Only 5.3 % of those asked increased their prices. As far as labour is concerned, 25.3 % of farmers faced a problem securing labour out of which 27.6 % was seasonal labour.

Problems arising from COVID-19 were mainly registered in production (42.2 % of cases), sales and marketing (27.2 % of cases), and in logistics, storage, and transportation (25.2 % of cases).

Processing and packing, and in particular online sales, as reported by 22 respondents, did not register any fundamental problems as a consequence of the pandemic.

The descriptive analysis is further complemented by the results of fitted Logit models to identify factors increasing sensitivity and at the same time resilience to the occurrence of problems in consequence of COVID-19. Specifically, the fitted models provide information on factors increasing/decreasing the likelihood of negative impacts on the total economic result and the likelihood of problems occurring at individual stages of economic activity.

Table 1. Determinants of economic activity – Logistic regression

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| | **Decrease in production** | **Problems in production** | **Problems in processing** | **Problems in sales** | **Problems in logistics** |
| Fresh foods | 0.44 | -0.01 | 1.22 | 1.24* | 0.48 |
| Durable foods | -0.35 | 0.88 | 1.68* | 1.71** | 1.09 |
| Income | -0.20* | 0.25** | -0.12 | 0.10 | -0.03 |
| Contractual relationships | -0.43 | 0.61 | -0.53 | 1.54*** | 0.50 |
| Labour | 0.61 | 1.11 | 3.28*** | 1.48** | 2.25*** |
| Seasonal labour | -1.08 | -0.22 | -2.01** | -2.03** | -2.74*** |
| Drop in price | 1.40*** | 0.42 | -0.10 | 1.32*** | 0.63 |
| Constant | 0.98** | -1.69*** | -2.66*** | -2.75*** | -1.67*** |

*Source: Own calculation, 2021*

Table 1 presents the results of fitted Logit models for different phases of production process. The models include production inputs and main characteristics of outputs as well as internal and external factors determining the farmers' economic activity (see section 2: Materials and Methods). All fitted models show overall good statistical quality. VIF test does indicate any problem with high collinearity. The employed regressors play a different role in each step of production process. In particular, the models differ in explanatory power and number of significant parameters. Most significant parameters can be found at the end of production process, especially in the model explaining the problems in sales. On the other hand, only one regressor is statistically significant at 5% significance level in the model 1 and 2.

Model 1 shows that the decline in production is positively determined by the decrease in the price. In other words, even though the producers were pushed to decrease the price, they still experienced the decline in production or in their sales, respectively (see OECD, 2020). Other factors did not have a significant impact on the production.

The occurrence of problems in the production (model 2) was positively associated with the size of the farm. The respondents linked the problems to the ability of ensuring production inputs. These conclusions are also confirmed by Seleiman (2020), Gurbuz et al. (2020), Jámbor et al. (2020). The problems of ability inputs concern not only the demanded quantity but also the right timing. Model 3 (problems in processing) shows the problem in processing. In this case, the probability of problem occurrence raises in the category of durable foods and with the number of employees. On the other hand, seasonal labour decreases the occurrence of this problem. The selling problems are positively associated with contractual relationships, number of employees and the decrease in the price. The direct proportion between the occurrence of the problems in the sales and the price decline corresponds with Model 1 and is an expected outcome. Moreover, the probability of problem occurrence is higher in the case of both fresh and durable foods. The negative association can be observed with the seasonal labour. Finally, the logistic problems are positively determined by the number of employees and negatively by the seasonal labour. The negative impact of seasonal labour is a common feature for models 3, 4 and 5 and can be related to time of the survey as well as adjustment processes in the production as a reaction to COVID-19 shock. Labour shortages are indicated as an important factor on the supply side by Hobbs (2020), Cortignani et al. (2020).

## 4. Conclusion

The first wave of COVID-19 affected almost two-thirds of respondents, to differing extents, in production and sales. Those asked primarily faced problems with securing deliveries of input materials, securing labour, increased hygiene demands, the restriction or non-functioning of certain marketing channels, and the stoppage of cross-border trade. However, some positive situations were also registered. Customers increased demand for local foods. Contactless payment methods were introduced, there was heightened interest in and usage of online technology in the sale of products, and investment plans were made. In the forthcoming period, such positives might entail the growth of economic activity and greater resilience to crisis situations among micro and small agricultural entities. What was the situation like abroad and how did farmers cope with it? This is the theme that we will focused on in our future research.

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# MONITORING VISITORS IN THE CONTEXT OF INCREASING INTEREST IN DOMESTIC TOURISM DUE TO THE PANDEMIC AND ITS IMPACTS ON THE NATURAL LANDSCAPE AND AGRICULTURE

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**Annotation:** Domestic tourism in the context of the Covid-19 pandemic is gaining in importance, with more and more visitors looking for trips to the natural sites. However, natural sites are struggling to cope with the sudden influx of tourists and their interest is often at odds with the capacity of the site. Movement of visitors thus has a negative effect on the agricultural landscape. The own research focuses on ways to use motion monitoring as a tool to protect agricultural sites. The main goal of the project is the use of information and communication technologies for monitoring of the visitors in selected area, namely the design and assessment of selected technologies for monitoring movement of persons and obtaining information on the behavior and characteristics of visitors and subsequent pilot verification available technologies. Based on the data obtained, the data can be used to protect the landscape and agricultural areas as the fields, meadows and pastures with an impact on tourism and regional development.

**Key words:** Internet of things, regional development, motion monitoring, CCTV, GDPR, tourism

**JEL classification:** L86

## 1. Introduction

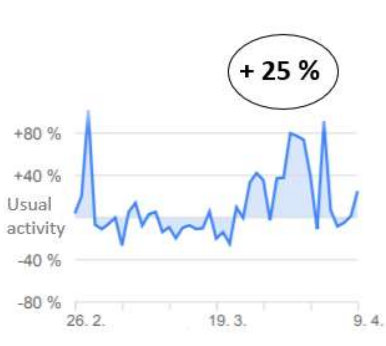
The concept of the Internet of Things (IoT) is now an integral part of information and communication technologies and is widely used across all areas from consumer use in smart homes to the central infrastructure management in agriculture, construction, transport and public administration to support monitoring and management of the operation of urban or municipal infrastructure. It is with the use of IoT at the level of the state, regions and municipalities that we encounter the concept of Smart City, whose concept uses digital, information and communication technologies to increase the quality of life in cities, especially in the field of tourism, transport and the environment. In the case of tourism, due to the increasing interest of tourists and the saturation of the area, motion monitoring comes to the fore with using special devices as cameras, sensors and detectors.

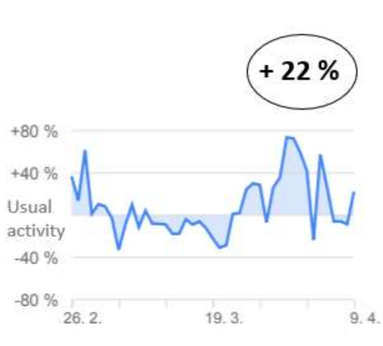
The motion monitoring using ICT technologies is a commonly used method today (da Costa Liberato, 2018), mainly through data obtained from mobile phones (Gretzel, 2016; Novák, 2010). In general, tracking movement based on data provided by mobile operators is nothing new today. However, the subject of this paper is not the issue of big data associated with mobile operators, but data collection using appropriate technologies, especially in places where there is a greater concentration of people and access to them from multiple directions and these areas are not bounded by a fence and data about the characteristics and numbers of visitors are not obtained directly, i.e. depending on the number of tickets sold, data from entrance turnstiles, etc. Commonly available and used technology for data collection in these areas can be smart solutions installed in the form of step tile, pressure sensor tubes or turnstiles with infrared beam, which follow the movement of visitors based on movement or stepping. It is these technologies that are widely used today in national parks and landscape protected areas, where the signal from the mobile device may not be strong enough and is therefore not relevant for the collection of this type of data (Ahas, 2006).

The obtained data on monitoring of persons in each locality are currently often primarily used as tools for detecting conflicts between the interests of tourism and nature protection, specifically as a tool for sustainable tourism (Skalková, Špyňar, 2011). Often, the sensitivity of the data obtained is still not taken into account to their sensitive personal character with regard to GDPR, where the camera equipment used captures the faces of visitors. The obtained data, which are the output of the measurement, should be evaluated due to their sensitive personal character and then effectively used for regional development of the selected locality. This research differs from others by the overview of ICT ensuring the collection of information on the characteristics and behavior of visitors through commonly available technologies suitable for outdoor use and their limitations from the point of view of the relevant legislation.

The issue of the links between the development of information and communication technologies (ICT) and individual travel behavior is not new (Mokhtarian, 2009). Tourism is an integral part of regional development and currently, given the impact of the Covid-19 pandemic, with more and more visitors seeking nature trips, this issue is gaining in importance, as is the prevention of mass tourism, where tourist areas are struggling capacity (as shown in Figure 1, 2). As already mentioned, trips can be optimized on an individual and collective level and thus contribute
to sustainable development, especially in metropolitan areas (Janelle and Gillespie, 2004). These optimization processes could be driven by the increasing availability of real-time travel information, especially in public transport (Jain, 2006).

Figure 1, 2. The increase in the number of visitors to natural sites in the Central Bohemian Region (Figure 1) and South Bohemian Region (Figure 2) compared to the usual aktivity.




*Source: authors, based on the data from gstatic.com mobility report 2021*

## 2. Materials and Methods

The cornerstone of this research is guided (structured) interviews with actors in the selected locality in order to identify their problems and needs and the subsequent selection of appropriate technology for own research, which consists in collecting data using the installed equipment. Based on the comparison of selected technologies and the synthesis of the findings, the device will be installed for the pilot check to collect data about the characteristics and behavior of visitors. An important step is to select the most suitable equipment, then the appropriate location, correct settings and ensure data transmission considering external influences such as weather, season, days of the week and time.

Data will be monitored mainly on the characteristics and behavior of visitors (eg. attendance, age structure, temperature). It is necessary to pay attention to places where specific numerical data on the number of visitors are not available. These are mainly placing where no entrance fee is collected, where the building is not bordered by a fence and access to it is not possible only through one central place. It is mostly a rural area. In addition to the installation of the most suitable equipment, suitable location, correct settings and data transfer, it is important
not to forget the influence of weather, seasons, days of the week, time, etc. Data will be collected in July, during the summer break in the Czech Republic when the largest concentration of tourists is expected. The device will be installed in one central place, from where the data will be sent to the application, from which they will be evaluated and compared due to different days of the week (weekdays and weekends), due to the weather (in warm weather without rain, more traffic is expected) and due to the time of the visit (higher attendance is expected from 9:00 to 17:00).

The obtained data will be analyzed due to the possible use of devices that detect visitors' faces and other personal data, it is necessary to assess these data in relation to the General Data Protection Regulation (GDPR). Data from the device will be sent directly to the university server and then analyzed in the ArcGIS application which will be used to connect the outputs to the map and weather layers.

The output in the final phase of the project can be published in the web interface of the selected locality (the city's website) and thus inform citizens about the current occupancy of the locality and the time required to visit this place. The data can be linked to other tourist information and attractions in the area and can thus not only contribute to the prevention of congestion, but also to develop the region. The overall process of the planned research solution is shown in the Figure 3.

## 3. Results and Discussion

The chapter with results and discussion is divided into two parts, which are crucial for the preparation of own research. The first is a comparison of available technologies that can be used to monitor the movement of people in an external location. The second part deals with the analysis of the legislative restrictions of the GDPR regulation in the use of camera systems for the collection of visitor data.

### Analysis of available technologies

Before the planned course of research, it is necessary to conduct a search and comparison of available technologies to find out which equipment is most suitable for own research in the field.

When choosing suitable technologies, it is first and foremost necessary to emphasize the surroundings in which the research will run. Monitoring of the movement of people is commonly encountered when measuring traffic in the commercial sphere, especially in the field of tourism and trade and services, where we commonly monitor the saturation of space, eg. in shopping malls or museums mentioned by Naramski in his publication entitled “The Application of ICT and Smart Technologies in Polish Museums — Towards Smart Tourism” (Naramski et al., 2020).

When it comes to spaces in city centers, we most often encounter monitoring data from mobile operators, or data on the development of traffic to public places provided by Google, which uses its free services such as Google Maps to obtain data on the location of users. This makes it easy to measure data from mobile phones when connected to a publicly available Wi-Fi network when measuring in these publicly available places. The author Novák deals with the principle of monitoring people through data from mobile operators and Wi-Fi monitoring in the paper "Monitoring of Movement on the Farm Using WiFi Technology" (Novák et al., 2019). Less often we encounter publications focused on the use of these technologies to ensure the collection of data on the movement of people in natural locations, where we cannot fully rely on the mobile network, Wi-Fi connection and power supply. Monitoring the movement of people is no less important in these areas, when due to the supersaturation of natural sites, it is necessary to monitor visitors to these places. An example can be case studies using data collection technology using smart solutions, for example in the Krkonoše National Park in the Czech Republic, where installed devices detected people who violate the rules for climbing Sněžka mountain and come to the top from unmarked routes and thus significantly disrupt the character of the landscape. The same is true in mountainous areas, where ski mountaineering are gaining in popularity, where ski alpinists do not respect marked routes, violate entry bans outside these routes in the most valuable localities of protected landscape areas and by driving in forbidden areas and their ski edges are destroying many growing young trees in very demanding winter season and what is more, they increase the risk of avalanche removal. Thanks to monitoring, it is possible to monitor the number of people who violate the prohibitions, find out which routes are most often for their descent and find out the level of risk in this area, for example in the event of an avalanche.

Numerous techniques are available for the monitoring of visitor flows in recreational areas and Muhar (Muhar et al., 2002) in his overview “Methods for Visitor Monitoring in Recreational and Protected Areas” divides the basic methods of monitoring into direct and indirect observation.

The simplest technological solution is special devices adapted for monitoring data collection, such as step tiles or tubes with a pressure sensor or a turnstile with an infrared beam. However, these technologies are more costly and its placement in each locality may not always be suitable, for example, those in the form of step tiles are conspicuous and can damage the character of the landscape. The mentioned devices are more suitable for the type of surface where visitors pass directly through this place.

The most available technology is a standard camera system, where a camera is placed at the place of observation, occupying the space of visitors' penetration. However, when using camera devices, we must pay attention to the correct setting of the camera so that we prevent the capture of visitors' faces without their consent and thus do not violate the GDPR regulations. A more interesting and sufficient solution could be a thermal camera, which would collect data on the number of visitors based on their body temperature. With regard to the Covid-19 pandemic,
we more often encounter the use of thermal cameras, where in addition to data collection, we can effectively monitor data on higher body temperature of visitors as a prevention against the spread of the disease. However, the use of thermal cameras for this purpose makes more sense in enclosed spaces.

The basis of motion monitoring is based on infrared technologies, which will provide us with passive motion monitoring. Motion detectors work on a similar principle, which use a passive infrared sensor to detect any intersection, which interrupts the signal and thus registers movement. These devices are commonly used for outdoor use but can be problematic in a fog. The problem arises when we monitor frequently visited places, where visitors come in groups and if the camera is set to capture from the side of the path, we cannot distinguish people who walk side by side and overlap each other. In this solution, one intersection is one point, but groups of people should be checked for accuracy. Another disadvantage is the setting of this sensor only in one direction, when we cannot distinguish the direction of movement of the person and we cannot distinguish in the case of two intersections, whether they are really two different people or whether the same person went one way and back the same way. In this case, we can recommend a Grid-eye sensor, which will solve the problem of direction detection, but will be more difficult to algorithmize. However, this solution is proven, in the practice is often used in security systems, but it is necessary to think about the power supply or other alternative power supply in the form of solar panels when collecting data.

An alternative solution may be radar detectors based on a chip emitting a beam which is subsequently reflected from the penetration of a person. The disadvantage is the high cost and requiring complex algorithms due to the relatively technically sophisticated solution. The advantage is high accuracy, any climatic conditions and the ability to detect the direction of movement of the monitored subjects. Like infrared radiation, we also encounter high consumption, when it is necessary to think about the energy supply, which depends on how often the device will measure. Compared to infrared radiation, it also has a wider range and can capture up to 90 degrees.

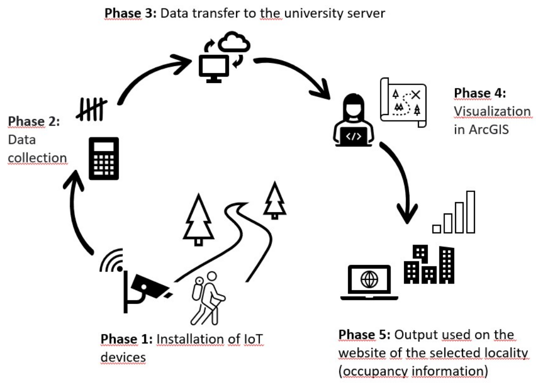
The main bottleneck of the mentioned solutions above is the recognition of the direction of movement. For example, if we are not in the area where there are clearly separated streams of people, as the escalators in subway, and one place for entry and another for exit is not clearly defined, it is necessary to clearly delimit the streams.

Each of these technologies has its advantages and disadvantages. We most often encounter the issue of GDPR, not only in the case of camera systems, as well as the power supply, problems with recognizing and identifying the direction of movement and differentiating the characteristics of people, such as children and adults. First, it is important to clearly define the needs of the locality, estimate the expected number of people (whether units, tens or hundreds of people per minute), set the time for scanning based on these numbers and ensure sufficient power supply according to the estimated scanning frequency, either in the traditional way or alternative in the form of a solar panel. It is important not to forget the influence of the weather, the correct setting of the selected equipment and the correct location, not only about the correct data collection, but also to minimize contact with visitors to prevent intentional vandalism.

The measurement output will be analyzed due to the possible face sensing when these personal data about the visitors it is necessary to assess in relation to the GDPR. The obtained data as the measurement output will be used to analyze the characteristics of visitors, their impacts on the landscape including agriculture areas and their possible use to support regional development. The output of the project is a comprehensive study on the issue of smart motion monitoring.

The obtained data will be used to analyze the traffic of the selected locality and this output will be focused on the other activities in the region, where based on these data cultural events can be planned in this region including promotion of these activities on social networks, media campaigns and these data about the current traffic can be included in the web interface so that visitors have an up-to-date overview of the occupancy of the area.

Figure 3. Data collection process




*Source: authors, 2021*

## GDPR in conflict of IoT interests

Camera equipment is generally an intrusion on people's privacy, and further development of camera systems can be expected in the future thanks to the technological advances, artificial intelligence and the transition to a more powerful 5G network. The risk is more evident especially in the case of extensive systematic monitoring of publicly accessible areas unless the property is under the protection of property and health under the auspices of the city police and state agencies.

A public space, in meaning public parks, residential streets and streets in the city center, parking lots, subway stations, sports facilities, is defined as a place that anyone can, at any time, without distinction and in more or less any circumstances, visit and this area is under the administration of public authorities (meaning cities, municipalities, the state). Monitoring of these publicly accessible areas is only possible if the camera surveillance is separated by random passers-by who do not intend to visit a public institution, i.e. the monitored area. According to the Office for Personal Data Protection, the operation of a camera system is considered to be the processing of personal data subject to obligations under the General Regulation if the monitored public space is automatically recorded at the same time.

The data stored in the recording equipment, whether video or audio, is personal data, provided that on the basis of these recordings (information from video or audio recordings), it is possible to directly or indirectly identify an individual human being. A specific person is identifiable if his/her characteristic identification features (especially his/her face) are visible from the image on which it is captured, and full identification of the person is possible on the basis of the connection of the identification features with other available data. Personal data then consists of those identifiers that allow the person in question to be associated with a certain action, captured in the image.

However, surveillance of persons using camera systems may not always be subject to GDPR regulation. If no camera recording is made, this is not a processing of personal data from the GDPR point of view and the GDPR rules do not apply to such activity. Even in this case, however, the camera operator must respect the right of individuals to privacy. The acquisition of ordinary camera recordings should not be considered as the processing of special categories of personal data ("sensitive" data). The processing of biometric data will only take place in those cases where image records will be processed by special technical means enabling the unique identification or authentication of a person.

As the operator of the camera system and thus also the controller of personal data, it is necessary to ensure compliance with all the basic principles of GDPR. In the context of cameras, this means taking into account, in particular, the principles of legality, fairness and transparency, purpose limitation, data minimization, storage and integrity restrictions and data confidentiality. The camera operator should therefore carry out a review of the camera system. In order to avoid conflict with this regulation, it is necessary to clearly define the purpose of the recording (protection of property, prevention of vandalism), set the scope of the camera equipment so that the cameras do not interfere excessively with the privacy of monitored persons, pre-set the retention period. The recording should not be stored longer than necessary for the intended purpose of CCTV. In general, a storage period of no more than a few days is recommended. The draft guideline of the European Data Protection Board states that the controller should carefully justify the storage period of more than 72 hours. In practice, the storage times of records usually range from three to fourteen days, and the storage time of several days is usually sufficient to fulfill the intended purpose of camera surveillance.

It is necessary to visibly mark the area occupied by the camera system and providing detailed information about the recording - the form of information signs at the entrances to the monitored area will suffice. Signs should be visible from a sufficient distance and clearly legible. For this purpose, it is advisable to include a camera pictogram. It should also be stated that the area is monitored by a camera system with recording, unambiguous identification of the personal data controller and a contact where it is possible to obtain more information on the processing of personal data and where data subjects can apply their possible requirements. In the latter case, it is necessary to secure the camera system and recordings and create the necessary documentation.

## 4. Conclusion

This paper describes the forthcoming research aimed at monitoring people in the external surroundings using commonly available technologies to ensure data collection. Its main content is mainly the methodology and literature review, which is an integral part of the planned research, the pilot verification of which will take place in the summer months. The basis of the literature research is based on a comparison of available technologies and legislative restrictions that cannot be neglected in relation to IoT to GDPR.

From the point of view of data collection by the installation of CCTV and other mentioned devices, there is no restriction if the data collection will be used for the research purpose and will be carried out in accordance with the rules on record keeping for the lowest possible retention time while maintaining information signs at the monitoring site. However, it is necessary to avoid invading the privacy of residents who do not interfere with the selected location - adjacent private land and to prevent the collection of biometric data in the form of facial images of visitors and sound recordings.

Hand in hand with filling the research gap on the topic of motion monitoring in the external non-commercial sphere and their limitations by the GDPR regulation, these findings can be used not only in the theoretical area but also as a benefit for practice, which are gaining importance and will encounter their more abundant use for the future.

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# THE APPROACH OF SMALL AND MEDIUM - SIZED AGRICULTURAL ENTERPRISES TO COST MANAGEMENT

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**Annotation:** The ability of small and medium-sized farms to optimize their costs is crucial for their future ability to survive. In a competitive environment, cost management is one of the most important activities of managerial accounting, which gives managers the opportunity to respond effectively to changes in the internal and external environment of the company. The aim of the research study is to present the approach of small and medium-sized agricultural enterprises to cost management. The object of the research are small and medium-sized business entities operating in the agricultural sector in the Slovak Republic. In order to obtain objective information on the companies' approach to cost management, an empirical research was conducted – a questionnaire survey supplemented by interviews with representatives of selected agricultural companies. Agricultural production is characterized by a high share of overhead costs, which are very difficult to identify and control, and there are problems in assigning them to the relevant outputs. The results of our questionnaire survey show that while in the past the methodology of scheduling overhead costs according to direct costs was used in companies, the introduction of standardized software, there has been a gradual change in the scheduling base in overhead scheduling, often regardless of how the scheduling base relates to the structure of overhead costs. Traditional cost management approaches tend to produce highly aggregated cost information. A possible way to monitor and manage costs is to use non-traditional methods and apply a cost controlling approach.

**Key words:** agricultural enterprises, cost, cost management, questionnaire survey

**JEL classification:** D24, Q19, M21

## 1. Introduction

Planning and cost management is one of the criteria how to successfully manage the company (Mandičák, Mesároš and Rakošiová, 2016). Efficiency and profitability of the production in agriculture has resulted from the intervention of farm managers into the economy of enterprises (Chrastinová and Brunaiová, 2012). Traditional cost accounting is changing to cost management. Target costing, value engineering and design-to-cost are becoming more and more common (Kulmala, Paranko and Uusi-Rauva, 2002). Cost management practices increasingly are informing decisions in important emerging areas such as forensic accounting, enterprise risk management, and business sustainability (Hansen, Mowen and Heitger, 2021). Cost management evaluation is the core part of cost management controlling system. It sets the direction for supervisors and employees, and lays the necessary foundation for incentive mechanism effective operating. Cost management controlling system evaluation is the integral part of evaluation system, referring to cost management methods (Guo and Zhang, 2015). One of the important sources of information about cost and profitability of produced commodities are total costs calculations. The calculations are a mathematical process, with the help of which the individual cost items are assigned by direct or indirect way to individual performances (Chrenková, 2011). Calculations are an issue that is probably the most challenging and interesting for controllers and managers. This is conditioned by the fact that without the correct calculation, to make the right decision is problem. The decision at the level of cost controlling on the method of calculating business performance is particularly important in terms of valuing these outputs and subsequently recognizing the economic results (Talnagiová, 2016). Controlling supports and complements the surveillance activity in the one and two tier system, as long as the management approach is followed and the existing information asymmetries between corporate management and stakeholders are dismantled (Velte, 2014). Cost controlling is a partial method of controlling focused primarily on the overhead costs. Cost controlling includes all measures, analyses and tools which consist in the purposive creation of cost structures. Cost controlling focuses on the cost structure, the roots of costs and the cost flexibility with an emphasis on the future (Foltínová and Špička, 2014). Controlling evaluates the transparency of cost and revenue generation at the corporate level and in large and medium-sized companies as well as at the internal level. The source of information for cost management is the cost and calculation system of the company, which allows monitoring the occurrence of costs along the line of internal departments and also along the line of business performance (Bestvinová, Mrvová and Hrablík Chovancová, 2017).

ABC (Activity Based Costing) is an accounting method by which enterprises calculate indirect cost on the identified activities (Sujová and Marcineková, 2015). In traditional cost systems, direct materials and labor are the only costs traced directly to the product. Manufacturing overhead costs are not traced, but allocated to the production departments. The ABC method models the usage of the organization resources by the activities performed and then links the cost of these activities to outputs, such as products, customers, and services (Ben-Arieh and Qian, 2003). The view of costs applying the ABC method offers, unlike traditional methods, the multidimensionality and variability of cost tracking based on real and relevant data. The direct allocation of costs to products or services does not capture the actual flow of costs to the business and, with a higher share of overhead costs, may provide misinformation to management. Practical experience shows that currently the ABC method appears to be the most effective cost controlling tool (Vereš and Bondareva, 2009).

## 2. Materials and Methods

The paper focuses on identifying and evaluating the approach of small and medium-sized agricultural enterprises to cost management. It analyzes the use of traditional and modern methods of cost management. What information is provided by the already established cost management system for agricultural holdings influences economic thinking at the company level and contributes in a very significant way to effective business management decisions.

The subject of the research were small and medium-sized business entities operating in the agricultural sector in the Slovak Republic, which hold a dominant position in the structure of Slovak agricultural enterprises. The primary technique of data collection was a questionnaire survey. The basis for the creation of the questionnaire, the results of which formed the basis of the research study, was the collection of theoretical knowledge in the field of cost management. The sources of information were mostly scientific publications of foreign authors.

The questionnaire was created through an Internet application and was distributed to companies in an online version. In order to ensure a higher return of the questionnaires, the companies were contacted by telephone. A total of 348 small and medium-sized farms were contacted. The return of the questionnaire forms was at the level of 32%, i.e. 112 companies. Company managers (managers, directors, heads of economic departments, controllers, accountants) were asked to fill in the questionnaire. The introductory part of the questionnaire contained questions concerning the number of employees, the legal form of business, the length of operation on the market, or foreign capital participation. This part of the questionnaire provided information on the structure of the sample examined. In terms of size, the research sample consisted of 61% (68) small and 41% (44) medium-sized agricultural entities. Limited liability companies accounted for the largest share, at 57% (64). The second most represented category were cooperatives, which accounted for 31% of the research sample (35). Joint stock companies represented 12% (13) of the surveyed sample of entities. This composition of the research sample is confirmed by the fact that in recent years the number of commercial companies, especially limited liability companies, has increased and exceeded the number of cooperatives, whose numerous development is characterized by a long-term declining trend. The questionnaire survey involved 54% (60) of agricultural holdings that have held their market position for more than 15 years, 37% (41) of holdings operating in the market between 5 and 15 years and 10% (11) of companies that have been operating in the market for less than 5 years. The structure of the research sample reflects the fact that agriculture has a relatively long history on the market. After accession of the Slovak Republic to the EU, agricultural enterprises with foreign capital also became a reality. From this point of view, 33 (29%) companies with foreign capital are represented in the research sample.

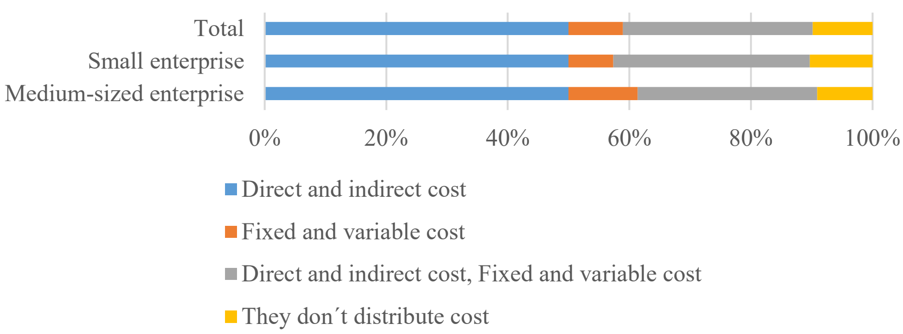
The main part of the questionnaire consisted of questions aimed at obtaining information on cost management in agricultural enterprises in Slovakia. Common mathematical methods supplemented by graphical representation were used to evaluate the questionnaire. The statistical method Chi-square test was also used, which is aimed at determining the dependence between the studied phenomena. In order to clarify and supplement the information obtained through the questionnaire, we also used the method of interview. We tried to obtain reliable information directly from the source. Corporate managers from five agricultural companies answered those questions on the basis of which we tried to better comprehend the respondents answers in questionnaire.

## 3. Results and Discussion

The growing complexity of economic processes forces companies to constantly improve their internal management systems and respond flexibly to new situations. One of the traditional tools of business process management is the calculation of costs. Costing is an activity that is an integral part of cost controlling. It is performed in order to determine the own costs per unit of calculation. The calculations resulting from the calculation are also of considerable importance for the management and control of the economy. The task of cost controlling is also to find and offer various modern methodologies to improve traditional methods of cost management, to find areas where resources are spent inefficiently, and thus to reveal hidden places for cost savings.

Using a questionnaire survey, we found out how the costs are distributed in agricultural holdings. This information brings us closer to the level of individual users' claims for information about the company's costs.

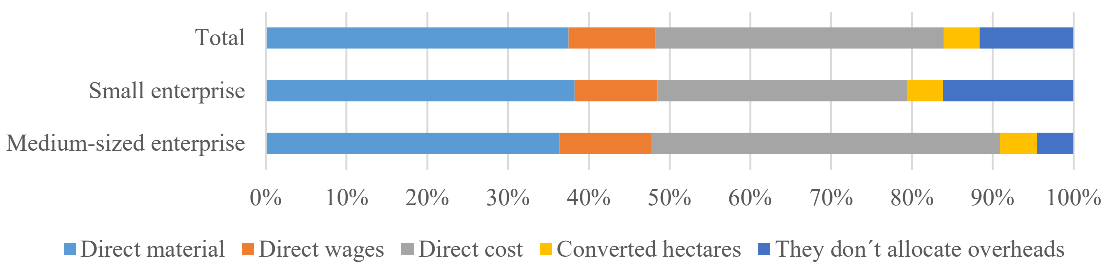
Figure 1. Costs allocation in agricultural enterprises



*Source: own processing*

The analysis of the questionnaire answers shows that 7 (10%) small and 4 (9%) medium-sized agricultural enterprises do not share the costs incurred in the enterprise. The division of costs in terms of dependence on the volume of production into fixed and variable is only rarely used by agricultural enterprises. A total of 5 (7%) small and 5 (11%) medium-sized enterprises chose this answer. The calculation of costs as well as the allocation of costs into fixed and variable is applied in the sample by 22 (32%) small and 13 (30%) medium-sized companies. Most agricultural companies whether small (50%) or medium-sized (50%), divide the costs in terms of calculation into direct and indirect. Due to the importance of these costs in traditional methods of calculation, but also in calculation by the ABC method, such a division of costs is the most used. Direct costs are costs that can be directly attributed to performance. On the other hand, indirect (overhead) costs related to crop and livestock production cannot be clearly calculated for individual crops or farms. Overheads contribute a significant amount to the structure of farms' own costs and represents a specific problem in terms of their allocation to the final products. Managing the costs of agricultural enterprise is one of the key requirements for successful business in the agricultural sector. The quality of decisions is based on information support for cost management, which is why cost controlling is becoming even more important. The choice of scheduling basis is a particularly challenging step that has an impact on the objective allocation of overheads to final products, so a thorough assessment of this decision is needed. The basis of the schedule should be as closely related as possible to overhead costs and their structure.

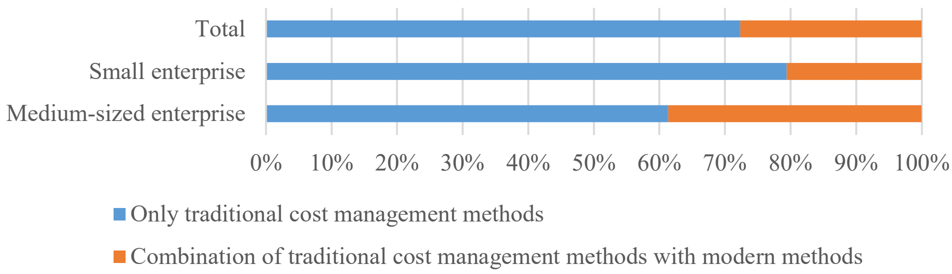
Figure 2. Cost allocation base for overhead cost allocation




*Source: own processing*

The results of the questionnaire survey show that the structure of the SME responses is again very similar. Count of 11 (19%) small farms and 2 (4%) medium-sized farms do not allocate overheads. Three respondents from a small enterprise and two respondents from a medium-sized enterprise stated that the allocation base used to calculate overhead costs in their companies is converted per hectare. The allocation base of direct wages is used by 7 (10%) small enterprises and 5 (11%) medium-sized entities. The vast majority of small farms, 26 (38%) and 16 (36%) medium-sized enterprises, choose direct material as the allocation base. On the other hand, most medium-sized farms use direct costs as an allocation base. Count of 19 (43%) medium-sized enterprises and 21 (31%) small enterprises chose this answer. The results of our questionnaire survey confirm the fact that the methodology of allocating overhead costs according to direct costs was used in agricultural enterprises 20 or more years ago. With the introduction of standardized software, the allocation base has gradually changed when scheduling overhead often regardless of how the allocation base relates to the structure of overhead costs. We asked representatives of the farms we were interviewing, based on what do they choose the allocation base. We wanted to find out why some companies use direct wages as an allocation base, because in our opinion, the use of such an allocation base loses objectivity, because wages are not the highest overhead costs. After interviewing with respondents from several selected farms, we have come to the conclusion that farms use software in which the allocation base is set up automatically and they are not interested in how objective it is. Another question was whether farms prefer modern or traditional cost management methods. In order to give respondents a better picture of what methods the theory defines under modern methods and which under traditional methods, and subsequently will be able to choose a relevant option, we briefly defined them in the questionnaire.

Figure 3. Cost management methods used by agricultural enterprises




*Source: own processing*

In Figure 3 shows that the responses of small and medium-sized enterprises had a similar structure. The vast majority, 54 (79%) of small farms, use only traditional cost management methods. For medium-sized companies our analysis has carried out similar result, as 27 (61%) entities again use only traditional methods for cost management. Count of 14 (21%) small and 17 (39%) medium-sized enterprises also combine them with modern methods. Traditional cost systems focus primarily on the product itself. They are based on the assumption that the resources enter directly into the product. The costs are monitored in relation to the product, assuming that each product consumes a proportionate share of the total costs. The basis for allocation of overhead costs are e.g. the number of hours of human labor consumed to produce the product, the machine hours, or material costs. However, this approach does not reflect the diversity of production in terms of volume and complexity. Nor does it take into account the fact that there is no direct link between production volume and cost consumption. The results of our research are also confirmed by Moravčíková (2015). The author claims that companies in Slovakia have a high degree of application of traditional methods of calculating total costs and that most companies allocate overhead costs through a set overhead. Vereš and Bondareva (2013) prove that the of costs by the ABC method enables variant and multidimensional tracking of cost items in comparison with traditional methods. At the same time, they confirm that the use of this method can significantly help to improve the company's financial situation. A large percentage of the small and medium-sized agricultural holdings in the research sample use exclusively traditional methods to calculate costs, which, despite their advantage, are relatively simple to apply and considered obsolete. These methods do not allow a consistent calculation of indirect costs, an accurate calculation of costs and the resulting inconsistent determination of the bid price, which can lead to incorrect management decisions. The level of indirect costs is high on agricultural enterprises. This fact is also confirmed by Hudáková Stašová and Tušan (2006), who performed an analysis aimed at determining the development of overhead costs in agricultural enterprises. They found that the share of total overhead costs plays an important role in deciding whether to use the method of calculating costs based on activities. The authors consider the considerably high overhead costs to be a good reason for the introduction and use of the ABC method, which reveals the inefficient implementation of activities at all levels.

We have also examined in detail the answers to the question aimed at identifying the used methods of cost management. In this context, we examined whether companies use modern methods of cost management depends on foreign capital participation in these companies. We performed a Chi-square test.

Table 1. Chi-square test to determine the relationship between the use of modern methods of cost management and foreign capital participation in agricultural enterprises

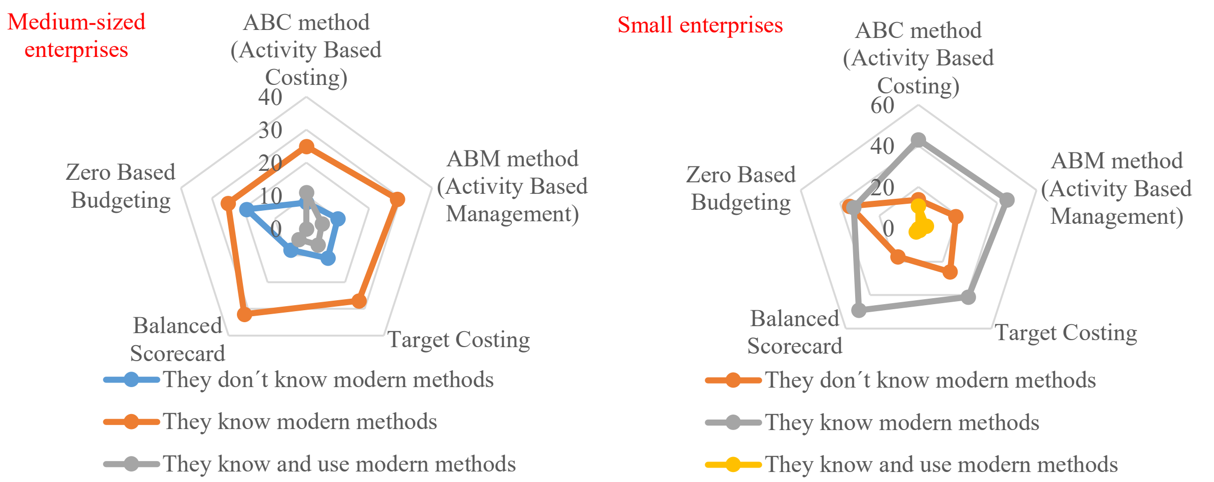
| **Chi-square test** | |
|---|---|
| p value | 4,87799E-0 |

*Source: own processing*

From the result of the Chi-square test, we could conclude that the null hypothesis cannot be rejected, i.e. that whether agricultural entities use modern methods in cost management also depends on the participation of foreign capital in enterprises.

Since the use of modern methods of cost management is very limited in agricultural enterprises, we examined in more detail which of the modern methods are most preferred in these enterprises, respectively used. Alternatively, about which modern cost management methods have examined enterprises further knowledge.

Figure 4. Use of specific modern methods of cost management in agricultural enterprises




*Source: own processing*

The process management, respectively ABC method, Target Costing method and ABM method have as of the modern tools the highest, although still very low, representation. As can be seen from the graph, although the reported methods are used occasionally on farms, many agricultural enterprises in the sample are familiar with these methods. On the other hand, we also evaluate negatively the fact that a significant number of companies are unaware of the given management tools, they are rather small farms. In order to find out more accurate information, we found out in an interview with representatives of agricultural enterprises how they implement the ABC method, which came out in our research as the most frequent method. We found that calculations according to activities are prepared only in the form of preliminary calculations and not the final ones, while these calculations are compiled on the basis of expert estimates, respectively standards that have been published in the literature and not on the basis of costs actually reported in previous periods. We conclude and rely on Škorecová's research (2015) that some companies mistakenly confuse the use of the ABC method with the use of technology cards, which were used in the past to monitor costs by activity.

## 4. Conclusion

For the allocation of overhead costs, agricultural holdings mainly use direct costs and direct material, i.e. monetary allocation bases. The research carried out in Czech manufacturing companies carried out a very similar result, as more than half of the surveyed companies (39 companies) use exclusively monetary allocation bases. Their use at the present time, when the importance of automation and robotics is growing and overhead costs are increasing, is not adequate, because they provide a distorted view of the resulting calculations (Hojná and Kafková, 2017). Agricultural entities in Slovakia apply the principles of cost controlling, which includes internal accounting, budgets and cost calculations, although with many shortcomings (Váryová et al., 2015). In the history of the use of management methods in agricultural enterprises in Slovakia and the Czech Republic, cost management by activity was known. Its beginnings in our companies dating back to the 70s and 80s of the last century, despite the fact that methods such as ABM or ABC and many others have not yet been known and applied in the world (Škorecová, 2015). Businesses in Slovakia make very little use of process management calculations as well as cost allocation by activity (Moravčíková, 2015). We reached the same conclusion because, of the 112 farms that made up the research sample, 81 (72%) small and medium-sized enterprises use only traditional cost management methods, which means that these companies are completely eliminating using more modern methods, which we consider to be a major shortcoming. At present, it is appropriate for companies to combine traditional cost management methods with non-traditional methods, in particular with process calculations (ABC method), which, unlike traditional methods, do not attribute costs to products but to the activities that generated them. A process-oriented controlling system comes to the fore. Its goal is to ensure the transparency of business processes and activities in order to increase the economic efficiency of individual activities and optimize the costs of individual activities. Experience has shown that the most effective controlling tool in this regard is the ABC method. Its application in agriculture has not been very successful so far. The biggest obstacle is the conservatism of managers (Hudáková Stašová and Tušan, 2006). Promoting modern tools and methods in farm management is a difficult process. Future research should therefore focus on integrating these tools into existing enterprise IT systems. The limiting factor of the research is the considerable ignorance of the representatives of agricultural enterprises about modern management tools and their negative attitude towards them. From an interview with selected farms, we found out that they are very reluctant to change the procedures and methods already used. The results of the questionnaire showed that the participation of foreign capital in business has a positive impact on the implementation of modern methods of cost management. For this reason, it would be appropriate to provide scientific conferences, trainings and seminars for the management of agricultural enterprises, where positive results from the implementation of modern cost management methods abroad will be presented. The changing nature of farming as a profession has an impact on agricultural education changes too (Kapsdoferová, Jacková and Švikruhová, 2021). Based on this practical experience we expect that managers of agricultural holdings will be more motivated to apply modern cost management approach in their companies.

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# PROPOSAL FOR A NEW CLASSIFICATION OF AGRICULTURAL LAND PROTECTION AS A RESPONSE TO INFRASTRUCTURAL AND CLIMATE CHANGE IN THE CZECH REPUBLIC

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**Annotation**: The aim of the article is to present a proposal for a new categorization of agricultural land protection, which will respect primarily the productive capacity of the soil. The proposal of new classes of soil protection was created according to the identification of the prevailing loss of qualitatively significant soils in the Czech Republic. New protection classes are defined based on the yield method. The authors worked with the premise that the most productive lands can provide the highest in-kind yields. The value of income in kind is reflected in the rated land unit (ESEU code). Therefore, normative crop yields have been calculated for the ESEU (in which the main land unit is in the range 01-64). For worse soils (ESEU with the main land unit 65 to 78), yields of permanent grassland were used. Four classes of agricultural land protection have been proposed: First class: Agriculturally valuable soils (100-81 points). Second class: Average soil (80-71 points). Third class: Below average soils (70-35 points) and fourth class: Agriculturally dispensable soils (34 -10 points). The new protection classes are set in a completely transparent manner. From the point of view of ecological soil protection, it is possible to create additional methodological material.

**Key words:** agricultural land, degradation, ESEU code, protection classes, classification, Czech Republic

**JEL classification:** Q15, Q24

## 1. Introduction

The aim of the article is to present a proposal for a new categorization of agricultural land protection, which will respect primarily the productive capacity of the soil.

Transparency and rationality of protection and, above all, the occupation of quality soils are absolutely a priority for maintaining the productive economic base. Soil degradation is a global problem of the 21st century. Accelerated soil degradation has reportedly affected 33% of the earth's surface (Bini, 2009). Over the last 250 years, land use change has been visible in Central Europe. These include the intensive use of the agricultural landscape, a significant increase in arable land and the current decline in grassland, forests and fallow land. There has also been a decline in landscape features such as roads and hedges (Baude and Meyer, 2012). The higher intensity of agricultural production since the 1960s has led to a change in land management in Europe. The growth of the application of new fertilizers and technologies leads to rapid changes in the landscape structure, landscape functions and the number of ecosystem services provided (Antrop, 2005). The increased potential for erosion danger and at the same time the decrease in the natural regulation of landscape erosion is related to the reduction of the capacity of natural soil production (Panagos et al., 2015).

Soil and landscape degradation may be associated with social, economic and environmental problems in the future. Landscape change and land use will also depend on a changing climate in the future (Baude et al., 2019). Bednář and Šarapatka (2018) state as a significant problem in the Czech Republic: Water and wind soil erosion, loss of organic matter, acidification and contamination with heavy metals. The authors confirm the conclusions of other authors

(Heepngoen et al., 2007) that the key parameters of agricultural land degradation are mainly altitude, height differences, slope steepness, precipitation and soil structure. In addition to geomorphological and climatic factors, the decline in soil quality is also influenced by inappropriate cultivation methods and poor location of agricultural crops (Gebeltova et al., 2020). Soil degradation in the Czech Republic (change in structural properties) has manifested itself mainly in areas with the highest quality soils (Gebeltova et al., 2014). These conclusions are also confirmed by research from Poland, for example. According to Nowak et al. (2017), Poland has the most degraded zones in fertile lowlands with intensive agriculture. There is habitat fragmentation, loss of biodiversity, loss of nutrients in the soil and pollution of water resources.

In addition to the qualitative degradation of agricultural land, there is also a degradation of the soil fund due to quantitative land loss. Current land take due to urban development across Europe appears to be a threat to sustainable land use (Henning et al., 2015). Urban and infrastructure development often takes place in areas with high-quality agricultural land. This is an irreversible loss of agricultural productive capacity (Gardi et al., 2014). The problem of quantitative soil degradation in the Czech Republic can be solved by a withdrawal fee. The aim of the levy is to internalize part of the social costs related to the loss of agricultural land. However, set-aside fees may also, paradoxically, favor the removal of the most valuable land. Municipalities play an important role. They are partial recipients of set-aside fees. They are thus motivated to remove the most valuable land with the highest fee. Municipalities are also decision-making bodies in the area of future land use within their jurisdiction. They decide on changes in the zoning plan of the municipality. (Vejchodská, 2019). The amount of the fee is mainly influenced by the protection class of agricultural land. The higher the soil protection class, the higher the fee (Czechia, Act No. 334/1992 Col.). There are five classes of protection in the Czech Republic. The most valuable soils are listed in the first group, and in the fifth class, soils are dispensable in agriculture. The classification is determined through the ESEU (Czechia, Degree No. 48/2011 Col.). In the first two classes of protection of ZP, there are flat plots of land, or plots of land only slightly sloping, from all climatic regions. These are soils medium deep and deep without a skeleton or with only a small amount of gravel. They are quality black soil, black soil, brown soil or fertile soils on river floodplains. On the other hand, cambisols, podzoles, cryptopodzoles are also included in the first class of protection, mainly on mild slopes with a skeleton content of up to 25%. Soils deep to medium deep in the cold climate region, insignificantly significant (altitude above 550 m, humid and cold climate) (Czechia, Degree No. 48/2011 Col.) These soils are not interesting for production, but should be protected with regard to geological and biodiversity. Yield evaluation of soils in the Czech Republic is expressed by a point scale of 6 - 100 points. It is based on GARE (Gross Annual Rent Effect) values, which expresses the normative profit from each ESEU. GARE is the basis for agricultural land valuation (Němec, 2001)

## 2. Materials and Methods

Data were used to determine soil production capacity:

a) Normative yields of basic crops: Yields were determined depending on standardized nutrient doses and standardized inputs for a specific estimated *soil-ecological units* /ESEU/. Inputs were defended in the project NAZV QH72257 (Voltr, 2008).
b) Characteristics of the ESEU: yields per hectare are different for each main soil unit /MSU/ and climate region (Voltr et al., 2012). MSU is a purposeful grouping of soil forms with related properties. It is determined by genetic soil type, subtype, species, soil-forming substrate, granularity, soil depth, degree of hydromorphism. Climate region includes areas with approximately identical climatic conditions for the growth

and development of agricultural crops. The conditions are given by temperature and precipitation conditions in the given area (Czechia, Degree No. 227/2018 Col.)

c) Coefficients that affect the amount of natural yield: These coefficients express the geological specifications: direction of sunlight on the land, slope of the land (plain, slope), stonyness and grain size of the land, depth of soil. (Voltr et al., 2012)

Methods:

The yield method of soil evaluation was used to determine productively valuable soils. The yield understands the normative potential of the soil (according to each ESEU). In 2020, 2,199 ESEU codes (RISWC, 2019) are economically evaluated and used in the Czech Republic. The authors assume that the soil that is able to generate the highest natural yield will be of the highest quality. Normative data and procedures were drawn from the certified methodology of Institute of Agricultural Economics and Information /further IAEI/ (Voltr et al., 2012)

$$\mathrm{YPP}_{crop} = Y_{\mathrm{MSCU}} * C_{\mathrm{CR,EXP}} * C_{\mathrm{SLOPE}} * C_{\mathrm{DE,SK}} \qquad (1)$$

Where:

$\mathrm{YPP}_{crop}$ … Yield of parameterized production of individual crops per ESEU

$\mathrm{Y}_{\mathrm{MSCU}}$ … Natural yields of agricultural crops for the main soil climate unit /MSCU/ (t/ha)

$\mathrm{C}_{\mathrm{CR,EXP}}$ … Coefficient for exposure to world parties depending on the climate region

$\mathrm{C}_{\mathrm{slope}}$ … Slope and exposure coefficient. Note: The coefficient is defined for each crop

$\mathrm{C}_{\mathrm{DE,SK}}$ … Coefficient for depth and skeletality. Note: The coefficient is defined for each crop

(Voltr et al., 2012)

A wheat commodity was selected to evaluate the production potential of agricultural land. Resp. normative natural yield of wheat (calculated according to the Equation 1).

Table 1. Selection of variables for calculation of Production potential of ESEU soil (t/ha) according to normative wheat yield (for ex. ESEU 1.22.42)

| | FIND (MSCU) | ASSIGN $\mathrm{Y}_{\mathrm{MSCU}}$ | FIND (CU) | FIND (SL,EXP) | ASSIGN $\mathrm{C}_{\mathrm{CR,EXP}}$ | FIND (SL,EXP) | ASSIGN $\mathrm{C}_{\mathrm{slope}}$ | FIND (DE,SK) | ASSIGN $\mathrm{C}_{\mathrm{DE,SK}}$ |
|---|---|---|---|---|---|---|---|---|---|
| code ESEU | digits ESEU 1.+2.+3. | (t/ha) | digit ESEU 1. | digit ESEU 4. | | digit ESEU 4. | | digit ESEU 5. | |
| **1.22.42** | **022** | 5.47 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| | **122** | 5.24 | 1 | 2 | 0.99 | 1 | 0.97 | 1 | 0.98 |
| | **222** | 5.31 | 1 | 3 | 1 | 2 | 0.97 | **2** | 0.94 |
| | **322** | 5.94 | **1** | **4** | 0.98 | 3 | 0.97 | 3 | 0.90 |
| | **422** | 4.91 | 1 | 5 | 1 | **4** | 0.94 | 4 | 0.86 |
| | **522** | 5.53 | 1 | 6 | 0.96 | 5 | 0.94 | 5 | 0.80 |
| | **622** | 5,00 | 1 | 7 | 1 | 6 | - | 6 | 0.73 |
| | **722** | 5.40 | 1 | 8 | 0.93 | 7 | - | 7 | 0.81 |
| | **822** | 4.71 | 1 | 9 | 1 | 8 | - | 8 | 0.75 |
| | **022** | 5.47 | 1 | 0 | 1 | 9 | - | 9 | 0.75 |

*Note:*

*MSCU = Code main soil and climate unit; CU = climate unit code; SL, EXP = slope and exposure code; DE, SK = depth and skeletality code.*

*Source: Authors according to the methodology (formula 1) and data sources Voltr et al. (2012); the search function EXCEL (VLOOKUP)*

An example of the methodological procedure for calculating $YPP_{wheat}$ is given in the example of ESEU 1.22.42 (Table 1). ESEU codes were converted from code form (e.g., 0.03.00) to number (00300) using the MS excel function (number separation from a text cell). The ESEU codes were further divided into individual parts (numbers), which inform about the affiliation of the soil to the climatic region and soil unit (first three ESEU numbers) and other characteristics: exposure to the sides of the world ($1^{st}$ and $4^{th}$ digits of ESEU), slope ($4^{th}$ digit ESEU), and depths of soil profile in combination with skeleton ($5^{th}$ digit ESEU). E.g., ESEU code 1.22.42, a normative wheat yield (formula 1) of 4.54 t/ha (5.24 t/ha x 0.98 x 0.94 x 0.94) was calculated (Table 1).
In one group of ESEU codes, the allocation of field commodities is agronomically defined based on the soil valuation (main soil unit 01-64). In the second group (main soil unit 65-78) only permanent grasslands are evaluated (due to weaker productive capacity of soils, climatic conditions). To express the economic potential of qualitatively worse soils (ESEU without a defined wheat yield), normative yields of permanent grasslands are therefore used.
The best ESEU with the highest wheat yield was assigned 100 points (100%). Each additional ESEU with lower wheat yields was adequately graded with a value of less than 100 (Table 2). The first ESEU with the highest normative yield of permanent grassland was scored by one unit less than the ESEU with the worst wheat yield. Other points (according to percentage expression) were assigned to the ESEU codes with permanent grasslands adequately with the size of the adjusted normative yield of permanent grasslands (Table 3).

### 3. Results and Discussion

The classification of agricultural land into protection classes is not completely transparent. No detailed methodology is available for the procedure for determining protection classes. A double view of conservation (albeit in the right direction) prevents the separation of productively valuable agricultural land from otherwise valuable land. One of the factors that determines soil protection is the economic evaluation of soils according to the gross annual rent effect (GARE). GARE is calculated as the difference of value parameters (revenues and costs) from a unit of land. However, crop yields on arable land in value terms (CZK/ha) do not accurately reflect soil quality, although they logically contribute to it through hectare yields. The proposed procedure (Tables 2 and 3) represents only a view that is naturally profitable. Soils with high natural production potential must be provided with a high level of protection. In the case of the occupation of quality land, it is necessary to prove that there is no alternative, more suitable occupation and, conversely, there is a transparent public interest. Tables 2 to 4 show the results according to Equation (1).

The point evaluation of agricultural land (registered in the Land Parcel Identification System - LPIS) was expressed as a value from 10 to 100 points. The value 100 corresponds to the code 3.03.00 (tab.2). It is a chernozem mainly on a flat or complete plane with omnidirectional exposure and a total skeleton content of up to 10%. These are deep, highly productive soils in a warm, slightly humid climate region with stabilized yields (RISWC, 2019, online). Soils with this ESEU have the prerequisites for the highest crop yields (solved on the example of wheat commodity, Table 2).

Table 2. Scoring of the adjusted normative yield of a wheat commodity (top twenty ESEU)

| ESEU | $Y_{MSCU}$ (t/ha) | $C_{CR,EXP}$ | $C_{slope}$ | $C_{DE,SK}$ | $YPP_{wheat}$ (t/ha) | Order ESEU (draft)[1)] | Profitability proposal (10-100 points) | Protection class proposal | Profitability of IAEI (6-100 points) | Protection class (2011)[2)] |
|---|---|---|---|---|---|---|---|---|---|---|
| 3.03.00 | 8.07 | 1 | 1 | 1 | 8.07 | 1 | 100 | I. | 100 | I |
| 3.09.00 | 7.79 | 1 | 1 | 1 | 7.79 | 2 | 97 | I. | 96 | I |
| 3.09.10 | 7.79 | 1 | 0.97 | 1 | 7.56 | 3 | 94 | I. | 95 | I |
| 3.10.00 | 7.52 | 1 | 1 | 1 | 7.52 | 4 | 93 | I. | 93 | I |
| 3.61.00 | 7.49 | 1 | 1 | 1 | 7.49 | 5 | 93 | I. | 92 | I |
| 2.03.00 | 7.45 | 1 | 1 | 1 | 7.45 | 6 | 92 | I. | 92 | I |
| 0.03.00 | 7.43 | 1 | 1 | 1 | 7.43 | 7 | 92 | I. | 91 | I |
| 3.06.00 | 7.41 | 1 | 1 | 1 | 7.41 | 8 | 92 | I. | 81 | II. |
| 3.14.00 | 7.38 | 1 | 1 | 1 | 7.38 | 9 | 91 | I. | 85 | II |
| 3.57.00 | 7.36 | 1 | 1 | 1 | 7.36 | 10 | 91 | I. | 66 | II |
| 3.02.00 | 7.36 | 1 | 1 | 1 | 7.36 | 11 | 91 | I. | 95 | I |
| 5.09.00 | 7.35 | 1 | 1 | 1 | 7.35 | 12 | 91 | I. | 79 | I |
| 3.10.10 | 7.52 | 1 | 0.97 | 1 | 7.29 | 13 | 90 | I. | 83 | II |
| 3.42.00 | 7.27 | 1 | 1 | 1 | 7.27 | 14 | 90 | I. | 75 | II |
| 3.08.00 | 7.25 | 1 | 1 | 1 | 7.25 | 15 | 90 | I. | 76 | II |
| 3.12.00 | 7.24 | 1 | 1 | 1 | 7.24 | 16 | 90 | I. | 83 | II |
| 3.07.00 | 7.24 | 1 | 1 | 1 | 7.24 | 17 | 90 | I. | 78 | III. |
| 3.01.00 | 7.22 | 1 | 1 | 1 | 7.22 | 18 | 89 | I. | 96 | I |
| 2.09.00 | 7.22 | 1 | 1 | 1 | 7.22 | 19 | 89 | I. | 89 | I |
| 1.03.00 | 7.22 | 1 | 1 | 1 | 7.22 | 20 | 89 | I. | 79 | I |

*Source: 1) authors according to the methodology for calculation (1), data in methodology (Voltr et al., 2012)*
*2) Czechia, Degree No. 48/2011 Col., Decree of the Ministry of the Environment*

The lowest value of 10 points was reassigned to code 0.78.89. They are glues mainly on steep slopes or slopes with a southern exposure and a total skeleton content of 0-100%. Deep, medium-deep to shallow soils in a very warm, dry climate region with unrated production capacity (RISWC, 2019, online). In the evaluation of roughly the worst 400 ESEU, the authors agree with the results of the evaluation of IAEI and RISWC (specified in: Czechia, Degree No. 48/2011 Sb.). Yields of permanent grasslands were used to evaluate the production capacity of worse soils (see methodology). See Table 3 for more information.

Table 3. Scoring of the adjusted normative yield of permanent grassland (last ten ESEU)

| ESEU | $Y_{MSCU}$ (t/ha) | $C_{CR,EXP}$ | $C_{slope}$ | $C_{DE,SK}$ | $YPP_{PGs}$ (t/ha) | Order ESEU (draft)[1)] | Profitability proposal (10-100 points) | Protection class proposal | Profitability of IAEI (6-100 points) | Protection class (2011)[2)] |
|---|---|---|---|---|---|---|---|---|---|---|
| 5.78.89 | 1.66 | 1 | 0.85 | 0.87 | 1.23 | 2190 | 12 | V. | 6 | V. |
| 3.78.89 | 1.66 | 1 | 0.85 | 0.87 | 1.23 | 2191 | 12 | V. | 6 | V. |
| 4.77.89 | 1.70 | 0.96 | 0.85 | 0.87 | 1.21 | 2192 | 11 | V. | 6 | V. |
| 2.77.89 | 1.73 | 0.93 | 0.85 | 0.87 | 1.19 | 2193 | 11 | V. | 6 | V. |
| 1.77.89 | 1.70 | 0.93 | 0.85 | 0.87 | 1.17 | 2194 | 11 | V. | 6 | V. |
| 4.78.89 | 1.62 | 0.96 | 0.85 | 0.87 | 1.15 | 2195 | 11 | V. | 6 | V. |
| 0.77.89 | 1.71 | 0.90 | 0.85 | 0.87 | 1.14 | 2196 | 11 | V. | 6 | V. |
| 2.78.89 | 1.64 | 0.93 | 0.85 | 0.87 | 1.13 | 2197 | 11 | V. | 6 | V. |
| 1.78.89 | 1.62 | 0.93 | 0.85 | 0.87 | 1.11 | 2198 | 11 | V. | 6 | V. |

*Source: 1) authors according to the methodology for calculation (1), data in methodology (Voltr et al., 2012)*
*2) Czechia, Degree No. 48/2011 Col., Decree of the Ministry of the Environment*

Table 4. Different assessment of the ESEU - the current form of the protection classes and the proposed change

| ESEU | $Y_{MSCU}$ (t/ha) | $C_{CR,EXP}$ | $C_{slope}$ | $C_{DE,SK}$ | $YPP_{wheat}$ (t/ha) | Order ESEU (draft)[1)] | Profitability proposal (10-100 p.) | Protection class proposal | Profitability of IAEI (6-100 p.) | Protection class (2011)[2)] |
|---|---|---|---|---|---|---|---|---|---|---|
| 7.56.00 | 6.46 | 1 | 1 | 1 | 6.46 | 164 | 80 | II. | 39 | I. |
| 7.28.11 | 6.43 | 1 | 0.97 | 0.98 | 6.11 | 318 | 76 | II. | 35 | I. |
| 7.29.11 | 6.20 | 1 | 0.97 | 0.98 | 5.89 | 465 | 73 | II. | 37 | I. |
| 7.30.11 | 6.06 | 1 | 0.97 | 0.98 | 5.76 | 543 | 71 | II. | 35 | I. |
| 9.56.00 | 5.26 | 1 | 1 | 1 | 5.26 | 948 | 65 | III. | 32 | I. |
| 8.35.01 | 5.17 | 1 | 1 | 0.98 | 5.07 | 1120 | 63 | III. | 31 | I. |
| 8.34.01 | 5.15 | 1 | 1 | 0.98 | 5.05 | 1143 | 63 | III. | 30 | I. |
| 9.36.01 | 4.86 | 1 | 1 | 0.98 | 4.76 | 1353 | 59 | III. | 30 | I. |
| 9.36.21 | 4.86 | 1 | 0.97 | 0.98 | 4.62 | 1433 | 57 | III. | 24 | I. |
| 5.61.00 | 7.01 | 1 | 1 | 1 | 7.01 | 35 | 87 | I. | 76 | III. |
| 3.25.01 | 7.09 | 1 | 1 | 0.98 | 6.95 | 44 | 86 | I. | 76 | III. |
| 2.42.00 | 6.89 | 1 | 1 | 1 | 6.89 | 52 | 85 | I. | 75 | III. |
| 5.14.00 | 6.88 | 1 | 1 | 1 | 6.88 | 54 | 85 | I. | 75 | III. |
| 2.13.00 | 6.84 | 1 | 1 | 1 | 6.84 | 60 | 85 | I. | 74 | III. |
| 3.08.50 | 7.25 | 1 | 0.94 | 1 | 6.82 | 64 | 84 | I. | 72 | III. |
| 3.08.40 | 7.25 | 1 | 0.94 | 1 | 6.82 | 65 | 84 | I. | 72 | III. |

*Source: 1) authors according to the methodology for calculation (1), data in methodology (Voltr et al., 2012)*
*2) Czechia, Degree No. 48/2011 Col., Decree of the Ministry of the Environment*

Table 4 shows some examples of the ESEU, which differ in the proposal of protection classes and in the current version of the protection classes. The first part (Table 4) lists the ESEU, which classifies the current legislation into the first class of protection. According to the methodology used (relation 1), these are soils that do not provide the normative best yield (wheat). These are soils that are located in a moderately warm, cold and humid climate region (CR: 7-9). These are soils of medium weight, stony, with a good water regime, of low production (MSU: 28, 29, 35, 36). Conversely, soils in the climatic region (2-5; warm, dry, slightly dry, slightly moist) are qualitatively good. The current methodology ranks them among the soils in the third class. (Soils with an average production capacity. These lands can be used in land use planning for construction and other non-agricultural uses) (Czechia, Degree No. 48/2011 Col.) Table 5 shows a proposal for new production classes of land protection.

Table 5. Proposal of four production classes of agricultural land protection by profitability (points)

| | New (authors' proposal) | | | | Old (Degree No. 48/211 Sb.) | | |
|---|---|---|---|---|---|---|---|
| Points | Protection Class | Soil description (quality) | Number of ESEU | Σ ESEU | Protection Class | Number of ESEU | Σ ESEU |
| 100 - 81 | 1 | Agriculturally valuable | 152 | 152 | 1 | 80 | 254 |
| | | | | | 2 | 174 | |
| 80 - 71 | 2 | Average soil | 454 | 454 | 3 | 303 | 303 |
| 70 - 35 | 3 | Below average | 1209 | 1593 | 4 | 596 | 1652 |
| 34 - 10 | 4 | Agriculturally dispensable | 384 | | 5 | 1056 | |
| Σ ESEU | | | | 2199 | | | 2199 |

*Source: Own elaboration and proposal; data: (Voltr et al., 2012); Czechia, Degree No. 48/2011 Col.*

From the point of view of agricultural use, classes 1, 2, 3 appear to be the most suitable. Group 4 contains those ESEU codes for which no crop yields in kind have been defined. The point evaluation of the 4th group is based on the yields of permanent grasslands.

Soil protection is also important in terms of climate change. E.g. in Germany, during the period 1996-2000, cereals could not be grown due to the water deficit on 10% of the agricultural land of Saxony-Anhalt and 25% of the agricultural land of Brandenburg. In the future, up to 40% of the agricultural land in these areas could be involved (Shindler, 2007). According to Zhang et al. (2019), humus and microorganisms have a key role in shaping water retention in urban soils by improving the soil hydrophysical properties and microstructure. Soils with higher organic carbon content significantly have better retention capacities (Zalacáin et al., 2019). In Europe, almost half of the soil is low in organic matter, especially in southern Europe, but also in some parts of France, the United Kingdom and Germany (EC, 2005). There can be a number of protection tools. Soil fertility, for example, protects organic farming (EC, 2019 online). Organically farmed soils show significantly higher biological activity (Pokorný et al., 2007). It is necessary to ask the question whether the organic way of farming is able to cover the demands for self-sufficiency of raw materials for food and feed production. The organic farming method is demanding on the land area, it uses lower doses of fertilization, mechanization and chemical protection (Berner et al., 2013). Meadows and pastures are protected from significant erosion by permanent vegetation cover. Under the greening of the CAP, environmentally sensitive permanent grassland has special protection. However, a ban on the conversion of grassland to arable land cannot provide a lasting solution to grassland loss (Plambeck, 2020). It follows from the above that it is necessary to emphasize the economic instruments of agricultural land protection: E.g. Direct support from the EU budget is provided only if the standards for growing crops on erosively endangered soil are met (in the Czech Republic: Government Regulation No. 48/2017 Sb. on setting requirements according to the standards of good agricultural and environmental condition). Another economic measure is payment for non-agricultural land use (administrative fee). In the Czech Republic, the administrative fee[1] is based on the price of the land according to the ESEU and the coefficient of protection class (Act No. 334/92 Col.). With the price of the highest quality land approx. CZK 20/m$^2$ (ESEU 03000) and the coefficient of maximum protection class (k = 9), the land withdrawal fee is 180 CZK/m$^2$ (approx. EUR 7/m$^2$)[2]. From 1 January 2009, the Slovak Republic tightened the conditions for the withdrawal of agricultural land for construction and other non-agricultural purposes. The basic Land withdrawal fee for the exclusion of the highest quality land (I. Protection class) from the fund is 20 EUR/m$^2$. On the contrary, the fee for the land with the lowest soil quality (9th grade) is 0.5 EUR/m$^2$ (Slovakia, Decree No. 58/2013 Col.). The emphasis on the objective definition of agricultural land protection classes is the way in the right direction.

## 4. Conclusion

The Czech Republic does not have enough agricultural land per capita to be able to follow the path of extensive farming. The development of the economy, infrastructure and housing cannot be hindered. However, it is possible to set such rules that would allow to change the zoning plans only according to rational assignments. Agricultural land cannot be produced, which is why it must be protected, especially the most fertile land. The proposal of new classes of soil protection was created according to the identification of the prevailing loss of qualitatively significant soils in the Czech Republic. New protection classes are defined on the basis of the yield method. The authors worked with the premise that the most productive lands are able to provide the highest in-kind yields. Therefore, normative crop yields were calculated for the ESEU (Main Land Unit 01-64). Wheat yields were used in the proposal. For worse soils (Main Land Unit 65-78), where crop yields are not defined by the Institute (IAEI), yields of permanent grasslands were used (Voltr et al., 2012). 4 classes of agricultural land protection have been proposed: First class: Agriculturally valuable soils (100-81 points). Second class: Average soil (80-71 points). Third class: Below average soils (70-35 points) and fourth class: Agriculturally dispensable soils (34-10 points). The new protection classes are set in a completely transparent manner. From the point of view of ecological soil protection, it is possible to create additional methodological material. From the point of view of agricultural use, soils may be worthless, but from the point of view of biological diversity or ecological significance they will be important. This would differentiate between the protection of agricultural land and geologically valuable land. Ecologically valuable soils (national parks and protected areas) already have increased protection. When removing these lands for non-agricultural lands, they are burdened with higher fees (Act No. 334/92 Col.).

[1] Land withdrawal fee (according to Act No. 334/92 Col.)

[2] CNB exchange rate list: 31.12.2020, EURO = 26.245 CZK, Available: https://www.kurzy.cz/kurzy-men/historie/ceska-narodni-banka/D-31.12.2020/, [Accessed: 10 Mar. 2021]

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# ECONOMICS OF MILK PRODUCTION IN SELECTED GROUP OF FARMS IN THE SLOVAK REPUBLIC IN COMPARISON WITH OTHER COUNTRIES

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**Annotation:** Milk production, especially cow´s milk, has an irreplaceable role in ensuring the country´s self-sufficiency with basic food. In recent years, the term "milk crisis", often associated with a long-term decline in the purchase price of milk, has often been inflected in Slovakia. Its slump brought a radical reduction in farmers´sales. For this reason is this topic still being discussed. They are looking for ways to help farmers find their internal reserves. The aim of the scientific paper is to identify and point out the decisive determinants of the development of cow´s milk production in Slovakia through selected indicators of product and economic analysis. We used direct data from agricultural holdings whose calculation of costs is considered as correct according to the methodology used for calculation of own costs. We compared 21 companies operating in better production conditions in Slovakia and 17 companies operating in worse production conditions. The paper reveals production and economic reserves in the production of cow´s milk. The paper consists of own calculation and analysis of economic and production indicators of Slovak farms and their comparison with indicators characterizing the economic level of cow´s milk production in France, Germany, the Netherlands, Belgium and Denmark. Although the production of milk in the conditions of Slovak farms is loss-making, this loss was the lowest of all the compared countries during the observed period of 2011 - 2017. Slovak farms have a comparative advantage consisting in lower personnel costs and overheads, but also in the relatively insufficient economic use of feed. It should be noted that Slovak farms have the lowest share of subsidies per kilogram of cow's milk produced. However, we can reasonably assume that the higher losses achieved per kilogram of milk produced require higher subsidies to finance them and ensure the sustainability of dairy farming.

**Key words:** dairy cows; economic indicators; enterprises; milk; milk production

**JEL classification:** Q12, M21, D57, H20, Q10

## 1. Introduction

The agriculture in Slovakia has undergone significant changes, not only in terms of its position in the national economy, but also in terms of its importance at the regional level. There are still persistent differences between better and worse natural conditions (Kravčáková, Vozárová and Kotulič, 2016). Among the agricultural products, the production of which worries the Slovak farmers considerable concern is cow's milk. Masár (2018) considers cow's milk production to be an important and traditional sector of agricultural primary production in Slovakia. Demand for milk and dairy products is increasing especially in industrialized countries, which represents a development opportunity for primary milk production. The situation on the international dairy markets significantly affects the production of primary production of milk and dairy industry in Slovakia due to the openness and production performance of the Slovak economy, especially within the EU (Matošková, Gálik, 2016). Klopčič et al. (2019) describe, that in recent years, the European Union (EU) dairy sector has experienced considerable changes, triggering heavily fluctuating milk prices and a crash in milk prices in 2015/2016.

As mentioned authors Bach, A., Terré, M. and Vidal, M. (2019), the industry has achieved impressive improvements in milk production per cow through continuous advancements in genetics, nutrition, health, and management. In the given year, we see a surplus of milk on the market and a significant drop in its realization - farm prices, not only in Slovakia. One of the specific measures was the abolition of milk quotas with effect from 1 April 2015. The spot price for free, uncontracted sales of raw cow's milk was expected to resolve this situation. The expectations of some analysts that this measure will be reflected in large fluctuations in realization prices and high milk surpluses on the market have been met. This has been going on for a relatively long time. The expectations of the European Commission calculated with a shorter time to deal with the milk crisis. During this time, strong breeds and clusters were supposed to get rid of competently unfit breeders. Economically strong holdings would fill the failure of the production of failed farmers. More than four years have passed since the abolition of quotas and the milk crisis is still a reality.

In countries such as France, where quotas were administratively managed and strongly linked to land, this system maintained dairy production in all regions but also sustained inefficient dairy production systems. The impacts of quota removal on markets, as well as the localization of dairy production was deeply analyzed by Salou et al. (2017). Authors reached, that quota removal alone has limited impacts on the redistribution of production across dairy systems. Quota removal associated with increased world demand has stronger impacts, but the expected redistribution effects towards more efficient systems remain rather limited even then. Milk production takes place in all EU countries and represents a significant proportion of the value of EU agricultural output.

Hemme, Uddin and Ndambi (2014) also confirm the significance of the time factor and claim that in the short term, farmers can cope with lower milk price and higher cost but in the medium and long-term term, the production costs should always be lower than the returns, independently from the milk price level. Hemme and Ndabi (2009) further add, that with recent global trends, competitiveness of milk production is of great importance, where the question on who will produce the cheapest milk in the future needs to be answered. Bragg and Dalton (2004) stated, that although low milk prices are postulated as a primary reason for exits from dairying, other factors may be important as well. The competitiveness of milk production also requires considerable investment in the procurement and modernization of technological systems for breeding, milking and milk storage.

The merits of investments in fixed assets are also emphasized by St-Pierre, Shoemaker and Jones (2000), who describe, that dairy scientists specializing in the area of farm management are increasingly involved in analysis of farm investments in fixed assets. Szabo and Grznár (2016) add, that a high level of the total agricultural production strongly correlates with the value of the utilized fixed assets. Here it is important to draw attention to the specific, narrow-purpose profile of fixed assets used in dairy farming. A hasty decision to abolish dairy cows on the basis of unfavorable economic results over a period of one or three years could be undesirable for the farm and in some cases even liquidation. In particular, we mean the costs which, if production were to be abolished, would be tied to the unused, for the enterprise dubious and therefore virtually illiquid fixed assets.

Some farmers have been preparing to lift their milk quotas by increasing their capacity because, as say Schulte, Musshoff and Meuwissen (2018) after the abolition of the milk quota in the European Union, milk price volatility was expected to increase because of the liberalized market conditions. From higher production capacities they expected lower, especially fixed costs per kilogram of milk and thus higher competitiveness

According to the Farm Accountancy Data Network, 128 thousand dairy cows were bred in Slovakia in 2017. Masár (2018) states in his publication that in 2017 the average number of dairy cows in the Slovak Republic was 131.3 thousand. pcs and in comparison with 2016 decreased by 4.6 thousand, i.e.by 3.4%. The production of cow's milk this year was at the level of 938.0 thousand. tonnes, which compared to the previous year was by 4.7 thousand. tonnes more (+ 0.5%). This increase was due to an increase in the average milk yield per dairy cow. In 2017, compared to 2016, it increased by 277.6 kg (+ 4.0%) and compared to 2013, we record an increase of 930.6 kg, i.e.14% more. In 2017, 279.8 thousand tonnes of milk and milk products were imported to Slovakia, i.e.by 47.9 ths. tonnes more (+ 20.7%) than in 2016. In the same year, 273.9 thousand tons were exported from Slovakia, which was about 7 thousand. tonnes (-2.5%) less than in 2016.

According to investigation, a trend about a moderate fluctuation of number of dairy cows was found out in the entire European Union. This is caused by increasing performance of dairy cows and a high level of breeding and nutrition. Along the check performance, yields of milk increased by 962 kg per lactation in the European Union in a 8-year period (Janecká et al., 2019).

## 2. Materials and Methods

The aim of the scientific paper is to point out the decisive determinants of the development of cow's milk production in Slovakia through the indicators of product and economic analysis. The priority of the analytical part of the research was the evaluation of selected production and economic indicators of production, with the intention of revealing and defining reserves for increasing the economic efficiency of cow's milk production in the conditions of Slovakia.

The primary sources of research were authentic data obtained directly from internal evidence of farms, consisting of the resulting cost calculations for cow's milk production. The final number of companies whose cost calculations we considered to be correct, i.e. processed in accordance with the methodology used to calculate the own costs of agricultural products was 38. Of this number, 21 companies managed in better production conditions in Slovakia (BPC). This is mainly the West Slovakia region. The second group of 17 companies operated in worse production conditions (WPC), i.e in the regions of northern Slovakia. In the conditions of Slovakia, such data is collected and processed only by the National Agricultural and Food Center, specifically the Research Institute of Economics of Agricultural and Food, which is a part of it. The last published information was for 2016, including production costs for dairy cows, which were processed from the data of 49 respondents. Selected economic indicators characterizing the economic level of milk production by Slovak farms were processed by methods of economic and synthesis analysis and were subsequently compared in time and space with each other.

Within the final calculation, we evaluated the percentage share of individual items of the calculation formula in the total costs per 100 FD in the companies in better and worse productional conditions in 2011 and 2017, while the total costs represented the base of 100%

(see Table 1, 2). We quantified the total costs per 100 FD as the sum of direct and operating costs. Subsequently, we analyzed the production of milk in kg per 100 FD, the development of milk revenues per 100 FD without and including subsidies, the development of dairy cow revenues per 100 FD in a group of companies in better and worse production conditions in 2011 - 2017. Subsidies form an important part of revenues and are allocated to the dairy cow. (tab. 3). From the difference between revenues and costs we quantified the economic result for the period 2011 - 2017 in the group of companies in better and worse production conditions (see Table 4). In this paper we evaluated the development of production costs per kg of milk, the development of production costs including subsidies per kg of milk, the development of subsidies per kg of milk, the development of farm realization price per kg of milk, the development of profit from milk sales per kg of milk in Slovakia and then compared to selected EU countries such as Belgium, Denmark, France, Germany and the Netherlands in 2012-2017. Cow's milk production in these countries accounts for more than 50% of total EU production. The data source was the FADN database.

For 2017, we quantified the economic result based on the compiled cost calculation as the difference between the realization price and cost of individual selected EU countries (see Table 10). Agriculture uses a general calculation formula, which consists of: purchased and produced feed and bedding, other direct materials, personnel costs, repairs and maintenance, depreciation, other direct costs and services, reduction of costs by settled depreciation. The sum of these items gives the direct costs together, after taking into account the production and administrative overheads, we quantify the total costs.

## 3. Results and Discussion

The costs incurred for the production of dairy cows during 100 feeding days (hereinafter referred to as "FD") in better production conditions increased to 861.73 EUR for the analyzed period from 2011 to 2017, which represents an increase of 11% (Table 1). Based on the average annual values of individual cost items of the calculation formula, we come to the conclusion that the highest cost item is feed consumption (334.83 EUR / 100FD), which is almost 39% of the total production costs. The average value of annual depreciation of fixed assets, including the basic herd, spent at 100 FD is almost 110 EUR and in the structure of costs with their 12.75% they took second place. Personnel costs were placed on the third place. These represent 74.49 EUR / 100 FD (8.64%). Direct costs increased by 14%, i.e. by 94.58 EUR / 100 FD. Production overheads increased by 7% over the period considered, and a reduction in administrative overheads of 8% is remarkable. The average overhead costs per 100 FD for dairy farming amounted to 129.81 EUR (15.06%).

Using the facts of Table 2, we present indicators of production costs for dairy farming spent in worse soil and climatic conditions. 17 companies - respondents operating in these regions of Slovakia report total production costs in 2017 at the level of 843.69 EUR. It was almost 141.27 EUR more compared to 2011 (+ 20%) and 62.91 EUR less than the average total cost of securing production during 100 FD in companies operating in better soil and climatic conditions. The highest share in the total volume of production costs has the consumption of feed and bedding (303.34 EUR / 100 FD = 40.57%). Overheads represent 14.26% (106.6 EUR / 100 FD). Personnel costs, as well as costs for auxiliary activities, oscillate around 9%.

Direct costs incurred per 100 FD in dairy farming increased on average for Slovakia (average of all 38 monitored farms) by 18.4%. In the development of total costs per 100 FD, we recorded an increase of 9.1%, while in companies operating in worse - northern conditions of Slovakia, overhead costs increased by 17.3%. Under better production conditions, the value of overheads decreased by 5.2%.

Based on the data in Table 3, we can state that the yields obtained from dairy farming increased by 24.9% during the analyzed period, while the total production costs increased by 17%. This development had a positive effect on the increase in the economic result.

Table 1. Costs of dairy cows, per 100 FD - average of farms farming in better natural conditions in the first and last year of the analyzed period

| Cost items | EUR/100 FD | | Structure in % | |
|---|---|---|---|---|
| | 2011 | 2017 | 2011 | 2017 |
| Feed and bedding purchased | 90.15 | 105.02 | 11.01 | 11.58 |
| Feed and bedding made | 224.67 | 245.27 | 27.43 | 27.05 |
| Medicines and disinfectant material | 16.30 | 20.79 | 1.99 | 2.29 |
| Other direct material | 31.95 | 46.21 | 3.90 | 5.10 |
| Wages and salaries direct | 61.48 | 81.64 | 7.51 | 9.00 |
| Social costs | 21.52 | 28.38 | 2.63 | 3.13 |
| Repairs and maintenance | 22.60 | 16.58 | 2.76 | 1.83 |
| L-T tangible asset depreciation excluding animals | 45.29 | 37.24 | 5.53 | 4.11 |
| Depreciation of animals | 60.57 | 77.04 | 7.39 | 8.50 |
| Breeding and veterinary services | 19.77 | 27.08 | 2.41 | 2.99 |
| Other direct costs and services | 37.83 | 32.77 | 4.62 | 3.62 |
| Costs of ancillary activities | 67.07 | 72.94 | 8.19 | 8.05 |
| Cost reduction and accounted revenues | -15.85 | -13.04 | -1.94 | -1.44 |
| Total direct costs | 683.35 | 777.93 | 83.43 | 85.81 |
| Production overhead | 69.44 | 74.11 | 8.48 | 8.17 |
| Administrative overhead | 66.30 | 54.57 | 8.09 | 6.02 |
| Total cost per 100 FD | 819.09 | 906.60 | 100.00 | 100.00 |

*Source: Authors own processing based on obtained data from internal evidence of farms*

From the results of study of Hemme, Uddin and Ndambi (2014) it is clear, that feed costs and labor costs are highly relevant and it is necessary to consider them, when considering strategies to reduce the cost. Grazed grass is the cheapest feed available for dairy cows in temperate regions, thus, to maximize profits, dairy farmers must optimize the use of this high quality feed (McClearn et al., 2019).

Table 2. Costs of dairy cows, per 100 FD - average of farms farming in worse natural conditions in the first and last year of the analyzed period

| Costs items | EUR/100 FD | | Structure in % | |
|---|---|---|---|---|
| | 2011 | 2017 | 2011 | 2017 |
| Feed and bedding purchased | 78.12 | 110.88 | 11.12 | 13.14 |
| Feed and bedding made | 214.32 | 240.67 | 30.51 | 28.53 |
| Medicines and disinfectant material | 6.12 | 13.61 | 0.87 | 1.61 |
| Other direct material | 12.36 | 33.78 | 1.76 | 4.00 |
| Wages and salaries direct | 62.39 | 75.48 | 8.88 | 8.95 |
| Social costs | 21.21 | 22.75 | 3.02 | 2.70 |
| Repairs and maintenance | 4.86 | 11.85 | 0.69 | 1.40 |
| L-T tangible asset depreciation excluding animals | 59.41 | 44.62 | 8.46 | 5.29 |
| Depreciation of animals | 55.04 | 57.95 | 7.84 | 6.87 |
| Breeding and veterinary services | 13.89 | 19.70 | 1.98 | 2.34 |
| Other direct costs and services | 21.54 | 31.51 | 3.07 | 3.73 |
| Costs of ancillary activities | 71.42 | 76.26 | 10.17 | 9.04 |
| Cost reduction and accounted revenues | -20.79 | -15.62 | -2.96 | -1.85 |
| Total direct costs | 599.89 | 723.44 | 85.40 | 85.75 |
| Production overhead | 47.21 | 56.94 | 6.72 | 6.75 |
| Administrative overhead | 55.32 | 63.31 | 7.88 | 7.50 |
| Total cost per 100 FD | 702.42 | 843.69 | 100.00 | 100.00 |

*Source: Authors own processing based on obtained data from internal evidence of farms*

The average milk production per 100 FD in Slovakia increased by 30.4% over the analyzed period and in 2017 it was at the level of 1 936 kg, i.e. 7 065 kg per dairy cow and year. The average for enterprises in WPC in 2017 was 1 759 kg per 100 FD, i.e. 6 419 kg per dairy cow per year, which was 34% more than in 2011. Enterprises in the BPC showed an annual yield of 8 266 kg per dairy cow, i.e. 25.5% higher compared to the base year 2011.

Revenues obtained from milk production on average for both groups of Slovak farms increased by 22.8%, while a more dynamic development is recorded in enterprises managing WPC (+ 28.9%). Revenues from milk production are decisive in the quantification of dairy yields (+ revenues for poultry farms, i.e. calves born, + revenues from the production of manure and possibly also slurry). The reason for the different growth dynamics of dairy yields and the dynamics of milk yields is the different valuation of individual dairy farming products, which is considered as joint production.

Table 3. Development of selected cost and revenue indicators in EUR per 100 FD - dairy cow performance

| Indicator | Group of farms | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| Direct costs total | BPC | 683.35 | 697.11 | 742.43 | 761.40 | 716.91 | 744.35 | 777.93 |
| | WPC | 599.89 | 568.27 | 620.51 | 625.10 | 658.92 | 691.97 | 723.44 |
| | Average | 624.93 | 606.92 | 657.09 | 665.99 | 676.31 | 707.68 | 739.79 |
| Overhead costs | BPC | 135.74 | 134.89 | 141.73 | 138.23 | 112.42 | 116.98 | 128.67 |
| | WPC | 102.53 | 94.34 | 101.14 | 117.98 | 108.19 | 101.77 | 120.24 |
| | Average | 112.49 | 106.51 | 113.32 | 124.06 | 109.46 | 106.33 | 122.77 |
| Total costs per 100 FD – dairy cow | BPC | 819.09 | 832.00 | 884.16 | 899.63 | 829.33 | 861.33 | 906.60 |
| | WPC | 702.42 | 662.61 | 721.65 | 743.08 | 767.11 | 793.74 | 843.69 |
| | Average | 737.42 | 713.43 | 770.40 | 790.04 | 785.77 | 814.01 | 862.56 |
| Production of milk in kg per 100 FD | BPC | 1 805.12 | 1 789.62 | 1 782.65 | 1 792.35 | 2 136.03 | 2 156.73 | 2 264.57 |
| | WPC | 1 312.37 | 1 416.32 | 1 428.84 | 1 446.49 | 1 664.56 | 1 724.46 | 1 758.62 |
| | Average | 1 484.83 | 1 546.98 | 1 552.67 | 1 567.54 | 1 829.57 | 1 875.75 | 1 935.70 |
| Revenues from dairy cow per 100 FD | BPC | 826.83 | 642.16 | 729.91 | 694.95 | 771.01 | 718.62 | 950.62 |
| | WPC | 594.31 | 548.13 | 596.99 | 647.50 | 639.20 | 616.29 | 777.42 |
| | Average | 670.95 | 583.64 | 638.62 | 670.94 | 685.96 | 652.86 | 837.69 |
| Revenues from milk per 100 FD | BPC | 750.94 | 557.42 | 627.37 | 600.81 | 674.20 | 627.41 | 848.24 |
| | WPC | 528.70 | 475.29 | 527.76 | 569.04 | 557.35 | 531.30 | 681.72 |
| | Average | 602.19 | 507.30 | 564.31 | 587.60 | 599.41 | 566.01 | 739.76 |
| Revenues from milk per 100 FD, without subsidies | BPC | 731.41 | 536.63 | 603.05 | 549.28 | 612.50 | 560.45 | 779.54 |
| | WPC | 509.39 | 454.27 | 503.72 | 518.08 | 496.35 | 464.35 | 613.79 |
| | Average | 582.88 | 486.28 | 540.27 | 536.64 | 538.41 | 499.05 | 671.83 |

*Source: Authors own processing based on obtained data from internal evidence of farms*

In today's competitive local and global market, the quality of milk is as much important as the quantity of milk to get maximum profit. With growing health concerns among the consumers, it is necessary to maintain quality milk production. Only healthy cows managed under hygienic and clean environment can produce quality milk (Pandey, 2020).

A significant part of revenues are also subsidies, which were allocated to the dairy cow. Despite the fact that the result of dairy farming on average for Slovakia shows a loss in all years, we can state that this indicator has a positive trend. In 2017, the loss decreased by 62.6% compared to 2011. Even in 2016, the loss was almost double the level of 2011. The negative economic result per 100 FD of dairy farming in 2017, quantified without the inclusion of subsidies, was at the level of - 101.19 EUR, i.e. 15% higher loss than in 2011. We could similarly evaluate the development of the economic result from milk production, where the average value for Slovakia is also loss-making. In 2017, it was at the level of - 36.40 EUR per 100 FD and this loss was 40% less than in 2011. This result would be significantly more negative if companies were not subsidized. Then the loss in 2017 per 100 FD would be at the level - 104.48 EUR. This is a 29% higher loss than in 2011. From the above data, we can clearly confirm that the production of cow's milk is loss-making in the long run.

Table 4. Development of the economic result in EUR per 100 FD for the performance of the dairy cow and for the main product of the performance - milk

| Indicator | Group of farms | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|
| Economic result per 100 FD – dairy cow | BPC | 7.74 | -189.84 | -154.25 | -204.68 | -58.31 | -142.71 | 44.02 |
| | WPC | -108.11 | -114.48 | -124.66 | -95.58 | -127.90 | -177.45 | -66.26 |
| | Average | -66.47 | -129.79 | -131.78 | -119.10 | -99.81 | -161.15 | -24.87 |
| Economic result per 100 FD without subsidies– dairy cow | BPC | -13.96 | -213.45 | -181.27 | -261.94 | -126.86 | -217.95 | -32.31 |
| | WPC | -129.81 | -138.10 | -151.67 | -152.84 | -196.45 | -252.68 | -142.59 |
| | Average | -88.17 | -153.41 | -158.79 | -176.36 | -168.36 | -236.38 | -101.19 |
| Economic result per 100 FD – milk | BPC | 13.76 | -174.74 | -168.38 | -208.85 | -72.20 | -139.18 | 32.30 |
| | WPC | -103.48 | -121.06 | -121.72 | -99.73 | -133.04 | -175.12 | -77.60 |
| | Average | -61.48 | -134.79 | -129.05 | -123.44 | -107.78 | -158.46 | -36.55 |
| Economic result per 100 FD without subsidies– milk | BPC | -5.77 | -195.52 | -192.69 | -260.39 | -133.89 | -206.13 | -36.40 |
| | WPC | -122.79 | -142.08 | -145.77 | -150.69 | -194.05 | -242.08 | -145.53 |
| | Average | -80.80 | -155.80 | -153.10 | -174.40 | -168.79 | -225.42 | -104.48 |

*Source: Authors own processing based on obtained data from internal evidence of farms*

Babb's (1981) research also focused on analyzing the relationship between milk prices and production costs.

Table 5. Production costs in cents/kg of milk

| Year | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk |
| Belgium | * | * | 51.07 | 1.14 | 50.64 | 1.12 | 47.47 | 1.23 | 44.51 | 1.15 | 44.92 | 1.12 |
| Denmark | * | * | 46.92 | 1.05 | 46.30 | 1.02 | 42.26 | 1.09 | 41.85 | 1.08 | 41.25 | 1.03 |
| France | * | * | 52.82 | 1.18 | 55.20 | 1.22 | 49.85 | 1.29 | 48.60 | 1.26 | 49.25 | 1.23 |
| Germany | * | * | 50.82 | 1.14 | 48.66 | 1.07 | 44.19 | 1.14 | 45.54 | 1.18 | 44.91 | 1.12 |
| Netherlands | * | * | 47.18 | 1.06 | 48.58 | 1.07 | 44.63 | 1.15 | 44.05 | 1.14 | 43.99 | 1.10 |
| Slovakia | 41,51 | 1,00 | 44.66 | 1.00 | 45.36 | 1.00 | 38.65 | 1.00 | 38.62 | 1.00 | 40.10 | 1.00 |

*Source: Authors own processing based on obtained data from FADN*

*Note: x/Sk = the value of the reference country to the value of SR; * unfounded data;*

When looking for ways to increase the economic efficiency of milk production in the conditions of Slovakia, we used the method of comparing data obtained from Slovak farms with data from French, German, Belgian, Dutch and Danish farms. Cow's milk production in these countries accounts for more than 50% of total EU production. Dairy farms in these countries are characterized by high production intensity. This was the key reason why we chose the average values of production and economic indicators as comparative. Szabo and Grznár (2016) explain, that a lower level of financial supports in the advanced countries remain to act as barrier, which slow down our catching up with the advanced competitors. The highest average costs incurred for the production of one kilogram of cow's milk in Slovakia for the analyzed period 2012 - 2017 were reported in 2014 at the level of 45.36 EUR and the lowest were in 2016 (38.65 EUR / kg). At the same time, we state that the costs of cow's milk production on Slovak farms are decreasing (year 2017 = 40.10 EUR / kg). The average cost per kilogram of milk produced in Slovakia for the period from 2013 to 2017 was 41.35 cents (Table 5). The average values of farms in all Western European countries showed higher production costs per unit of production throughout the period under review. French farms show an average cost higher than in Slovakia by 22% and in 2015 it was 29% more. The smallest deviation from the Slovak average is shown by the average of Danish farms (+ 6%).

Milk price is depending on the economic and political situation in the world, it is also influenced by the geographic location, seasonality, and raw materials (feed, electricity, fuel) prices (Paura and Arhipova, 2016).

Table 6. Production costs including subsidies in cents/kg of milk

| Year | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk |
| Belgium | 40.41 | 1.01 | 46.96 | 1.09 | 46.09 | 1.11 | 45.2 | 1.29 | 42.12 | 1.22 | 42.53 | 1.18 |
| Denmark | 41.94 | 1.05 | 42.85 | 1.00 | 42.76 | 1.03 | 39.75 | 1.14 | 39.34 | 1.14 | 38.74 | 1.07 |
| France | 40.99 | 1.03 | 46.88 | 1.09 | 49.67 | 1.19 | 45.74 | 1.31 | 44.49 | 1.29 | 45.14 | 1.25 |
| Germany | 44.08 | 1.10 | 45.90 | 1.07 | 44.39 | 1.06 | 41.20 | 1.18 | 42.44 | 1.23 | 41.81 | 1.16 |
| Netherlands | 42.96 | 1.07 | 44.57 | 1.04 | 46.47 | 1.11 | 42.46 | 1.22 | 42.07 | 1.22 | 42.01 | 1.16 |
| Slovakia | 39.98 | 1.00 | 42.92 | 1.00 | 41.71 | 1.00 | 34.91 | 1.00 | 34.61 | 1.00 | 36.16 | 1.00 |

*Source: Authors own processing based on obtained data from FADN*

*Note: x/Sk = the value of the reference country to the value of SR; * unfounded data;*

Production costs, reduced by subsidies, are contained in Table 6. In this case, too, we obtained data for selected Western European countries from the source already mentioned [1], where the subsidies listed are directly related to the production of cow's milk. We either did not have access to comparable information for Slovak farms, or they were possibly inaccurate. For example, some Slovak companies included systemic land subsidies in their dairy revenues in the calculation, which is contrary to the current methodology. Therefore, when quantifying income from dairy farming, we included only subsidies that were allocated to the dairy cow in a given year. As in all EU countries, these subsidies are comparable in nature and depend on the number of dairy cows, but not on the volume of production. They are relatively fixed in nature, which means that the share of subsidies per kilogram of milk is not directly dependent on the volume of production. Using this methodological procedure, we quantified subsidies per kilogram of milk, which meet the condition of transnational comparability. It should be emphasized here that we do not take into account other subsidies, which, although not directly related to milk production, can be, a source of compensation for losses from cow's milk production.

The average cost of producing a kilogram of milk, including subsidies for the analyzed period in Slovakia was 38.38 cents. French farms showed costs by 19%, Belgium by 14%, Germany and the Netherlands by 13% and Denmark by 7% higher. Direct subsidies spent on cow's milk are the subject of Table 7. Comparing the average values over a period of five years, we find that Slovak farms, with the exception of Dutch ones, have the lowest share of direct subsidies per kilogram of cow's milk.

Table 7. Subsidies in cents/kg of milk

| Year | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk |
| Belgium | * | * | 4.11 | 2.36 | 4.55 | 1.25 | 2.27 | 0.61 | 2.39 | 0.60 | 2.39 | 0.61 |
| Denmark | * | * | 4.07 | 2.34 | 3.54 | 0.97 | 2.51 | 0.67 | 2.51 | 0.63 | 2.51 | 0.64 |
| France | * | * | 5.94 | 3.41 | 5.53 | 1.51 | 4.11 | 1.10 | 4.11 | 1.02 | 4.11 | 1.04 |
| Germany | * | * | 4.92 | 2.83 | 4.27 | 1.17 | 2.99 | 0.80 | 3.10 | 0.77 | 3.10 | 0.79 |
| Netherlands | * | * | 2.61 | 1.50 | 2.11 | 0.58 | 2.17 | 0.58 | 1.98 | 0.49 | 1.98 | 0.50 |
| Slovakia | 1,53 | 1,00 | 1.74 | 1.00 | 3.65 | 1.00 | 3.75 | 1.00 | 4.01 | 1.00 | 3.94 | 1.00 |

*Source: Authors own processing based on obtained data from FADN*

*Note: x/Sk = the value of the reference country to the value of SR; * unfounded data;*

The realization price at which farmers sell cow's milk also plays an important role in assessing the level of economic efficiency of cow's milk production. The development of realization prices is presented in Table 8.

The development of realization prices of cow's milk in Slovakia was analyzed also by Gálik (2019), who states that to ensure the smooth running of the farm, generate profit and invest in modern technologies, better quality genetic material and the purchase of valuable feed, the realization price is important, which during the years 2015 and 2016 rapidly decreased, the reason was the abolition of milk quotas in 2015 and subsequently the price fell below the level of production costs.

Table 8. Farm realization prices in cents/kg of milk

| Year | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk | ₵/kg | x/Sk |
| Belgium | 30.19 | 0.98 | 37.22 | 1.09 | 36 | 1.07 | 27.93 | 0.97 | 26.7 | 1.03 | 35.06 | 1.02 |
| Denmark | 34.04 | 1.10 | 38.63 | 1.13 | 39.67 | 1.18 | 31.03 | 1.07 | 28.68 | 1.11 | 36.78 | 1.07 |
| France | 32.58 | 1.06 | 35.30 | 1.03 | 37.34 | 1.11 | 32.29 | 1.12 | 30.18 | 1.16 | 34.42 | 1.00 |
| Germany | 32.90 | 1.07 | 38.75 | 1.13 | 38.78 | 1.15 | 30.53 | 1.06 | 27.93 | 1.08 | 37.40 | 1.09 |
| Netherlands | 32.38 | 1.05 | 37.40 | 1.09 | 38.90 | 1.16 | 30.75 | 1.06 | 28.75 | 1.11 | 35.45 | 1.03 |
| Slovakia | 30.85 | 1.00 | 34.22 | 1.00 | 33.59 | 1.00 | 28.89 | 1.00 | 25.91 | 1.00 | 34.39 | 1.00 |

*Source: Authors own processing based on obtained data from FADN*

*Note: x/Sk = the value of the reference country to the value of SR; * unfounded data;*

Through comparable indices, we came to the conclusion that the lowest average six-year price of milk was paid to Slovak farmers. Syrůček et al. (2019) confirm that despite the farmers' efforts to produce milk as efficiently as possible, the profitability is greatly variable and low milk prices often result in economic losses for dairy cow operations. Farmers in Belgium were slightly better off (+ 3%) and the highest annual milk prices paid by farmers in Denmark were the highest, up to 11%.

Table 9. Profit from milk sales in cents/kg (including subsidies)

| Year | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk | ₡/kg | x/Sk |
| Belgium | -10.22 | 1.12 | -9.74 | 1.12 | -10.1 | 1.24 | -17.27 | 2.87 | -15.42 | 1.77 | -7.47 | 4.22 |
| Denmark | -7.90 | 0.87 | -4.22 | 0.49 | -3.09 | 0.38 | -8.72 | 1.45 | -10.66 | 1.22 | -1.96 | 1.11 |
| France | -8.41 | 0.92 | -11.5 | 1.33 | -12.3 | 1.52 | -13.45 | 2.24 | -14.31 | 1.64 | -10.72 | 6.06 |
| Germany | -11.18 | 1.22 | -7.15 | 0.82 | -5.61 | 0.69 | -10.67 | 1.77 | -14.51 | 1.67 | -4.41 | 2.49 |
| Netherlands | -10.58 | 1.16 | -7.17 | 0.82 | -7.57 | 0.93 | -11.71 | 1.95 | -13.32 | 1.53 | -6.56 | 3.71 |
| Slovakia | -9.13 | 1.00 | -8.69 | 1.00 | -8.12 | 1.00 | -6.02 | 1.00 | -8.71 | 1.00 | -1.77 | 1.00 |

*Source: Authors own processing based on obtained data from FADN*

*Note: x/Sk = the value of the reference country to the value of SR; * unfounded data;*

When searching for reserves for increasing economic efficiency, we also used the analysis of production costs per kilogram of cow's milk structured according to a calculation formula (Table 10).

Table 10. Production costs of cow´s milk in cents reported in 2017

| Country | Belgium | | Denmark | | France | | Germany | | Netherlands | | Slovakia | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item of calculation formula | ₡/kg | % | ₡/kg | % | ₡/kg | % | ₡/kg | % | ₡/kg | % | ₡/kg | % |
| Feed and bedding | 12.0 | 26.8 | 13.3 | 32.3 | 11.5 | 23.4 | 10.7 | 23.9 | 12.4 | 28.3 | 16.3 | 40.7 |
| From which: purchased | 9.80 | 21.8 | 11.4 | 27.7 | 8.42 | 17.1 | 7.97 | 17.7 | 11.1 | 25.3 | 5.07 | 12.7 |
| made | 2.25 | 5.0 | 1.91 | 4.6 | 3.08 | 6.3 | 2.76 | 6.1 | 1.34 | 3.0 | 11.2 | 28.1 |
| Breeding and veterinary services, medicines, disinfectants and other material | 3.07 | 6.8 | 3.29 | 8.0 | 1.69 | 3.4 | 3.68 | 8.2 | 4.13 | 9.4 | 3.50 | 8.7 |
| Repairs and maintenance | 2.17 | 4.8 | 3.75 | 9.1 | 4.21 | 8.5 | 4.06 | 9.0 | 2.31 | 5.3 | 0.62 | 1.5 |
| Personnel costs | 17.7 | 39.5 | 8.31 | 20.1 | 15.1 | 30.8 | 14.9 | 33.3 | 10.1 | 23.0 | 4.73 | 11.8 |
| Depreciation | 5.12 | 11.4 | 4.62 | 11.2 | 8.22 | 16.7 | 5.75 | 12.8 | 5.26 | 12.0 | 4.93 | 12.3 |
| Other direct costs and services | 4.20 | 9.3 | 4.88 | 11.8 | 7.11 | 14.4 | 5.69 | 12.7 | 4.62 | 10.5 | 4.98 | 12.4 |
| Cost reduction and accounted revenues | -3.62 | -8.1 | -5.00 | -12.1 | -6.94 | -14.1 | -5.88 | -13.1 | -3.01 | -6.8 | -0.69 | -1.7 |
| Total direct costs | 40.7 | 90.7 | 33.1 | 80.4 | 40.9 | 83.1 | 38.9 | 86.8 | 35.9 | 81.6 | 34.4 | 85.8 |
| Overheads | 4.20 | 9.3 | 8.08 | 19.6 | 8.30 | 16.9 | 5.93 | 13.2 | 8.09 | 18.4 | 5.71 | 14.2 |
| Total costs per kg of milk | 44.92 | 100.0 | 41.25 | 100.0 | 49.25 | 100.0 | 44.91 | 100.0 | 43.99 | 100.0 | 40.10 | 100.0 |
| Subsidies | -2.39 | -5.3 | -2.51 | -6.1 | -4.11 | -8.3 | -3.10 | -6.9 | -1.98 | -4.5 | -3.94 | -9.8 |
| Total costs per kg of milk reduced about subsidies | 42.5 | 94.7 | 38.7 | 93.9 | 45.1 | 91.7 | 41.8 | 93.1 | 42.0 | 95.5 | 36.1 | 90.2 |
| Realization price | 35.0 | 78.0 | 36.7 | 89.2 | 34.4 | 69.9 | 37.4 | 83.3 | 35.4 | 80.6 | 34.3 | 85.8 |
| Economic result from realization= price - cost | -7.47 | -16.6 | -1.96 | -4.8 | -10.7 | -21.8 | -4.41 | -9.8 | -6.56 | -14.9 | -1.77 | -4.4 |

*Source: Authors own processing based on obtained data from FADN*

The overview of costs reported in 2017 confirms that in the production of a kilogram of milk, Slovak farmers consume 3 to 5 cents more fodder than their competitors from selected Western

European countries. Consumption of feed and bedding has the largest share, up to 40.7% of total costs. In-house feed has a share of up to 28.1%, which is significantly different from the costs reported in the comparative countries. In most Western European countries (except Denmark) personnel costs have the highest share. The dominant revenue item that reduces costs is the sales of meat from cull cows. Slovakia has the lowest reduction in production costs. We are of the opinion that this situation is not the result of lower culling of dairy cows, but the low price for carcasses from dairy cows.

The lowest direct costs for the production of a kilogram of milk in 2017 are reported by Danish farmers, followed by Slovakia (34.40 cents). After Belgium, overheads were the second lowest in Slovakia (5.71 cents) and Slovakia also recorded the lowest level of costs incurred in the production of a kilogram of milk (36.16 cents). However, in 2017, Slovak farmers also show the lowest realization prices (34.39 cents / kg), as well as the lowest loss.

The authors Mach and Řezbová (2009) dealt with the determination of factors that influence the efficiency of milk production. They compared the level of cost in primary milk production among Czech and European producers.

## 4. Conclusion

As written by Klopčič, M. et al. (2019), in recent years, the policy environment and market situation of the dairy sector in the EU have seen significant changes, triggering a crash in milk prices in 2015–2016 when EU dairy farmers faced an overproduction of milk and the lowest commodity prices since 2009 due to abolition of the milk quota, the altered market situation and changes in the Common Agricultural Policy for the period 2012–2020.

In this paper we bring selected information from research aimed at revealing production and economic reserves in the production of cow's milk in the conditions of Slovak farms. We have confirmed our hypothesis, which assumes that cow's milk production is loss-making in all the countries compared. This situation is unsustainable in the long run. Farmers are forced to eliminate economic losses from dairy farming through subsidies, not only subsidies directly related to dairy farming. To reduce losses, farmers are also forced to use subsidies that are systemic and do not take into account the production structure of the farm (e.g. systemic land subsidies). Based on the results of our analysis, we can state that Slovak farms are able to compete with top farms at the European level. Our argument is based mainly on the cheaper production of Slovak milk, which can be compared to the competition, and are also sold at lower prices.

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# SENSITIVITY OF CZECH WHEAT PRODUCTION TO CLIMATE CHANGE EFFECTS

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**Annotation:** The paper deals with the analysis of climate change effects in the Czech wheat production. In particular, we use the panel data for individual districts in the Czech Republic over the period 2002 – 2019 to estimate yield function. Average monthly precipitation and temperatures and their combinations with time dummy variable were chosen as proxy variables for the identification of climate change effects. Other factors, used as control variables of the transformation process, include industrial and livestock fertilizers together with price indices of production inputs and outputs. The fitted yield function indicates a positive impact of temperatures in the first spring months unlike in the months before the harvest, when above-average temperatures decrease the yield. These effects are further intensified with increasing temperatures. Precipitation has a similar effect to temperatures. Index of output and input prices has a positive impact, although its influence is subsequently weakened in accordance with the second-order coefficient. Moreover, a positive impact of manure and technological progress is also evident.

**Key words:** wheat, yield function, climate change, fixed effect model, district

**JEL classification:** Q11, Q18

## 1. Introduction

Research into the impact of climate change on wheat yield has been carried out in recent years by numerous authors from different continents - for example (Mearns, 1995; Smith et al., 1996; Luo et al., 2003; Buriro et al., 2011, Ortiz et al., 2008, Eitzinger et al., 2003). Currently, an important topic is the impact of global climate change on agricultural production, where temperature significantly affects crop production. Climate change scenarios, especially global warming, may be beneficial in some wheat-growing areas, but may also significantly reduce wheat productivity in the areas where temperatures are already high (Ortiz et al. 2008). High temperature stress is the main factor limiting wheat yield as it adversely affects the development and growth of wheat and, as a result, low yields per hectare are achieved in many parts of the world (Buriro et al. 2011).

The following studies support this statement. For example, in Pakistan, simulations were performed to assess the impact of increasing the maximum and minimum temperature on wheat yield. The results show that temperature changes reduced wheat yield in the Pothwar area (Jabeen et al. 2017). Similar results have been obtained in the Roseworthy area of Australia. The authors also find that the average grain yield is positively correlated with the increase in precipitation and $CO_2$ concentration and negatively correlated with the increase in temperature. Furthermore, it is evident that the main determinant of the change in average grain yield is the change in the rainfall with a correlation coefficient of 0.88. According to the study, the increase in temperature has a significantly lower effect (impact) on the change in grain yields. According to the authors and their predictions, for example, in Roseworthy, the average grain yield will decrease by 32% (in 2080) compared to the current average grain yield of 3.63 t / ha (Luo et al., 2005). One way to solve future problems may be to irrigate crops, which eliminates the decrease in precipitation in arid areas. A recommendation in this case might be a shift in sowing relative to a shift in the growing season (Jabeen et al., 2017).

As already stated, for some areas, climate change can be an advantage and wheat yield per hectare will increase due to higher temperatures. Sommer et al. (2013) point to the fact that in the case of predicting the impact of climate change, wheat yields in the Central Asian region (within defined scenarios) increased by 12% in 14 of the 18 analyzed localities. However, the individual areas differed in the type of soil, varieties used, agronomic management, etc., which increases the need to take these factors into account in other studies. The results show that the increase in temperature had the most significant positive effect on yields. Sommer at al. (2013) present that Central Asia could thus benefit from climate change due to more favorable winter and spring temperatures. Eitzinger et al. (2003) provide another evidence of positive reactions of changes in crop yields due to climate change for the southeast of the Czech Republic and northeast of Austria, based on the scenario an increase in average temperature of 3 degrees and an increase of annual precipitation of 3.9% can be expected. At the same time, it also points to the decrease of water stress of plants due to the reduction of the overall evapotranspiration caused by the shortened vegetation period.

Climate change inevitably affects agriculture. For this reason, Sabella et al. (2020) evaluated the suitability of individual genotypes for cultivation in the future years. The results show the difference between them in terms of yields. Due to climate change, average temperatures are rising, which plants have responded to with a shorter life cycle due to the physiological strategy of plants to escape high summer temperatures by early grain ripening. From the results, the Cappelli cultivar seems to be very suitable for growing in the areas rich in atmospheric $CO_2$ with high temperature stress.

## 2. Materials and Methods

The estimate of the yield function is based on panel data representing the average wheat yields in individual districts of the Czech Republic for the period 2002 – 2019. Moreover, the wheat yields data in individual districts are complemented by average months temperatures and precipitation, quantities of fertilized used and output and input price indices in the analyzed period.

The model is specified in the form of a fixed effects model and is estimated in the Gretl SW. The fixed effects model uses only the constant parameter to distinguish regional specifics. This way the individual constants captures the heterogeneity of the data.

According to Hsiao (2003), the fixed effects model can also be called a covariance analysis model. Its advantage is the combination of a regression model and a model of analysis of variance. The covariance analysis model covers both quantitative and qualitative factors.

To derive parameters using the fixed effects model, it is necessary to assume that: there is a dependence of $y_{it}$ on the K explanatory variables $\mathbf{x}_{it} = (x_{1it} \ldots x_{Kit})'$ and the constants are specific to the i-th unit at time t, but are constant at the same time,

then

$$y_{it} = \alpha_i^* + \boldsymbol{\beta}_i'\boldsymbol{x}_{it} + u_{it}; \qquad i = 1, 2, ..., N, t = 1, 2, ..., T. \tag{1}$$

$\boldsymbol{\beta}'$ is (1xK) vector of parameters and $\alpha_i^*$ is a vector of constants which represent differences in individual districts using dummy variables.

The error component $u_{it}$ represents the effects of other variables characterized by the i-th observation and a given time interval. Furthermore, we assume that this component is uncorrelated with the regressors, $x_{it}$, for all i and t, and meets the following properties: $u_{it} \sim IID(0; \sigma_u^2)$, i.e. is independently identical distributed with zero mean and constant variance.

Written in vector form is valid:

$$Y = \begin{bmatrix} \boldsymbol{y}_1 \\ \vdots \\ \boldsymbol{y}_N \end{bmatrix} = \begin{bmatrix} \boldsymbol{e} \\ \boldsymbol{0} \\ \vdots \\ \boldsymbol{0} \end{bmatrix} \alpha_1^* + \begin{bmatrix} \boldsymbol{0} \\ \boldsymbol{e} \\ \vdots \\ \boldsymbol{0} \end{bmatrix} \alpha_2^* + \cdots + \begin{bmatrix} \boldsymbol{0} \\ \boldsymbol{0} \\ \vdots \\ \boldsymbol{e} \end{bmatrix} \alpha_N^* + \begin{bmatrix} \boldsymbol{x}_1 \\ \boldsymbol{x}_2 \\ \vdots \\ \boldsymbol{x}_N \end{bmatrix} \beta + \begin{bmatrix} \boldsymbol{u}_1 \\ \vdots \\ \boldsymbol{u}_N \end{bmatrix} \qquad where$$

$$\boldsymbol{y}_i = \begin{bmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{iT} \end{bmatrix} \qquad \boldsymbol{X}_i = \begin{bmatrix} x_{1i1}\, x_{2i1} \ldots x_{Ki} \\ x_{1i2}\, x_{2i2} \ldots x_{Ki} \\ \vdots \quad \vdots \quad \ldots \quad \vdots \\ x_{1iT}\, x_{2iT} \cdots x_{Kit} \end{bmatrix}$$

$$[Tx1] \qquad\qquad [TxK]$$

$$\boldsymbol{e}' = (1, 1 \ldots 1) \qquad \boldsymbol{u}_i' = (u_{i1}, \ldots u_{iT})$$

$$[1xT] \qquad\qquad [1xT]$$

The yield function uses a Taylor's second order approximation to capture individual effects of regressors:

$$lny_i = \alpha_i + \sum_{i=1}^{m} \beta_i \, lnx_i + \frac{1}{2} \sum_{i=1}^{m} \gamma_i lnx_i lnx_i + u_i \tag{2}$$

where:
y … endogenous variable,
x … vector of exogenous variables,
$\alpha_i$, $\beta_i$ and $\gamma_i$ are parameters (incl. constant terms) to be estimated,
$u_t$ … residual term, which is supposed to be $u_{it} \sim IID(0; \sigma_u^2)$.

The aim of the article is to quantify the influence of external factors that significantly affect yields per hectare. For this purpose, average monthly precipitation and temperatures and their combinations with time dummy variable were chosen as proxy variables for the identification of climate change effects. Other factors, used as control variables of the transformation process, will include industrial and livestock fertilizers together with price indices of production inputs and outputs.

Vector of regressors consists of:

| | |
|---|---|
| TM3 – TM7 | average temperatures in the period from March to July |
| PM3 – PM7 | average precipitation totals in the period from March to July |
| PP | ratio of output price indices to input price indices |
| Fert_m | mineral fertilizers |
| Fert_s | manure |
| t | time vector |

All variables were logarithmically transformed and normalized by their geometric mean.

## 3. Results and Discussion

Table 1 presents the results of the fitted model (2). The model shows the overall good fit. In particular, majority of the first as well as second order parameters are significant even at 1% significance level. The parameters on the variables interacting with time are the only exceptions. In this case, only price ratio and temperatures in June and July and precipitation in March in interaction with time are statistically significant. Moreover, the null hypothesis of different interceptions between groups was rejected even at 1% significance level and Pesaran CD test rejected spatial correlation. Finally, the other tests indicate that the standard econometric assumptions are met by the estimate as well.

The results show that temperatures at the beginning of the growing season (March and April lTM3 and lTM4) have a positive effect on the wheat yield, evaluated on the sample mean. Moreover, since the second order parameters of March and April temperatures are positive and significant, it suggests that the effect of early temperatures is intensifying with the increase of temperatures above the average. The opposite patterns can be observed for temperatures in May, June and July. In particular, the raise of the temperatures above the average has a negative impact on the wheat yield in May, June as well as July. Moreover, these negative effects are more and more pronounced with higher temperatures, see the significant and considerably large negative values of second order parameters.

The highest sensitivity of wheat to the temperatures was estimated in June (lTM6). The 1% increase in temperature in May and June causes -0.49% and -0.57% decrease in wheat yield, respectively (evaluated on the sample mean). Then, the second order parameters of May and June temperatures (lTM5_2, lTM6_2) strongly amplify the negative effect of high temperatures on the final production, especially in June. This finding corresponds to studies by Burriro et al., 2011.

Table 1. Results of estimating the yield function

| | Coefficient | Std. Error | t-ratio | p-value | |
|---|---|---|---|---|---|
| const | 0.0359259 | 0.0140552 | 2.556 | 0.0107 | ** |
| lTM3 | 0.052166 | 0.0155014 | 3.365 | 0.0008 | *** |
| lTM4 | 0.173594 | 0.0376197 | 4.614 | <0.0001 | *** |
| lTM5 | −0.488607 | 0.0589924 | −8.283 | <0.0001 | *** |
| lTM6 | −0.574460 | 0.082066 | −7.000 | <0.0001 | *** |
| lTM7 | −0.251574 | 0.0879877 | −2.859 | 0.0043 | *** |
| lPM3 | 0.0689023 | 0.008226 | 8.376 | <0.0001 | *** |
| lPM4 | 0.0172536 | 0.00709176 | 2.433 | 0.0151 | ** |
| lPM5 | −0.00684341 | 0.00922975 | −0.7415 | 0.4586 | |
| lPM6 | −0.0276148 | 0.00935757 | −2.951 | 0.0032 | *** |
| lPM7 | −0.00502760 | 0.00949428 | −0.5295 | 0.5965 | |
| lTM3_2 | 0.0217581 | 0.00990169 | 2.197 | 0.0282 | ** |
| lTM4_2 | 0.0930844 | 0.11075 | 0.8405 | 0.4008 | |
| lTM5_2 | −0.985116 | 0.297333 | −3.313 | 0.001 | *** |
| lTM6_2 | −2.16146 | 0.512326 | −4.219 | <0.0001 | *** |
| lTM7_2 | −1.20915 | 0.744855 | −1.623 | 0.1048 | |
| lPM3_2 | −0.0392284 | 0.0108886 | −3.603 | 0.0003 | *** |
| lPM4_2 | −0.00566484 | 0.0052051 | −1.088 | 0.2767 | |
| lPM5_2 | −0.0523972 | 0.0192772 | −2.718 | 0.0067 | *** |
| lPM6_2 | −0.0470313 | 0.0172987 | −2.719 | 0.0067 | *** |

| | | | | | |
|---|---|---|---|---|---|
| lPM7_2 | −0.0197560 | 0.0100189 | −1.972 | 0.0489 | ** |
| lPP | 0.696754 | 0.0923027 | 7.549 | <0.0001 | *** |
| lFert_m | −0.0204839 | 0.0545754 | −0.3753 | 0.7075 | |
| lFert_s | 0.110636 | 0.0439866 | 2.515 | 0.012 | ** |
| lPP_2 | −3.23128 | 1.40126 | −2.306 | 0.0213 | ** |
| lFert_m_2 | −0.0621748 | 0.132618 | −0.4688 | 0.6393 | |
| lFert_s-2 | 0.270838 | 0.0790012 | 3.428 | 0.0006 | *** |
| t | 0.0118642 | 0.00214591 | 5.529 | <0.0001 | *** |
| t_2 | 0.00126973 | 0.000667854 | 1.901 | 0.0575 | * |
| lPP_t | 0.105071 | 0.032479 | 3.235 | 0.0013 | *** |
| lFert_m_t | 0.0000385379 | 0.00445585 | 0.008649 | 0.9931 | |
| lFert_s_t | 0.00204842 | 0.00242904 | 0.8433 | 0.3992 | |
| lTM3_t | 0.000481788 | 0.00177756 | 0.271 | 0.7864 | |
| lTM4_t | −0.00667592 | 0.00592074 | −1.128 | 0.2597 | |
| lTM5_t | 0.0136603 | 0.00891344 | 1.533 | 0.1257 | |
| lTM6_t | −0.0535308 | 0.0148456 | −3.606 | 0.0003 | *** |
| lTM7_t | 0.0569664 | 0.0208844 | 2.728 | 0.0065 | *** |
| lPM3_t | 0.00435742 | 0.00156274 | 2.788 | 0.0054 | *** |
| lPM4_t | −0.00154940 | 0.00148234 | −1.045 | 0.2961 | |
| lPM5_t | 0.00159 | 0.00169513 | 0.938 | 0.3485 | |
| lPM6_t | 0.000746946 | 0.00156206 | 0.4782 | 0.6326 | |
| lPM7_t | −0.00131850 | 0.0015996 | −0.8243 | 0.4100 | |

| | | | |
|---|---|---|---|
| Mean dependent var | 0.004253 | S.D. dependent var | 0.202871 |
| Sum squared resid | 13.69797 | S.E. of regression | 0.109568 |
| LSDV R-squared | 0.735222 | Within R-squared | 0.628235 |
| LSDV F(35, 748) | 27.31272 | P-value(F) | 0.000000 |
| Log-likelihood | 1058.075 | Akaike criterion | −1882.150 |
| Schwarz criterion | −1281.088 | Hannan-Quinn | −1656.262 |
| rho | 0.127988 | Durbin-Watson | 1.510304 |

*α = 0,01 ***     α = 0,05 **     α = 0,1**

*Source: own calculation using 1258 observations and 76 cross-sectional units*

The effect of precipitation can be assessed as positive and at the same time statistically significant mainly in the first and second spring month of lPM3 and lPM4. The results show that a 1% increase in precipitation will have a positive effect on average yields of 0.069% in March and 0.17% in April, evaluated on the sample mean. On the contrary, at the end of the growing season, especially when the grain ripens in month June, the increased amount of water is undesirable and has a negative effect. This statement is supported by a statistically significant first-order parameter of the variable lPM6. Moreover, these negative effects are also more and more pronounced with higher precipitation, see the significant and negative values of second order parameters.

The effect of the ratio of output and input price indices can initially be described as positive with the intensity of 0.697. The price index expresses the ratio of the market price indices of wheat to the price index of inputs into the sector. The growth of the ratio lPP of output prices to input motivates producers to higher yields. It is obvious that the increase of fertilizer and fuel prices will also be reflected in the output price of wheat. The market accepts the higher price, because wheat serves not only as a commodity intended for food purposes, but also as a raw material for the production of biofuels, which is commonly speculated. Especially during the economic crisis, the price of stable agricultural commodities rises. However, this effect in the form of a second-order coefficient subsequently weakens, as evidenced by the minus sign of the second-order parameter. This indicates that from the beginning the positive effect will be further smaller, see the largest parameter of the coefficient of the second order with a value of 3.231.

The use of livestock manure has a similarly positive effect on wheat yield, as wheat is known for its demands for sufficient nutrients, especially nitrogen. As the amount of fertilizer increases, the effect intensifies. The positive effect of livestock fertilizers with a intensity of parameter 0.11% will be further strengthened, as evidenced by the double value of the second order parameter.

The final estimates also confirm that technological progress represented by the proxy variable - the time vector - will be manifested in the increase of wheat yields about 0.012%. It can be concluded that the newly bred varieties grown are more resistant to thermal stress and they have higher yields.

The combined variable lTM6_t declares that temperatures in June change significantly the impact over time and this change reinforces the negative effect on wheat yield. On the other hand, the parameter of lTM7_t suggests that the negative effect of July temperatures is going down over the time. This finding is in line with agronomic deadlines. The parameter of the variable lPM3_t shows a similarly positive and time-varying effect of precipitation in March. This corresponds in part to the results of a study by Eitzinger et al.(2003).

## 4. Conclusion

The results show the effect of average months temperatures and precipitations, fertilizer inputs, prices and climate change effects on the wheat yield. In general, it can be stated that agriculture is strongly dependent on the course of climatic conditions in a given year. The analyzed period 2002-2019 points to several key facts. Firstly, the climate change imposing a gradual increase in average temperatures might have positive effects in the first growing months. However, these positive effects might be deteriorated by the negative ones at the end of the growing season. In particular, the overall effect, calculated as a sum of elasticities of individual months, is significantly negative. For wheat, the optimal range of growth temperatures is in the range of 18-25 degrees. Temperatures below -14 (for some varieties even a little less) and over 30-35 degrees (again depending on the variety) are considered critical. These critical temperatures apply to completely healthy plants that are not weakened. Then, it is important to consider precipitation during the growing season. Based on the fitted model, precipitations have positive significant impact on the yield in March and April. On the contrary, at the end of the growing season, especially when the grain ripens, the increased amount of precipitations is undesirable and has a negative effect.

In general, it is very difficult to assess the impact of precipitation, as wheat has considerable compensatory capacity and the moisture deficit can manifest itself over a long growing season. Regarding the impact of precipitation, it is also important to distribute it during the period. Therefore, another subject of the study may be the effect of excessive precipitation totals, which lead to average values in the monthly reports. There is a situation that the measured total precipitation may occur within one day and the remainder of the month may actually be dry. Due to changing global climatic conditions, it will be necessary for individual farmers to select the right genotypes for cultivation in selected localities. By choosing them, they can maximize the yield per hectare while following the fundamental farming principles.

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# SUSTAINABILITY OF RUSSIAN AGRICULTURE DURING ECONOMIC CRISES

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**Annotation:** The article is devoted to the development of an approach to identifying the sustainability of agricultural production in Russia during periods of economic crises and the explanation of its factors. Based on the analysis of main characteristics of Russian agrarian sector, the main trends in agriculture have been identified. The application of the method of analytical alignment of time series and Chow test for the indicator of Gross Value Added by the type of activity "Agriculture, Forestry, Hunting, Fish Farming and Fishing" for the period from 1994 to 2020 made it possible to prove the sustainability of agriculture during the crises. The use of comparative analysis in dynamics made it possible to establish that its main factors were stable effective demand for products from the population and the processing industry, multi-structure, location of producers in a vast territory with different conditions, the formation of comfortable external conditions for the activities of producers within the framework of the implementation of State programs. Particular attention is paid to the analysis of the results of the agricultural sector during the pandemic, which led to a decrease in the results and efficiency of the producers of most industries, but did not have a significant negative impact on the agricultural sector of Russia. The grouping of Russian regions made it possible to prove that the location of production in territories with different economic, social and climatic conditions is one of the factors that form the stability of the agrarian sector. It was found that the producers of Russia, as well as the Czech Republic, the United States increased the volume of exports of grain and other agricultural products, which refuted the assumptions of economists about the destruction of supply chains and a decrease in consumer demand during the pandemic.

**Key words**: economic crisis, sustainability, pandemic, agriculture, gross value added, economic factors

**JEL classification:** Q01; C01; C22; O13; F63

## 1. Introduction

The presented research topic is especially relevant today, because Covid-19 led to the formation of the global economic crisis. The pandemic crisis in the Russian Federation was expressed in the closure of small and medium-sized businesses in various types of economic activities. It took place due to the imposed restrictions on visiting shops, restaurants and movement, migration between cities and regions. The decline in the number of jobs led to an increase in unemployment and a decrease in the income of some groups of the population. The created conditions disrupted the processes of formation of Gross Value Added in most types of economic activity.

The agricultural sector is currently strategically important due to it's goal of ensuring the country's food security. Agriculture provides non-commodity goods and services, shapes the environment, affects social and cultural systems, and contributes to economic growth (Huylenbroeck et al, 2007). So, it has the potential to become a locomotive for economic development (Romantseva, 2020). According to the data in the Input-Output tables of most European countries and the United States, agriculture has the highest level of total cost ratios compared to other industries (Linchpin, 2021), for example, in Russia in 2018 it was 489.4

rubles of products of other industries per 1000 rubles of agricultural products. It is for these reasons that producers of the agrarian sector of Russia were selected as the object of the study.

The prospects for the development of agrarian sector are currently being given a lot of attention by economists in all countries. Special attention is paid to the agricultural sector from the point of view of its insufficient participation in the general trend of digital transformations in the economy. Nagy, J., Jámbor, Z. and Freund, A. (Nagy, Jámbor and Freund, 2020) note that the growing requirements for the products of the agricultural sector in terms of volumes that ensure the country's food security and quality to ensure a healthy lifestyle of the population require a transition to new technologies. At the same time, companies are not fully included in the digitalization process, and the problem is in the insufficient qualifications of employees, limited resources. This can affect the further development of agriculture, disrupt its stability. The works of many scientists are devoted to sustainable development of agriculture, they explain it as a growth based on environmental protection, human and ecological health, as well as economic and social development (Zaganjori et al, 2020). In accordance with the research topic in the paper, sustainability is understood as a continuation of trends in agriculture, the preservation of the main types of resources and production volumes.

Fang Cheng, FAO commodity and trade economist, notes "the price increases in staple foods as a result of COVID-19 can have significantly negative impacts on food security and nutrition". The same paper notes the impact of the crisis, which is manifested in "disruptions in logistics, trade and markets that pose challenges to the agri-food value added chains" (FAO, 2020). Endashaw Workie and others (Workie et al, 2020) in their research define the following features of the present period and the prospects for the development of the industry: shortage of labor due to restrictions on movement, morbidity, social distancing, which affects producers, traders, processing industries, leads to disruptions in logistics and food supply chain. On the other hand, a decrease in demand due to a decrease in purchasing power, which will affect the ability of agrarians to invest in their products and initiate a trend towards a reduction in the resource potential of the industry (Anokhina, 2020).

The aim of the paper is to develop an approach to identifying the sustainability of agriculture during periods of economic crises and its factors. The main objectives of the study are:

- to determine whether the impact of economic crises in Russia on the state and development of the agrarian sector was significant;
- to identify trends in the level of indicators characterizing the role of agriculture in the country's economy;
- to determine the impact of the pandemic crisis on agricultural production differentiated by territory;
- to identify the features of Russian agriculture which ensure its sustainability

## 2. Materials and Methods

Producers of agricultural products in Russia are considered as the object of research. The information base was data in the form of time series, cross-sectional data in the context of the constituent entities of the Russian Federation. The sources of information were official statistics data published by the Federal State Statistics Service of the Russian Federation, including indicators of the System of National Accounts, Input-Output tables, socio-economic indicators in the economy in general and in agriculture. International comparisons are provided with information presented in similar tables published by the US Bureau of Economic Analysis (BEA, USDA), data from the System of National Accounts of Germany for 1995 and 2014, published by the European Commission in the framework of WIOD - World Database "Input-Output". The period under analysis includes some moments, worthy of attention from the point of view of the state and development of agriculture. The period from 1994 to 2020 includes sub-periods of different quality due to the influence of external factors on the formation of changes in production, financial mechanisms, results and efficiency of activities of residents of the internal economy of the Russian Federation. We can highlight the following milestones in the period under study:

1) In 1998 an economic crisis was caused by a huge public debt, a decline in world prices for raw materials, which formed the basis of Russia's exports, the collapse of the pyramid of state short-term obligations built by the government, which led to a default, a sharp drop in the rate of the domestic currency against the background of a long period of budget deficit since 1990 (RIA News, 2013);

2) In 2008 there was the global economic crisis, which has profound consequences in the Russian economy due to the large volume of borrowing by participants in economic processes, capital outflow and tightening conditions for external borrowing (World Bank Group, 2019);

3) The period from 2014 to 2015 is characterized as a currency crisis reflected the sharp weakening of the Russian ruble against foreign currencies caused by a rapid decline in world prices for oil, the export revenues of which the Russian budget largely depend on. This has also intensified due to the impact of the economic sanctions against Russia (Pshenichnikov and Kot, 2016).

4) 2020 has become a crisis year around the world due to pandemic. It is associated with restrictions in the activities of small businesses, the suspension of the work of large enterprises of various types of economic activities, a decrease in income of the population and household consumption.

The research methodology in accordance with the objectives of the study includes such stages:

I. Revealing the sustainability of agricultural production during periods of economic crises in Russia based on author's approach. Methods: time series analytical alignment, piecewise linear function method using Chow criterion.

II. Identifying a trend in the change in the main indicators of the role of agriculture in the country's economy during periods of crisis, including identifying the impact of the multy-structure of agriculture on its sustainability. Method of comparative analysis of relative indicators

III. Identifying regional differences in the impact of the pandemic on agricultural output to prove the role of territorial distribution in sustainability of agriculture. Method: statistical grouping and comparative analysis.

Crisis situations in the economy most often lead to significant structural changes in certain industries and types of economic activity in the time period t *, which is expressed in a change in the nature of the trend in the time series of the indicator under study. To identify the influence of external economic factors on the activities of the industry in a specific period of time (crisis year), it is proposed to use time series analytical alignment and the Chow test.

The methodology of applying this test is as follows:

The studied time series is divided into two sub-periods: before the critical moment t * and after the critical moment t *;

Analytical alignment of the time series as a whole and by sub-periods is carried out using the Least Squares Method and a linear function;

A working hypothesis is put forward that the vector of estimates of all parameters of the trend for the first sub-period is equal to the vector for the second sub-period:

$$H_0: \beta' = \beta''; D(\varepsilon') = D(\varepsilon'') = \sigma^2 \tag{1}$$

The empirical value of the criterion F is calculated using the formula below and compared with the critical level:

$$F = \frac{\left(\sum_{i=1}^{n} e_i^2 - \sum_{i=1}^{n_1} e_i^2 - \sum_{i=n_1+1}^{n} e_i^2\right)\cdot(n-2p-2)}{\left(\sum_{i=1}^{n_1} e_i^2 + \sum_{i=n_1+1}^{n} e_i^2\right)\cdot(p+1)} > F_{\alpha;p+1;n-2p-2} \tag{2}$$

where p – number of parameters excluding intercept,

$\sum_{i=1}^{n} e_i^2$ - sum of residual squares for a trend for the entire population.

$\sum_{i=1}^{n_1} e_i^2$, $\sum_{i=n_1+1}^{n} e_i^2$ - sums of residual squares for the first and the second sub-periods

If the empirical *F* value has exceeded the critical level, then the null hypothesis is rejected, therefore, the time series contains structural changes that significantly affect the formation of the levels of the studied economic indicator.

The main indicators that should be taken into account in the analysis of the activities of agricultural producers in the light of the sustainable development of the industry, according to most authors (Rumánková, L. et. al, 2020), are efficiency, productivity and competitiveness.

The main indicator for our methodology is the index of the physical volume of Gross Value Added (GVA) by type of activity "Agriculture, Forestry, Hunting, Fish Farming and Fishing" (in accordance with the classification of 2016 of the System of National Accounts) as the main productive indicator characterizing the development of the agricultural sector in Russia. This indicator can be used for characterization of agriculture since the share of crop and livestock production industries in gross output by type of activity was 95% for the period on average (Zinchenko, 2017).

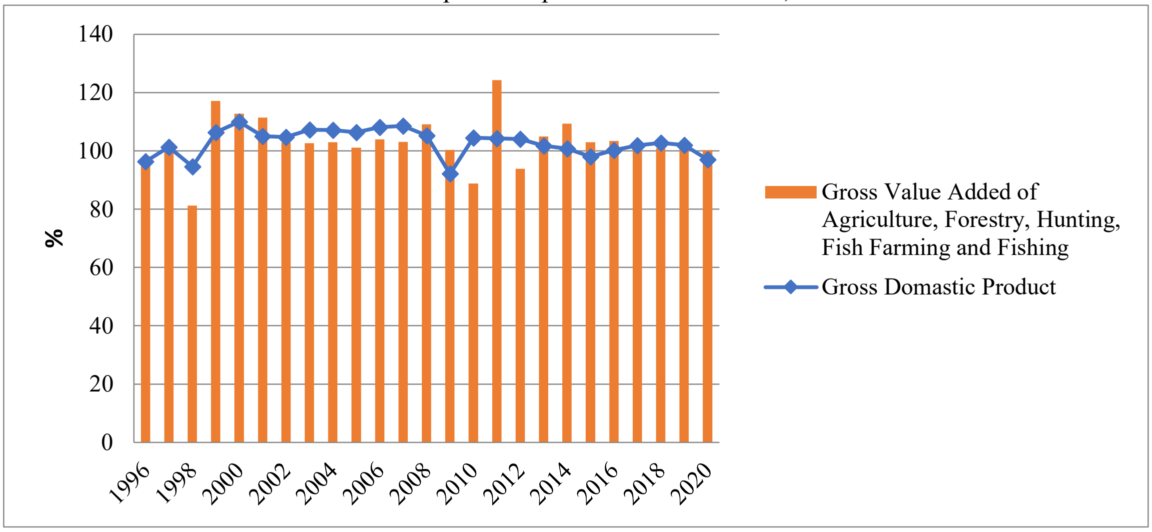
The same indicator was used to study territorial differences in the performance of agricultural producers during a pandemic. On the base of it a typological grouping was constructed. This type of grouping makes it possible to assess the differences in the level of the studied indicator by groups, to characterize the distribution of statistical population units by the level of the effective indicator and to determine the main characteristics of the groups.

Comparative analysis makes it possible to identify differences in the level of indicators in dynamics and by territory, to identify patterns in the development of agriculture.

### 3. Results and Discussion

Analysis of the index of the physical volume of the Gross Domestic Product (GDP) as the main indicator of the state and development of the country's economy as a whole made it possible to identify significant reductions in certain periods associated with the noted socio-economic crisis (Figure 1).

Figure 1. Index of the physical volume of the Gross Domestic Product and the Gross Value Added of the type of economic activity "Agriculture, Forestry, Hunting, Fish Farming and Fishing" in comparison with the previous period for 1996 - 2020,%



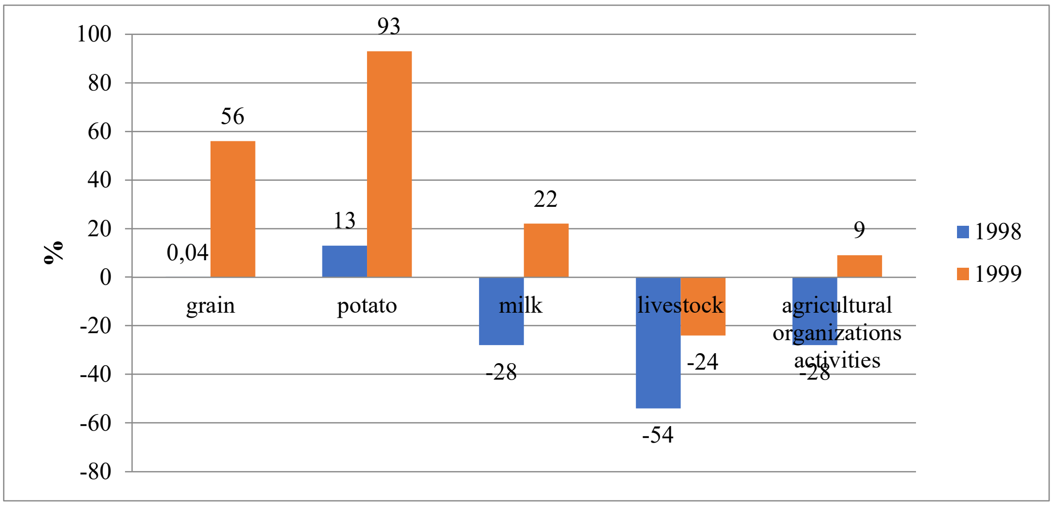

*Source: Constructed by the author*

So, we note a decrease in GDP in 1998 by 5.3%, in 2009 by 7.8%, in 2015 by 2%, in 2020 by 3%. However, the influence of factors turned out to be multidirectional on different types of economic activity. Checking the period 1994 - 2008 for structural changes in 1998 gave the following results: $F_{emp}$ (7.51) > $F_{crit}$ (3.98). This reflects the need to consider piecewise functions, which indicates the presence of changes in the general trend since 1999 and confirms that the crisis year 1998 was a turning point for Russian agriculture.

The features of the agriculture in Russia, which lead to the dependence on natural and climatic conditions, an increased lag in investment efficiency, at the same time provide opportunities for maintaining production during a crisis, when incomes of the population, household consumption decrease, and the depreciation of the national currency occurs. Thus, the 1998 crisis continued the trend that had emerged in the early 90s in agriculture: a decrease in GVA (from 1993 to 1997 by 21%), while it led to an increase in GVA in 1999 by 17.1%. The collapse of the ruble in 1998 led to a sharp rise in prices for imported products, which accounted for 65% of consumption. Incomes of the population decreased, while the share of food expenditures in total household expenditures remained the same. This stimulated the consumption of domestic products, created conditions for raising the level of incomes, profitability of the activities of Russian producers, increasing resource potential, forming a tendency for the growth of gross output and gross value added until 2009 (on average 6% annually) (Figure 2).

The profitability of agricultural organizations increased by 37 percentage points, the share of unprofitable enterprises decreased from 88% in 1998 to 54% in 1999.

Figure 2. Profitability of the sale of the main types of agricultural products and the activities of agricultural organizations in general, %




*Source: Constructed by the author*

The contribution of agriculture to the formation of Russia's GDP increased from 5.6% to 6.5%, the share of people employed in agricultural production remained at over 14%, with a high unemployment rate of 13%. (Table 1)

The share of domestic products in personal consumption of households remained, and even increased by 0.4 and 0.7% for dairy and meat products, respectively. Thus, we can state the presence of stability in agriculture during the first economic crisis. One of the reasons can be called the diversity in Russian agriculture, the movement of production in the sector of personal subsidiary farms in difficult economic periods (57.3 and 54.8% in 1998 and 1999, respectively), which main goal is the production of products for their own consumption, providing personal income of household members. It does not lead to a qualitative increase in production, but allows the rural population to survive and preserve the resource base. Similar conclusions can be drawn in relation to the studied type of economic activity during the periods of the following crises 2008-2009 and 2014-2015.

For the period from 1999 to 2014 application of the Chow test gave the following results: $F_{emp}$ (0.84)< $F_{crit}$ (3.89). It indicates that there is no change in the trend, i.e. it can be argued that the impact of the global monetary and economic crisis of 2008 on the agricultural sector was not significant. The stability of the agricultural sector can be explained by the presence of effective demand for domestic products: the share household spending on food was above 30% due to a stable increase in household incomes in the period 1999-2013 annually by 8.2% and a decrease in imports of basic types of food in accordance with the objectives of the State Programs for the Development of Agriculture and the current sanctions.

Analyzing the next period regarding the presence of structural changes in 2014, we got $F_{emp}$ (0.41) < $F_{crit}$ (4.46), consequently, changes in the external conditions of the activities of agricultural producers in 2014 did not have a significant impact on the formation of trends in agriculture. In these periods general trends remained for most indicators of the conditions and results of the agricultural sector (Table 1)

Table 1. Indicators of the role of agriculture in the country's economy during periods of crises, %

| Indicator | 1998 | 1999 | 2008 | 2009 | 2014 | 2015 | 2020 |
|---|---|---|---|---|---|---|---|
| Physical volume index of: | | | | | | | |
| Gross Domestic Product | 94.7 | 106.4 | 105.2 | 92.18 | 100.7 | 98.0 | 97.0 |
| Gross Value Added of a type of activity * | 81.2 | 117.1 | 109.1 | 100.3 | 109.4 | 103.0 | 100.2 |
| Share of GVA of the type of activity* in GDP | 5.6 | 6.5 | 4.2 | 4.4 | 4.0 | 4.3 | 4.1 |
| Share of household expenditure on food | 51.3 | 52.0 | 29.1 | 30.5 | 31.9 | 35.4 | 37.2 |
| Share of people employed in agriculture | 14.51 | 14.39 | 10.11 | 10.12 | 7.67 | 7.60 | 6.7 |
| Unemployment rate | 13.3 | 13.0 | 6.2 | 8.3 | 5.2 | 5.6 | 5.7 |
| Share of domestic products in household consumption: | | | | | | | |
| milk and dairy products | 84.6 | 85.0 | 78.8 | 80.0 | 74.3 | 77.3 | 80.4 |
| meat and meat products | 66.8 | 67.5 | 65.3 | 69.1 | 82.1 | 87.3 | 90.3 |
| Share of agricultural production by categories of farms: | | | | | | | |
| agricultural organizations | 40.4 | 42.6 | 48.0 | 45.7 | 51.7 | 54.0 | 57.7 |
| personal subsidiary farms | 57.3 | 54.8 | 43.6 | 46.8 | 38.2 | 34.5 | 28.6 |
| peasant (farming) households | 2.3 | 2.6 | 8.4 | 7.5 | 10.2 | 11.5 | 13.7 |

**All-Russian Classifier of Economic Activities 2016 "Agriculture, Forestry, Hunting, Fish Farming and Fishing"*

*Source: Constructed by the author*

The pandemic crisis formed a lot of challenges for agriculture. The consequences of the coronavirus for the economies of the countries of the world are described in detail by specialists of the Organization for Economic Co-operation and Development (OECD, 2020a; OECD, 2020b). To understand their impact we should compare the main results of the activities of agricultural producers in 2020 and in 2019. In 2020, we observe a decrease in the physical volume of gross domestic product by 3% due to a decrease in production in most sectors of the material sphere (mining - by 9.5%, electricity supply - by 3.3%, etc.) with an increase in the volume of services provided. The physical volume of GVA in the sectors “Agriculture and forestry, hunting, fish farming and fishing” remained stable, increasing by 0.2%. At the same time, the size of the sown areas remained (with a long-term trend of their reduction), the volume of production of the main types of agricultural products increased: milk - by 2.7%, meat - by 3.1%, grain - by 9.7%.

Export has a significant share in the structure of the use of gross agricultural output and the formation of incomes in countries with developed market economies. For example, in Germany this indicator is 20.3%, the agricultural sector of Russia is striving for these indicators (in 2018 it was 12.3%, which is even higher than in the United States by 2.3 percentage points). That is why most Russian and foreign economic scientists expressed concerns about the devastating impact of the pandemic on international food supply chains (Elleby, 2020), but the results of 2020 showed an increase in exports of food products and agricultural raw materials in general by 19.2% and grain - by 27.7%, compared to the previous period.

According to the International Trade Statistics Database - TrendEconomy.com, the pandemic had the strongest impact on foreign trade in the UK, where grain exports decreased by 27.2% compared to 2019, meat - by 0.72%, and other agricultural products - by 9.9%. During the pandemic, China reduced its exports of grain by 14.4%, meat by 15.5% and other products by 2.9%. A decrease in exports of the Czech Republic is observed for meat products (by 3.4%) with a significant increase in grain international supplies - by 36.6%. The export processes of the United States did not disrupt; in 2020, grain exports increased by 14.58%, meat - by 2.58%, and other products - by an average of 9.25%.

One of the factors for the sustainability of Russian agriculture is the distribution of producers over the vast territory of the country with different soil and climatic conditions, economic development, specialization, and the institutional structure of production. The impact of the pandemic has led to different consequences for farmers in the regions. For the analysis, 3 types of regions (without federal cities) were identified by the level of the index of the physical volume of Gross Value Added by the type of economic activity "Agriculture, Forestry, Hunting, Fish Farming and Fishing" in 2020 compared to 2019. Three groups of regions were identified using the following approach: Group I - regions in which agricultural production decreased (index is below 100%), the rest was divided into two groups based on the median value (104.0), i.e. Group II - an increase in production volume of less than 4%, Group III - an increase of more than 4% (Table 2).

Table 2. Characteristics of groups of Russian regions, distinguished by changes in the physical volume of agricultural products in 2020 compared to 2019

| Indicator | Groups of regions by changes in the volume of agricultural production | | | On average |
|---|---|---|---|---|
| | decrease | increase by 0.1-4% | increase over 4% | |
| Number of regions | 21 | 26 | 32 | 79 |
| Production index in comparable prices, % | 94.6 | 101.8 | 108.7 | 102.7 |
| Sown area index, % | 99.8 | 99.3 | 100.9 | 100.1 |
| Production per capita, kg: | | | | |
| milk in 2019 | 237.6 | 262.6 | 240.3 | 246.9 |
| milk in 2020 | 242.0 | 268.5 | 250.4 | 253.7 |
| livestock and poultry in 2019 | 109.7 | 126.0 | 122.3 | 119.5 |
| livestock and poultry in 2020 | 110.2 | 127.4 | 131.5 | 123.2 |
| agricultural products, th. rub. | 47.9 | 43.7 | 52.3 | 48.0 |
| Real money income index, % | 97.4 | 98.4 | 97.6 | 97.8 |
| Population index, % | 99.8 | 102.2 | 99.6 | 100.6 |
| Rural population index, % | 103.5 | 99.8 | 99.5 | 101.0 |

*Source: Constructed by the author*

The results of the grouping allow us to note that in 26.6% of the constituent entities of the Russian Federation the volume of agricultural production decreased by 5.4%, the sown area slightly decreased. In 2020 this group produced milk and meat less than the average for the general population of regions by 4.7% and 16.2%, respectively, while physiological consumption rates was not provided by domestic production. This group includes the regions of the southern part of Russia, which, in years with favorable weather conditions, provide most of agricultural production, but disrupted from the dry summer of 2020. Regions with more favorable conditions in terms of temperature and air humidity in 2020 had a greater increase in comparison with the decrease in production volumes of the first group by 1.8 and 8.7%, which provided an overall increase of 2.7%.

In all groups of regions, real incomes of the population decreased in 2020, but it did not affect household spending on food purchases, which is explained by the low level of elasticity of these goods by household income (the correlation coefficient between the real money income index and the index of food expenditures per member households was 0.09 in 2020, the coefficient of elasticity was 0.54) and provides a stable effective demand and profitability of producers.

Particular attention should be paid to the impact of sanctions on the sustainability of agriculture. Most authors, analyzing the impact of sanctions, note the specificity of agricultural products. Thus, Liefert, W. (Liefert, et al, 2019), based on the results of their analysis, conclude that ruble depreciation and a ban on imports have led to an increase in the domestic price of imported goods, which leads to an increase in the domestic production. These economic factors remained during the pandemic and made it possible to ensure stable production volumes at a low price elasticity of demand for products.

The other side of sustainability is maintaining product quality. Kontsevaya, S. (Kontsevaya, Smutka, 2020) notes that one of the results of the impact of economic sanctions is a decrease in the quality of agricultural and food industry products produced in Russia due to the lack of competition of European goods in the domestic market. This can lead to a decrease in demand for domestic products and lead to a loss of stability in the industry. However, the author does not take into account the high competition between Russian agricultural producers of different types, as well as the presence of manufacturers from the CIS countries in the domestic market. It remained during the pandemic. Thus, it cannot be argued that the period of sanctions and pandemic has reduced the resilience of agriculture in terms of product quality.

## 4. Conclusion

The study made it possible to reveal a decrease in the gross domestic product of the Russian Federation during periods of economic crises and pandemics, while during the years of crises the gross value added in agriculture increased, with the exception of 1998. Application of the Chow test to the analysis of the time series of the GVA physical volume index showed significant structural changes in the time series only in 1999.

During the pandemic, Russian agriculture remained practically one of the branches of the material sphere, which did not reduce the volume of production, increased the scale of export of products due to the absence in most enterprises located in rural areas, restrictions on movement and lock down, the need to ensure the consumption of the population at the expense of its own production, lack of a high incidence rate in a number of regions.

Thus, the factors of stability of agriculture have been identified: effective demand for products, multi-structure in agriculture, distribution of enterprises of the agricultural sector over a large territory with different conditions and specialization of production (the possibility of locating production in farms of different categories, redistribution of resources), low level of spread of diseases in rural areas in comparison with urban territories, the implementation of measures of government support for agriculture. However, there are also a number of factors, the strengthening of the influence of which limits the development of the agrarian sector in Russia and can destabilize it. The first is the dependence of production on imported resources. The share of imports in terms of intermediate consumption as a whole increased from

2011 to 2016 by 1.5 percentage points up to 8.5%. The second is the low level of digitalization of agricultural production and rural areas in general, which reduces the competitiveness of domestic production due to a decrease in indicators of its intensity, efficiency and quality of products. Solving the problem of reducing the influence of negative factors and enhancing the effect of the existing favorable conditions for the agricultural sector of Russia is a priority task of the State programs for the development of agriculture.

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# SURVEY METHODOLOGY – SURVEY 2021

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**Annotation:** The main goal of the article is to present the methodology and selected preliminary results of an extensive survey of the development of information and communication technologies in agricultural enterprises, which was conducted in the first quarter of 2021 throughout the Czech Republic. The research was primarily focused on capturing current trends in the use of ICT with emphasis on selected key areas (broadband, social networks, communication tools, regional internet portals, used categories of hardware, software used, mobile communications, Internet of Things, storage and data security, etc.).This survey builds on previous large-scale surveys, which have been carried out by the department in several stages since 1999, with the last stage being carried out in 2017. Some of the stages were carried out directly in cooperation with the Ministry of Agriculture (as was the last stage in 2017). Compared to recent years, the survey includes new domains, such as the use of IoT in plant and animal production, data storage and security, the impact of the Covid-19 pandemic on basic company operations, etc.). The survey was prepared, conducted, and administered by the Department of Information Technology, Faculty of Economics and Management, CZU Prague.

**Key words:** Information and communication technologies, internet connectivity, mobile communications, software, hardware equipment.

**JEL classification:** L86

## 1. Introduction

The dynamics of the development of information and communication technologies (ICT) is still very high, and surprising in many ways. New models of smartphones, new revolutionary gadgets (tablets, netbooks), e-book readers, GPS device devices, IoT devices (Internet of Things), are being introduced on regular basis. Broadband, its availability and mobility are the basic preconditions for the effective use of today's modern technologies. The development of broadband networks has a revolutionary impact today, similar to the impact of the development of electricity and transport infrastructure a hundred years ago. In October 2018, the government of the Czech Republic approved the cross-sectional strategic document Digital Czech Republic, which covers all the impacts of digitization on the economy and society. "It is a set of concepts ensuring the preconditions for long-term prosperity of the Czech Republic. Its content can be defined by the term: Strategy of coordinated and comprehensive digitization of the Czech Republic 2018+. "Digital Czech Republic" covers three basic principles that work in unison. The areas of focus are interaction of the Czech Republic in the European Union in the digital agenda, digital public administration, and the preparation of society and the Czech economy for digitization." (MPO, 2019) The plans seek to maximize the social and economic potential of ICT, and the potential of key economic and social activities in all areas (education, trade, work, communications, culture, etc.). The long-term strategic plan was launched by the Czech government as Digital Czech Republic (Šimek, Vaněk and Jarolímek, 2008), which mentions, among other things, the need to close the digital divide between urban and rural residents. (MMR, 2018) Digital divide stems from the lack of access to high-speed internet and causes the inability to fully utilize available facilities and services through Internet.

"The conditions for the adoption of modern ICT tools in rural areas and in the conditions of agricultural enterprises that operate here have long been at a lower level compared to a number of other sectors and the environment of medium-sized and large settlements." (EDC, 2012).

Due to its importance, this issue is continuously addressed by authors from many countries across continents, such as (Rampersad and Troshani, 2020, Ye and Yang, 2020, Wilson and Hopkins, 2019, Bowen and Morris, 2019, Levine, 2020). In the conditions of the Czech Republic, it has long been monitored by the DIT research team (Šimek, Vaněk and Jarolímek 2008, Vaněk, Jarolímek and Šimek 2008, Vaněk, Jarolímek and Vogeltanzová, 2011) on the contrary, despite its fundamental importance, it is not the subject of research by the CZSO or other institutions. The project solution thus brings the potential of original results with theoretical and especially practical benefits, such as high-speed connectivity (broadband) and other parameters such as the EDGI index, the basis of all indicators of company development DESI index, eGovernment Benchmark, and more.

The OECD methodology also works with population density, according to which a defining feature of rural municipalities is population density lower than 150 inhabitants / km2. In this respect, in 2017, the rural area of the Czech Republic consisted of 5,360 municipalities, which represented 81.7% of the state's area, on which less than 30% of the republic's total population lived. In comparison with the definitions based on population, it is interesting that according to the Eurostat methodology, which defines the degree of urbanization (DEGURBA) based on population density in spatial cells of 1km2 and the creation of spatial clusters of these cells, there are currently 30 municipalities in the Czech Republic in the category up to 500 inhabitants classified as urban or suburban. In the population category 501 - 1,000 inhabitants it is 59 municipalities and 86 municipalities and in the population category 1,001 - 2,000 inhabitants. According to the Eurostat methodology, the Plzeňský, Jihočeský, Vysočina and Pardubický regions fall into the rural area, and the Karlovarský, Ústecký, Liberecký, Jihomoravský, Olomoucký, Moravskoslezský and Zlínský regions are classified as transitional regions. (Regulation EU, 2017, OECD, 2018)

There are several specific problems, for example from the point of view of the development of the information society, the availability of fast internet is of primary concern. In this context, we are talking about the so-called digital divide, which is palpable for the majority of the population in marginal areas and has not yet been sufficiently resolved in the Czech Republic. This problem is also strongly perceived at the level of the European Union, which gradually increases its efforts trying to solve it.

This work presents a methodology and selected results of an extensive survey of the development of information and communication technologies in agricultural enterprises, which was conducted in the first quarter of 2021 throughout the Czech Republic.

As mentioned above, compared to recent years, the survey includes other new research areas of interest. During this period, the issues of IoT in agriculture, data protection and the impact of the Covid-19 pandemic on agricultural holdings were newly included in the survey.

The paper deals mainly with the methodology of the survey itself, which represents working with almost 5,000 companies in the database in order to get the maximum number of respondents in a limited time, focusing on areas of Internet connectivity, emphasizing individual technologies, as well as broadband and mobile devices. Other issues are mentioned for information only and will be published later when the finalized results are available.

## 2. Materials and Methods

The survey in 2021 was based on the research experience in 2017. It was newly expanded with sections aimed at initial mapping of the usage of the Internet of Things (IoT) and identifying current developments and the impact of the pandemic countermeasures on business operations. Therefore, in the questionnaire, which had an optimized range of 16 questions, questions No. 17, 18 were added, and another 6 questions were modified to reflect the current trends of information and communication technologies in the agricultural sector.

Compared to 2017, the questionnaire was partially modified and expanded. While items related to precision agriculture were made less significant, questions related to internet connection, internet use and mobile communication were reworked to contain more detailed answers. Issues related to data storage and protection, the use of sensors and the impact of the pandemic on business operations have been specified in a completely new way. The area of ICT was not extended towards social networks and their use, technical equipment, the scope of software, segments of animal production, crop production, farming and consulting, and neither towards obtaining specific information regarding particular business activities.

Table 1. Examples of modified and new questions in the survey.

| Modified questions – old vs. new | |
|---|---|
| Question 7: | *How does the company access the Farmer's Portal? (original question no. 13)*<br>How does your business handle data storage? |
| Question 8: | *What do you think are the benefits of precision agriculture? (original question no. 14)*<br>How does your business secure computers and data? |
| Question 15: | *Does your company use correction technology for navigation systems (RTK)? (original question)*<br>What tools do you use for corporate communication? |
| Question 16: | *What are the obstacles to the development of precision agriculture? (original question)*<br>What tools do you use for online communication? |
| New questions | |
| Question 17: | What statements does your company identify with regarding the COVID19 measures? |
| Question 18: | In what manner does your company use sensors (Internet of Things devices)? |

*Source: Own processing.*

The answers were not obligatory, for some questions it was possible to enter more answers, for this reason the sums of absolute numbers in the tables do not correspond to the total number of completed questionnaires. For some questions there was the possibility of an open answer, these answers are presented in the tables of "other answers".

The possibility to answer in the form of a "other answer" is especially important for obtaining other variants of answers that are not currently covered in the questionnaire. In the event of a greater occurrence of a certain variation, this allows to accommodate that option into the next version of the survey.

From the questionnaire it was possible to find out a certain broader view of the agricultural public on the issue of the Internet of Things, monitoring ICT development trends and the impact of the pandemic on business strategies and prepare for possible further stages of the survey, which could examine these issues in even greater detail.

The survey was mainly focused on enterprises that manage at least 100 ha of agricultural land. The survey was prepared during the first two months of 2021 and took place from March 9 to April 27, 2021 (the authors assume the gradual completion of the questionnaires still in progress until May 31, 2021).

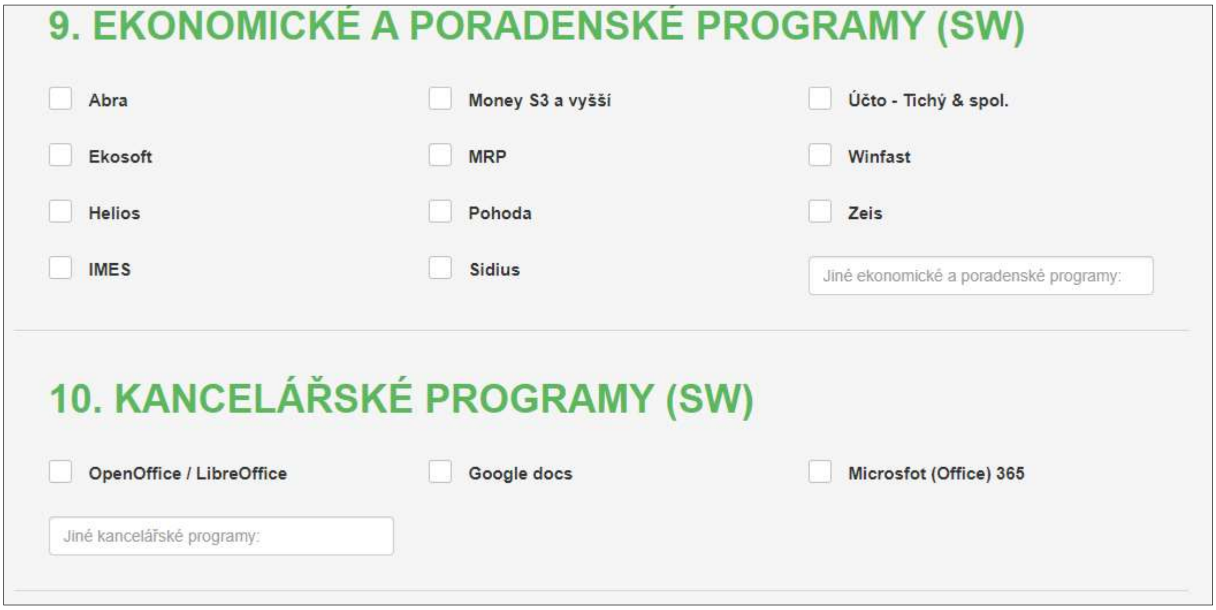
In 2021, 4,313 enterprises were addressed, which manage a total of 3,774,752 ha of agricultural land, of which 2,077,656 ha is arable land, an area that represents 88.5% of agricultural land and 71.5% of arable land in the Czech Republic. The basic identification of companies was based on the Czech LPIS. A comparable survey – i.e., a survey focused on agricultural enterprises or the countryside in general - has never been carried out in such detail in the Czech Republic, even though this issue is crucial in addressing the so-called digital divide in Czech rural areas. A motivation letter, including instructions, was sent by e-mail to all selected respondents. At the moment, no questionnaires were sent by post, because in 2017 only a marginal number of questionnaires (50 pieces) were returned by post. The questionnaire was therefore available only as an online web form that allows changes to be saved on an ongoing basis and can be completed later. Compared to previous years, the possibility to download the form was removed due to its redundancy and the web form with temporary storage of the file completely replaced the printed questionnaire.

Data collection on the Internet was performed through the Internet portal Agris.cz (http://www.agris.cz). The portal is managed by the Department of Information Technology. The portal is well known to experts in agriculture. Figure 1 is an example of Web Form 2021, which was available at https://pruzkum.agris.cz.

Figure 1. Web form – Exploration 2021.


*Source: Agris.cz, 2021.*

Figure 2. Web form – Exploration 2021 – Sample questions a).



9. EKONOMICKÉ A PORADENSKÉ PROGRAMY (SW)

- Abra
- Money S3 a vyšší
- Účto - Tichý & spol.
- Ekosoft
- MRP
- Winfast
- Helios
- Pohoda
- Zeis
- IMES
- Sidius
- Jiné ekonomické a poradenské programy:

10. KANCELÁŘSKÉ PROGRAMY (SW)

- OpenOffice / LibreOffice
- Google docs
- Microsfot (Office) 365
- Jiné kancelářské programy:

*Source: Agris.cz, 2021.*

Figure 3. Web form – Exploration 2021 – Sample questions b).

13. ODKUD ZÍSKÁVÁTE INFORMACE PRO VAŠI ČINNOST?

| | Pravidelně | Občas (nárazově) | Téměř vůbec | Nepoužíváme |
|---|---|---|---|---|
| Internet | ○ | ○ | ○ | ○ |
| Semináře komerčních firem | ○ | ○ | ○ | ○ |
| Semináře státních institucí | ○ | ○ | ○ | ○ |
| Odborný tisk | ○ | ○ | ○ | ○ |
| Od kolegů | ○ | ○ | ○ | ○ |
| Vzdělávací kurzy (univerzity, školy) | ○ | ○ | ○ | ○ |

14. VYUŽÍVÁ PODNIK SOCIÁLNÍ SÍTĚ PRO PODNIKATELSKOU ČINNOST A MARKETING?

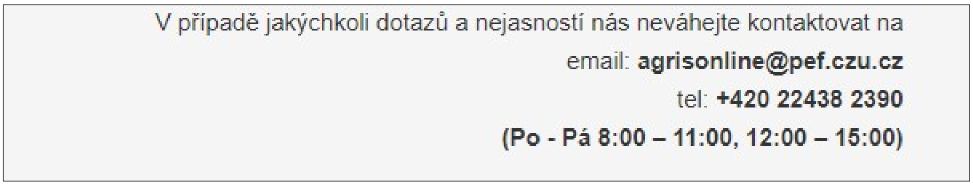
- Facebook
- Google+
- LinkedIn
- Twitter
- Instagram
- Jaké jiné sociální sítě Váš podnik využívá:

*Source: Agris.cz, 2021.*

The survey itself was planned in several time phases, when selected groups of companies were gradually sent information about the ongoing survey by e-mail. Included in the e-mail was a direct link to a web-based questionnaire, which was placed on the relatively well-known AGRIS portal, which is also operated by DIT and CZU: http://www.agris.cz/pruzkum.

Throughout the survey, telephone and e-mail consultation support was available to respondents, which was actively used. The aim was to make it easier for the addressed companies to fill in the questionnaires and to get a response in a relatively short time, and to address to possible problems related to filling in the questionnaire, refusing to fill in the questionnaire or handling requests for deletion from the contact database, etc.

Figure 4. Web form – Support contact information.




*Source: Agris.cz, 2021.*

Respondents were contacted by e-mail repeatedly - if the company did not respond to the first invitation e-mail, a second reminder e-mail was sent within a few weeks.

Table 2. Survey 2021 - Process of data acquisition for the survey.

| Status for 30th April 2021 | Amount |
|---|---|
| Contacted by e-mail once | 4313 |
| Contacted by e-mail twice | 4111 |
| Finalized questionnaires | 611 |
| Questionnaires in progress | 139 |
| Declined invitations | 21 |
| Company no longer exists | 34 |

*Source: Own processing.*

Table 3. Survey 2021 – Additional information regarding Table 2.

| | |
|---|---|
| Contacted by e-mail once | Number of subjects contacted by the first invitation e-mail. |
| Contacted by e-mail twice | Number of subjects contacted by second reminder e-mail (second e-mail was sent in cases, where the survey was not completed or declined within 3 weeks from the first invitation e-mail). |
| Finalized questionnaires | Total number of finished questionnaires. |
| Questionnaires in progress | Total number of questionnaires in progress, unfinished or incomplete. |
| Declined invitations | Number of respondents who declined to participate in the survey. |
| Company no longer exists | Number of subjects from the database, that no longer exists (company was disbanded or sold, changed its business activity, etc.). |

*Source: Own processing.*

The questionnaire on the website could be processed gradually, which has already proved its worth in previous surveys. A certain necessary limitation is the need for the final confirmation of the questionnaire and closing it, otherwise the questionnaire will remain in the state of being still in progress. As of April 30, 2021, a total of 139 questionnaires were in such a state. Most of these questionnaires were filled in correctly, but they were not closed. Therefore, they will be completed (closed) automatically after manual check. The questionnaire survey is in the run-up period, when respondents are still allowed to save their answers in the questionnaire. The results are continuously processed and will be further published on an ongoing basis.

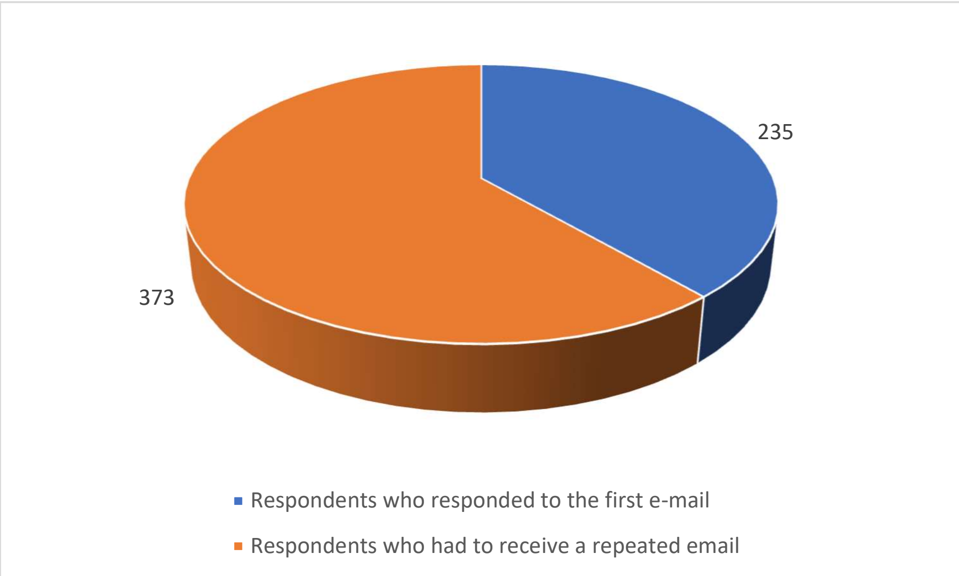
## 3. Results and Discussion

The methodological procedure of addressing the companies was characterized in more detail in the Materials and Methods section of this article. In this section we would like to focus on selected selected results.

Respondents were contacted by e-mail repeatedly - if the company did not respond to the first e-mail, it was contacted again by second e-mail within 3 weeks. After receiving the first e-mail, 5% of the respondents completed the questionnaire, and after being notified by the second e-mail, it was 15% of the respondents with the completed questionnaire. The number of completed questionnaires after the first and second e-mail is shown in Graph 1.

The number of completed questionnaires after both e-mails as of 30th of April 2021 corresponds to 20% of the return of the questionnaires, which is already a sufficient sample to represent the monitored agricultural holdings. This return will increase even more after the end of the catch-up period and by closing the ongoing questionnaires, as mentioned above in the Materials and Methods chapter. The third round of notifications to respondents was considered, which would happen in the second quarter of 2021. Technical implementation is not a problem here, the SW solution of the survey allows it, but it would delay reaching final results of the survey.

Graph 1. Number of finalized questionnaires after first and second e-mail (30th of April 2021)

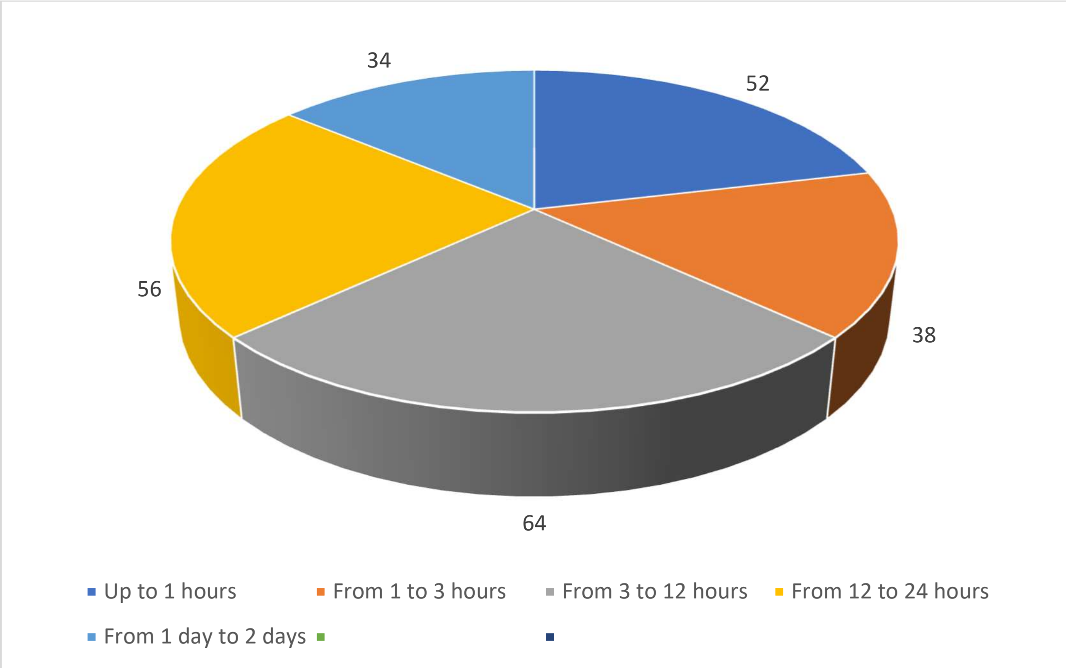



*Source: Own processing.*

Detailed statistics have been created, where the speed of opening the questionnaire after receiving the e-mail is monitored. The speed of response to the first e-mail is shown in Graph 2. The speed of response to the second reminder e-mail is shown in Graph 3.

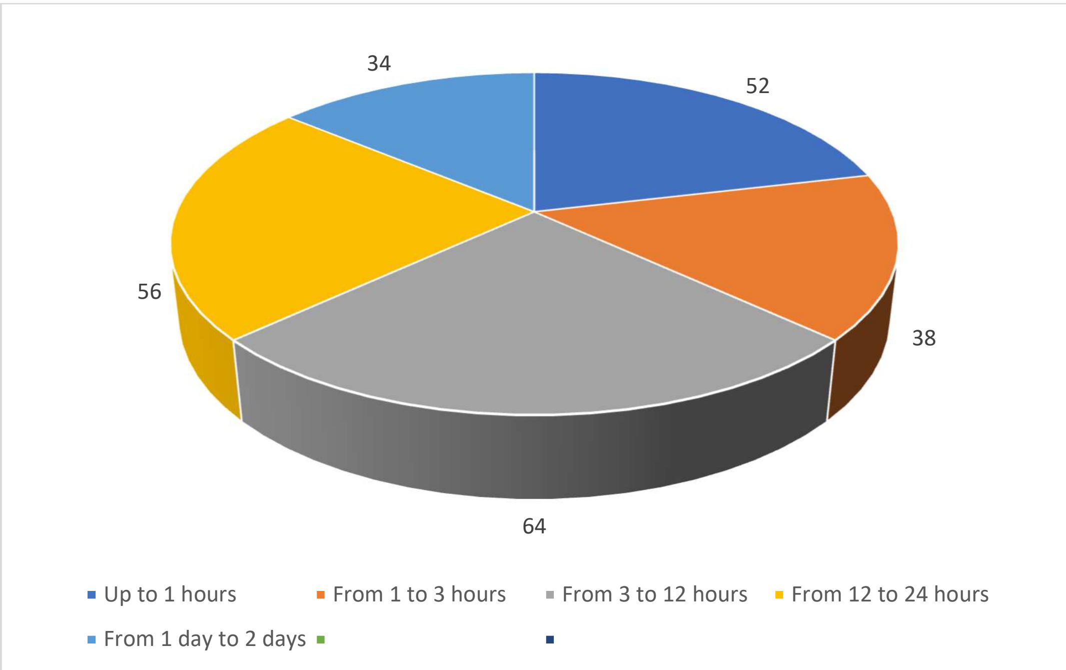
The resulting statistics show that the most frequent response ranged from 3 to 12 hours after receiving the first email. The response to the second e-mail was already 12 - 24 hours (respondents were already aware of the research and only delayed its completion). Preliminary results show that respondents in the agricultural sector are accustomed to replacing the telephone with electronic mail, to which they have access at any time during the day or during their absence from work from home. Nowadays, the exact working hours seem to have completely disappeared and respondents have access to e-mail at any time and from anywhere. This is also related to the use of a better and faster internet connection, when the share of wi-fi and mobile connection is increasing even in rural conditions. The provisional results show a significant finding that 28% of respondents are considering using a 5G mobile network connection. This trend points to an interesting finding about the current development of broadband in rural areas, which will be further examined in more detail.

Graph 2. Response time between receiving the first invitation e-mail and opening the questionnaire




*Source: Own processing.*

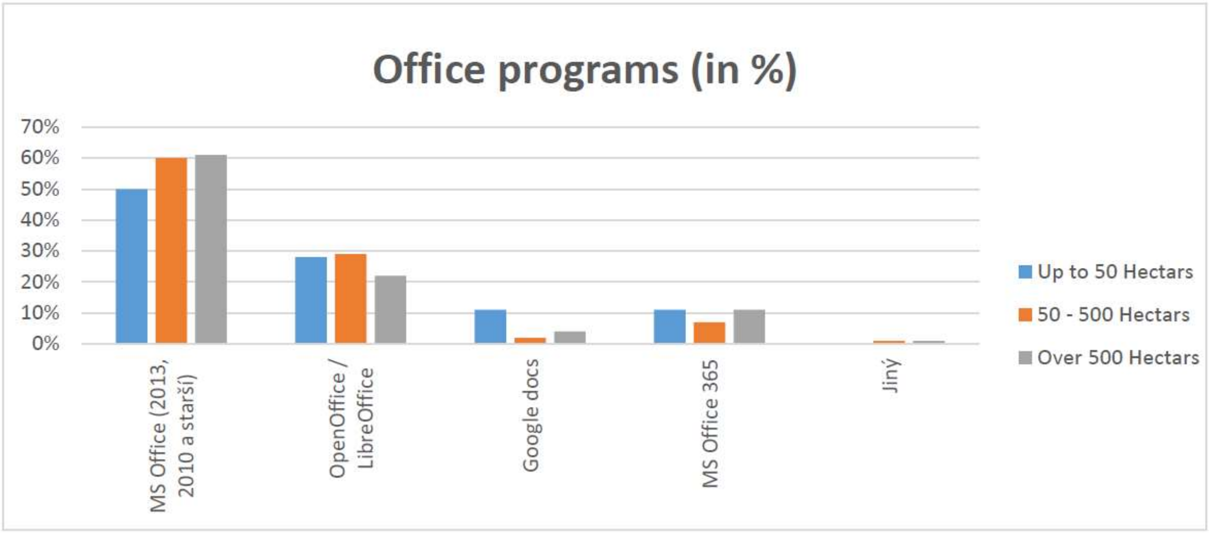
Graph 3. Response time between receiving the second reminder e-mail and opening the questionnaire (in %)




Source: Own processing.

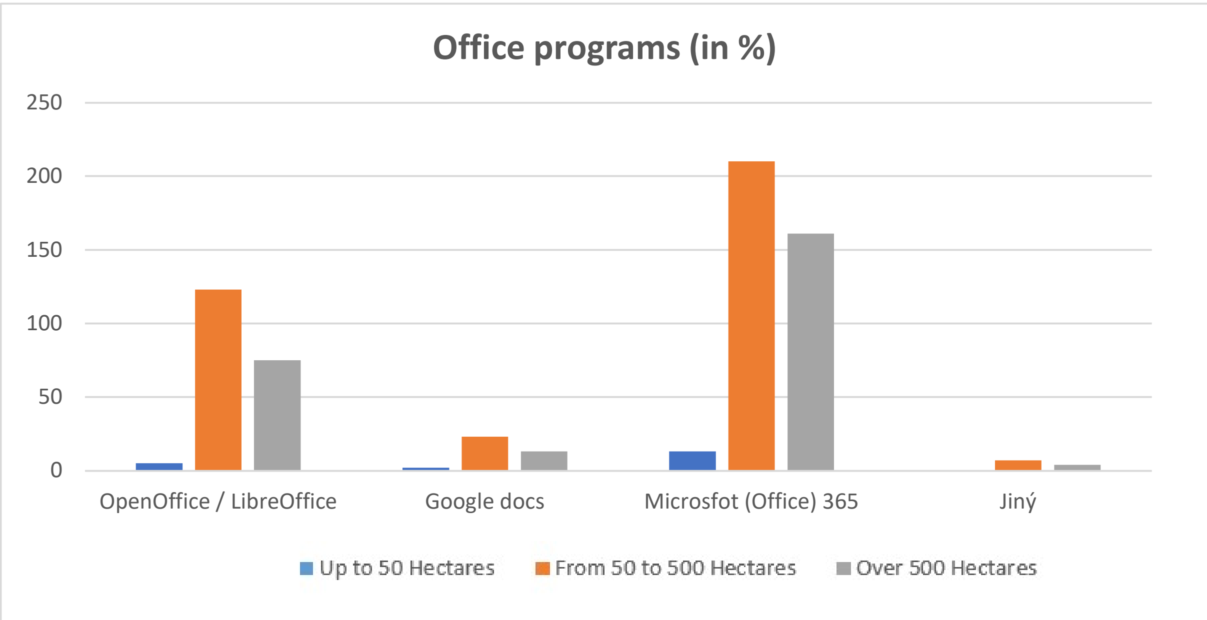
For comparison, Graphs 4 and 5 show the findings from 2017 and the preliminary results of 2021 in the selected segment of office software equipment, when there was a slight change in its distribution. The "boxed MS Office" still strongly prevails, regardless of the size of the company. The new cloud solution Google or Microsoft has a relatively large representation. The number of companies using the OpenOffice / LibreOffice package, which is free, has increased.

Graph 4. Usage of “office” software according to Survey 2017




*Source: Own processing.*

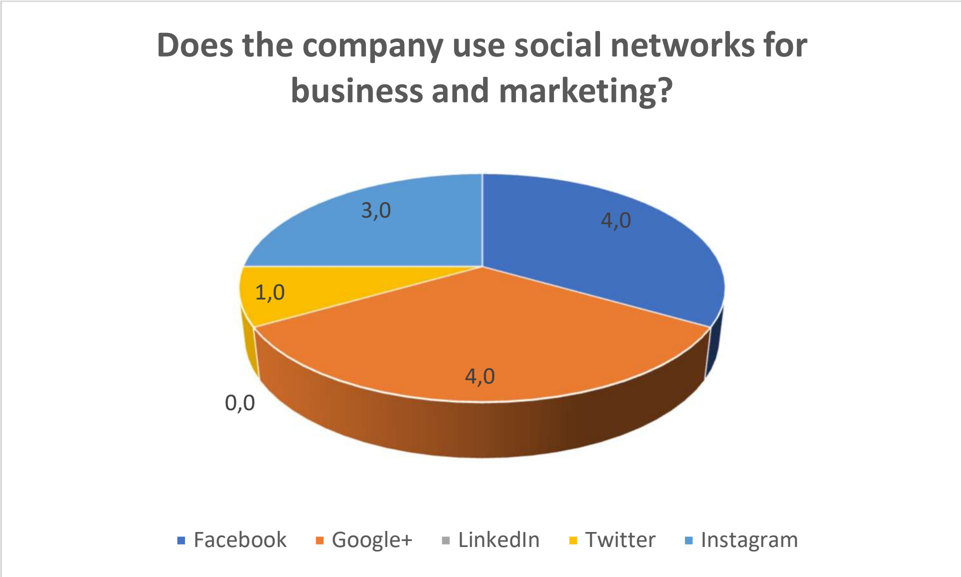
Graph 5. Usage of “office” software according to Survey 2021




*Source: Own processing.*

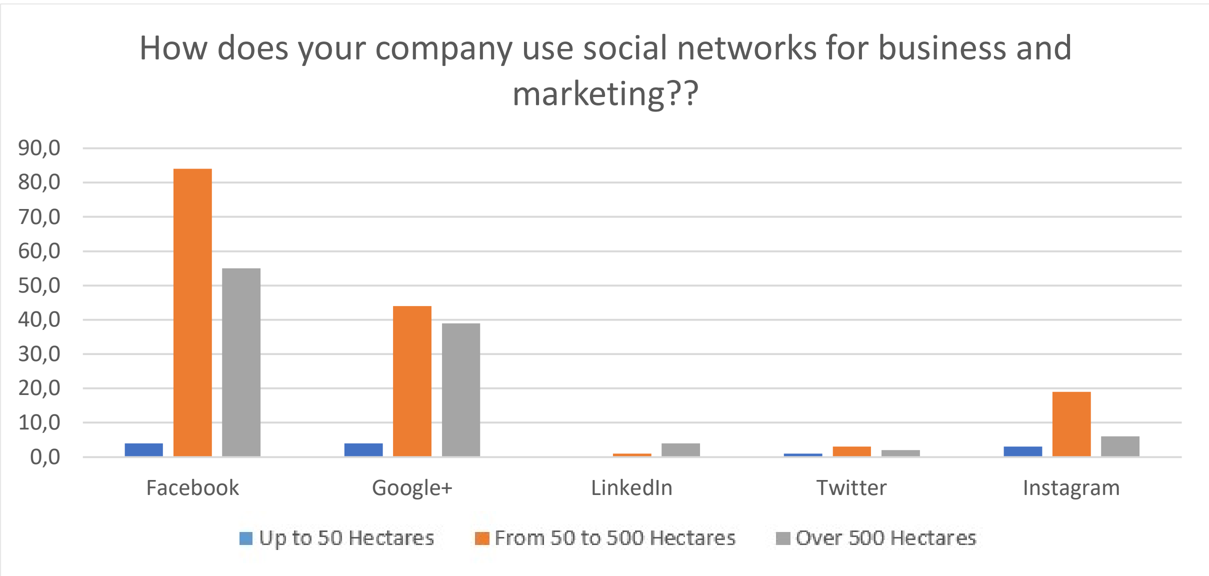
The second preliminary result provides an answer to the question about the use of social networks by companies for their business and marketing. Graph 6 shows that Facebook and Google+ still have the greatest share. Social networks are generally the domain of medium and large enterprises, which was confirmed by preliminary results (Graph 7). The number of answers for the LinkedIn social network, which was ticked by a total of 5 respondents, is interesting, because after rounding it amounts to 0%. As a result, it can be concluded that the LindkedIn professional network is not of interest to agricultural holdings. Rather, local labor is used in this area. In the future, we can expect an increase in Instagram's preference at the expense of Facebook, as companies react to the current development of the use of social networks by the public with a slight delay.

Graph 6. Use of social networks for business activities and marketing




*Source: Own processing.*

Graph 7. Use of social networks for business activities and marketing according to the size of enterprises




*Source: Own processing*

It is certainly worth mentioning the answers of the respondents regarding the current situation with Covid-19. Almost 19% of respondents said that administrative staff started working from home, and more than 47% of respondents said that they had partially reduced contact with customers and suppliers. The results show that the situation around the coronavirus pandemic has, of course, significantly affected rural areas, where farms undoubtedly belong. These results that will be part of further processing and publishing.

Results that were not available at the time of writing the article will be presented at the conference Agrarian Perspectives XXX.

## 4. Conclusion

At the beginning of the research, in accordance with the project, the classification and mapping of the digital divide was performed from the point of view of individual factors - directed in relation to the issue of ICT. The aim of the project is to determine the possibilities of suppressing the digital divide in the environment of rural areas, where the divide is most pronounced.

The paper focuses mainly on research methodology. The above-mentioned extensive survey of the state and development of information and communication technologies (ICT) in agricultural production companies in the Czech Republic, the so-called “Survey 2021”, brought a number of new findings and interesting information, such as the development of Internet access towards continuous access without time limitations. Furthermore, the survey showcased relatively high interest in the use of mobile connection networks of the new generation 5G among its participants. Businesses are making even more use of Microsoft's "boxed" solutions, but at the same time, the share of businesses that have started using OpenOffice / LibreOffice is increasing.

Regarding Covid-19, the results of the survey will of course not be comparable to previous years. The Covid situation affected all sectors, including agriculture, where the pandemic affected labor, prices and sales of agricultural commodities. On the other hand, agriculture is one of the sectors where production cannot stop technically and technologically, especially animal production and seasonal plant operations. Some activities (mostly administration and planning) can also be partially implemented in the form of work from home, similarly to industries.

The results are being processed further and will be subsequently published. Given the importance and rapid development, this issue will be the subject of research in the next survey stages as well.

**Acknowledgements**

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# EXPORT RESTRICTIONS UNDER THE PANDEMIC SHOCK: IMPLICATIONS FOR THE COMPETITIVENESS OF WHEAT PRODUCTION IN RUSSIA

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**Annotation:** As a wheat exporter, Russia ranks first in the world. Almost half of domestic wheat production is exported due to its competitiveness characterized by the relatively high level of comparative advantage. According to the study in the context of export parity and significant export volumes, domestic wheat prices follow world market prices and largely depend on major importers' demand. Global wheat prices have been rising consistently over the past months caused by the recovery in Chinese economy, adverse weather conditions, disruptions in food value chains and liquidity injections in the USA and EU economies to mitigate the impacts of the COVID-19 pandemic. To restrain the rise in domestic prices, Russian government decided to introduced a floating export duty on wheat. This mechanism in the context of high world grain prices, economic stagnation, shrinking disposable incomes and increased risks of further devaluation of the national currency would lead to deterioration of the financial and economic situation, reduction of investment opportunities and technological lagging of Russian wheat producers behind their competitors in the world market. In this respect, Russian government efforts should be focused on increasing production and improving the competitiveness of wheat instead of restricting exports. A comprehensive set of measures regulating the wheat market also implies subsidizing wheat consumers, support for the development of transport and logistics infrastructure, and targeted assistance to vulnerable groups of the population. Such approaches would support grain consumers while respecting the interests of producers and exporters, thereby helping to achieve the national agri-food export target of USD 45 billion in the coming ten years.

**Key words:** Export restrictions, competitiveness, wheat market, export parity

**JEL classification:** Q17, Q18

## 1. Introduction

As Russia is the world's largest wheat exporter, its domestic market is sensitive to the world price fluctuations. To restrain the impact of rising global prices on the domestic cereals market, starting from June 2021 the Russian government decided to introduce a permanent damping mechanism in the form of a floating export duty on wheat, corn and barley (RBC, 2021). The duty on wheat was set at 70% of the difference between the base price calculated periodically on the basis of export contractual prices and USD 200. It is envisaged that the proceeds from the duty will be transferred to Russia's regions in the form of subsidies depending on the volume of their grain production.

It should be noted that a floating export duty on wheat had already been applied in Russia since July 2015, but it was zeroed out in September 2016. At that time, the calculation was based on the following formula: 50% of the customs value minus RUB 6,500, but no less than RUB 10 per ton (Table 1), i.e. RUB 6,500 of the price per ton was exempted from the customs duty.

In addition to the floating duty, the Russian government actively used other measures to limit grain exports (duties, quotas and export bans). Such measures were temporary and taken as a response to a poor harvest or a need to stabilize the domestic market in the face of increased demand for grain in the world.

Table 1. Russian government's measures restricting exports of grains

| Effective period | Type of measure | Grains covered | Duty or quota size |
|---|---|---|---|
| January – May 2004 | Export duty | Wheat and Rye | Euro 25 per ton |
| November 2007 – April 2008 | Export duty | Wheat and barley | wheat - 10%, but no less than EUR 22 per ton, barley - 30%, but no less than EUR 70 per ton |
| May – June 2008 | Export duty | Wheat and barley | wheat - 40%, but no less than EUR 105 per ton, barley - 30%, but no less than EUR 70 per ton |
| August 15, 2010 – June 31, 2011 | Embargo | Wheat, barley, rye, corn, wheat or wheat-and-rye flour | |
| February – June 2015 | Export duty | Wheat | 15% plus EUR 7.5, but no less than EUR 35 per ton |
| July – September 2015 | Export duty | Wheat | 50% minus RUB 5,500 per ton, but no less than RUB 50 per ton |
| October 1 – September 22, 2016 | Export duty | Wheat | 50% of the customs value minus RUB 6,500, but no less than RUB 10 per ton |
| April – June 2020 | Export quota for goods exported beyond the Eurasian Economic Union | Wheat, rye, barley and corn | 7 million tons |
| February 15 – June 30 2021 | Export quota for goods exported beyond the Eurasian Economic Union and export duties | Wheat, rye, barley and corn | 17.5 million tons;<br>Export duty rates within the quota:<br>Wheat – EUR 25 per ton starting from February15 and EUR 50 per ton starting from March 1;<br>Corn – EUR 25 per ton starting from March 15;<br>Barley – EUR 10 per ton starting from March 15. |

*Source: resolutions of the Russian government on grain export regulations*

A number of researchers noted that the use of ad hoc measures often has a negative impact on a country's participation in global value chains and on sectoral investments. For instance, according to Mitra and Josling (2009) all export restrictions lead to a deterioration of welfare in both the country imposing such measures and the rest of the world.

Assessing the consequences of wheat export restrictions during the global food crisis of 2007-2008, Götz et al. (2013) point out that the degree of integration of the Russian domestic market into the global wheat market decreased, causing prices to fall below their long-term equilibrium level and reducing private investment in the country's grain sector.

Russia's imposition of a ban on grain and flour exports after the 2010 drought in order to limit domestic price increases, preserve livestock and grain reserves for the domestic market has also been viewed as rather controversial. In this regard, Ksenofontov et al. (2019) note that the export ban causes direct losses to grain traders and producers and undermines Russia's reputation as a reliable supplier to the world market, which subsequently has to be restored by selling grain at a discount to competitors' prices.

Moreover, this ban brought very limited benefits to Russian consumers (Welton, 2011). Consumer prices for grain products continued to rise: from July to December 2010, flour prices increased by 18 percent and bread prices by 10 percent. The embargo had a negative impact on Russian wheat importers who were forced to switch to higher-priced supplies from other countries. Clearly, the beneficiaries of this measure were Russian livestock breeders who managed to keep their livestock. Nevertheless, Welton (2011) believes that in that situation a better solution (as opposed to the export ban) would have been to subsidize flour millers and bakers, provide targeted support to vulnerable groups, and support investments in the development of the grain complex, since a high-tech and productive grain sector helps strengthen the competitiveness of domestic livestock production in the long term.

In this respect, the objective of this study is to assess the basic factors determined current conditions for wheat market development and the impact of floating export duty on the competitiveness of wheat production in Russia, taking into account the implications for the main stakeholders of wheat value chain: producers, consumers and exporters. This will allow us to elaborate the recommendations on how to adjust the damping mechanism of wheat export regulation to balance the stakeholders' interests in the case of high world wheat prices.

## 2. Materials and Methods

The study is based on ITC, OECD, FAO, Federal State Statistics Service of Russia (Rosstat) and Bank of Russia data on Russia's wheat market. These data were analyzed using descriptive statistics and index approaches to estimate the major production and consumption patterns, quantitative and structural changes in the Russian wheat market, as well as export potential values of wheat. Factor analysis was applied to assess the influence of exchange rate and world price on Russia's domestic wheat price under current conditions.

Wheat export competitiveness was characterized by Balassa's Revealed Comparative Advantage (RCA) Index. This indicator is calculated as the ratio of exports of a particular product to the total export of all goods from the country in comparison with the similar ratio for the world as a whole (Balassa, 1977). If a country's revealed comparative advantage for a particular product exceeds 1 (RCA>1), it is considered to be a competitive producer and exporter of that product compared to the "average" country. The higher the value of RCA for a particular product, the higher the export opportunities for that product.

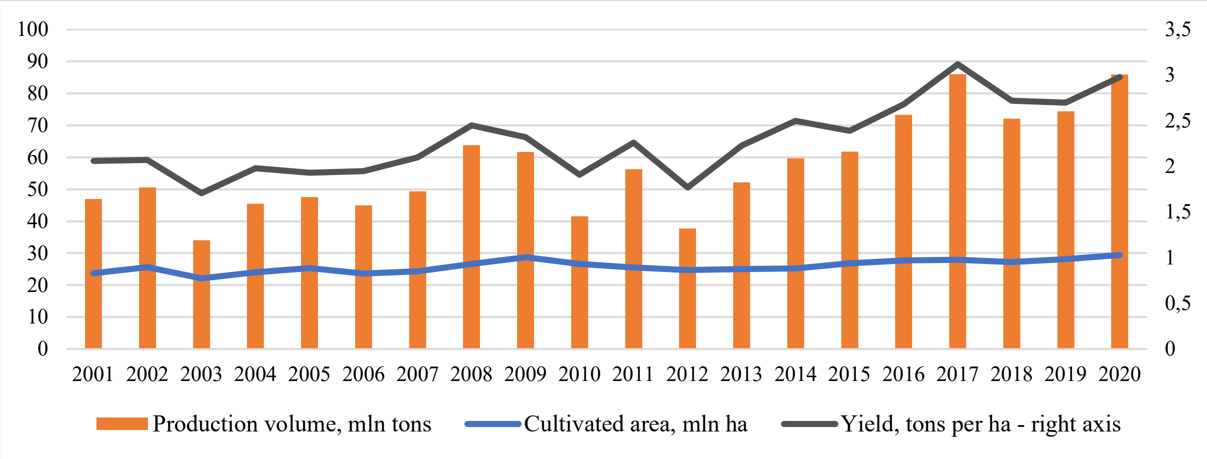
To characterize the wheat export opportunities, dynamics of nominal protection coefficients (NPC) of Russian wheat producers was considered (OECD, 2021). These indicators are measured as the ratio of average domestic producer prices, including subsidies paid per ton of output, to external reference prices. In turn, external reference prices are deep-water port FOB prices less the costs of handling and transportation of wheat to the border. In the context of barrier-free trade conditions, NPC is equal to 1, that indicates compliance of domestic prices with external reference prices. This situation is characterized by equal profitability of grain supplies to domestic and foreign markets.

All mentioned above indicators and estimates for Russian wheat market form an analytical approach to the qualitative assessment of the impact of damping mechanism of wheat export regulation on the main stakeholders of wheat value chain. Such general approach allows us to consider the relevant issues in the first approximation and creates the basis for more in-depth analysis using sophisticated applied economic and mathematic tools and methods.

## 3. Results and Discussion

Wheat is a major agricultural commodity in Russia. In 2020, wheat accounted for 32% of Russia's crop production and 28% of the country's agri-food exports value. Favorable weather conditions, domestic support of agricultural producers, investments in technological modernization, transport and logistics infrastructure of the grain market, integration into global value chains and strengthening trade and economic relations with importing countries contributed to the development of wheat production. Over the period from 2001 to 2020, wheat production, yield and cultivated area increased by 83%, 45% and 24%, respectively (Figure 1).

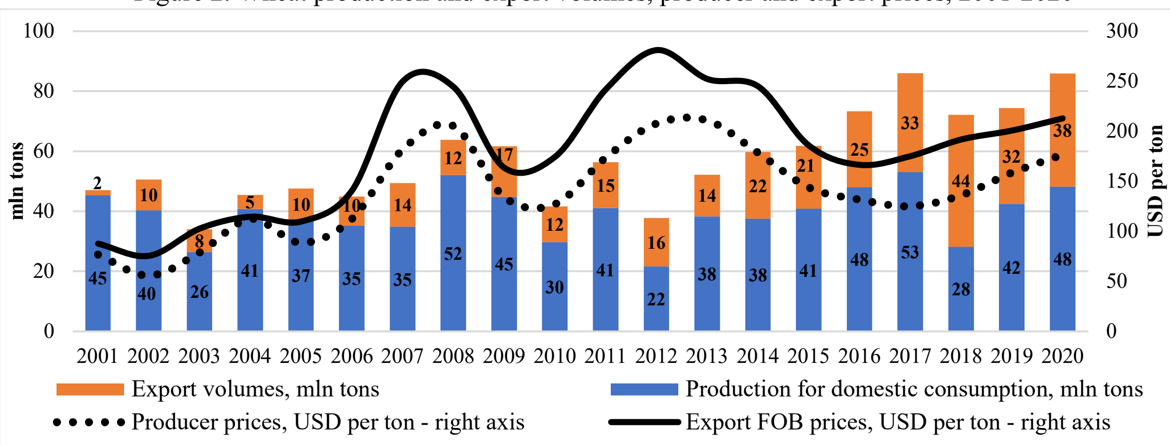
Figure 1. Wheat production, cultivated area and yield in Russia, 2001-2020




*Source: Rosstat, 2021*

Since 2016, Russia has been the world's largest wheat exporter. The volume of wheat exports is approaching the volume of its production for domestic consumption (Figure 2). Between 2018 and 2020, Russia exported 49% of the wheat produced in the country. Due to significant export volumes domestic wheat prices follow world market prices and largely depend on major importers' demand. At the same time, increasing exports also strengthens its influence on the development of the Russian market. As evidenced, export supplies reached 44 million tons worth USD 8.4 billion in 2018.

Figure 2. Wheat production and export volumes, producer and export prices, 2001-2020



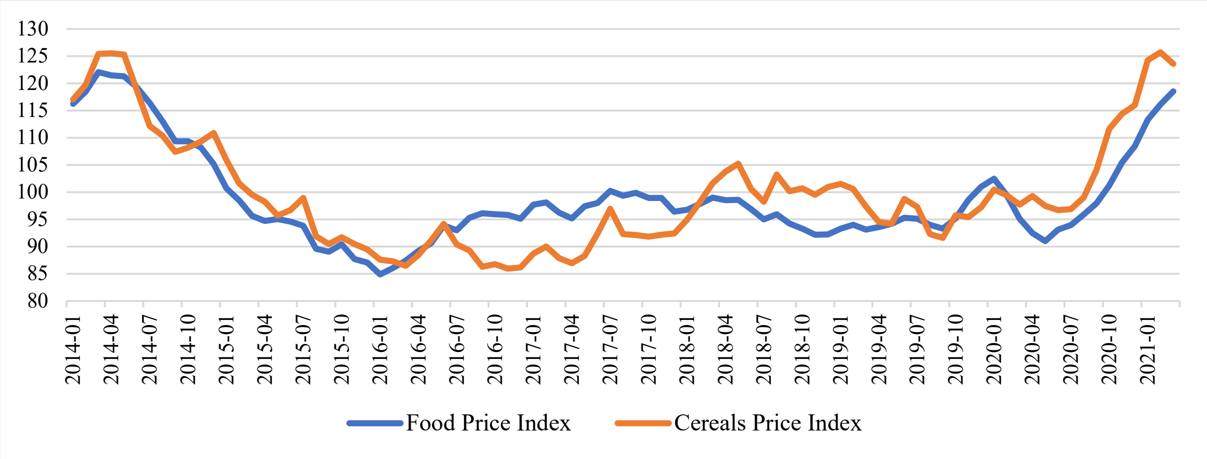

*Source: Rosstat, ITC Trade Map and OECD PSE database for Russia, 2021*

Meanwhile, price volatility in major agricultural markets has doubled since 2000 (World Bank, 2011) and global food prices have been consistently rising since the mid-2020 (Figure 3). Since

July 2014, the highest monthly average increase in the FAO cereals price index was recorded in January 2021. Prices for cereals reached the highest levels in February 2021.

The growth of world prices was caused by the recovery of demand in China, unfavorable weather conditions, disruption of product supply chains and liquidity injections into the USA and EU economies to mitigate the impact of the COVID-19 pandemic. In addition, global prices were also affected by the measures restricting exports of grains announced by the Russian government in 2021 (Table 1). This spurred export activity and demand of importers who wanted to make their purchases before the export restrictions were put into effect.

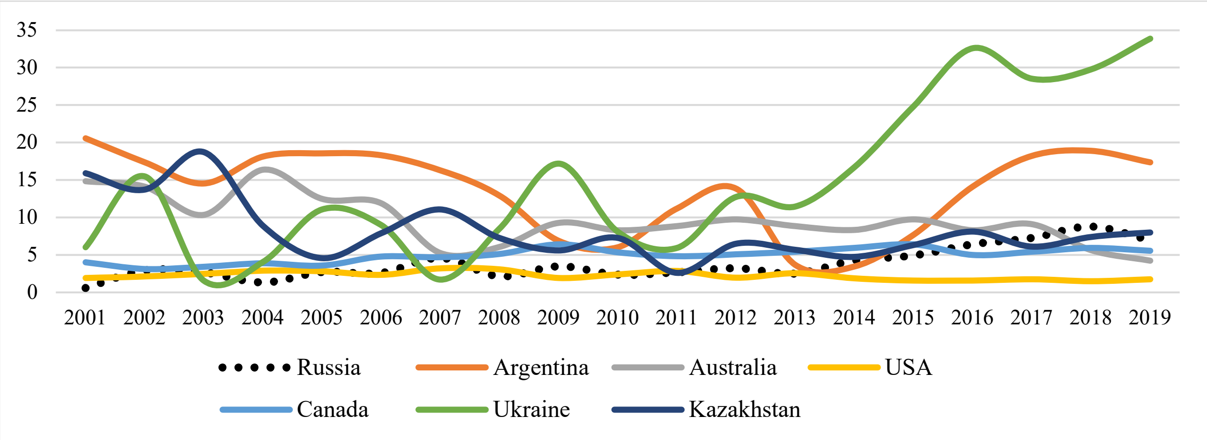
Figure 3. FAO monthly food price index, 2014-2016=100




*Source: FAO, 2021*

Competitiveness of Russia's wheat export is characterized by the relatively high level of comparative advantage. RCA index for Russian wheat exceeds the similar indices for the USA, Australia, and Canada (Figure 4). However, it is far below the Ukrainian and Argentine indicators.

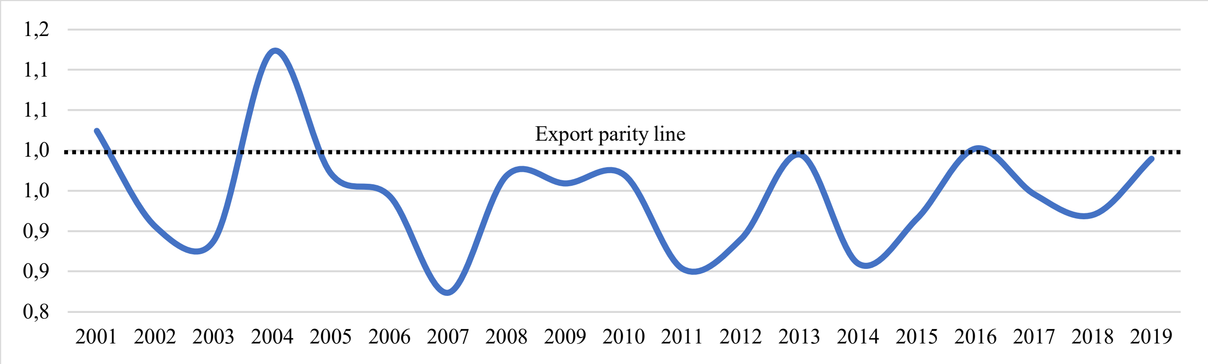
Figure 4. Dynamics of the revealed comparative advantage index for wheat in 2001 – 2019, %




*Source: calculations are based on the ITC Trade Map data, 2021*

In 2019, domestic wheat prices reached parity with export prices, i.e. NPC for Russian wheat producers was close to 1 (Figure 5). In this respect, over the past decade parity of domestic and external reference prices for wheat was also recorded in 2013 and 2016.

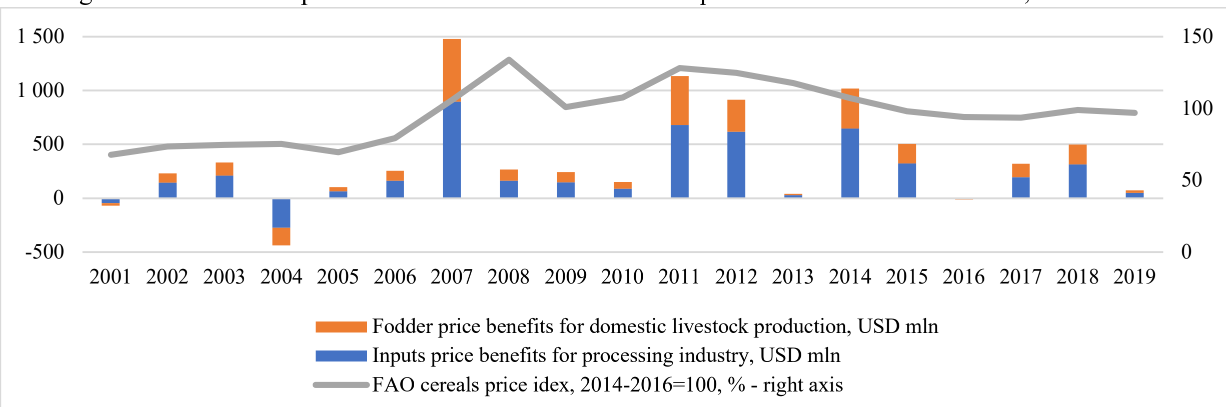
Figure 5. Nominal protection coefficients for Russian wheat producers, 2001-2019




*Source: OECD PSE database for Russia, 2021*

Regarding the other years, domestic wheat prices were lower than export prices, which helped improve the financial and economic status of domestic wheat consumers - livestock producers and grain processors (Figure 6). For example, in 2011 the financial benefits of consumers who purchased wheat domestically amounted to USD 1.1 billion including benefits on reduced fodder prices to the tune of USD 455 million. After that, the amplitude of benefit fluctuations has gradually declined. The downward trend in benefits to domestic consumers from domestic wheat purchases indicates a levelling-off of returns from domestic and foreign market operations. In general, consumers' benefits depend on a number of factors, primarily such as the level of world prices, the Ruble exchange rate, the volume of production and supply of wheat in the domestic market, as well as state policy measures to support production, to encourage or limit trade.

Figure 6. FAO cereals price index and transfers from wheat producers to wheat consumers, 2001-2019




*Source: FAO and OECD PSE database for Russia, 2021*
*Note: the benefits were converted to USD value units using the average annual exchange rates reported by the Bank of Russia*

In the context of export parity and significant export volumes, domestic wheat prices follow world market prices and largely depend on major importers' demand. It is very likely that the influence of domestic demand on the development of the Russian wheat market will weaken in the future due to a number of reasons. First, under conditions of export parity, the reduction of indirect transfers from producers to consumers may reduce the competitiveness and export opportunities of both livestock and wheat products as well as flour. It should also be noted that high values of nominal protection coefficients of meat producers in Russia cause the lack of strong incentives for beef and pork exports, while the utilization of wheat and flour products export potential would increase their current export values by as little as USD 186 mln (ITC Export Potential Map, 2021).

Secondly, given the stagnation of the Russian economy and the decline in real disposable income of the population by 11% (Rosstat, 2021), the consumer demand for meat products will be shrinking. The reduction in domestic demand, the lack of price incentives for exports, the inaccessibility of markets in many countries for Russian meat producers due to the unfavorable epizootic situation in Russia may lead to stagnation in livestock production and reduced use of grain for fodder purposes. In addition, the depreciation of the Ruble also has a negative impact on domestic demand and the prospects of those agri-food sectors that use grain as feed or raw material.

Thus, external factors will strengthen their impact on the development of the grain complex of Russia against the backdrop of weakening domestic factors. This means that with the growth of grain export the risks of domestic price volatility under the influence of the world market conditions and the Ruble exchange rate are increasing.

To mitigate such risks Russian government without any justifications decided to introduce a permanent damping mechanism in the form of a floating export duty on wheat. Possible effects of export restriction measures on the main stakeholders of grain food chains should be taken into account when assessing the feasibility of applying a floating duty under current conditions. In this regard it is important to understand to what extent the growth of prices in the domestic wheat market depends on the increase in world quotations. According to Rosstat, in December 2020 wheat producers' prices rose by 41.8% in rubles and by 20.5% in US dollars as compared with the same period of the preceding year (Table 2). Over the same period the FOB contractual prices increased by 39% in rubles or by 18.1% in US dollars. Estimations demonstrate, that under the existing conditions the growth of domestic prices for wheat by 58% was determined by the increase of the world prices. The contribution of the depreciation of the national currency to the increase in domestic prices was 46%, and other factors affecting the difference between contract export prices and producer prices led to a decrease in domestic prices by 4%. In other words, under current conditions, in addition to world prices, the ruble exchange rate has a significant impact on domestic wheat prices.

Table 2. Average producer prices and average FOB export prices of wheat in Dec. 2020 vs. Dec. 2019

| | **December 2019** | **December 2020** | **December 2020 vs December 2019, %** |
|---|---|---|---|
| Producer prices: | | | |
| RUB/ton | 10,459 | 14,830 | 141.8 |
| USD/ton | 166.2 | 200.3 | 120.5 |
| Contractual export FOB prices: | | | |
| RUB/ton | 12,788 | 17,772 | 139.0 |
| USD/ton | 203.2 | 240.0 | 118.1 |
| Difference between contractual export prices and producer prices: | | | |
| RUB/ton | 2,329 | 2,942 | 126.3 |
| USD/ton | 37.0 | 39.7 | 107.4 |

*Source: Rosstat, Bank of Russia and ITC Trade Map, 2021*

*Note: Russian ruble prices were converted into US dollar prices using the average annual exchange rates reported by the Bank of Russia. Over the period under review, the Ruble depreciated by 17.7%*

The next important issue is to substantiate the level of the price cap which, if exceeded, triggers the damping mechanism. According to foreign trade statistics, after the ban on grain and flour exports effective from August 15, 2010 to July 1, 2011 was lifted and until mid-2015 there was a long period of relatively favorable external conditions when the average price of wheat amounted to USD 256/ton. The market then sagged and the average price of wheat exports sank to USD 176/ton. The period of low prices lasted until October 2018. After that, the frequency of fluctuations in export prices around the mark of USD 200/ton intensified while their amplitude decreased. Overall, over the past three years, the average export price has stayed at USD 202/ton. This is likely to have been used as justification for linking the floating export duty mechanism to the export price of USD 200/ton.

However, data from specialized information resources on prices show that USD 200/ton is the minimum FOB price offered for Russian wheat at deep-water ports recorded in 2020. At the end of January 2021, export prices for wheat briefly exceeded USD 300/ton. It is evident that in the context of high world food prices (not only grain prices) the proposed price cap for imposing the damping mechanism in the grain market needs to be reviewed and thoroughly justified.

It should be noted that grain supplies to the world market are associated with certain costs borne by exporters. Such costs include transportation of grain to ports, as well as grain handling costs, port fees, fumigation, and export paperwork processing costs. Analysis of the current level of these costs shows that the largest share of them is transportation costs - about USD 25 per ton. The integrated service rate at grain terminals in Russia is at the level of about USD 15 per ton and gradually decreasing. Probably in this context the optimal amount of excess of average export FOB prices over the wheat producer prices (transportation costs and grain terminal service fees) would be about 40 USD per ton. This is slightly less than the annual average for 2018-2020 (USD 45 per ton), but exceeds its value in 2020 (Figure 2). Grain exporters benefit from VAT refunds for exported products, as well as the amounts of excess of their margins over transportation and logistics costs.

Taking into account the estimate of trade and logistics costs for grain exports at the export contractual price of USD 280 per ton, under floating duty implementation deliveries would take place if the producers' price does not exceed USD 185 per ton. In this case, based on the assumption that the exports amount to 30 million tons, USD 1.7 billion (approximately RUB 125 billion) would be withdrawn from exporters in the form of duties. This amount of withdrawal is almost equal to the amount of state support provided to agricultural producers. Based on the assumed total sales of 45 million tons, the producers who sell wheat on the domestic market will receive USD 1.5 billion less. The government plans to distribute funds taken from exporters to regions based on their share in the overall Russian grain production. Meanwhile the shortfall in incomes of those producers who sold wheat on the domestic market would not be subject to compensation.

Thus, the mechanism introduced by the government for the withdrawal of income from producers and exporters of wheat in the context of high world grain prices, economic stagnation, shrinking disposable incomes and increased risks of further devaluation of the national currency would lead to deterioration of the financial and economic situation, reduction of investment opportunities and technological lagging of Russian wheat producers behind their competitors in the world market. Simplification of the technological mode would lead to a drop in yields and a decrease in wheat production already in the medium term, negatively affecting not only exporters but also consumers. To minimize the adverse effects of the introduction of a floating duty and to balance the interests of wheat producers and consumers the damping mechanism should be adjusted by raising the price ceiling for calculating the duty to USD 250 (November 2020 level) and by reducing duty rate to 50%. This approach, aimed at relatively soft export restrictions in the face of high world grain prices, is not consistent with the outcomes of other authors proving the harmful nature of any export restrictions.

However, against the backdrop of free movement of goods within the Eurasian Economic Union such restrictions are even milder and can lead to Russia's regional partners using a scheme in which they will actively export their grains while covering shortages in their own markets with relatively cheap Russian wheat. Thus, stimulated grain exports of Eurasian integration partners can contribute to a certain extent to support Russia's domestic grain prices.

Taking into account the past years' experience in a favorable world price situation, it is important to focus efforts on increasing production and improving the competitiveness of wheat. This would help improve the financial and economic situation, expand investment programs in the sector and strengthen global and regional value chains. As mentioned above, the development of the grain sector would also strengthen the competitiveness of domestic livestock farming in the long term.

Besides, a comprehensive set of measures regulating the grain market also implies subsidizing grain consumers, support for the development of transport and logistics infrastructure, and targeted assistance to vulnerable groups of the population. This is especially important in the context of a devaluating national currency, decreasing consumer incomes and increasing poverty. The rise in world prices is a global challenge, and a policy aimed at social protection, increasing production and exports would be an effective response to it. This policy measures are fully consistent with the publications of other authors.

## 4. Conclusion

Since 2016, Russia has been the world's largest wheat exporter due to its competitiveness characterized by the relatively high level of comparative advantage. The volume of wheat exports is approaching the volume of its production for domestic consumption. In the context of export parity and significant export volumes, domestic wheat prices follow world market prices and largely depend on major importers' demand. However, under current conditions, in addition to world prices, the ruble exchange rate has a significant impact on domestic wheat prices. To restrain the impact of rising world prices on the domestic cereals market, a permanent damping mechanism in the form of a floating export duty on wheat has been introduced in Russia since June 2021. This mechanism in the context of high world grain prices, economic stagnation, shrinking disposable incomes and increased risks of further devaluation of the national currency would lead to deterioration of the financial and economic situation, reduction of investment opportunities and technological lagging of Russian wheat producers behind their competitors in the world market.

To mitigate the adverse effects of export restrictions the damping mechanism should be adjusted by raising the price ceiling for calculating the export duty and by reducing duty rate to 50%. This adjustment may balance the interests of stakeholders in the case of high world wheat prices.

However, to provide the long-term frameworks for domestic grain market development, Russian government efforts should be focused on increasing production and improving the competitiveness of wheat. A comprehensive set of measures regulating the wheat market also implies subsidizing wheat consumers, support for the development of transport and logistics infrastructure, and targeted assistance to vulnerable groups of the population. Such approaches would support grain consumers while respecting the interests of producers and exporters.

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# MANAGEMENT OF CAPTURING VALUE IN THE SMALL FARM BUSINESS MODELS AS A TOOL OF REDESIGNING AND INNOVATION

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**Annotation:** This paper focuses on small farms in organic farming and responds to the issue of sustainability of the sector, to which it applies modern tools to support decision-making. Based on the business model canvas creation the paper defines the place of the value capturing and definition of the strongest element of the analyzed farms. For the future farms´ development paper suggests the changes in the farms structures and considers comprehensive changes consist of increased efficiency and diversification of activities, customers and suppliers, which is intended to strengthen business and reduce risk. However, the research also aims to evaluate the research structure of farms based on business models and analysis in terms of risk and efficiency, which combines the requirements of the European Union for sustainability and the requirements of individual farmers. Scenario's evaluation based on the results given by the Farmasim management simulator shows the options of the future development for each farmer and also the need of the support for their activities.

**Key words:** Business model, business model canvas, diversification, scenarios, management simulator.

**JEL classification:** Q12, Q13, C53

## 1. Introduction

A business model is one of many business tools that show the structure of a business. It does not always have to be precisely defined, but can be included, for example, in the information structure or psychology of a company (Nielsen et al., 2014). The basis for defining a business model is its use in strategic decision-making and successful setup of business operations that participate in the operation of the company (Doz, Kosonen, 2010). The overall concept consists of displaying the required company, helping to subsequently respond to the management of the company, setting goals and predicting its future development. A suitable business model is a competitive means formed from what a company can learn about processes and whether it can understand the principle of structure (Osterwalder et al., 2012). One possible change in the business model is the use of diversification, which is often supported by subsidies that aim to slow down the negative impact of globalization on the traditional agricultural structure (Robinson, 2016). Diversification in agriculture has previously been carried out automatically, with unused resources being used for non-agricultural purposes and during periods of inactivity of farm animals assisting in other activities (Slee, 1987). With the help of the EU, this original agricultural trend is trying to apply modern agricultural policy to today's style of agriculture (Rašticová, 2002).

Ilbery (1991) divides diversification into structural, agricultural and passive. Carter (2001) accepts this typology, but on the contrary, many authors criticize it for dividing and disregarding the time evolution of the farm (Robinson, 2004). Among other things, Ilbery (1991) excludes the tendencies of today's agrotourism as diversification and does not include the use of labor outside agriculture. In later years, Holloway and Ilbery (1996) divides agriculture into unconventional agricultural production and non-agricultural production, such as agritourism. On the contrary, the mentioned authors agree on the non-use of organic farming as an extension of activity. In their opinion, it is only a method of classical agriculture using other regulations and standards.

Mollers (2006) categorizes the diversification strategy into four benefits for the company: risk minimization, crisis reduction, optimization, allocation of available resources and factors of production, and capital accumulation. If a company diversifies and in what way, it is based on these very starting points specific to the given company. If a company does not have free resources, it will not diversify in this respect, if it is facing a seasonal crisis, it will try to use this time horizon for one of the types of diversification. A farm focusing only on crop production will usually try to sell it directly due to time constraints and low profitability (Magdoff, 2007).

## 2. Materials and Methods

This paper is focused on three entities doing business in organic farming, to which modern management tools for decision support will be applied. The data was obtained from in-depth interviews with farm owners and through the design of current canvas business models to show the capture of business value. Business canvas models were used to design diversification strategies and evaluate them using the Farmasim management simulator and a measurable multi-criteria evaluation based on diversification and efficiency.

This paper uses the real state of farms in the period from September 2020 to the end of February 2021 and is based on data obtained in this section. Data were obtained from farm owners through in-depth semi-structured interviews. The effectiveness of the models is evaluated using financial analysis and efficiency in the Farmasim management simulator. Subsequently, the premises for value creation and the creation of scenario proposals addressing possible crises are created.

This research covers the topic of development scenario evaluation, complete research, including analysis of farms, creation of current and recommended business models is available in the diploma thesis of the main author of the paper. A complete presentation of the Farmasim management simulator is available on the website of this TACR (Technology Agency of the Czech Republic) project (please see farmasim.pef.czu.cz). The previous researches conducted by using the Farmasim software were elaborating the Czech small-scale beef cattle farming (Krejčí et al, 2019), the economic impact of the diversification into agrotourism (Pitrová et al, 2020) and the follow-up mathematical programming model (Hlavatý et al, 2021).

Three farms are evaluated - Biofarma Sasov, an organic farming company, operating animal and plant production, without conventional farming. From animal production the farm breeds meat breeds of cattle, pigs and horses, from plant production they are potatoes, rape, hemp, energy crops (technical hemp and safflower), lupine, garlic, buckwheat, barley, wheat, peas, wormwood and vetch. Most of the production is processed in the company and transformed into the final product.

Furthermore, Biofarma Podmokly, which is focused on breeding beef cattle in an ecological way. Another large part of the activities is the provision of services related to the ownership of machines, where services such as transport and processing, earthworks and repair of machines are provided. Mr. Kubala is also personally interested in consulting in the field of agriculture.

Biofarma Svinná, which deals with the cultivation of non-perennial crops, forestry and logging, animal production, construction and mixed farming. The construction industry is involved in the activity due to the reconstruction of the property, which is at the beginning of its renovation.

Please see the activities structure in the Table 1.

Table 1. Activities structure

| Sasov | Activities | % Activity intensity | % Sales | % costs |
|---|---|---|---|---|
| | Crop production | 12,5 | 5% | 30% |
| | Lifestock production | 20% | 13% | 25% |
| | Products | 40% | 30% | 22% |
| | Services | 20% | 15% | 10% |
| | Horses | 2,5% | 2% | 5% |
| | Energy | 5% | 35% | 8% |
| **Podmokly** | Crop production | 30% | 5% | 25% |
| | Lifestock production | 35% | 35% | 45% |
| | Services | 35% | 60% | 30% |
| **Svinná** | Crop production | 50% | 55% | 30% |
| | Lifestock production | 40% | 45% | 65% |
| | Reconstruction of the comples | 10% | 0% | 5% |

*Source: Own creation*

## 3. Results and Discussion

Evaluation of development scenarios using the Farmasim model

This paper evaluates the vision for animal production with the help of the Farmasim Management Simulator, where two simulations are created. The first scenario according to the current strategy, which shows a more aggressive scenario with the goal of growth. The information used in the simulation comes from farmers and shows livestock numbers, financial information, prices and costs, which are fixed for use in the simulator for a period of 10 years. Furthermore, the simulation does not address the demand for created products, competition, changes in EU legislation, unsold pieces, non-use of all resources and a change in crop production. On the contrary, the work takes into account the necessary change of herd, filling of capacities, change of business model and the influence of diversification on income and costs. The whole process is based on previous information, plans, opportunities and possibilities of farms. The whole development should not show the exact development, but only outline the possibility of how the development would change if the above changes in the model were successful and the expansion of activities would develop positively. The simulation will be performed for 10 years.

Basic scenario

As "scenario 1", the work considered how the situation with the basic herd, which is currently available, would develop if the breeding and activities of the farm did not expand further. This scenario serves as a model and characterizing the situation without changes, it would only be about maintaining the current state of cattle without the expansion of the entrepreneur. The output is taken as a zero value, the result as a deviation from the current pattern. The entrepreneur is able to secure the scenario from his own resources and not expand the economy.

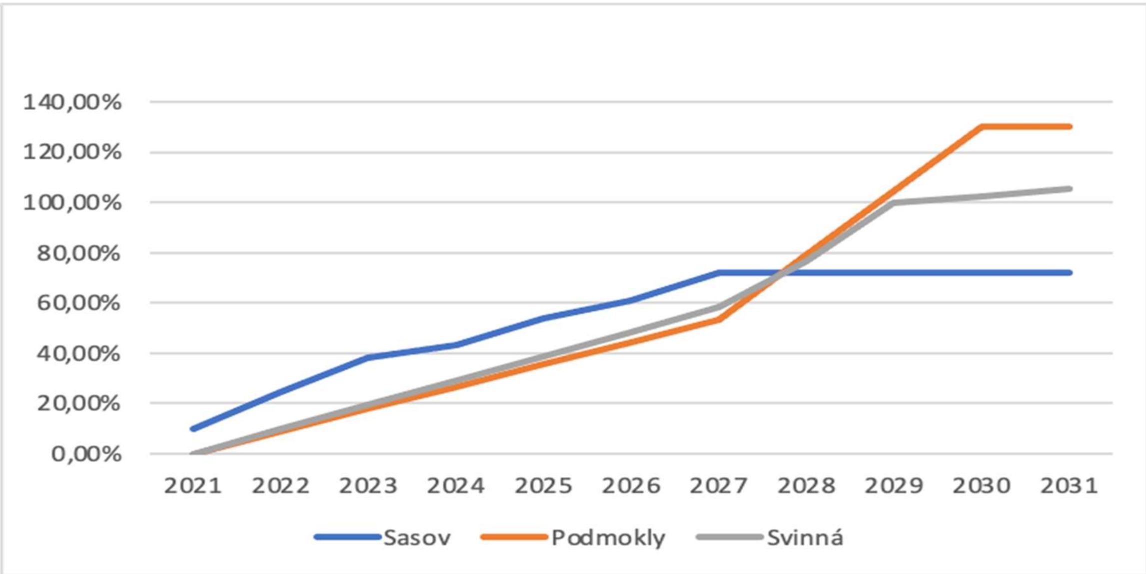
Expansive scenario

To unify and illustrate the potential of existing farms of individual farms, a scenario was used, which annually expands the herd and capacities for its subsequent breeding, according to its maximum financial, spatial and supply possibilities. The departure from reality will be mainly in ignoring the increase in the cost of cattle and staff, which should be deducted from the results and should take into account the declining costs of scale.

Results of FARMASIM outputs

Graph 1 shows the percentage deviation from scenario number one, which characterizes the deviation from the current strategy that entrepreneurs apply. This method was chosen because of the comparability of individual outputs and the ability to show the potential growth of the farm.

Figure 1. Comparison of farm growth opportunities




*Source: own creation*

Sasov

In this scenario, the growth potential was less pronounced, as diversification did not have a significant effect on growth, but rather on risk mitigation. The scenario examines the development of the number of cattle and pigs, which was limited by higher costs and requirements for the construction of stables. There have also been higher costs for animals and land that is not its own. Lease is paid for 80% of the land. Due to the size of the farm, the increase is a total of 72.3%, but in terms of animals, compared to the farms Podmokly and Sasov, their production has almost doubled. The result also indicates that the farm has already expanded and further growth is not possible. The capacities would be filled in the month of June 2027, with the proviso that under the given conditions it would no longer be possible to further increase the number of farms in compliance with all quality requirements, including installments.

Podmokly

In this scenario, the cost of acquiring the slaughterhouse was estimated at 2.3 million crowns. The installments, which were divided over a period of 6 years, were also taken into account. With the expansion of the herd, staff costs also increased. Initially, the farm would use the current staff and in 2026 it would hire more employees, the same in the last year of the simulation. The outcome of the scenario at maximum production utilization could increase by 130% in 10 years compared to the current strategy. The capacity would be filled in 2030 in November.

Svinná

The procedure for the Svinná scenario was similar and the income was reduced by installments for the acquisition of slaughterhouses. The overall changes were reflected in the involvement of business in services. Slow growth was expected from the beginning. In 2027, Svinná, like the Farm in Podmokle, would repay the loan and greater profitability would begin to show, until 2029, until the month of June, when the capacity would be filled. However, it continues to grow more slowly due to the inclusion of accommodation services according to the vision of the owner. Overall, over the ten years of the simulation, profitability increased by 105.6%

Overall assessment of growth potential

Scenarios need to be understood as the maximum possibilities of using all resources of farmers, under optimal conditions of sale, cooperation of resources and required market conditions. The scenarios show what options each farmer has and what projects shown in the scenarios need to be supported by other activities.

## 4. Conclusion

The business model is used, as a tool, to truly represent the business and does not merely act as a model comparison to reality. Teece (2010), on the other hand, sees the essence of the business model in understanding the business goal and also draws attention to the importance of the human element in the added value of the product. The human element mentions at higher levels of management along with technical progress. Braye (2010) also tries to use a business model to discover where uniqueness and thus the already mentioned value creation arises in the whole process.

Farm business models are used as a basis for creating scenarios and feasible plans for future development. Scenarios based on the epicenter of the model were constructed realistically and it is possible to expect that it is from these blocks that the future development of individual farms will be based. According to the surveyed subjects, more qualified people are needed for the development of farms than companies have used so far. Even the application of individual steps for development requires a more qualified workforce and generational continuity, which will bring new ideas and new tools to the field of agriculture.

The benefits of using scenarios for business management should be preparedness, complete avoidance of crisis situations, or through early assessment of the use of the opportunity to gain a competitive advantage (Kaplan, 2006).

In the end, the following summary features characterizing the ecological focus of farms became apparent and appear in all the subjects examined, which define the specifics and describe the form of the created business models. Through the tools used, the work captures the unique value of the company, the role of the entrepreneur in society, the vision of the business, threats and opportunities occurring in the industry through the use of diversification. This is confirmed by Meffert (1996), according to him, diversification is a way to reduce risks, but on the other hand it stimulates growth, as it contributes to easier knowledge of its suppliers and customers.

The following summary features characterizing the ecological focus of farms are manifested and appear in all surveyed entities, which define the specifics and describe the form of created business models. The framework concept of the sector forms the framework of all three farms and their activities, derives from them value chains representing by the scenarios of the Farmasim model. Through the tools used, the paper captures the individual value of the company, the role of the entrepreneur in society, the vision of business, threats and opportunities occurring in the industry.

- The most characteristic feature is the role of farm owners as leaders in the whole cycle of activities, and the reluctance to delegate any activity, which indicates the focus and functioning of the farm and is associated with risks.
- The second feature is the dependence on support from the European Union and the government of the Czech Republic, for which they are grateful and feel that if they distanced themselves from these sources, it would not be possible to ensure operation at the same sales prices. On the other hand, they realize that they need change and acknowledge the declining position of the classical way of farming itself.
- Each of the farm owners subjected to the research feels a social responsibility towards the landscape and work is also a hobby for them, where they spend over 12 hours a day. All farmers tend to slow down the growth trend and focus primarily on quality. The development trend is also associated with a shortage of skilled workers.
- The owners are behind the building to the current state and it is not just about acquiring property and its maintenance.
- Farmers do not invest in sales promotion through the media, they believe that products are represented as they are.
- The last feature is that the activities of farms are purposefully interconnected and the services and products they create, follow each other and use each other.
- Cultivated land has been converted from conventional to ecologically certified land. The reason is subsidies for organic land, which will ensure a faster return on investments.

The above-mentioned features appear in each case study and are reflected in the strategies as very important components for decisions about the development of the company. Subsequent specifics of individual farms are expressed as a basis for diversification and further development of activities.

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# SUBSTITUTION OF FOODSTUFF IMPORT FLOWS WITHIN EAEU UNDER RUSSIAN IMPORT BAN

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**Annotation**: Russian import ban of 2014 can be seen as an opportunity for neighbouring countries, and especially for countries of Eurasian Economic Union (EAEU) to benefit from falling EU imports on Russian market and gain market share. Using gravity models of trade, current paper attempts to test the hypothesis of whether participation in EAEU has helped to increase export trade flows from the EAEU countries to Russia. Model estimation for the dataset covering EU and EAEU countries and product groups HS01-HS24 shows, that participation in EAEU has given benefit only in few product categories, such as live trees and cocoa and cocoa preparations, however there is no positive effect in other product groups. It shows an evidence of the fact, that falling import flows after import ban introduction were not substituted by EAEU countries. Effect of import ban is present in all product groups in scope of the ban, and in some product groups out of scope, while distance does not play big role for the trade flows. These results might be seen as a sign for revisiting the EAEU trade agreements in order for member states to extract more benefits from the agreements.

**Key words**: Russian Federation, import ban, EAEU, gravity model of trade.

**JEL classification**: F51, F14, Q17.

## 1. Introduction

International trade in Eurasian region is dynamically evolving in recent years, staying at the same time under the significant influence from political developments. Eurasian Economic Union (EAEU) is one of the latest trade blocs which was formed between the countries of former Soviet Union. The positive impact of trade unions on international trade activity has been confirmed by many authors (Seyoum and Ramirez, 2012; Hart et.al., 2015). The most significant effect is achieved for countries with small economies and large share of domestic trade. For example, Belarus and Kazakhstan as part of the EAEU have great growth potential in agriculture and the food industry (Vakulchuk & Knobel, 2018). Sanctions can be a foreign policy tool (Evenett, 2002) or can be used as a method of protecting the domestic market and supporting its own manufacturers (Smutka et al., 2016). Sanctions affect trade flows in different ways. The imposition of sanctions reduces trade flows, not only for products which are subject to sanctions, but also for those that are freely available (Galbert, 2015). On the contrary, the threat of sanctions stimulates increases of trade flows in order to accumulate reserves (Afesorgbor, 2018). Dong Yan and Li Chunding (2018) in their article argue that due to the sanctions imposed by the EU and the US on Russia in 2014 all participating countries suffer, but Russia suffers more than the US and the EU. The imposed countersanctions of Russia have an impact more on the EU than on the United States. At the same time, there are favourable effects in specific product groups for domestic manufacturers in Russia (Krivko et al., 2019), and there might be little incentive for Russian Government to lift the ban anytime soon, as it effectively substitutes agricultural support for domestic producers (Krivko & Smutka, 2020).

Using a gravity model to study international trade has a long history. Firstly, it was suggested by Jan Tinbergen (1962) and significantly improved by Anderson and Wincoop (2003).

The gravity model can cover the entire trade as a whole but can also examine only certain types of products. Koo (1994) in his article examines the influence of factors on the meat trade. The author uses gravity model to assess the impact of tariff and non-tariff barriers using cross-sectional and time-series data analysis. Dascal (2004), using the methodology developed by Koo (1994), investigated the factors influencing the export of wine - GDP per capita, distance EU membership, exchange rate and wine production index. A common methodological problem of gravity models are unobservable effects. There are individual factors that have a significant impact on the resulting variable, but these factors might be omitted from the model. Thus, these unobservable factors make significant influence on the results of the model. A possible solution to this problem is using OLS panel model with fixed effects or OLS panel model with random effects with generalized least squares method (GLS) (Lee, 2007). Fixed effects and GLS eliminates the problem of autocorrelation and heteroscedasticity, however this type of regression model does not account for the individual effects inherent in each country.

## 2. Materials and Methods

Dataset contains annual data of export flows for period 2000-2019 from EAEU countries (Armenia, Belarus, Kazakhstan, Kyrgyz Republic) and from EU28 countries to Russia. Dataset includes import flows for product groups with HS01-HS24 groups and covers products in scope and out of scope of import ban. Data is sourced from UN COMTRADE database. Summary statistics of the dataset is shown in Table 1.

Table 1. Summary statistics

| Statistic | N | Mean | St. Dev. | Min | Pctl(25) | Pctl(75) | Max |
|---|---|---|---|---|---|---|---|
| **Export, '000 USD** | 15,360 | 23,696.100 | 178,269.000 | 0 | 2.2 | 8,595.9 | 7,372,021 |
| **Import, '000 USD** | 15,360 | 8,223.484 | 32,409.440 | 0.000 | 0.000 | 1,555.327 | 838,452.800 |
| **Distance** | 15,360 | 1,866.188 | 853.245 | 300 | 1,543.8 | 2,328 | 3,907 |
| **GDP of partner, mln USD** | 15,360 | 639,972.900 | 967,302.700 | 10,703.420 | 70,914.910 | 507,131.500 | 4,473,822.000 |
| **GDP Russia, mln USD** | 15,360 | 3,289,049.000 | 584,197.100 | 2,142,460.000 | 2,841,957.000 | 3,760,350.000 | 3,968,180.000 |

*Source: UN COMTRADE, 2021.*

Table 2 provides overview of products in scope of Russian import ban on the two digits HS group level.

Table 2. HS product groups impacted by Russian import ban.

| HS group | Product |
|---|---|
| **HS01** | Live animals |
| **HS02** | Meat and edible meat offal |
| **HS03** | Fish, crustaceans, mollusks, aquatic invertebrates |
| **HS04** | Dairy products, eggs, honey, edible animal product |
| **HS07** | Edible vegetables and certain roots and tubers |
| **HS08** | Edible fruit, nuts, peel of citrus fruit, melons |
| **HS16** | Meat, fish and seafood food preparations |
| **HS19** | Cereal, flour, starch, milk preparations and products |
| **HS21** | Miscellaneous edible preparations |

Analysis is done by employing gravity model in classic specification advanced by control variables for import ban, participation in EAEU, common border, common language, common history, and presence of seaport. Specification of the model is as follows:

$$ln y_{it}^{j} = \beta_0 + \beta_1 \ ln x_1 + \beta_2 \ ln x_2^{j} + \beta_3 \ ln x_3^{j} + \beta_4 \ BAN_i^{j} + \beta_5 \ EAEU^{j} + \beta_6 \ BORD^{j} + \beta_7 \ LANG^{j} + \beta_8 \ HIST^{j} + \beta_9 \ PORT^{j} + \gamma_j + \varepsilon_t \quad \textbf{(1)}$$

Where $y_{it}^{j}$ - export of product $i$ from country $j$ to Russia; $x_1$ – GDP of Russia in year $t$; $x_2^{j}$ – GDP of country $j$ in year $t$; $x_3^{j}$ – distance between capital of country $j$ and capital of Russia; $BAN_i^{j}$ – dummy variable for presence of product $i$ from country $j$ in the Russian import ban list; $EAEU^{j}$ – dummy variable denoting whether country $j$ is EAEU member; $BORD^{j}$ – dummy variable for common border with Russia; $LANG^{j}$ – dummy variable for common language; $HIST^{j}$ – dummy variable for common history; $PORT^{j}$ – dummy variable for presence of sea port; $\beta_0$ , $\beta_1$ - regression coefficients; $\gamma_j$ - random effects; $\varepsilon_t$ - error term.

Hausman test is used to determine whether fixed effects or random effects model is more suitable. Gravity model is estimated as fixed effects and random effects model for each of product groups. Estimation is done by employing OLS and GLS methods as appropriate. Based on the results of Hausman test, random effects model has been chosen as most appropriate for most of the product groups.

Based on the specification of the empirical model, current analysis attempts to accept or reject following hypothesis: participation in EAEU increases export trade flows from participating country to Russia for the products in scope of Russian import ban. Hypothesis is tested on the level of product groups. Hypothesis should be accepted if estimated regression coefficients of dummy variable $EAEU^{j}$ is statistically significant.

## 3. Results and Discussion

Results of models' estimation show mixed picture for different product groups. Table 3 reports results of model estimation for products in scope of Russian import ban. For all product groups, except HS02 (Meat and edible meat offal), there is a clear evidence of positive influence of Russian GDP and GDP of partner on trade flows, as model coefficients are statistically significant. At the same time, coefficients are positive, pointing out to positive trade elasticity of GDP. Highest trade elasticities are reported for HS01, HS07 and HS08, which is not unexpected, as latter two groups represent products which are traditionally imported to Russia.

Estimates for distance show little connection to export flows from the countries in dataset to Russia. In general terms, this might be an evidence of smaller trade costs associated with such trade. Decrease in significance of distance in international trade has been under discussion in trade literature (Coe et al., 2007; Disdier and Head, 2008), and is also connected to so-called "distance puzzle", or in other words persisting significance of distance variables in empirical studies, while theoretical framework would suggest that it should decline when trade is globalizing. One of the solutions of the distance puzzle has been proposed by Yotov (2012). Our findings support the theory and shows the absence of distance puzzle.

In connection to the distance variable, it is important to compare it with variable for common border. Common border is important for 6 product groups in scope of Russian import ban (HS01, HS02, HS03, HS04, HS07, HS08). Not surprisingly, highest elasticities are estimated for vegetables (HS07) and fruits (HS08), which are perishable products, and therefore customs clearance and rapid logistics chains are critical for such products. It is possible to conclude, that presence of common border is more important than distance. This might be also an evidence of regionalization of trade, and it will be very important to compare this with estimates for EAEU participation variable.

Common language, common history and presence of seaport do not show any significant influence of export of banned products to Russia.

Table 3. Results of gravity model estimation for product groups in scope of Russian import ban. Numbered columns represent models for HS product groups.

| Independent variables | *Dependent variable* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ln Export | | | | | | | | |
| | 01 | 02 | 03 | 04 | 07 | 08 | 16 | 19 | 21 |
| ln GDP Russia | 3.804*** | 0.117 | 0.804 | 2.971*** | 3.636*** | 3.876*** | 1.437*** | 1.767*** | 2.285*** |
| | (0.444) | (0.638) | (0.515) | (0.504) | (0.433) | (0.537) | (0.504) | (0.338) | (0.323) |
| ln GDP of partner | 0.927*** | 1.312*** | 0.483* | 1.102*** | 1.034*** | 1.157*** | 0.931*** | 1.672*** | 1.367*** |
| | (0.318) | (0.344) | (0.253) | (0.282) | (0.308) | (0.352) | (0.318) | (0.210) | (0.231) |
| ln Distance | -1.978 | -1.282 | -1.968** | -1.740* | 0.989 | 1.896 | -1.587 | -1.059 | -2.143** |
| | (1.203) | (1.230) | (0.896) | (1.013) | (1.166) | (1.304) | (1.169) | (0.769) | (0.878) |
| Border | 3.835** | 4.465** | 3.379** | 2.795* | 6.288*** | 5.385*** | 1.974 | 1.387 | -0.849 |
| | (1.905) | (1.949) | (1.421) | (1.604) | (1.846) | (2.065) | (1.852) | (1.218) | (1.390) |
| Language | -0.812 | -2.080 | 1.347 | 1.260 | -0.142 | 0.651 | 1.178 | 1.926* | 1.944 |
| | (1.762) | (1.808) | (1.318) | (1.488) | (1.708) | (1.913) | (1.716) | (1.129) | (1.285) |
| History | -1.876 | -1.121 | -5.129*** | -1.925 | -0.584 | -0.107 | -0.560 | -0.293 | -0.877 |
| | (1.750) | (1.787) | (1.301) | (1.471) | (1.696) | (1.896) | (1.700) | (1.118) | (1.277) |
| Sea Port | -2.947** | -1.684 | 0.586 | -2.880*** | -2.262* | -0.730 | -1.596 | -0.476 | -0.977 |
| | (1.242) | (1.271) | (0.926) | (1.046) | (1.203) | (1.346) | (1.207) | (0.794) | (0.906) |
| Ban | **-1.055***** | **-4.402***** | **-3.660***** | **-2.064***** | **-2.973***** | **-4.116***** | **-1.879***** | -0.056 | **-0.579***** |
| | **(0.179)** | **(0.267)** | **(0.218)** | **(0.211)** | **(0.174)** | **(0.219)** | **(0.207)** | (0.139) | **(0.130)** |
| EAEU | -0.526 | -0.253 | **1.002**** | -0.246 | **-0.704*** | **-1.119**** | -0.372 | **-0.872***** | -0.222 |
| | (0.411) | (0.605) | **(0.491)** | (0.477) | **(0.401)** | **(0.501)** | (0.472) | **(0.317)** | (0.298) |
| Constant | -46.164*** | 0.204 | 3.402 | -35.461*** | -67.420*** | -79.892*** | -14.351 | -32.418*** | -26.500*** |
| | (11.323) | (13.348) | (10.282) | (10.769) | (10.994) | (12.758) | (11.649) | (7.727) | (8.246) |
| Observations | 640 | 640 | 640 | 640 | 640 | 640 | 640 | 640 | 640 |
| $R^2$ | 0.192 | 0.378 | 0.399 | 0.183 | 0.338 | 0.370 | 0.140 | 0.234 | 0.214 |
| Adjusted $R^2$ | 0.180 | 0.369 | 0.390 | 0.172 | 0.328 | 0.361 | 0.128 | 0.223 | 0.203 |
| F Statistic | 149.396*** | 382.130*** | 417.784*** | 141.487*** | 321.023*** | 370.579*** | 102.712*** | 192.507*** | 171.814*** |

*Source: EU COMTRADE, 2021, authors' calculations.*

*Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.*

Most interestingly, coefficients for the EAEU participation are negative, and only coefficients for fish and crustaceans (HS03), vegetables (HS07), fruits (HS08) and cereals (HS19) are statistically significant. It is possible to make two main conclusions for these findings. Firstly, there is no clear evidence whether EAEU countries have substituted falling imports of products under the ban. It rather seems that these imports were compensated by Russia from outside of the EAEU bloc of countries. Based on the obtained estimates, participation in EAEU is not associated with increase in exports to Russia. Secondly, as coefficients are negative, participation in the EAEU do not automatically increase export flows in selected product groups (products in scope of import ban). Both conclusions allow to reject the hypothesis stated above and conclude, that there is no evidence that participation in EAEU increases export trade flows from participating country to Russia for the products in scope of Russian import ban. In general, this is an unexpected result, as several authors have pointed out that usually trade unions have positive effect on international trade (Seyoum and Ramirez, 2012; Hart et.al., 2015), especially for small countries.

Estimation of the same model for products out of scope of the ban might give an interesting comparison of EAEU participation effect. Table 4 reports results of gravity model estimation for selected products which are out of scope of the ban. As expected, estimates for ban variable are not significant for most of these products, with exception of trees and flowers (HS06), gums, resins, and vegetable saps (HS13) and beverages (HS22).

Table 4. Results of gravity model estimation for selected product groups out of scope of Russian import ban. Numbered columns represent models for HS product groups.

| Independent variables | *Dependent variable* ln Export | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 06 | 10 | 12 | 13 | 14 | 17 | 18 | 22 | 24 |
| ln GDP Russia | 1.500$^{***}$ | 0.326 | 3.173$^{***}$ | -0.824$^{**}$ | 0.686$^{**}$ | -0.053 | 1.049$^{***}$ | 2.437$^{***}$ | -0.700 |
| | (0.460) | (0.524) | (0.425) | (0.356) | (0.276) | (0.359) | (0.391) | (0.331) | (0.490) |
| ln GDP of partner | 0.823$^{**}$ | 1.115$^{***}$ | 1.207$^{***}$ | 1.502$^{***}$ | 0.341$^{**}$ | 1.422$^{***}$ | 1.507$^{***}$ | 1.089$^{***}$ | 1.298$^{***}$ |
| | (0.338) | (0.287) | (0.316) | (0.254) | (0.139) | (0.220) | (0.250) | (0.246) | (0.297) |
| ln Distance | -1.034 | 0.892 | 0.099 | -1.726$^{*}$ | 0.297 | -0.100 | -2.888$^{***}$ | -1.576$^{*}$ | 0.022 |
| | (1.292) | (1.029) | (1.211) | (0.962) | (0.492) | (0.804) | (0.918) | (0.944) | (1.083) |
| Border | 4.524$^{**}$ | 5.238$^{***}$ | 2.886 | 1.417 | 2.477$^{***}$ | 3.361$^{***}$ | 2.095 | 0.387 | 0.111 |
| | (2.045) | (1.630) | (1.917) | (1.523) | (0.779) | (1.274) | (1.454) | (1.494) | (1.715) |
| Language | 0.483 | -5.224$^{***}$ | -0.481 | 2.682$^{*}$ | 0.646 | 0.698 | 0.930 | 2.160 | 2.014 |
| | (1.890) | (1.512) | (1.772) | (1.409) | (0.723) | (1.181) | (1.347) | (1.381) | (1.590) |
| History | -2.577 | 4.792$^{***}$ | 0.665 | -4.243$^{***}$ | -0.751 | 0.529 | -1.815 | -1.529 | -1.024 |
| | (1.879) | (1.494) | (1.762) | (1.399) | (0.714) | (1.169) | (1.334) | (1.373) | (1.574) |
| Sea Port | -1.837 | -1.006 | -1.229 | -1.700$^{*}$ | -0.344 | -1.284 | -1.215 | -0.898 | 0.233 |
| | (1.333) | (1.063) | (1.250) | (0.993) | (0.508) | (0.831) | (0.948) | (0.974) | (1.119) |
| Ban | **-0.595**$^{***}$ | -0.154 | 0.062 | **0.310**$^{**}$ | -0.063 | 0.001 | 0.092 | **-0.681**$^{***}$ | -0.213 |
| | **(0.184)** | (0.219) | (0.169) | **(0.143)** | (0.116) | (0.148) | (0.161) | **(0.132)** | (0.203) |
| EAEU | **2.014**$^{***}$ | **-0.966**$^{*}$ | **-1.160**$^{***}$ | **-1.104**$^{***}$ | **-1.513**$^{***}$ | **-0.603**$^{*}$ | **1.747**$^{***}$ | -0.280 | **-2.597**$^{***}$ |
| | **(0.424)** | **(0.496)** | **(0.391)** | **(0.329)** | **(0.262)** | **(0.337)** | **(0.366)** | (0.305) | **(0.461)** |
| Constant | -19.057 | -21.478$^{*}$ | -56.921$^{***}$ | 12.913 | -15.648$^{***}$ | -9.938 | -5.579 | -29.218$^{***}$ | -0.217 |
| | (12.012) | (11.064) | (11.210) | (9.057) | (5.562) | (8.134) | (9.105) | (8.735) | (11.018) |
| Observations | 640 | 640 | 640 | 640 | 640 | 640 | 640 | 640 | 640 |
| $R^2$ | 0.132 | 0.073 | 0.222 | 0.096 | 0.088 | 0.102 | 0.227 | 0.186 | 0.072 |
| Adjusted $R^2$ | 0.120 | 0.060 | 0.211 | 0.083 | 0.075 | 0.089 | 0.216 | 0.175 | 0.058 |
| F Statistic | 96.046$^{***}$ | 49.832$^{***}$ | 179.744$^{***}$ | 67.074$^{***}$ | 60.965$^{***}$ | 71.548$^{***}$ | 185.277$^{***}$ | 144.085$^{***}$ | 48.696$^{***}$ |

*Source: EU COMTRADE, 2021, authors' calculations.*

*Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.*

EAEU participation variable is statistically significant only for trees (HS06), oil seed (HS12), gums, resins, and vegetable saps (HS13), vegetable products (HS14), cocoa and cocoa preparations (HS18) and tobacco products (HS24). Only in case of trees, flowers, and cocoa the coefficients are positive. In line with results for products in scope of import ban, there is mixed evidence that EAEU participation has helped respective countries to increase export of food products to Russia. Positive effect of EAEU participation is present for few product groups (trees and cocoa and cocoa preparations), while for the majority of product groups positive effect is not present.

## 4. Conclusion

In general, EAEU countries do not seem to be the winners of Russian import ban. Russia is the biggest economy in the EAEU bloc by all measures, and it would be natural to expect increase in exports from EAEU countries towards Russia as a result of import ban. Counterintuitively, participation in trade bloc has not automatically allowed member states to enjoy higher trade flows with Russia and use the opportunities of import ban. Results of modelling shows no effect of EAEU participation in product groups in scope of import ban, however positive effect is present in two product groups, which are out of ban scope. In general terms, EAEU countries did not substituted falling import flows after the import ban introduction, and these trade flows were substituted from outside of the trade bloc.

It should be noted that gravity models used in current research might be subject to omitted variables' bias, and therefore obtained results might give an evidence of the fact, that other factors have influence on trade flows within EAEU bloc. However, based on current results, it is possible to conclude, that EAEU trade agreements might be revisited and re-negotiated in future, in order to allow member states to receive more benefits from the trade with Russia.

Here, it seems also important to consider changes in trade competitiveness of EAEU member states in selected products after introduction of Russian import ban. Current results suggest that these countries did not increase competitiveness towards Russia, however specific analysis still needs to be done.

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# INFLUENCE OF COVID-19 ON FUTURE AGRI-BUSINESS MANAGERS – WORK ABROAD ANALYSIS

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**Annotation**: The COVID-19 pandemic has caught the world unprepared in many ways. We must deal with it in all areas of life. Besides the obstacles associated with health, the problem of education is the most discussed in society in terms of managing education process and consequences of the pandemic. The article analyzes the impact of the pandemic on practical aspects of the readiness of future agri-business managers. For them, as for all managers in globalized world, the knowledge of international management and intercultural skills is crucial. We aim at the impact of the pandemic on work experience abroad among 204 future managers in the agri-food industry. The research was conducted in the form of a questionnaire survey and evaluated by statistical analysis. Obtained results suggest differences between men and women, and between students who already have a previous work/brigade or Work and Travel experiences abroad and those who do not. In addition, the results of descriptive statistics provide an insight into the experience of students with these types of acquisition of practical work experience abroad with upsetting results about the dwindling number of managers prepared for the future. Moreover, their attitudes to the issue are also changing by the pandemic which results in alarmingly low involvement of students in these activities. Our results concluded that the situation may result in a generation of post-covid graduates (future managers) lacking practical experience of working abroad, which will disadvantage them in labor market.

**Key words**: COVID-19, students, work abroad, managerial skills, agri-business, Slovakia, experiences, Work and Travel

**JEL classification**: I15, I23, Q17

## 1. Introduction

The influence of pandemic on travel plans of tertiary students is alarming regarding possible strong and negative effects on their work plans after graduation. We can generalize that students of the Faculty of Economics and Management - SUA (Slovak University of Agriculture in Nitra) are future managers of agri-food industry and therefore, they are the best respondents for research aimed at practical preparing of future managers in agri-food sector (Massari, 2021). Regarding positive industry outcomes, tertiary institutions have a responsibility to ensure their course offerings remain abreast of current changes (Fullingim, 2018), providing students with the most up-to-date information and equiping their graduates with the necessary skills to embark on a career in their chosen industry (Miani et al., 2021). In this study, we would like to express a sincere concern about the level of skills of a generation of incoming managers (Pitt, 2021). The fear of the health consequences of COVID-19 (Fitzpatrick, et al., 2020; Schweda, et al., 2021) is understandable; furthermore, it can affect professional training of present students, as the current situation makes it impossible for them to acquire valuable intercultural knowledge, language competences, and other skills (Ratten and Jones, 2021) that travel and work experience abroad brings.

The main objective of this paper was to analyze the impact of the COVID-19 pandemic on international skills of future managers in agri-business and influence on their working experiences abroad. To achieve this, we performed an online questionnaire survey (Regmi, 2016), on the sample of 204 master's degree SUA students of the Faculty of Economics and Management (FEM) and analyzed their plans to acquire work experiences abroad (Mohajeri Norris and Gillespie, 2009). Our findings suggest that attitudes of the analyzed students vary between men and women only in case of aspects of life which COVID-19 has influenced in the most positive way. Differences were also found between students with and without experiences with work broad. These differences were identified in opportunities abroad they deleted because of COVID-19, their experiences with work/brigade, and/or their willingness to give up future opportunities if the situation with COVID-19 persist.

Next part of the paper includes summary of relevant literature in the topic, and description of the survey and the analyzed sample. Further, we set statistical hypothesis and describe limitations of our study. The results part shows outcomes of the descriptive statistics and statistical analysis. These are highlighted in the conclusion along with the recommendations for further research and description of potential use of the reached findings.

**Theoretical Background**

Nowadays, work organizations often depend on communication and interaction between geographically dispersed persons. As a result, business travel has increased over the past several decades (Gustafson, 2012) in regard of globalization and geographically expanded markets. Increasing importance of travelling in business is also pushed by a growing number of multi-unit companies, networking, outsourcing, and improved infrastructures for mobility (Beaverstock, et al., 2009). But as more tasks and responsibilities are placed on managers, the question of how today's professionals have been prepared for such demanding and complex roles (Sortedahl, et al., 2017) arises. Key tools for such preparation are effective education, soft skills training, hard skills improvement, and previous work and travel experiences. Regarding this, travel mode choices of tertiary students' are studied from different angles (Mohammadzadeh, 2020). Travel helps a single person to gain new experience, increase autonomy, develop real-time skills, improve language skills, increase resilience to stress, train solutions to new unpredictable problems, develop cultural competences, increase cultural sensitivity, and build tolerance and multicultural personality (Zhai and Scheer, 2002; Stebleton, et al., 2013; Davis and Knight, 2017; Merklen and Wolfe, 2020). Unfortunately, the current situation influenced by COVID -19 works against these opportunities.

The SARS-CoV-2 virus is transmitted via close contacts among people. Therefore, social distancing and restriction of travel behavior (Zhang, et al., 2021) with no access to foreign countries is of key importance. Previous cases of Ebola outbreak in West Africa, the recurring waves of avian and swine flu in South East Asia, and the Zikavirus in the Caribbean already heightened the public's awareness about the mobility of highly contagious foreign viruses (Zenker, 2021). During pandemics, countries have adopted different degrees of restrictions which affecting peoples' lifestyles, social interactions, economic conditions and particularly the travel and outdoor activities (de Haas et al., 2020, Mogaji, 2020). Furthermore, various control and preventive mechanisms have been recommended or imposed by the governments (school closures, remote or online teaching, working from home, closure of shops and restaurants, suspending public transport, closing international borders and airports, etc.) (Abdullah, et al., 2020). Despite these all, several factors including individual characteristics and lifestyle still influence the choice of travel. Factors which influence tertiary students' travel mode choices can be sorted into situational (availability of infrastructure, transit accessibility, trip characteristics, and cost) and psychological (individuals' intentions, beliefs, norms, and attributes) (Mohammadzadeh, 2020). In addition, Zhou (2012) observed that occupation, income, car ownership, and possession of a driver's license influence these choices, too. In the situation of restrictions, students represent one of the most affected groups. Because of lockdowns they were directed to online distance learning and those who work were ordered to home office or variously restricted. Some of them were fired as the first choice of employer. Thus, COVID-19 affected students twice as much. They face negative impact of restrictions on their complex development, to which the knowledge and capabilities acquired by travel contribute significantly.

One of the key positive effects of traveling abroad is increasing of person's intercultural communication skills which are crucial for future success in managerial positions. Matsumoto (2000) highlighted that intercultural communication processes have potential for both self-growth and the development of new ways of thinking. Managers who are preparing for multinational assignments should acquire skills essential for strategic negotiations and multicultural exchange (Stringer and Cassidy, 2009). They have to acquire adaptability to different national processes and improve their negotiation skills and decision-making strategies (Carte and Fox, 2008). From the very beginning of the pandemic, academicians are highly involved in the impact of current situation on students, especially tertiary students, from various points of view. Since China was the first impacted country, studies connected to the pandemic were started by Chinese authors also in the topic of consequences on tertiary students (e.g. Jiāng, 2020; Chen, et al., 2020; Ye, et al., 2020; Fu, et al., 2021). Later, the knowledge was enlarged mainly by U.S authors (e.g., Charles, at al., 2021; Conrad, et al., 2021; Powell, et al., 2021) since country is one of the most affected worldwide, but evidence is considerable also from other countries, such as Australia (Aucejo, et al., 2020; Kuliukas, et al., 2021) or Bangladesh (Fu, et al., 2021). For example, Habe, et al. (2021) examined 314 sports and music students, and revealed differences in eight flow dimensions and a global flow score in favor of sports students since they experienced more positive effects and less negative effects of COVID-19 on their lives and studying than musicians. Conrad, et al. (2021) showed that students who had to leave behind valuable personal belongings reported more COVID-19-related worries, grief, depression, anxiety, and PTSD symptoms. Sayeed, et al., (2020) conducted a web-based cross-sectional study on 589 students which showed through multivariate logistic regression that students' age, gender, family income, residence, and family size were associated with COVID-19- related mental health difficulties. Jiang, R. (2020) added that university students possessed insufficient COVID-19 knowledge and high-risk perceptions since the pandemic impacted their mental health. Fu, et al. (2021) assessed the psychological status of college students and offered evidence for psychological intervention implemented to reduce the harm caused by thepandemic. As one of the side effects, Powell, et al. (2021) highlighted negative influence on food choices, with food availability and household roles as powerful factors influencing them.

Many social scientists and researchers explored the economic, social, and psychological consequences of COVID-19 on travel behavior. Zenker and Kock (2020) assumed that the pandemic would "create deep marks in the travel thinking and feeling and change how people travel" and introduced the Pandemic Anxiety Travel Scale (Zenker, et al., 2021). The concept of anxiety is hardly novel, but its importance increased in regard of COVID-19 across nations and age groups. The topic is particularly convex in case of tertiary students who lost the opportunity to study in presence form as well as the chance to gain practical experiences from working and travelling abroad. These missed opportunities have been described in the literature from various angles. Mangrum and Niekamp (2020) reported, that due to the suspension of in-person classes in response to the COVID-19 pandemic, students at universities with earlier spring breaks travelled more while those with later spring breaks did not. Aucejo, et al. (2020) added that due to COVID-19: 13% of students have delayed graduation; 40% have lost a job, internship, or job offer; and 29% expect to earn less at age 35. Moreover, these effects have been highly heterogeneous. Due to COVID-19, one quarter of students increased their study time by more than 4 hours per week while another quarter decreased it by more than 5 hours per week which deepened the already existing socioeconomic divides. Abdullah, et al., (2020) concluded that all these studies highlight that travel behaviors during pandemic could be remarkably different compared to the normal daily life and many factors affect such changes in travel behaviors and patterns.

## 2. Materials and Methods

To understand the impact of the COVID-19 pandemic on international skills of future (agri-business) managers, we surveyed 204 master's degree students of the Faculty of Economics and Management of the Slovak University of Agriculture in Nitra and analyzed their existing and planned foreign work experiences. According to COVID-19 related restrictions the study was conducted in the form of a questionnaire survey. Our research was based on Abdullah, et al., (2020) who recommended exploration of key changes in travel behaviors before and during COVID-19 and Zenker, et al., (2021) who suggested to include a construct that measures the intra-personal anxiety of travelers (and non-travelers) during the pandemic. According to this, the article examines working experiences abroad and connected future plans of agri-business students influenced by the COVID-19 pandemic. Respondents were selected from master's degree students of FEM at SUA by stratified randomization. We addressed 400 students of master's degree, out of which 207 cooperated. Therefore, the return rate was calculated as 50.86%. After data adjusting (Munk, et al., 2013) the sample was narrowed to 204 respondents. Master's degree students were addressed exclusively to describe the impact of the pandemic on their readiness for taking managerial positions in agri-business, since they will be the first post-pandemic graduates with the intentions to enter labor market. There is a general concern according to the level of skills and knowledge of students during the pandemic and this study aimed at this problem in agri-business from the angle of practical working experiences since they were considered as crucial in entrepreneurship education (Kozáková, et al., 2016).

The questionnaire study included 10 ordinary questions, for purpose of this article marked as Q1-Q10, and one selecting question market as Q0 (Table 1). It included closed questions only.

Table 1. Design of questionnaire

| Question | Code | Options. |
|---|---|---|
| Gender | Q0 | Men-1; Women-2 |
| Which aspect of your life has been influenced by COVID-19 in the most negative way? | Q1 | Travel- 1; Culture - 2; Relationships-3; Education-4; Work-5; Other- 6 |
| Which aspect of your life has been influenced by COVID-19 in the most positive way? | Q2 | Travel- 1; Culture - 2; Relationships-3; Education-4; Work-5; Other- 6 |
| How strongly has your travel plans been influenced by COVID-19? | Q3 | Not at all-1; Weak-2; Average-3; Strong-4; Very strong-5 |
| Have you given up a holiday abroad because of COVID-19? | Q4 | Yes-1; No-2 |
| Would you be willing to give up holidays abroad in the future if the COVID-19 situation persists? | Q5 | Yes-1; No-2 |
| How strongly have your job opportunities been influenced by COVID-19? | Q6 | Not at all-1; Weak-2; Average-3; Strong-4; Very strong-5 |
| Which of the above opportunities abroad have you given up because of COVID-19? | Q7 | Work and Travel-1; Traineeship- 2; Work-3; Language residence- 4; None - I have not planned anything like that anyway-5 |
| Have you had any experience with work abroad? | Q8 | Yes-1; No-2 |
| Have you had any experience with Work and Travel abroad? | Q9 | Yes-1; No-2 |
| Would you be willing to give up working abroad in the future if the COVID-19 situation persists? | Q10 | Yes-1; No-2; I have no such intentions-3 |

*Source: own design*

Population size is represented by 400 master's degree FEM students of SUA exclusively, since it is the only specialized university aimed at agri-business in Slovakia. With 95 % of probability that our sample accurately reflects the attitudes of the population and 8 % margin of error, the sample of 204 can be considered as representative. Descriptive statistics of student's answers and subsequent statistical analysis were made by using the SPSS software.

The Shapiro Wilk test of normality was used to test if the sample comes from a normal distribution with the result that our example data are skewed and kurtosis and therefore that they do not come from normal distribution, which was confirmed by the calculated p-value. To indicate whether there is an autocorrelation between variables the Durbin – Watson test on autocorrelation was used (Abrahamse and Louter, 1971) with the outcome of 2.103 which fits the demanded range 1.5-2.5 which means that there is no autocorrelation between variables. Subsequently, the Kruskal-Wallis nonparametric statistical test (Kruskal and Wallis, 1952; Rimarčík, 2007) was applied with the assumptions (for all the examined variables) set as:

H0: There is no difference between observed variables (There is no statistically significant difference between variables to the impact of COVID-19 on work abroad).

Ha: There is a difference between observed variables (There is a statistically significant difference between variables to the impact of COVID-19 on work abroad). Customized forms of alternative hypothesis Ha for examined variables are:

- H1: There is a statistically significant difference between attitudes of men and women - agri-business students - to the impact of COVID-19 on work abroad.
- H2: There is a statistically significant difference in attitudes to the impact of COVID-19 on work abroad between agri-business students with and without past experience with brigade or work abroad.

- H3: There is a statistically significant difference in attitudes to the impact of COVID-19 on work abroad between agri-business students with and without past experience with Work and Travel abroad.

Computed p-value lower than the significance level alpha=0.05 indicates to reject the null hypothesis H0, and accept the alternative hypothesis Ha. The significance level of 5% (p = 0.05) indicates, that the risk of rejecting the correct hypothesis while rejecting the null hypothesis is exactly 5% (Cyhelský and Suček, 2009).

## 3. Results and Discussion

We conducted a research aimed at the situation according to travel plans of 204 master's degree tertiary students of SUA Nitra. The questionnaire was filled by 45 men and 158 women. This distribution corresponds to the composition of students at SUA and other Slovak universities on social sciences study programs. Initial questions direct to the general influences of COVID-19 on students' life. They reported the most negative influence on travelling (79; 39%), followed by work and education both on second place (36; 18%), culture (24: 12%), relationships (16; 8%) and other (11; 5%). In contrast, they reported the biggest positive influence on relationships (121; 40 %) followed by other no specifying effect (62; 30%) education (30; 5%), work (23 s; 11 %) and culture (7; 3%). It is no surprise that travelling was the least one (1; 1 %).

Next part of the research aimed at students travel plans. On the 1-5 scale (Table 1) they rated how strongly had COVID-19 influenced their travel plans (Q3) with the average rating of 3.73. This means that averagely, their attitudes were close to strong influence. Consequently, we asked if they gave up a holiday abroad because of COVID- 19 (Q4) which 154 of them answered as “yes” (75%) and additional 50 as “no” (25%). Afterwards, we aimed at their willingness to give up upcoming holidays abroad in case the situation will not stabilize until then (Q5). Quite similarly as previous, 150 of them (74%) reported “yes” and 54 reported “no” (26%). This outcome is interesting, because if in future situation does not change, their decisions according travelling will not change, too. Averagely, just one percent of respondents will travel abroad even though pandemic will persist and despite they already skipped travelling abroad last season.

In case of university students, travelling abroad is very intricately connected with their working plans. According to this, we asked them how strongly had COVID-19 influenced their job opportunities (Q6) with the average answer rating: 3.07. This indicates that students consider the power of COVID-19 influence of their job opportunities as average.

Since work plans of tertiary students very often correlate with their study plans and education, we asked them also about their past experiences with work/brigade/Work and Travel abroad with the intention to show how their travel plans (connected with acquiring of work experiences) looked before the pandemic and how they would look if no pandemic appeared. It have to be highlighted that past experiences of these students with work abroad were not exceptionally large. Answers on Q8 showed that just 20 of them (10%) have some and 90% have no experience with Work and Travel program. Also, answers on Q9 showed that just 32 students (16%) worked abroad in past and 84% have no such experience. Altogether, work out of Slovakia was experienced just by 52 of these students (25%) and other 152 of them (75%) have no such experience

In the end, we asked students about their plans with working abroad. The answers showed that 54 of them (27%) would not give up plans to work abroad even if situation with COVID-19 persisted. Other 86 (42%) would not do so and unless the situation improves, they will not plan to work abroad even if they intend to. Additional 64 students (31%) do not have to solve this dilemma since they have no such plans anyway.

The aim of the consequent statistical analysis was to analyze the existence of significant differences between the influence of COVID-19 on work experiences abroad on men and women (Q0) agri-business students. In addition, another two variables were included: (Q8) past experience with brigade or work abroad and (Q9) past experience with Work and Travel abroad, with the purpose to find differences between experienced and unexperienced students. As the first step, we conducted the Shapiro-Wilk test of normality for variables Q0, Q8 and Q9 which showed that they do not follow a normal distribution (< 0.0001) and thus, for further analysis the use of a nonparametric test was required. For these variables the Durbin-Watson test was also conducted to describe relation between observations with the result of no autocorrelation for all of them (1.5-2.5). As non-parametric test the Kruskal-Wallis test was chosen to describe the differences among the variables with the result of significations in case of all three variables. Therefore we rejected the null hypothesis H0 and accepted the hypotheses H1, H2 and H3.

Table 2. Kruskal Wallis Test - Grouping Variable: Q0 (Sex)

| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Kruskal-Wallis H | 1.18 | 3.62 | 2.1196 | 2.72 | 0.0001 | 0 | 0.0655 | 0.3667 | 0.2187 | 0.0469 |
| df | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asymp. Sig. | 0.2576 | **0.0499** | 0.1454 | 0.1255 | 0.991 | 0.9977 | 0.798 | 0.5448 | 0.6401 | 0.8285 |

*Source: own calculations*

The conducted Kruskall-Wallis test of the factor gender analyzed with variables Q1-Q10 (Table 2) showed the significant differences only for one (aspect of student's life which has been influenced by COVID-19 in the most positive way). Therefore, we accepted the null hypothesis in case of variables Q1, Q3, Q4, Q5, Q6, Q7, Q8, Q9 and Q10 and rejected it in the case of Q2. These outcomes indicate that attitudes to the impact of COVID-19 on work abroad in relation to the examined agri-business students are influenced by their gender only in case of aspect of their life which has been influenced by COVID-19 in the most positive way. The Kruskal-Wallis test showed that there was a statistically significant difference in their attitudes between men and women od $\chi 2$ (2 =3.8462; p=0.0499 which is an extremely limit value close to no significant difference.

Table 3. Kruskal Wallis Test - Grouping Variable: Q8 (past experience with work abroad)

| | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Kruskal-Wallis H | 0.367 | 1.057 | 0.026 | 2.553 | 1.062 | 1.907 | 1.035 | 15.263 | 11.154 | 2.694 |
| Df | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asymp. Sig. | 0.545 | 0.304 | 0.872 | 0.11 | 0.303 | 0.167 | 0.309 | **0.000** | **0.001** | 0.101 |

*Source: own calculations*

Furthermore, the Kruskall-Wallis test of past experience with work abroad analyzed with variables Q0-Q10 (Table 3) showed the significant differences for two variables (Q7, Q9). Therefore, we accepted the null hypothesis for variables Q0, Q1, Q3, Q4, Q5, Q6, and Q10 and reject it for Q7 and Q9. These outcomes indicated that attitudes to the impact of COVID-19 on work abroad of examined agri-business students were influenced by existence of previous experience with Work and Travel abroad and already cancelled working opportunities abroad. The analysis showed that there was a statistically significant difference in attitudes of agri-business students with and without previous experience with work abroad in case of Q7 ($\chi2$ (2)=15.263; p=0.000) and Q9 ($\chi2$ (2)=11.154; p=0.001).

Table 4. Kruskal Wallis Test - Grouping Variable: Q9 (past experience with Work and Travel abroad)

| | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Kruskal-Wallis H | 3.414 | 0.219 | 0.064 | 5.672 | 3.496 | 2.009 | 1.322 | 42.716 | 11.154 | 5.662 |
| df | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Asymp. Sig. | 0.065 | 0.640 | 0.800 | 0.017 | 0.062 | 0.156 | 0.250 | **0.000** | **0.001** | **0.017** |

*Source: own calculations*

Lastly, we examined the factor of past experience with Work and Travel abroad in connection with variables Q0-Q10 (Table 4) with the outcome of significant differences for three variables Q7, Q9 and Q10. According to this, we accepted the null hypothesis for variables Q0, Q1, Q2, Q3, Q4, Q5, Q6 and rejected it for variables Q7, Q9 and Q10. This indicated that attitudes to the impact of COVID-19 on work abroad were influenced by the existence of students´ previous experience with work (Q7: ($\chi2$ (2)=42.716; p=0.000), previous cancellation of working opportunities abroad (Q9: ($\chi2$ (2)= 42.716; p=0.001), and their willingness to give up working abroad in the future if the COVID-19 situation persisted (Q10: ($\chi2$ (2)= 5.662; p=0.017).

The travel plans of students represent one of the key questions in the current pandemic situation. Jiang, (2020) suggested that during its outbreaks, social support and targeted interventions tailored to university students should be provided, and university administration should strengthen the cultivation of students' mental toughness using standard teaching processes. But it has to be taken into consideration, that due to COVID-19 (Aucejo, et al., 2020), lower-income students are 55% more likely to have delayed graduation than their higher-income peers. In addition, COVID-19-related economic and health shocks induced socioeconomic factors and constituted key mediators in explaining the large (and heterogeneous) effects of the pandemic.

***Limitations***: Our research aimed at influence of COVID-19 on work experiences of agri-business students analyzed the series of 10 questions concerning the issue. However, the extent of the article did not allow us to describe the problem in wide coherence, primarily with influence of COVID-19 on teaching process and educational experiences of students abroad. Moreover, we did not consider the factor of income which can influence student's ability to travel abroad, too. Lastly, our research did not consider broader significant predictors of mode choice during the pandemic (Abdullah, et al., 2020): gender, car ownership, employment status, travel distance, the primary purpose of traveling, and pandemic-related underlying factors.

## 4. Conclusion

In this study, we would like to express a sincere concern about the level of skills of a generation of incoming managers (not just the agri-business mangers). The fear of the consequences of COVID-19 is understandable, but the consequences of the pandemic on their professional training will perhaps be even worse, as the current situation makes it impossible for them to acquire valuable intercultural knowledge, language competences and other skills that travel and work experience abroad entail. To understand the impact of the COVID-19 pandemic on international skills of future agri-business managers, we surveyed 204 master's degree students of FEM from SUA and analyzed their previous and planned working experiences. We can conclude that COVID-19 influenced students´ lives most negatively in case of travelling (39%). The work and education were both in the second place (18%). On the other hand, the biggest positive influence of COVID-19 was on their relationships (40 %). Averagely, respondents' attitudes were close to strong influence of COVID-19 to their travel plans, since 75% of them cancelled their last holidays abroad and 74% would do it again in case the situation will not be any better.  From the perspective of job opportunities, they consider the power of COVID-19 influence as average. Since 20 % of them have experienced Work and Travel abroad and another 16% individual work abroad, for upcoming season 27% would not cancel their plans to work beyond Slovakia even if the situation with COVID-19 persisted. However, in case of persistent pandemic situation, 42% would rather stay at home and lose the chance to acquire valuable knowledge and skills from abroad necessary for their future managerial career.

Statistical analysis showed significant differences between men and women in attitudes to the impact of COVID-19 on work abroad only in case of the question aimed at the aspect of their live which had been influenced by COVID-19 most positively. There is also a statistically significant difference between agri-business students who have or have not experienced work abroad in their attitudes to the impact of COVID-19 in case of opportunities they cancelled in relation to the pandemic and their past experiences with Work and Travel program. We can also confirm the difference between students who have or have not experienced work abroad in their cancelled opportunities, their experience with work abroad and their willingness to give up future plans if the situation with COVID- 19 persists.

***Recommendations for further research***: The length of this study did not allow us to touch every important aspect of the problem, and therefore we would like to introduce some recommendations for future research. Firstly, we strongly recommended to repeat similar survey in autumn 2021 to evaluate students work and travel experiences during summer semester and upcoming holidays. The comparison of new data with our findings can show the dynamics of the issue.  Secondly, we would like to recommend enrichment of these outcomes of study aimed at influence of COVID-19 on education, particularly study abroad - for example Erasmus or Double Degree programs. Thirdly, it would be essential to analyze students travel behaviors generally as explained by Abdullah, et al., (2020) who proceed that understanding and predicting travel behaviors is vital for transport planning, decision making, and policy making during pandemic situations based on the travel needs of people. Such knowledge can be utilized for rescheduling public transport operations. Finally, it would also be remarkably interesting to apply general approach of Zenker et al., (2021) who measured how people are psychologically affected by pandemic anxiety using their original scale.

***Usage of findings***: Our findings are of key importance to SUA Nitra since they show the necessity of enriching the education of the practical cross-cultural communication, cultural empathy, and other soft skills usually obtained during work and travel experiences abroad. These findings also indicate the need of larger support of competent bodies and policy makers on national and integrated level, since it can be assumed that similar COVID-19-related restrictions across EU resulted in similar damages of students´ abilities. Therefore, we strongly recommend creation of wider opportunities for working abroad for students and recent graduates to eliminate their disadvantage against older managers who have already used the opportunities given by staying abroad.

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# TRENDS IN EAEU AND EU AGRARIAN TRADE COMPETITIVENESS UNDER RUSSIAN IMPORT BAN

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**Annotation**: Eurasian Economic Union (EAEU) is one the most recent trade blocs on the post-Soviet territory. In light of the Russian import ban, the paper attempts to investigate changes in trade competitiveness of EAEU countries and EU member states towards Russia by analysing changes of Lafay indexes for products in and out of the ban list. EAEU has increased its specialization in dairy products and fish and crustaceans (which might be an indication of re-export) but decreased in meat products. EAEU countries had better relative position in the region than EU, however Russian import ban did not cause explosive growth in food exports from EAEU to Russia. Overall competitiveness of EAEU countries was higher than for EU countries, but it took longer for EAEU countries to return to growth in trade specialization after 2014. Results might indicate signs of missing convergence between EAEU economies, including Russia, and higher rigidity of these economies to changes in supply and demand balance of regional trade.

**Key words**: Russia, trade competitiveness, Lafay index, Russian import ban, EAEU, European union.

**JEL classification**: F51, F14, Q17.

## 1. Introduction

Many countries on the post-soviet territory can still be considered as developing. After three decades from dissolution of Soviet Union, their economies are still challenged with unstable economic growth, internal and external shocks and emerging trade, both inside this territory and externally. Eurasian Economic Union (EAEU) is one of the latest organizations in the region focused on promoting free trade between its members (Russia, Belarus, Kazakhstan, Armenia, Kyrgyz Republic). Despite its relative novelty (since 2012), it is already possible to assess interim results of cooperation in order to define the future prospects of this trade bloc. One of the significant events, which should have impact on EAEU trade, was Russian import ban, which was introduced in 2014 and prohibited food and agricultural products to be imported to Russia from EU member states, USA, Australia, Norway and Canada. Effects of Russian import ban have been described in the literature (Liefert et al., 2019; Boulanger et al., 2016; Banse et al., 2019), however these works are mostly focused on impact on EU countries and effects on domestic market of Russia. Effects on neighbouring countries, including EAEU countries, have received significantly less attention.

Interconnections between trade competitiveness (and in turn trade specialization) and other economic indicators are at centre of several pieces of contemporary economic literature. Positive effect of trade specialization on poverty reduction in developing countries has been noted by Santos-Paulino (2017). Author specifically highlights, that agricultural exports have significant positive effect on poverty reduction in low-income countries. On the other side, Shahzadi & Yaseen (2019) shows, that over the last two decades, low-income countries have been under-specialized in technological products, but specialized in agricultural and food trade. This brings authors to the conclusion about necessity of policy measures to promote development of technological production in low-income countries. At the same time, Timmer et al. (2019) argue that functional specialization has been gaining more importance to economic growth, then trade specialization. According to this logic, parties in contemporary trade relations do not trade goods, but they oftentimes trade tasks. De Benedictis et al. (2009) showed the evidence, that despite broad consensus among economists about the fact, that countries tend to specialize in specific sectors, countries in fact diversify; moreover, sectoral export diversification increases with income.

Trade competitiveness is usually assessed by means of revealed comparative advantage indexes, such as Balassa's RCA (Balassa, 1965) and RSCA, Lafay index (Lafay, 1992), and recently the cross-country specialization index B* (Amador et al., 2011). All indexes have strong and weak properties, which has been discussed in the literature to date (see, for example, Amador et al., 2011), however to the best of our knowledge, Lafay index is one of the most widely used.

This paper attempts to analyse trade developments between EAEU countries and Russia and compare it with trade developments between EU and Russia considering Russian import ban. Main aim of the paper is to determine the changes in trade competitiveness and specialization for EAEU and EU countries towards Russia before and after Russian import ban. Findings should help to answer the question of whether trade specialization of EAEU countries in selected products has risen after Russian import ban in comparison to EU countries.

## 2. Materials and Methods

Dataset contains annual data for import and export to Russia for period 2000-2019 for countries of EAEU (Armenia, Belarus, Kazakhstan, Kyrgyz Republic) and for EU28 group. Analysis is done on the level of product groups within HS01-HS24 groups. Trade competitiveness is assessed by calculating Lafay indexes for each product group (Lafay, 1992) in the following form:

$$LFI_j^i = 100\left(\frac{x_j^i - m_j^i}{x_j^i + m_j^i} - \frac{\sum_{j=1}^{N}\left(x_j^i - m_j^i\right)}{\sum_{j=1}^{N}\left(x_j^i + m_j^i\right)}\right)\frac{x_j^i + m_j^i}{\sum_{j=1}^{N}\left(x_j^i + m_j^i\right)} \quad (1)$$

where $x_j^i$ – export of product $j$ of country $i$; $m_j^i$ – import of product $j$ of country $i$; $N$ – number of items.

Lafay index is calculated for each product group in scope of research (HS01-HS24). Changes in trade competitiveness is assessed by estimating series of cross-sectional panel data regressions (beginning and end of period) of Lafay index distributions for the period of 2000-2019 in the following specification (as discussed in Pavitt (1989), Cantwell (1989), ECB (2003), Sanidas & Shin (2010)):

$$LFI_{ij}^{END} = \alpha_i + \beta_i LFI_{ij}^{START} + \varepsilon_{ij} \quad (2)$$

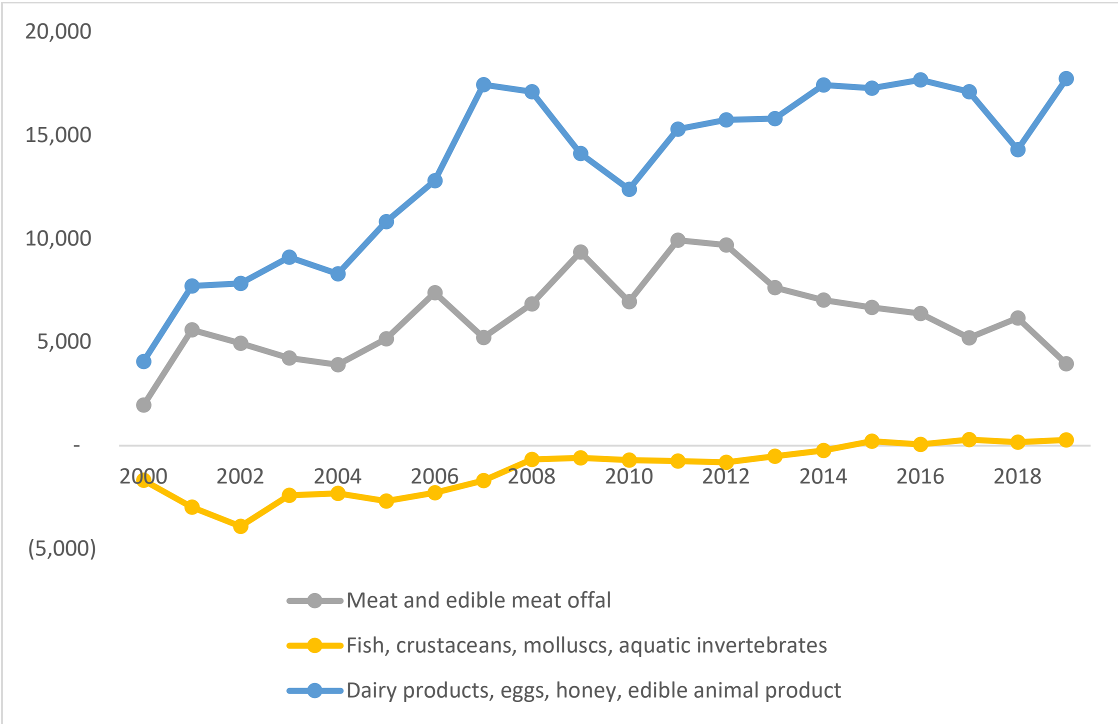
where: $LFI_{ij}^{END}$ – distribution of Lafay index for country $i$ and commodities $j$ in the end of reference period; $LFI_{ij}^{START}$ – distribution of Lafay index for country $i$ and commodities $j$ in the start of reference period; $\alpha_i$ and $\beta_i$ - standard linear regression coefficients; $\varepsilon_{ij}$ – residual term.

Under this specification, regression coefficients show change in trade competitiveness across different product groups as assessed by Lafay index. As was discussed by Sanidas & Shin (2010), coefficient $\beta_i$ describes the change in trade specialization of country towards trade partner. When the specialization pattern has not changed between two points of time, coefficient is expected to be equal to 1. Therefore, value of $\beta_i$ higher than 1 shows increased specialization in sectors where the country had a competitive advantage already. Value between 0 and 1 denotes regression towards the mean, which is the situation where sectors with comparative disadvantage improves its position, while sectors with comparative advantage worsen their positions (Sanidas and Shin, 2010). Regression method used in the analysis compares two cross-sections at two points of time, and there is no dynamic time component included. However, this method allows to build series of coefficients and analyse changes during specified period of time.

## 3. Results and Discussion

Trade competitiveness of EAEU countries, as assessed by Lafay index, had positive dynamics for dairy products, but decreasing trend for meat, as shown on Figure 1.

Figure 1. Main changes in Lafay index of EAEU countries.




*Source: UN COMTRADE, 2021, authors' calculations.*

During last 20 years, trade competitiveness of EAEU countries in dairy products has been rising from 2000 to 2008, but after the Global Financial Crisis the trend has been reversed to downward. Year 2011 has shown recovery, but trade competitiveness has not improved until Russian import ban was introduced in 2014. The ban has given additional momentum, but the effect seems to be only short-term. Trade specialization in meat products copied the dynamics of dairy products during 2000-2011, had opposite trend in the period after 2011. Import ban had no positive effect on trade specialization of EAEU countries in meat products.

One of the most remarkable changes is the change in EAEU trade competitiveness for fish and crustaceans. Until import ban was introduced, EAEU countries had negative Lafay index, which points out to the absence of trade specialization in these product categories due to prevalence of imports over exports. Negative values of Lafay index would be expected for these countries, as none of them has access to the sea and stable fish processing industry. Nevertheless, trade specialization of these countries has been shifted after 2014 to positive values and have been fluctuating in the positive territory since then. As there were no major changes related to access to the sea for these countries, these changes can be associated with re-export of banned products via these countries. Concerns about these effects have been already raised in the literature (Liefert and Liefert, 2015) and questions about how such practices impact trade in EAEU region are still open (Romashkin et al., 2020). Design of this study does not allow to distinguish between the countries, however some of the evidence has been presented in the literature already (Belova, 2017).

Overall trade competitiveness and trade specialization can be assessed by estimating regressions for distributions of Lafay indexes. Results for EU countries are shown in the Table 1.

Table 1. Results of regression estimation for Lafay indexes, HS01-HS24 product groups for EU countries (2010-2019)

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Coef. | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| $\boldsymbol{\beta_i}$ | 0.905*** | 1.053*** | 1.115*** | 0.846*** | 0.800*** | 0.981*** | 0.967*** | 0.911*** | 1.024*** | 1.016*** |
| Std. error | (0.033) | (0.060) | (0.059) | (0.054) | (0.074) | (0.056) | (0.034) | (0.043) | (0.056) | (0.054) |
| $\boldsymbol{\alpha_i}$ | 0.000 | 0.000 | -0.000 | -0.000 | 0.000 | -0.000 | 0.000 | 0.000 | -0.000 | -0.000 |
| Std. error | (0.079) | (0.131) | (0.141) | (0.149) | (0.180) | (0.118) | (0.073) | (0.090) | (0.110) | (0.113) |
| $R^2$ | 0.971 | 0.933 | 0.941 | 0.917 | 0.841 | 0.934 | 0.974 | 0.954 | 0.938 | 0.941 |
| Residual Std. Error (df = 22) | 0.387 | 0.644 | 0.693 | 0.728 | 0.880 | 0.578 | 0.356 | 0.440 | 0.539 | 0.553 |
| F Statistic (df = 1; 22) | 745.031*** | 307.547*** | 353.468*** | 243.359*** | 116.305*** | 309.243*** | 815.178*** | 454.283*** | 333.258*** | 348.314*** |

*Source: UN COMTRADE, 2021, authors' calculations.*
*Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses*

Trade specialization of EU countries towards Russia was steadily growing in 2010-2012, where estimated coefficient has been growing from 0.905 to 1.115. This shows the prevalence of food exports from EU towards Russia during these years. Year 2013 has shown the effect of regression towards mean, when the estimated coefficient was equal to 0.846. Interestingly, import ban was not introduced in this year, however relative weight of food exports from EU to Russia has started to decline already. Next year will show even deeper decrease in EU food exports to Russia, and coefficient dropped to 0.800 as a result. Based on the specification of the model, this means that EU had decreasing specialization in the products where it already had lower trade competitiveness and increasing specialization in the products where EU already had higher trade competitiveness. After import ban of 2014, EU started to increase its trade competitiveness only in 2018, when the coefficient has achieved value of 1.024.

Results for EAEU countries are shown in the Table 2. Trade competitiveness of EAEU countries have shown better dynamics in comparison to EU countries. Thus, coefficient for EAEU countries is higher than for EU countries in 8 years out of 10. Highest value of the coefficient was achieved in 2011, which was the recovery effect after Great Recession. In 2014, EAEU countries has increased trade competitiveness, while EU countries have shown opposite dynamics. In the years after introduction of Russian import ban, EAEU countries has shown better dynamics of trade competitiveness in comparison to EU. To some extent, this can be explained by substitution of EU imports to Russia by imports from within EAEU, however the magnitude of this was relatively low, as coefficient was lower than 1.

Table 2. Results of regression estimation for Lafay indexes, HS01-HS24 product groups for EAEU countries (2010-2019).

| | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Coef. | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| $\boldsymbol{\beta_i}$ | 0.823*** | 1.275*** | 1.026*** | 0.944*** | 1.045*** | 0.990*** | 0.999*** | 0.952*** | 0.874*** | 1.104*** |
| Std. error | (0.015) | (0.034) | (0.034) | (0.038) | (0.030) | (0.024) | (0.023) | (0.030) | (0.031) | (0.046) |
| $\boldsymbol{\alpha_i}$ | -0.000 | -0.000 | 0.000 | -0.000 | -0.000 | 0.000 | 0.000 | -0.000 | 0.000 | -0.000 |
| Std. error | (0.061) | (0.110) | (0.142) | (0.163) | (0.124) | (0.107) | (0.099) | (0.130) | (0.132) | (0.172) |
| $R^2$ | 0.992 | 0.985 | 0.976 | 0.966 | 0.982 | 0.987 | 0.989 | 0.979 | 0.973 | 0.963 |
| Residual Std. Error (df = 22) | 0.297 | 0.537 | 0.697 | 0.798 | 0.610 | 0.524 | 0.487 | 0.636 | 0.646 | 0.845 |
| F Statistic (df = 1; 22) | 2,848.264*** | 1,428.650*** | 907.932*** | 632.053*** | 1,223.831*** | 1,654.997*** | 1,931.681*** | 1,039.338*** | 785.804*** | 575.433*** |

*Source: UN COMTRADE, 2021, authors' calculations.*
*Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses*

Such slow dynamics of EAEU trade competitiveness increase after Russian import ban allows to conclude, that EAEU countries had better relative position in the region than EU, however Russian import ban did not cause explosive growth in food exports from EAEU to Russia. Re-export can be considered as one of the factors supporting increase in EAEU trade competitiveness in this period (Romashkin et al., 2020), however its effect seems to be relatively small. Nevertheless, EAEU had better dynamics in trade competitiveness then EU during period of 2010-2019.

## 4. Conclusion

Trade competitiveness of EAEU group has undergone several changes after Russian import ban. EAEU countries has shown increasing trade competitiveness in dairy products, declining in meat products, and positive dynamics in fish and crustaceans (which might be an indication of re-export of banned products). However, overall trade competitiveness has shown mixed picture.

Comparing dynamics of EU and EAEU, it is possible to determine several periods of their trade relations with Russia. For EU these are expansion (2010-2012), deceleration (2013-2017), new momentum (2018-2019). For EAEU these are expansion (2010-2012), consolidation (2013-2018), new momentum (2019). EAEU has shown better magnitude of changes in trade competitiveness, however it took longer for these countries to improve its positions in trade with Russia. These results might indicate signs of missing convergence between EAEU economies, including Russia, and higher rigidity of these economies to changes in supply and demand balance of regional trade. In other words, it seems that EAEU countries did not compensate falling exports from EU to Russia as a result of import ban.

Going forward, additional insight into the topic of EAEU trade developments can be gained by analysis of trade competitiveness on the level of EAEU member countries, including Russia, and comparing this trade bloc to similar in other regions, such as NAFTA, where USA (similarly to Russia in EAEU) has significantly bigger market than other members.

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# THE IMPACT OF COVID-19 AND THE CRISES IN GENERAL ON THE PRICES OF MARKETABLE ASSETS - FOCUSING ON AGRICULTURAL COMMODITIES

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**Annotation**: The submitted paper deals with the relationship between shares and agriculture, and energy commodity prices under the impact of the financial crisis. For this purpose, there have been used data of World bank commodity indices, Bloomberg commodity agriculture sub-index and S&P500 index to track these changes within the period 02/2000 - 02/2021. There was used the dynamic regression model ADL to address the research questions whether the relationship between commodities and stocks exists, what is the characteristic of this relationship (is the relationship positive or negative, long-term or short-term) and what is the effect of crisis. Based on the results it is possible to note the relationship has been found long-term and short-term. This relationship is negative between agriculture commodities and stock market and positive between the energies and agricultural commodities. This result shows the tendency of stakeholders to move the liquidity from the stock markets to the other classes of assets during the period of crisis and should be considered for current situation on the markets which is affected by Covid19 pandemic.

**Key words**: agricultural commodity, commodity markets, crisis, stocks

**JEL classification**: Q02, G12, C53

## 1. Introduction

Especially in the last year 2020, we were able to observe a similar development on the stock and commodity markets as during the last financial crisis in 2008. The decline in stock prices and the rise in commodity prices suggest a certain similarity, which is reflected also in agricultural commodity prices. A large amount of excess liquidity and the pursuit of the highest possible return leads investors to speculative purchases, which move from stock markets to energy and agricultural commodities. Creti et al. (2013) confirm that correlations between commodity and stock markets evolve through time and are highly volatile, particularly since the 2007–2008 financial crisis. The latter has played a key role, emphasizing the links between commodity and stock markets, and underlining the financialization of commodity markets. At the idiosyncratic level, a speculation phenomenon is highlighted for oil, coffee, and cocoa, while the safe-haven role of gold is evidenced. Živkov, D. et al. (2020) investigated permanent and transitory spill over effects from Brent oil futures to four agricultural futures - corn, wheat, soybean, and canola. They constructed permanent and transitory volatilities via component GARCH model, considering six different distribution functions. Created volatility time-series are embedded in the robust quantile regression framework. In addition, they also performed subsample analysis, observing two diametrically opposite subsamples in terms of risk in each agricultural commodity market, i.e. with the highest and lowest standard deviations. Transitory effect from oil market has slightly stronger influence on the agricultural commodities than its permanent counterpart, which is a sign that short-term information flow has more intense effect than fundamental factors. The full-sample findings suggest that volatility shocks that originate in the oil futures market spill over towards corn, wheat, and soybean futures markets, while in the canola case, a rise in oil volatility actually decreases volatility in canola market. Smiech et al. (2019) used daily series for volatility of corn, soybean, wheat, rice, US dollar, crude oil, and S&P500 futures spanning the period January 4, 2000 to April 1, 2017. The results of the generalized impulse response functions suggested that the strongest response of food markets volatility results from shocks originating from another food market (except for the rice market). Much smaller, but still a positive response of the food markets volatility to the shocks in the "non-food" markets can be observed. Finally, food markets volatility was more sensitive to shocks from different markets during the global financial crisis and surges in food prices. The most general conclusion of their paper is that the role of the financial and energy markets in creating the food markets volatility is limited. In particular, volatility of energy prices appears to be insignificant for food prices. Interestingly, the corn market seems to be the most important food market, as it is the net volatility transmitter to the soybean, wheat, and rice markets. Since the share of corn production used for biofuels (ethanol) has risen significantly during the analysed period, it can be concluded that the relations between energy and agricultural commodities markets have become tighter, although in an indirect way, i.e. via the market for corn.

## 2. Materials and Methods

There are several methods for finding relationships between economic variables, which are a suitable tool for quantifying relationships between random processes. Econometric modelling is one of the recognized and very popular technique. From many approaches within econometric models based on time series, a cointegration analysis was chosen, which is suitable for time series with long memory. By differentiating long-memory series, it is possible to transform into short-memory series, which we then refer to as integrated order one with description I (1). Time series must be assessed in terms of their stationarity. Stationary and non-stationary series differ in unconditional variances and autocorrelation functions. The distinction between time series types into stationary and non-stationary is very important when examining their relationships. According to Cipra (2008), one of the most widely used models of multidimensional time series is one-equation regression models. The dynamic regression model ADL - Autoregressive distributed lag model - (n, $p_1$, $p_2$) with two explanatory variables in the form of ADL (1,1,1) was chosen for the work. We can use the equation:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \gamma_{10} x_{1t} + \gamma_{11} x_{1t-1} + \gamma_{21} x_{2t} + \gamma_{22} x_{2t-1} + u_t \quad \textbf{(1)}$$

where:
n … number of delays of the endogenous variable y,
p … number of delays of exogenous variables x,
t … number of observations t = 1…T,
y … endogenous variable,
x … exogenous variable,
$\beta_0$ … constant,
$\beta_1$ … parameter of endogenous delayed variable,
$\gamma_i$ … parameters of exogenous variables,
$u_t$ … random variable.

Their construction needs to be approached very carefully, because when working with non-stationary time series, a situation can arise that is referred to as spurious or false regression (Arlt and Arltová, 2009).

The procedure for estimating this model is as follows:

1. Estimation of the multiple regression model, i.e. without delayed variables.

2. Extended Dicky-Fuller (ADF) residue test. If the residues are stationary, it is possible to go to the choice of delay based on information criteria (AIC, BIC, HQC), include delayed variables and estimate the ADL model.

3. The estimation is followed by verification of the model from the economic, statistical, and econometric point of view.

4. Based on the results, an Engle-Granger cointegration test is performed, which decides on a possible long-term relationship between the monitored processes.

5. After finding the cointegration relationship, it is possible to derive the Error correction (EC) model.

The aim of the paper is to determine and quantify the relationships between the Bloomberg Agriculture Commodity (BAC) index, which represents an endogenous variable and it is based on the futures nearby contracts prices of selected agricultural commodities (corn, soybeans, sugar, coffee, wheat and cotton). Together with S&P500, which is the first exogenous variable and which is widely regarded as the best single gauge of large-cap U.S. equities (the index includes 500 leading companies and covers approximately 80% of available market capitalization) and the second exogenous variable WBEI (World Bank Energy Commodity Price Index), which monitors price indices of energy commodities (mainly coal, crude oil, and natural gas) on monthly base.

All data of monthly time series were collected for the period 02/2000 - 02/2021 from the databases of World Bank and Bloomberg.com. Data from January 2009 to December 2011 were specially selected to define the period of the crisis, when the most significant changes in all indicators took place and the volatility of time series increased compared to the previous period.

The research questions that have been identified are the following:

1. Is there a relationship between the price index S&P500, WBEI and the agricultural commodity price index BAC?

2. Is this relationship positive or negative? Is it possible to conclude that if stock prices fall, investors are more concerned with investing in agricultural commodities?

3. Are the relationships between the selected price indices long-term or short-term in nature?

4. Are the relationships between the selected processes in the crisis stronger?

## 3. Results and Discussion

The investigated time series were evaluated as non-stationary at the significance level of 0.01 using the ADF test. First, estimates of multiple regression of the model without delay were performed (see table 1) and ADF residue test with selected function without constant.

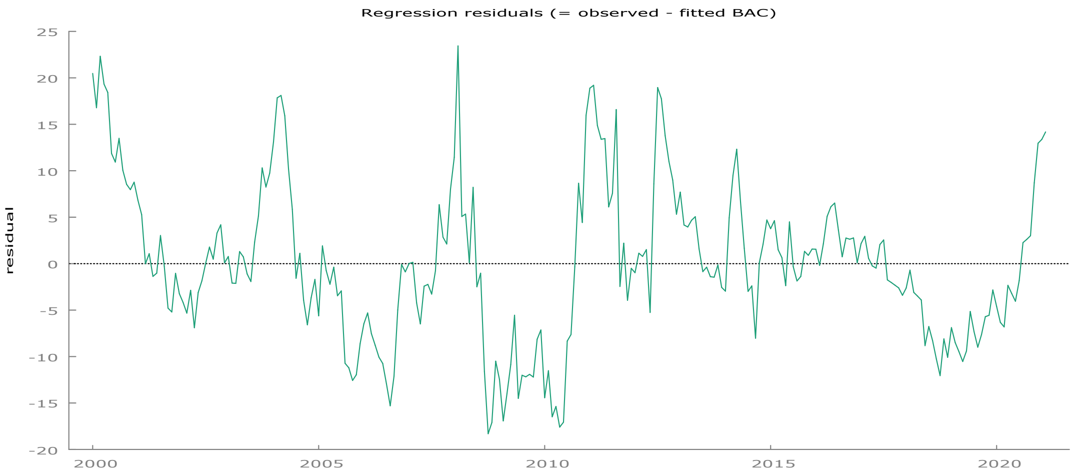
Table 1. Results of estimating the multiple regression model

| | Coefficient | Std. Error | t-ratio | p-value | |
|---|---|---|---|---|---|
| Const. | 64.5951 | 1.87619 | 34.43 | <0.000 | *** |
| SP500 | −0.0115588 | 0.000752843 | −15.35 | <0.000 | *** |
| WBEI | 0.220511 | 0.0157780 | 13.98 | <0.000 | *** |

*Source: own calculations using observations 2000:02-2021:02 (T = 253)*

The results of this test confirm the stationarity of residues and it is possible to confirm the first scientific question and consider the presence of not only a short-term but also a long-term relationship between the selected time series of price indices (see figure 1).

Figure 1. Stationary residuals of the multiple regression model




*Source: own calculations using Gretl*

The results shown in table 2 answer the second research question and declare a negative relationship between the S&P500 stock price index, which is in line with expectations. In this case, falling stock prices motivate investors to buy agricultural commodities that can be considered less risky. This relationship works with the lowest intensity. It corresponds with results of Crespo et al. (2021), who observed in the model for wheat prices a positive price response to shocks in US industrial production and the negative price response to the stock market index for the United States, where the price reaction occurs in the short run.

The market for energy commodity prices behaves in the opposite way, which in the sum of current and lagged parameters points to a positive dependence between price indices. Here it is possible to work with a complementary effect, where agricultural commodities can be purchased for processing and subsequently traded on the biofuels market. This is in line with the results of Candila and Farace (2018) who focused on investigating the volatility spill overs from selected agricultural commodity markets (corn, sugar, wheat, soybean, and bioethanol) to five Latin American stock markets (Argentina, Brazil, Chile, Colombia, and Peru). They stated that when a negative shock hits the commodity market, Latin American stock market volatility tends to increase. This happens, for instance, for the relationships between corn prices and Chilean and Colombian stock market and between wheat prices and Peruvian and Chilean stock market.

However, the shortest inertia in the time series of the agricultural commodity price index, which is represented by a delayed endogenous variable by one month, has the strongest effect. The intensity of the parameter is the highest. Also, Živkov, D. et al. (2020) could say that the best diversification instrument in combination with oil is soybean futures in tranquil periods, since it is the least susceptible to oil volatility shocks. On the other hand, in the crisis subperiod, corn, wheat and soybean receive significant amount of volatility shocks from oil market, even in conditions of low volatility, which is depicted by the lowest quantiles. Therefore, investors in crisis period should abandon oil-agricultural futures combination and seek some other assets which will serve as more appropriate safe haven.

Table 2. Results of ADL model estimation in linear form

| | **Coefficient** | **Std. Error** | **t-ratio** | **p-value** | |
|---|---|---|---|---|---|
| Const. | 7.28877 | 2.07941 | 3.505 | 0.0005 | *** |
| SP500_1 | −0.00119939 | 0.000462428 | −2.594 | 0.0101 | ** |
| WBEI | 0.166011 | 0.0483306 | 3.435 | 0.0007 | *** |
| WBEI_1 | −0.148132 | 0.0488717 | −3.031 | 0.0027 | *** |
| BAC_1 | 0.891327 | 0.0304769 | 29.25 | <0.000 | *** |

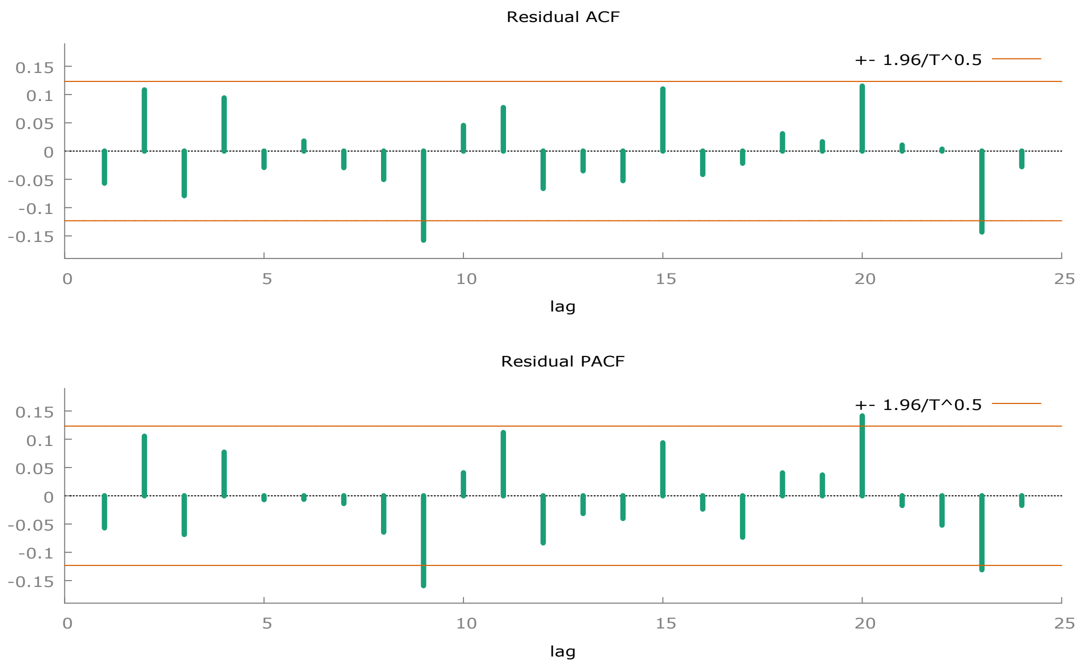
*Source: Own calculations using observations 2000:02-2021:02 (T = 253) and using HAC standard errors;*

*Notes:* * $t_\alpha = 0.1$, ** $t_\alpha = 0.05$, *** $t_\alpha = 0.01$

| | |
|---|---|
| *Joint test on named regressors* | *p-value <0.000* |
| *Adjusted R-squared* | *0.92* |
| *Breusch-Godfrey* | *p-value = 0.08* |

In order to be able to verify the model, it is necessary to perform a number of tests. In the ADL model, there is no autocorrelation of residues at the significance level of 0.1%, which is confirmed by the Breuch-Godfrey test and figure 2.

Figure 2. Residual correlogram




*Source: own calculations using Gretl*

The problem is caused by the presence of heteroskedasticity, which in turn causes the least squares estimates not to be the efficient. It also underestimates standard errors and significance tests are not credible enough. To avoid this situation, robust estimates of standard errors using HAC errors were used to estimate the ADL model. The assessment of the stability of the parameters using the Chow test was also successful and it can be stated at the p-value of 0.12 that the parameters are stable in a wide range and do not differ significantly before and after the economic crisis. Evidence of the agreement of the model with the data is also the coefficient of determination, which says that 92% of the variability of the endogenous variable is explained by the variability of predetermined variables (see figure 3).

Figure 3. Comparison of actual and fitted data of BAC


*Source: own calculations using Gretl*

The third scientific question concerned the finding of a cointegration relationship between selected time series and will be answered after the Engle-Granger cointegration test. The result of this test is the finding that at the level of significance of 0.1% it is possible to confirm the long-term relationship between stock price indices, agricultural commodities, and energy commodities. On other hand, some authors (e.g. Öztek and Öcal, 2017) focused on two commodity sub-indices; agricultural commodity and precious metal. They found evidence against the rising trend for the agricultural commodity sub-index. Empirical results show that high market volatility during financial crises seems to be the main source of high correlations and lower market predictability (Popesko, et al., 2016). Moreover, increase in correlation is not a new phenomenon and cannot be attributed to the recent financial crisis. For the precious metal sub-index, market volatility plays crucial role in the dynamic nature of correlation along with rising trend. Furthermore, heterogeneous structure of commodity markets delivers better portfolio diversification opportunities during calm periods compared to turmoil periods.

In terms of assessing direction and intensity, it is possible to further derive the Error correction (EC) model, whose recalculated parameters are very similar to the estimated parameters of the multiple regression model in table no. 1 and it can be stated that the decrease of the S&P500 price index by one percentage point will cause the agricultural commodity price index to increase by 0.011 percentage points. In contrast, for the energy commodity price index (WBEI), its growth by one percentage point will cause the BAC price index to increase by 0.22 percentage points.

The article also dealt with the finding of whether in the crisis in 2009-2011 this relationship, proven on a number of observations, is stronger or not. The model estimated on the abbreviated series selected for the period of economic crisis is as follows.

Table 3. Estimation of the ADL model in crisis

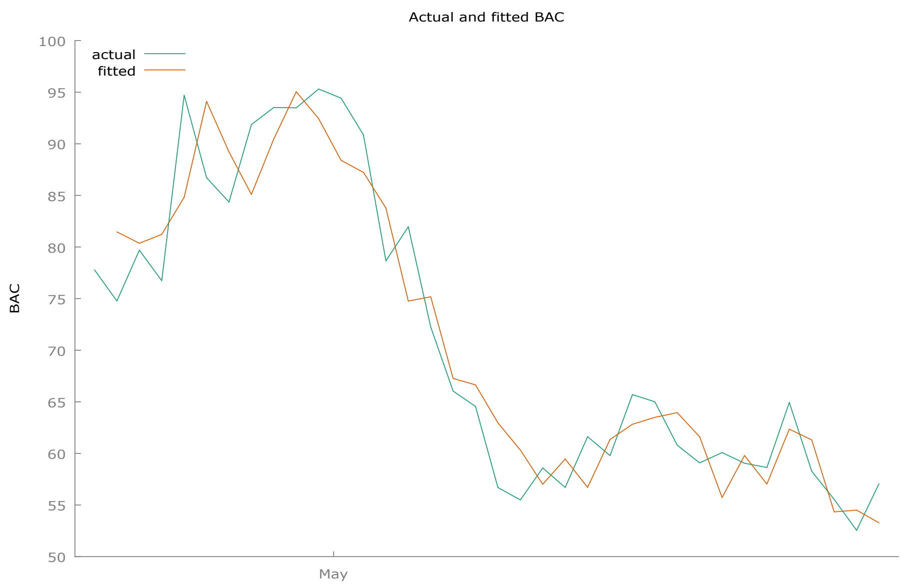
| | Coefficient | Std. Error | t-ratio | p-value | |
|---|---|---|---|---|---|
| const | 17.2575 | 7.13136 | 2.420 | 0.0216 | ** |
| SP500_1 | −0.0419946 | 0.0149684 | −2.806 | 0.0086 | *** |
| WBEI_1 | 0.470987 | 0.108848 | 4.327 | 0.0001 | *** |
| BAC_1 | 0.729271 | 0.0992771 | 7.346 | <0.0001 | *** |

*Source: own calculations using observations 2009:01 – 2011:11 (T = 35) and using standard HAC errors*

| | | | |
|---|---|---|---|
| *Notes: R-squared* | *0.910233* | *Adjusted R-squared* | *0.901546* |
| *F(3, 31)* | *104.7793* | *P-value(F)* | *<0.0001* |
| *Breusch Godfrey test* | *p-value = 0.4* | | |

According to the results given in table 3, it is possible to answer the last fourth research question and conclude that in the crisis period, the intensity of both exogenous variables is higher, and their effect is thus intensified. This is also confirmed by the results of the work of Dahl et al. (2020) who accounted for structural variations in data by dividing the data into two subsamples: from July 1986 to December 2005 (pre-2006 subsample) and from January 2006 to June 2016 (post-2006 subsample). Their findings indicate that there is minuscule information transmission among crude oil and agricultural commodities over the pre-2006 subsample, however, crude oil becomes the net receiver of information over the post-2006 subsample. They also indicated asymmetric and bidirectional flow of information among crude oil and agricultural commodities that intensifies during periods of financial and economic turmoil. Then stated that net volatility spill over increases in periods of large declines in the crude oil price, such as in 2008 and later in 2014. Figure 4 then shows the actual and theoretical values of the agricultural commodity price index during the economic crisis, which graphically express that the included explanatory variables were appropriately selected, and the model is verified.

Figure 4. Comparison of actual and fitted data of BAC in crisis 2009-2011




*Source: own calculations using Gretl*

## 4. Conclusion

The results of the examination of time series of selected price indices showed the relationship between S&P500, BAC and WBEI, which can be observed both in the long and short term. A negative relationship was demonstrated between the S&P500 stock price index and agricultural commodity indices, suggesting a shift in investor interest towards more stable commodities in the event of a sharp fall in stock prices. This relationship works with the lowest intensity. On the contrary, the energy commodity price index shows a positive dependence with agricultural commodity index, which is seen in the sum of current and lagged parameters. The result of the Engle-Granger cointegration test is the finding that at a level of significance of 0.1%, it is possible to confirm the long-term relationship between stock price indices, agricultural commodity, and energy commodity indices. Furthermore, it can be stated that a decrease in the S&P500 index by one percentage point will cause an increase in the price index of agricultural commodities by 0.011 percentage points. From the model estimated for the crisis period (2009 - 2011) it can be deduced that in the crisis period the intensity of both exogenous variables is higher, and their effect is thus intensified. Similar fluctuations occurred in 2020 and it can be assumed that we will see similar dependencies and fluctuations in the following years, when the COVID-19 pandemic will still affect world economies. This we can only predict, because the crisis is still in the beginning and it is not clear when the state returns to a stabilized mode.

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# ATTITUDES OF YOUNG COLLEGE AGE CONSUMERS TO THE USE OF PACKAGING WHEN SHOPPING AT RETAIL IN THE CONTEXT OF THE COVID PANDEMIC 19

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**Annotation**: In the last decade, a growing trend can be observed in all areas of consumption due to this fact amount of waste from packing from individual households is increasing rapidly. These topics have become the subject of extensive discussions among the professional and lay public in the context of sustainability, the environment and also the renewable resources. Many young people in economically developed countries have embraced the ideas of the Zero Waste and have actively considered the issues of recycling and economy in packaging management. Many young people in economically developed countries have embraced the ideas of the Zero Waste and have actively considered the issues of recycling and economy in packaging management. The aim of the article is to evaluate the current attitudes of young people in college age in the Czech Republic to the purchase of unpackaged good. Research was carried out in January 2021. Total number of respondents were 389. All respondents were university students. The contingency tables and $\chi 2$ test as methods were used for evaluation relationship between variables. For measuring of strength Cramer´s V was used. Four null hypotheses were defined. 83 % of respondents sort waste, from that more than 90 % of respondents sort plastics, paper, and glass at household. In contrast, only 22% of respondents sort bio-waste and 41% of respondents sort beverage cartons. Women showed more knowledge of sorting waste than men. More than 90 % of respondents stated that the volume of packaging waste in their households increased in the last year.

**Key words**: consumer, shopping preferences, waste sorting, unpackaged, zero waste.

**JEL classification**: P25, R11, R23, R58

## 1. Introduction

The current growing trend of consumption is still unsustainable and cannot be continued in the future, this fact must be accepted and accepted as a reality (Zaman and Lehmann, 2011). The globalization of world markets had a significant impact on the global agri-food complex (Gharehgozli et al., 2017). This is also confirmed by Townend (2010), who argues that new global resource management systems and climate change are bringing a shift from local to global thinking.

In this context, the issue of excessive packaging production and the related amount of waste comes to the fore (Beitzen-Heineke et al., 2017). Murray (2002) calls waste "shadow side of economy" and emphasizes that mass waste is primarily the result of mass production. Many companies have now noticed an increased consumer interest in environmental issues, including the use of sustainable packaging materials that are safe and environmentally friendly (Jerzyk, 2016). Sustainable packaging concepts have evolved along with the integration of sustainable development principles into industrial and organizational platforms at various levels (Boz et al., 2020).

Concerns about the unsustainability of the current conventional food system open up space for discussion on new alternative forms of food sales (Forssell and Lankoski, 2015). There are currently several well-established alternative food retail concepts, the main aim is to solve the environmental and social aspects of consumption (Beitzen-Heineke et al., 2017). Acuña Alvarado et al. (2020) point to the fact that in the case of alternative agri-food networks this is a relatively new phenomenon, which forms a new area for research. Food packaging waste is a valuable resource for material recovery if it is properly sorted by consumers (Nemat et al., 2020). Sattlegger (2021) considers the use of packaging and food packaging to be essential for the successful operation of supermarkets and hypermarkets, but notes that these retailers are also forced to respond to new trends in consumer preferences.

Many young people in economically developed countries have embraced the ideas of the Zero Waste movement and have actively considered issues of recycling and economy in packaging management. The Zero Waste concept is based on the 3 R rule (reduce, reuse, recycling), which is considered to be the basis of ecological balance. Fulfillment of this rule should be achieved through conscious behavior and informed choice (Song et al., 2014). Krausz et al. (2013) define Zero Waste as "a global movement focused on replacing linear resource-to-waste systems with circular systems found elsewhere in nature". Badowska and Delińska (2019) define Zero Waste as "a lifestyle that assumes the maximum reduction of household waste production". Noble et al. (2009) draw attention to specific patterns of consumer behaviour in young individuals in higher education and state that this social group represents great potential for retail in market segmentation.

The Covid 19 pandemic has dramatically affected the daily lives of all people and has far-reaching implications for all areas of society (Shabhaz et al., 2020, Richards and Rickard, 2020). The Covid 19 pandemic has also caused significant changes in food retail and catering services and transformed consumer perceptions and behaviours (Leone et al., 2020). In this context, the food sector shows great sensitivity, especially in connection with the increased demands on food safety, both in their processing, packaging and distribution. The risk of contamination must be avoided (Shabhaz et al., 2020). Consumers are showing higher interest and expectations in terms of safety in stores, the frequency of their purchases and the length of time they stay in the store have decreased. There has also been a significant increase in food retail sales through various internet platforms (Wang et al., 2020). Some changes in consumer behaviour when buying food can be considered permanent in the long run (Richards and Rickard, 2020).

The aim of the article is to evaluate the current attitudes of young people in college age from agriculture universities in the Czech Republic to the purchase of non-packaging goods and to find out their views on the use of packaging in the current context of the Covid 19 pandemic.

## 2. Materials and Methods

The theoretical framework of the presented article was prepared with the scientific and professional articles and supplemented with current information from relevant sources. Method of examining documents by Hendl (2015) was used. Primary data were obtained by quantitative research using questionnaire survey methods via Internet. The research parameters were chosen with regard to Noble et al. (2009), who focused on consumer research at college age.

The research was carried out in January 2021 through electronic surveys. From total number of respondents (n = 389), 27.5 % (107) were men and 72.5 % (282) were women. All participants were full-time students and belonged to the age category of 19-26 years, which is the usual college age in the Czech Republic. Due to the focus of the research, all participants in the questionnaire survey were students from agriculture universities from Czech University of Life Sciences – Faculty of Economics and Management (37.0%, 144 from total number), University of South Bohemia in České Budějovice - Faculty of Economics (29.6%, 115 from total number) and Mendel University in Brno - Faculty of Business and Economics (33.4%, 130 from total number). All universities are in the Czech Republic.

**Statistical Means for Analysis**

The contingency table is used for transparent visualization of mutal relations of two statistical variables. The type of the contingency table is given by the number of rows r and the number of columns s, is means $r \times s$ (Hindls et al., 2007).Obviously, $\chi^2$is a measurement of the overall dissimilarity of $n_{ij}$ and $m_{ij}$. The bigger the difference between observed and expected values, the higher is the test statistic $\chi^2$.

$$m_{ij} = \frac{n_i . n_j}{n} \tag{1}$$

$$\chi^2 = \sum \frac{(frequency\ observed - frequency\ expected)^2}{frequency\ expected} \tag{2}$$

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \left(n_{ij} - m_{ij}\right)^2 / m_{ij} \tag{3}$$

*i* and *j* are indexes of rows and columns, $n_{ij}$ are observed marginal frequencies, $n_i$ and $n_j$ are marginal totals, $n$ is grand total of observations, $m_{ij}$ are expected frequencies.We compare $\chi^2$ to the critical value $\chi^2$ with a chi-square distribution of *(r-1)(s-1)* degrees of freedom at the chosen level of significance. We reject the hypothesis if $\chi^2$ is larger than the table value. A completely equivalent expression of the test is a comparison of the p-value, obtained from the calculated statistics, with the value (1 - selected level of probability). This test is valid asymptotically, and thus can only be applied if there is a sufficient number of observations. All expected values ought to be higher than one (Hendl, 2015), at the same time, the table should not contain more than 20% theoretical incidence rates (frequencies) of less than 5. Where zero values occur in any of the fields, we proceed to analyze a derived table, created by merging a small number of categories (Hendl, 2015; Howell, 2011). Cramér's *V* was used to determine the degree of association between the variables (Blaikie, 2003).

The method of adjusted residuals was used to determine in which cells of the contingency table statistically significant deviations (residues) occur. These are calculated for the individual cells of the contingency table according to the formula.

$$ar_{ij} = (n_{ij} - m_{ij}) / \sqrt{\left(1 - \frac{n_i}{n}\right) * \left(1 - \frac{n_j}{n}\right) * m_{ij}} \tag{4}$$

A sign scheme was used to express statistical significance, where one to three signs express significance at the level of 0.95, 0.99 and 0.999.

The null hypotheses for research are summarized in the following table.

Table 1. Summary of established hypotheses

| No. of Hypothesis | Text of Hypothesis |
|---|---|
| **H01** | The respondent's knowledge of the use of waste does not depend on gender. |
| **H02** | The respondent's objective knowledge of the amount of waste per capita in the Czech Republic in 2019 does not depend on gender. |
| **H03** | The respondent's subjective knowledge of the use of sorted waste is not related to the real knowledge of the amount of all waste produced per capita in the Czech Republic in 2019. |
| **H04** | Knowledge of the term Zero Waste does not depend on the gender of the respondent. |

*Source: Own research, 2021*

## 3. Results and Discussion

More than 97 % of students thought that waste sorting has an impact on the state of the environment. Answer "definitely yes" was chosen by three quarters of the participants 75.1 % (292). Answer „rather yes“ was chosen by 22.6 % (88). Only 2.3 % (9) of participants expressed a skeptical attitude (answers "rather not" and "definitely not"). The findings indicate a high level of interest of young people in higher education in environmental issues. The same conclusions were reached by Rossi and Rivetti (2020), Maichum et al. (2017) or Jerzyk (2016).

The respondents stated in 389 cases (83 %) that they are sorting waste in household where they live. This finding corresponds to the results of a survey conducted in 2020 among the general population over the age of 15 by the Public Opinion Research Centre of the Institute of Sociology of the Academy of Sciences of the Czech Republic, which shows that approximately 92.0% of all households in the Czech Republic sort waste at least occasionally (Hanzlová, 2020), 82.0% do also regularly (Rondo Data research, 2019). The following table (Table 2) provides an overview of individual types of waste, which are sorted by respondents' households in terms of their frequency (n = 323).

Table 2. Classification of waste in respondents' households according to its type

| Waste type | Absolutely | Relatively |
|---|---|---|
| **Plastics** | 317 | 98.1% |
| **Paper** | 296 | 91.6% |
| **Glass** | 291 | 90.7% |
| **Beverage cartons** | 132 | 40.9% |
| **Metal** | 101 | 31.3% |
| **Bio waste** | 71 | 22.0% |

*Source: Own research, 2021*

The results show that almost all university students who sort waste in their household (n = 323) sort plastics (98.1 %, 317). More than 90.0 % of respondents sort paper (91.6 %, 296) and glass (90.7 %, 291). Approximately 41.0 % (40.9%, 132) of respondents also separate beverage cartons. Approximately (31.3 %, 101) of the surveyed persons sort metal waste and more than a fifth also sort bio waste (22.0 %, 71). The results of the Rondo Data research (2019) also showed that the citizens of the Czech Republic sort paper, glass and plastic most often.

Those respondents who do not sort waste (17.0 %, 66 persons out of the total number of n = 389) most often identified the lack of household space (51.5 %, 34) and the absence of containers for sorted waste at the place of residence as the main reason in 22 cases (33.3 %). These findings are confirmed by Jigani et al. (2020) who state that, in order to be motivated for sorting, it is important for persons producing the waste to have waste receptacles for sorted waste close to their home. Another important factor is the authors consider the correct marking of containers according to the established colour scheme. Nemat et al. (2020) concluded from their experiment that the main role in motivating consumers to sort food packaging waste is played by the visual attributes of packaging, material and the package´s waste sorting related functions.

It was also investigated whether the respondents believe that they know how to use ordinary household waste. Within this question, 30.8 % (120) of university students expressed the opinion that they are very well informed, 64.5 % (251) of persons stated a partial knowledge of this issue. Less than 5.0 % (4.6%, 18) of students stated that they did not know the way in which ordinary waste is used. These answers were further examined in more detail within the established null hypotheses H01.

Table 3. Respondent's subjective knowledge of the use of sorted waste

| Gender | Yes, very good | Yes, partially | No | Total |
|---|---|---|---|---|
| **Female** | 78 | 190 | 14 | 282 |
| **Male** | 42 | 61 | 4 | 107 |
| **Total** | 120 | 251 | 18 | 389 |

*Source: Own research, 2021*

The value of the statistic χ2 (4.92) is lower than the critical value of the distribution χ2 (5.99) by 2 degrees of freedom at the significance level of 0.05. The null hypothesis cannot be rejected. Thus, knowledge of the use of ordinary waste does not depend on the gender of the respondent.

Following the subjective feeling of information about waste management, the respondents were also asked how much of all waste per capita in the Czech Republic in 2019 accounted for. For this question, respondents had a choice of 4 options. The answer "0 - 200 kg" was chosen by 18.3 % (71) of respondents. More than a third of university students marked the answer "2001 - 3000 kg" (34.4 %, 134) and approximately the same number of people 36.2 % (141) chose the answer "3001 - 4000 kg". More than one tenth of respondents thought that the observed value was higher than 4001 kg (11.1 %, 43). In the Czech Republic, there were 3537 kg of all waste per capita in 2019 (Czech Statistical Office, 2019). Within this question, the null hypothesis H02 was examined.

Table 4. Respondent's objective knowledge of the amount of waste per capita in the Czech Republic in 2019

| Gender | 0-2000 kg | 2001 – 3000 kg | 3001 – 4000 kg | More then 4000 kg | Total |
|---|---|---|---|---|---|
| **Female** | 49 | 98 | 112 | 23 | 282 |
| **Male** | 22 | 36 | 29 | 20 | 107 |
| **Total** | 71 | 134 | 141 | 43 | 389 |
| | | | **Adjusted residuals** | | |
| **Female** | -2.5 | 0.9 | 9.8 | -8.2 | |
| **Male** | 2.5 | -0.9 | .9.8 | 8.2 | |
| | | | **Sign scheme** | | |
| **Female** | | | + | -- | |
| **Male** | | | + | ++ | |

*Source: Own research, 2021*

The calculated statistic $\chi2$ for Table 4., which is 12.65, is higher than the critical value of the distribution of $\chi2$ by 3 degrees of freedom at the significance level of 0.05. The null hypothesis can be rejected. The degree of dependence measured by Cramer's V is 0.17, the dependence is weak. Objective knowledge depends on the gender of the respondent. In terms of gender, women chose the correct answer more often, because 39.7 % (112 people) chose it among all respondents of this gender. Men chose the correct answer only in 27.1 % (29 people). It follows from the above that women have shown a higher level of awareness on this issue. Based on their research, Badowska and Delińska (2019) also reached the same conclusions. As can be seen from the above values, only less than 40.0 % of respondents out of the total number of respondents (n = 389) chose the correct answer, which contrasts with the belief of almost all respondents that they are somewhat familiar with waste management (95.3 % , 371). Subsequently, the relationship between the subjective opinion on the knowledge of the use of waste sorting and the real knowledge of the amount of all waste per capita in the Czech Republic was examined.

Subsequently, the relationship between the subjective opinion on the knowledge of the use of waste sorting and the real knowledge of the amount of all waste per capita in the Czech Republic was examined.

Table 5. Respondent's subjective knowledge of the use of sorted waste in relation to the real knowledge of the amount of all waste produced per capita in the Czech Republic in 2019

| Answers | Yes, very good | Yes, partially | No | Total |
|---|---|---|---|---|
| **0 – 2000 kg** | 20 | 45 | 6 | 71 |
| **2001 – 3000 kg** | 35 | 94 | 5 | 134 |
| **3001 – 4000 kg** | 51 | 85 | 5 | 141 |
| **More then 4001 kg** | 14 | 27 | 2 | 43 |
| **Total** | 120 | 251 | 18 | 389 |

*Source: Own research, 2021*

The value of the $\chi2$ (6.39) statistic is lower than the critical value of the $\chi2$ (12.59) distribution by 6 degrees of freedom at the 0.05 significance level. The null hypothesis H03 cannot be rejected. Thus, no connection was found between the subjective knowledge of the reaction to waste sorting and its real knowledge of the amount of all waste produced per capita in the Czech Republic in 2019.

In the next part of the questionnaire survey, it was found out whether the respondents are aware of the concept of Zero Waste and know the content of this concept. Within this question, the null hypothesis H04 in relation to the gender of the respondents was examined.

Table 6. Knowledge of the term Zero Waste in relation to the gender of the respondent

| Gender | Yes, I know the exact content of the term | Yes, partly I know what it is | No, I've never heard of it | Total |
|---|---|---|---|---|
| **Female** | 108 | 155 | 19 | 282 |
| **Male** | 33 | 57 | 17 | 107 |
| **Total** | 141 | 212 | 36 | 389 |
| | | **Percentage** | | |
| **Female** | 38.3 % | 55.0 % | 6.7 % | 100.0 % |
| **Male** | 30.8 % | 53.3 % | 15.9 % | 100.0 % |
| **Total** | 36.2 % | 54.5 % | 9.3 % | 100.0 % |
| | | **Adjusted residuals** | | |
| **Female** | 5.8 | 1.3 | -7.1 | |
| **Male** | -5.8 | -1.3 | 7.1 | |
| | | **Sign scheme** | | |
| **Female** | | | -- | |
| **Male** | | | ++ | |

*Source: Own research, 2021*

The calculated statistic $\chi2$ for Table 6, which is 8.25, is higher than the critical value of the distribution of $\chi2$ by 2 degrees of freedom at the significance level of 0.05. The null hypothesis can be rejected. The degree of dependence measured by Cramer's V is 0.15, the dependence is weak.

Women had a higher general knowledge of the term Zero Waste than men (93.3 % vs. 84.1 %). Differences can also be observed for individual answers, when out of the total number of responding women (n = 282) less than 40.0 % (38.3 %, 108) declared accurate knowledge of the concept. In research of Badowska and Delińska (2019) among young respondents under 24 in Poland, concluded that only a third of respondents (32.02%) showed knowledge of Zero Waste. The popularization of the concept and ideas of Zero Waste has been happening mainly in recent years, which may have influenced the results of this research. It can also be concluded that there is a greater interest in the issue of unpackaged shopping among university-educated people, as Hanzlová (2020) states. Furthermore, the respondents were asked in the form of a voluntary question to explain this concept themselves. Only one-fifth of respondents (20.6%, 29 people) answered those who declared exact knowledge of the term (n = 141).

The concept of non-packaging sales in retail is well known for majority of respondents, 85.3% (332) of the total number of young people of university age who participated in the questionnaire survey (n = 389). In terms of individual forms of purchase, young people most often registered specialized shops with unpackaged goods (63.8 %, 248) also the possibility of shopping without packaging at food e-shops with delivery to the household (42.4 %, 165) and the possibility of such shopping in some supermarkets or hypermarkets (32.4 %, 126). Furthermore, students indicated on a scale the extent to which they identified with certain claims concerning changes in their consumer behaviour in the last year. The results showed that more than 90.0 % (91.3 %, 355) of the total number of respondents (n = 389) registered an increase in the waste produced in their households.

Based on his research, Jerzyk (2016) declares clear differences in the perception of packaging between individual generations of consumers. While Millennials focuses on packaging, its aesthetics, innovation and environmental friendliness. Generation Z considers the originality and prestige of the packaging and the possibility to express belonging to a certain social group through its purchase. Noble et al. (2009) reached similar conclusions as Jerzyk (2016) about the Z generation in 2009 about university students of the Y generation. It can therefore be assumed that this is the opinion of the respondents in the context of age rather than a stable generational statement. . Based on their research, Naderi and van Steenburg (2018) state that young people behave pro-environmentally for rational and personally oriented reasons.

Boz et al. (2020) considers the current situation in the field of plastic pollution, packaging waste, declining air, soil and water quality, climate change and others to be a major challenge for the packaging industry. Acuña Alvarado et al. (2020) describe alternative agri-food networks as extremely resilient in times of crisis, as exemplified by the current Covid 19 pandemic. Hobbs (2020) predicts that the pandemic will increase interest in local food production as consumers prefer safe food and will wish to support local producers and traders. These facts form the premise of a good perspective of the business concept of non-packaging sales in retail.

## 4. Conclusion

The aim of the article is to evaluate the current attitudes of young people in college age in the Czech Republic to buy unpackaged goods and find out their views on the use of packaging in the current context of the Covid 19 pandemic. The research shows that more than 83% of respondents sort waste, most often sorted waste is plastics, paper and glass. Awareness of the term Zero Waste was declared by 90.7% of young people in college age. Women showed more knowledge of this issue than men (93.3% vs. 84.1%). The concept of unpackaged sales in retail was recorded by 85.3% of people. More than 90% of stakeholders stated that the volume of packaging waste in the household in which they live has increased in the last year. At the same time, however, college students consider the effort to minimize packaging to be a current problem and consider importance to this issue in relation to the environment and the future.

The theoretical contribution of the article is to point out the use of packaging and zero waste among consumers from agriculture universities in the context of the Covid 19 pandemic. The practical contribution of the article is to present the results of the attitudes of a specific group of the population - young university students from agriculture universities. It can be considered as a limitation that the research was carried out at three selected agricultural universities. From the point of view of further expansion of research comparison with other universities in the Czech Republic can be considered. The authors of the articles also consider a possible comparison with other EU countries as possible direction of research.

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# RE-PRODUCT MAPPING OF UZBEK AGRI-FOOD PRODUCTS IN THE WORLD MARKET AND DETERMINE THEIR COMPETITIVENESS IN DIFFERENT TRADE BLOCS

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**Annotation**. The trade balance of Uzbekistan in 2015 amounted to -2,095 million dollars, and in 2019 this figure reached -7,308 million dollars. The foreign trade of Uzbekistan in 2015 amounted to 30.4% of GDP, and in 2019 this figure reached 73%. Uzbek agro-food inflation averaged 5.39 % between 2005 and 2018, reaching a record 20.10 % in 2018 and a record low of -0.40 % in 2016, and averaged 16.9 % in 2019.

This article analyses Uzbek foreign trade in agri-food products from the following perspectives: international competitiveness and trade balance of Uzbekistan. The intention of the analyses is to determine the identification of changes in agricultural trade character. Changes in commodity structure are specified and individual changes are explained.

Competitiveness is analyzed in relation to different groups of countries (CIS countries without Asian countries, EU28 without other European countries, Asian countries without CIS countries, other European countries without EU and CIS, and developing countries) and significant trading partners in the agricultural sector. A significant drawback of Uzbek agricultural trade is its ability to create added value. The unit value of Uzbek imports is much higher than the unit value of exports.

Agrarian trade competitiveness and territorial and commodity structure changes are analyzed for the last 10 years. The agrarian trade commodity structure of agricultural trade is analyzed on the basis of the standard Harmonized System. The basic source of data for the analysis in the article is UN COMTRADE.

The analysis is based on the following method and indexes: Herfindahl-Hirschman index, "product mapping approach" method, the trade balance index and Lafay index. In addition, some other statistical characteristics are applied: chain index, geomean, import/export coverage ratio, basic index, etc. Uzbek agricultural exports are competitive with regard to CIS countries and Asian countries and limited when compared with other countries.

**Key words**: Agrarian trade, Uzbekistan, competitiveness, Export and import.

**JEL Classification**: Q13, Q17

## 1. Introduction

The export potential of agricultural products is one of the organic parts of the national economy. The main role of agricultural exports is the ability to foster the current state of the Uzbek agro-industrial complex and to use its competitive prospects. The sharp decline in interregional trade turnover is due to various geopolitical factors during the pandemic (Covid-19).

In the past few years, the global economy has undergone significant changes in its overall picture. This is the result of fundamental changes in the economic and geopolitical framework of global development. In this context, the idea of returning the so-called geopolitics and geoeconomics to the practice of world economic, but also in a broader sense, political relations have appeared in the professional literature. It aims to use trade policy instruments to achieve the strategic geopolitical goals of individual powers and their geopolitical ambitions. (Benešová, Novotná, Šánová, & Laputková, 2016a; Veebel & Markus, 2018).

In 2013, the Republic of Uzbekistan signed a protocol on membership in the CIS free trade zone. The main goal of the Protocol is the effort of Uzbekistan to unify trade regimes in relation to CIS and to foster existing cooperation within the customs union of the former Soviet countries (Smutka et al., 2015a). Uzbekistan has similar structural problems to Russia. These challenges include unfinished transformation, over-reliance on natural resources, lack of innovation and low productivity (Connolly, 2015; Hartwell, 2013).

Uzbek agrarian foreign trade experienced significant changes in the period of 2010 to 2019 was significantly changed. Only in the period from 2010 through 2019 its export value decreased from 723 million USD to 445 million USD. The growth of imports even exceeded the growth of exports (from 863 million USD up to 1.1 billion USD). The performance of agrarian trade is growing year by year. Therefore, for the effective development of national exports, it is necessary to focus attention on those segments of agricultural production that are competitive and have comparative or absolute advantages especially in relation to the regional partners. The territorial structure of Uzbek agricultural and foodstuff exports in the period of 2010 to 2019 was heavily focused on Asian and CIS countries. Only in 2010, the share of CIS members in agricultural exports and imports reached 80.8% and 63.4%, respectively. In the same year - the share of other Asian countries in agri-food exports and imports reached cc 10.4% respectively 13.2%. Later on (in 2019), the share of CIS countries was reduced in favor of other Asian countries. While CIS country's share in exports and imports was reduced to 70.5% respectively 67.3%, the share of other Asian countries increased up to 16%, respectively 12%. The dominant positions are kept by Russia, Kazakhstan and Belarus. On the other hand, the share of exports to Russia is decreasing, and Kazakhstan has become an extremely important trade partner for Uzbek agrarian exports within the last few years. (Ilyina, D. FAO 2016). Within the mentioned time period, the Republic of Uzbekistan and other post-soviet countries significantly changed their trade strategies and policies. The negative feature of Uzbek agrarian trade is a much faster growth of import value in comparison to the growth of export value. The result is constantly increasing negative trade balance. The main role of agricultural exports is the ability to exaggerate the current state of the Uzbek agro-industrial complex and to use its competitive prospects.

## 2. Materials and Methods

The article analyzes the export potential of Uzbekistan in the international market of agricultural products for the last two decades (2010–2019). The article is focused on trade competitiveness in relation to individual groups of trade partners of Uzbekistan. Trade performance is analyzed in relation to the following groups: Asian countries (without the CIS), European countries (without CIS and EU28), CIS countries (without Asian countries), and other European countries (without EU28). The classification of agricultural products in the article uses the Harmonized System (according to UN Comtrade methodology), which divides agricultural trade into 24 aggregations. The article calculates all values at current prices in USD.

The article analyzes the allocation of comparative advantages in relation to the Asian market, as well as to the rest of the world (CIS members, other European countries (without EU28), the European Union (EU28) and developing countries). The following methods are used to achieve the above-mentioned results: Herfindahl-Hirschman index, Lafay index, trade balance index and product mapping. The Herfindahl-Hirschman index uses a common measure for market concentration and the determination of market competitiveness. The LFI and TBI indices only provide limited knowledge of trade competitiveness development. The "product mapping method" defines the whole process of profiling the commodity structure of the agrarian foreign trade of Uzbekistan. This approach is based on a combination of both above-mentioned indicators (a similar approach has already been tested by Maitah et al., 2016; Bielik et al., 2013; Rezbova et al., 2014; Svatos et al., 2010; Borak et al., 2018; Braha et al., 2019; Ferto 2017, 2018; Jambor et al., 2017; Wajda-Lichy & Kawa, 2018; Bilan et al., 2018; Kozlovskyi et al., 2018). The Lafay index (Lafay, 1992) analysis is used to help provide information on bilateral trade relations between countries and regions. The use of the Herfindahl-Hirschman index is a common indicator of market concentration and is used to determine market competitiveness. HHI is calculated by squaring the market share of each country competing in the market and then summing the results. It can range from zero to 10,000. A market with an HHI of less than 1,500 is considered a competitive market, an HHI of 1,500 to 2,500 is a moderately concentrated marketplace, and an HHI of 2,500 or more is a highly concentrated marketplace. Using the LFI index, we may observe the difference between the general normalized trade balance and each item's normalized trade balance. The LFI index, by taking imports into account, allows controlling for intra-industry trade and re-export streams. Defined in this way, it is superior to the traditional Revealed Comparative Advantages index (Balassa, 1965). Thus, the LFI index is used to eliminate the influence of cyclical factors that may affect the amount of trade streams in the short term, and to focus on bilateral trade relations between regions and countries.

Contrarily, negative values indicate de-specialization (Zaghini, 2003; Smutka et al., 2015b). While the LFI index is focused on the analysis of the development of competitiveness, the TBI index analyzes the development of the trade balance. A country is defined as a "net importer" in a specific product group if the TBI value is negative, and a "net exporter" if the TBI value is positive. (Widodo, 2009; Ischukova, Smutka, 2013 and 2014).

Figure 1 represents the matrix for the allocation of the whole set of exported commodities into 4 groups in accordance with two selected indicators (LFI and TBI). The data sources for individual analysis are the State Committee of the Republic of Uzbekistan on Statistics and UN COMTRADE.

The Herfindahl-Hirschman index is calculated by squaring the market share of each country competing in the market and then summing up the results. The Herfindahl-Hirschman index is formulated as follow:

$$\text{HHI} = S12 + S22 + S32 + \ldots .\ Sn2 \qquad \textbf{(1)}$$

Where: $Sn$ is the market share percentage of country n expressed as a whole number, not a decimal.

The next method used in this paper is the product mapping method. This method determines the whole process of profiling the commodity structure of the agrarian foreign trade of Uzbekistan:

Figure 1. Modified product mapping scheme

<table>
<tr><td rowspan="2">Lafay index</td><td>Group B:<br>Comparative Advantage Net-importer<br>(LFI > 0 and TBI < 0)</td><td>Group A:<br>Comparative Advantage<br>Net-exporter<br>(LFI > 0 and TBI > 0)</td></tr>
<tr><td>Group D:<br>Comparative disadvantage<br>Net-importer<br>(LFI < 0 and TBI < 0)</td><td>Group C:<br>Comparative disadvantage<br>Net-exporter<br>(LFI < 0 and TBI > 0)</td></tr>
<tr><td>Uzbek Agrarian Foreign Trade Commodity Structure</td><td colspan="2">Trade Balance Index</td></tr>
</table>

*Source: own modification and processing (2021)*

The trade balance index (TBI) by Lafay (1992) is an indicator of export-import activities.

The TBI is mainly used to analyze whether a country specializes in imports (as a net importer) or exports (as a net exporter) for a specific group of products, and is simply formulated as follows:

$$TBIij = (xij-mij)/(xij+mij) \qquad \textbf{(2)}$$

where TBIij denotes the trade balance index of country i for product j; xij and mij represent exports and imports of group of products j by country i, respectively. (Lafay, 1992). Values of the index range from -1 to +1. At the extremes, the TBI equals -1 if a country only imports; in contrast, the TBI equals +1 if a country only exports. Indeed, the index is not defined when a country neither exports nor imports. A country is termed a "net exporter" if the TBI reaches positive values and "net importer" in a specific product if the TBI values are negative (Widodo, 2009; Zaghini, 2003).

By considering imports, the Lafay index (LFI) allows controlling for intra-industry trade and re-export flows (Lafay, 1992). In this sense, it surpasses the traditional index of Revealed Comparative Advantages (Balassa, 1965).

Since comparative advantages are structural, by definition it is extremely important to exclude the influence of cyclical factors that may affect the amount of trade flows in the short term.

The Lafay index takes these effects into account, given the difference between the normalized trade balance of each position and the overall normalized trade balance. Finally, the Lafay index weighs the contribution of each product according to its importance in trading.

For a given country, i, and for any given product j, the Lafay index is defined as:

$$LFI_j^i = 100\left(\frac{x_j^i - m_j^i}{x_j^i + m_j^i} - \frac{\sum_{j=1}^{N}(x_j^i - m_j^i)}{\sum_{j=1}^{N} x_j^i + m_j^i}\right)\frac{x_j^i + m_j^i}{\sum_{l=1}^{N} x_j^i + m_j^i} \qquad \textbf{(3)}$$

where xij and m ij are exports and imports of product j of country i, towards and from the rest of the world, respectively, and N is the number of items.

Positive values of the Lafay index indicate the existence of comparative advantages in a given item; the larger the value, the higher the degree of specialization. (Zaghini, 2003).

The RSCA index is a common decreasing commons transformation of the Balassa index (Balassa, 1991) or revealed comparative advantage (RCA). In practice, the Balassa index is a generally accepted method for analyzing the transaction date (Bielik, Smutka and Svatos, 2013; Dalum, Laursen and Villumsen, 1998; Maitah, Rezbova and Smutka, 2016; Rezbova, Smutka and Purkrabek, 2014; Cieślik et al., 2018). RCA is based on export performance and observed trade patterns. This index was used to determine the most important areas and product groups for the region's export trade. It is used in the international economy to calculate the relative advantage or disadvantage of a particular country in a particular class of goods or services. RCA measures a country's exports of a commodity (or industry) relative to its total exports and to the corresponding exports of a set of countries.

$$RCA = (Xij/Xit)/(Xnj/Xnt) = (Xij/Xnj)/(Xit/Xnt) \qquad \textbf{(4)}$$

where X represents exports, i is a country, j is a commodity (or industry), t is a set of commodities (or industries) and n is a set of countries. The RSCA index is characterized as follows:

$$RSCA = (RCAit-1)/(RCAij+1) \qquad \textbf{(5)}$$

The values of the RSCAij index range from minus one to one. RSCAij greater than zero implies that country i has a comparative advantage in a group of products j. In contrast, RSCAij less than zero implies that country i has a comparative disadvantage in a group of products j (Svatos and Smutka, 2012).

This article presents an extended version of an article presented at the Agrarian Perspectives conference under the title Comparative advantage: Products mapping of Uzbekistan´s agricultural exports (Ortikov and Vacek, 2018) and in the Journal of International Studies under the title Competitiveness of Uzbek agrarian foreign trade – different regional trade blocs and the most significant trade partners. (Ortikov, Smutka and Benesova, 2019).

**3. Results and Discussion**

The agrarian trade of Uzbekistan is concentrated on CIS members, Central Asian and European countries (Table 1). The most dominant role is played by CIS members, Asian countries and EU members. But during the analyzed time period the role of individual partners changed. The total value of agricultural trade performance recorded significant growth. The nominal value of exports decreased from about 723 mil. USD to about 445 mil. USD. The value of imports recorded growth from 863 mil. USD up to 1.4 bil. USD. The total value of the negative agri-food trade balance increased from 140.2 mil. USD up to about 700 mil. USD. The problem of Uzbek agrarian trade value development is connected to much lower inter-annual growth rate of export value in comparison to inter-annual growth of import value. Because of much higher imports' dynamics in comparison to exports, Uzbekistan recorded the significant reduction of export/import coverage ratio.

Table 1. Uzbek agrarian exports' concentration - by regional groups (HHI index)

| **Groups** | **2010** | | **2019** | |
|---|---|---|---|---|
| | **Market share** | **HHI index** | **Market share** | **HHI index** |
| Asia (without GIS countries) | 14.0% | 196.0 | 16.0% | 256.0 |
| Africa | 0.1% | 0.0 | 1.0% | 1.0 |
| EU 28 | 4.0% | 16.0 | 10.1% | 102.0 |
| Other European countries (without EU and CIS) | 0.7% | 0.5 | 0.5% | 0.3 |
| CIS (without Asian countries) | 80.8% | 6,528.6 | 70.5% | 4,970.3 |
| North America | 0.4% | 0.2 | 1.6% | 2.6 |
| Latin America | 0.1% | 0.0 | 0.2% | 0.0 |
| Australia and Oceania | 0.0% | 0.0 | 0.0% | 0.0 |
| World | 100.0% | 6741.3 | 100.0% | 5,332.1 |

*Source: own processing, 2021*

During the analyzed time period export/import coverage ratio significantly decreased from 84% to 39%.

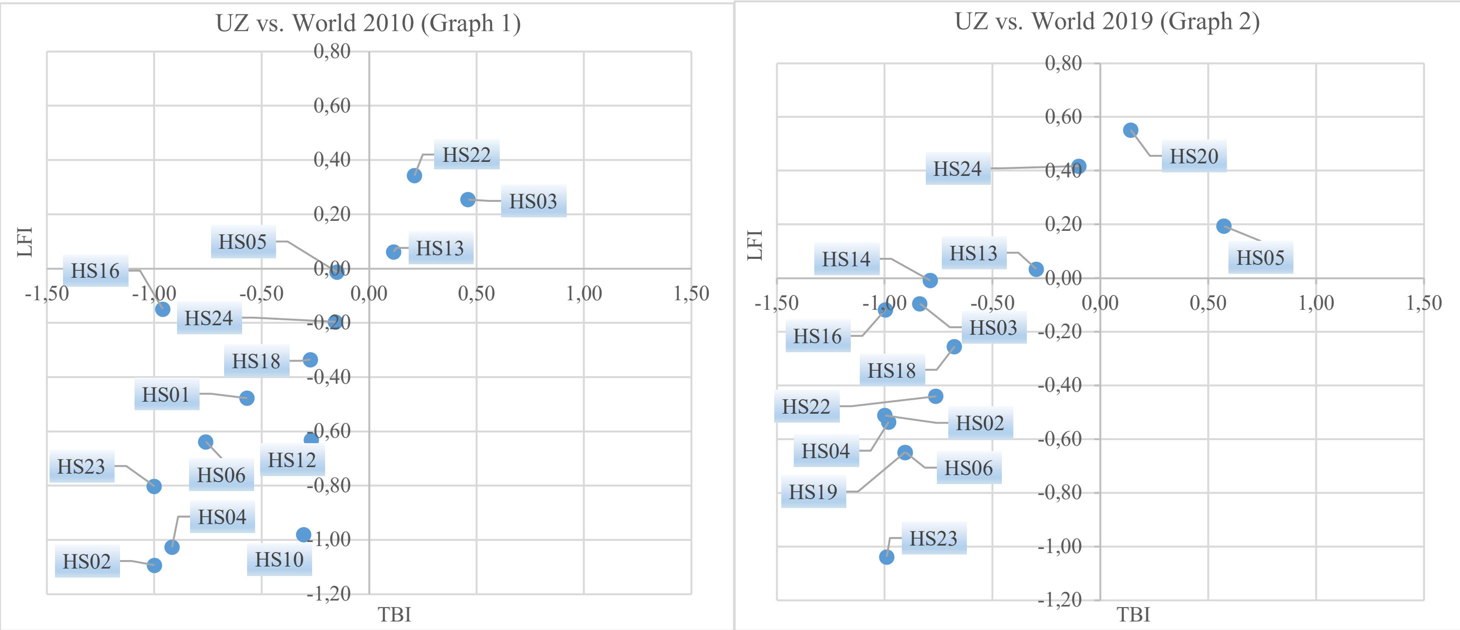
In 2000, the Asian share in Uzbek agricultural exports and imports reached about 14% and 16%, respectively. In the same year - the share of EU28 in agricultural exports and imports reached about 4% and 10.1%, respectively and the share of CIS members in agricultural exports and imports reached 80.8% and 70.5%, respectively.

Table 2. Uzbek agrarian foreign trade value development between 2010 and 2019 in USD

| **2010** | **Africa** | **Asia** | **CIS** | **Australia and Oceania** | **EU 28** | **Other European countries** | **North America** | **Latin America** | **World total** |
|---|---|---|---|---|---|---|---|---|---|
| Export | 472,816 | 101,525,002 | 584,297,384 | 82,285 | 28,838,225 | 5,247,670 | 2,556,550 | 375,707 | 723,395,639 |
| Import | 2,290,843 | 113,574,116 | 547,275,202 | 3,605,879 | 170,740,536 | 6,160,991 | 479,211 | 19,531,782 | 863,658,560 |
| Balance | -1,818,027 | -12,049,114 | 37,022,182 | -3,523,594 | -141,902,311 | -913,321 | 2,077,339 | -19,156,075 | -140,262,921 |
| Balance/ Export | -384.51% | -11.87% | 6.34% | -4282.18% | -492.06% | -17.40% | 81.26% | -5098.67% | -19.39% |
| 2019 | Africa | Asia | CIS | Australia and Oceania | EU 28 | Other European countries | North America | Latin America | World total |
| Export | 4,242,449 | 71,303,099 | 313,852,390 | 129,227 | 45,160,072 | 2,367,330 | 7,106,512 | 949,032 | 445,110,111 |
| Import | 1,801,970 | 136,545,955 | 770,881,216 | 32,654 | 182,540,924 | 9,406,982 | 28,085,124 | 15,990,928 | 1,145,285,753 |
| Balance | 2,440,479 | -65,242,856 | -457,028,826 | 96,573 | -137,380,852 | -7,039,652 | -20,978,612 | -15,041,896 | -700,175,642 |
| Balance/ Export | 57.53% | -91.50% | -145.62% | 274.19% | -304.21% | -297.37% | -295.20% | -42707.18% | -157.30% |
| Export Basic index 2019/2010 | 0.23 | 3.82 | 0.54 | 1,360.28 | 1.57 | 0.45 | 2.78 | 9,989.81 | 0.62 |
| Import Basic index 2019/2010 | 0.05 | 3.82 | 1.41 | 0.56 | 1.07 | 1.53 | 58.61 | 275.73 | 1.33 |

*Source: COMTRADE database, 2021 and own calculations.*

Graphs 1 - 2. Uzbek agrarian exports' comparative advantages distribution – traditional and modified "Product mapping approach"




*Source: own processing, 2021*

As can be seen in tables 2 the current agricultural trade performance of Uzbekistan is heavily focused on CIS and Asian countries. Those partners represent nearly 86 % of export value and 80% of import value in 2018. The key aspect of Uzbek agrarian trade is its competitiveness (especially low-price competitiveness). Based on volume (tons) and value (total value and unit value) analysis, bulk commodities (e.g., vegetables, fruits) could be considered the main driver of agricultural export growth. Another very specific feature of Uzbek agri-food trade is its concentration on post-Soviet countries. The markets of those countries represent the key territory for export-oriented activities. And mutual trade agreements (preferential trade agreements and free-trade zones) could be considered the key element supporting national export ambitions.

The existence of comparative advantages is proved through the application of LFI and TBI indices, taking into consideration only agricultural trade performance. The above-mentioned graphs provide an overview related to the global competitiveness of individual Uzbek agrarian trade items (graphs 1 and 2). The graphs provide a different overview of the modified product mapping approach. The results provided by the modified approach deliver a more accurate overview of the distribution of the comparative advantages of Uzbek agrarian exports. The number of items located in groups B and C is significantly reduced, and the whole commodity structure is divided into two groups, A (with comparative advantages) and D (without comparative advantages). The modified approach is able to specify in more detail the current level of Uzbek agrarian trade competitiveness and competitiveness development. Using this applied approach, it is evident that the structure of Uzbek agrarian commodity trading has been significantly changing its character. The commodity structure is still looking for its optimal state (for details see tables 3 and 5 (global) and also tables 4 and 6 (for CIS countries)).

Table 3. Uzbek agrarian trade commodity structure in 2010 (traditional product mapping approach) in USD

| **All trade transactions worldwide 2010** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **B-2010** | **Export** | **Share in export** | **Import** | **Share in import** | **A-2010** | **Export** | **Share in export** | **Import** | **Share in import** |
| | | | | | HS03 | 5,384,700 | 0.74% | 1,991,026 | 0.23% |
| | | | | | HS07 | 214,586,716 | 29.66% | 17,011,514 | 1.97% |
| | | | | | HS08 | 344,494,681 | 47.62% | 5,565,867 | 0.64% |
| | | | | | HS13 | 2,710,066 | 0.37% | 2,154,418 | 0.25% |
| | | | | | HS14 | 17,903,138 | 2.47% | 34,718 | 0.00% |
| | | | | | HS20 | 30,590,859 | 4.23% | 6,316,406 | 0.73% |
| | | | | | HS22 | 11,019,425 | 1.52% | 7,180,195 | 0.83% |
| | | | | | Total | 626,689,585 | 86.63% | 40,254,144 | 4.66% |
| **D-2010** | **Export** | **Share in export** | **Import** | **Share in import** | **C-2010** | **Export** | **Share in export** | **Import** | **Share in import** |
| HS01 | 3,411,291 | 0.47% | 12,373,861 | 1.43% | | | | | |
| HS02 | 7,729 | 0.00% | 19,036,987 | 2.20% | | | | | |
| HS04 | 806,266 | 0.11% | 18,827,332 | 2.18% | | | | | |
| HS05 | 1,410,125 | 0.19% | 1,905,018 | 0.22% | | | | | |
| HS06 | 1,803,815 | 0.25% | 13,259,820 | 1.54% | | | | | |
| HS09 | 6,078,550 | 0.84% | 33,996,309 | 3.94% | | | | | |
| HS10 | 25,085,090 | 3.47% | 47,006,697 | 5.44% | | | | | |
| HS11 | 4,854,925 | 0.67% | 253,712,272 | 29.38% | | | | | |
| HS12 | 20,302,492 | 2.81% | 35,236,280 | 4.08% | | | | | |
| HS15 | 1,735,354 | 0.24% | 195,352,510 | 22.62% | | | | | |
| HS16 | 53,295 | 0.01% | 2,653,364 | 0.31% | | | | | |
| HS17 | 1,427,559 | 0.20% | 75,979,918 | 8.80% | | | | | |
| HS18 | 10,449,972 | 1.44% | 18,309,307 | 2.12% | | | | | |
| HS19 | 26,519 | 0.00% | 22,133,485 | 2.56% | | | | | |
| HS21 | 291,449 | 0.04% | 33,642,574 | 3.90% | | | | | |
| HS23 | 272 | 0.00% | 13,954,299 | 1.62% | | | | | |
| HS24 | 18,961,351 | 2.62% | 26,046,851 | 3.02% | | | | | |
| Total | 96,706,054 | 13.37% | 823,426,884 | 95.34% | | | | | |

*Source: own processing, 2021*

Table 4. Uzbek agrarian trade commodity structure by CIS countries in 2010 (traditional product mapping approach) in USD

| **Trade transactions by CIS countries 2010** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **B-2010** | **Export** | **Share in export** | **Import** | **Share in import** | **A-2010** | **Export** | **Share in export** | **Import** | **Share in import** |
| | | | | | HS01 | 1,720,817 | 0.29% | 1,552,849 | 0.28% |
| | | | | | HS05 | 36,480 | 0.01% | 20,129 | 0.00% |
| | | | | | HS06 | 1,799,515 | 0.31% | 343,624 | 0.06% |
| | | | | | HS07 | 182,969,423 | 31.31% | 2,365,853 | 0.43% |
| | | | | | HS08 | 327,899,815 | 56.12% | 1,050,616 | 0.19% |
| | | | | | HS09 | 2,068,590 | 0.35% | 180,213 | 0.03% |
| | | | | | HS12 | 11,632,745 | 1.99% | 3,821,259 | 0.70% |
| | | | | | HS13 | 37,613 | 0.01% | 7,157 | 0.00% |
| | | | | | HS14 | 209,053 | 0.04% | 13,868 | 0.00% |
| | | | | | HS16 | 1,427,559 | 0.24% | 692,902 | 0.13% |
| | | | | | HS20 | 25,903,061 | 4.43% | 2,737,428 | 0.50% |
| | | | | | HS22 | 10,455,913 | 1.79% | 2,543,923 | 0.46% |
| | | | | | HS24 | 14,124,017 | 2.42% | 3,811,413 | 0.70% |
| | | | | | Total | 580,284,601 | 99.31% | 19,141,234 | 3.50% |
| **D-2010** | **Export** | **Share in export** | **Import** | **Share in import** | **C-2010** | **Export** | **Share in export** | **Import** | **Share in import** |
| HS02 | | | 38,429 | 0.01% | | | | | |
| HS03 | 165,170 | 0.03% | 226,544 | 0.04% | | | | | |
| HS04 | 751,595 | 0.13% | 7,495,229 | 1.37% | | | | | |
| HS10 | 1,155,229 | 0.20% | 45,784,802 | 8.37% | | | | | |
| HS11 | 8,348 | 0.00% | 249,910,891 | 45.66% | | | | | |
| HS15 | 1,550,076 | 0.27% | 151,841,353 | 27.74% | | | | | |
| HS17 | | | 29,127,068 | 5.32% | | | | | |
| HS18 | 85,541 | 0.01% | 5,126,094 | 0.94% | | | | | |
| HS19 | 26,519 | 0.00% | 16,260,685 | 2.97% | | | | | |
| HS21 | 270,305 | 0.05% | 11,880,302 | 2.17% | | | | | |
| HS23 | | | 10,442,571 | 1.91% | | | | | |
| Total | 4,012,783 | 0.69% | 528,133,968 | 96.50% | | | | | |

*Source: own processing, 2021*

Table 5. Uzbek agrarian trade commodity structure in 2019 (traditional product mapping approach) in USD

| All trade transactions worldwide 2019 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **B-2019** | **Export** | **Share in export** | **Import** | **Share in import** | **A-2019** | **Export** | **Share in export** | **Import** | **Share in import** |
| HS13 | 1,330,162 | 0.30% | 2,454,232 | 0.21% | HS05 | 2,396,108 | 0.54% | 649,872 | 0.06% |
| HS24 | 8,773,568 | 1.97% | 10,710,778 | 0.94% | HS07 | 131,433,934 | 29.53% | 27,449,760 | 2.40% |
| | | | | | HS08 | 247,335,341 | 55.57% | 12,267,523 | 1.07% |
| | | | | | HS09 | 17,278,624 | 3.88% | 8,919,540 | 0.78% |
| | | | | | HS20 | 8,619,517 | 1.94% | 6,490,796 | 0.57% |
| Total | 10,103,730 | 2.27% | 13,165,010 | 1.15% | Total | 407,063,524 | 91.45% | 55,777,491 | 4.87% |
| D-2019 | Export | Share in export | Import | Share in import | C-2019 | Export | Share in export | Import | Share in import |
| HS01 | 1,680,818 | 0.38% | 146,355,165 | 12.78% | | | | | |
| HS02 | 9,898 | 0.00% | 14,546,472 | 1.27% | | | | | |
| HS03 | 311,365 | 0.07% | 3,502,478 | 0.31% | | | | | |
| HS04 | 144,728 | 0.03% | 15,583,714 | 1.36% | | | | | |
| HS06 | 1,074,235 | 0.24% | 21,189,234 | 1.85% | | | | | |
| HS10 | 640,751 | 0.14% | 408,995,761 | 35.70% | | | | | |
| HS11 | 234,377 | 0.05% | 90,595,649 | 7.91% | | | | | |
| HS12 | 13,935,734 | 3.13% | 103,638,945 | 9.05% | | | | | |
| HS14 | 40,829 | 0.01% | 344,304 | 0.03% | | | | | |
| HS15 | 306,451 | 0.07% | 90,437,341 | 7.89% | | | | | |
| HS16 | 7,256 | 0.00% | 3,362,941 | 0.29% | | | | | |
| HS17 | 2,134,614 | 0.48% | 47,965,214 | 4.19% | | | | | |
| HS18 | 2,778,857 | 0.62% | 14,380,174 | 1.26% | | | | | |
| HS19 | 1,051,740 | 0.24% | 21,134,818 | 1.84% | | | | | |
| HS21 | 865,169 | 0.19% | 45,547,269 | 3.98% | | | | | |
| HS22 | 2,580,999 | 0.58% | 19,129,857 | 1.67% | | | | | |
| HS23 | 145,036 | 0.03% | 29,879,711 | 2.61% | | | | | |
| Total | 27,942,857 | 6.28% | 1,076,589,047 | 94% | | | | | |

*Source: own processing, 2021*

Table 6. Uzbek agrarian trade commodity structure by CIS countries in 2019

| Trade transactions by CIS countries 2019 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **B-2019** | **Export** | **Share in export** | **Import** | **Share in import** | **A-2019** | **Export** | **Share in export** | **Import** | **Share in import** |
| HS22 | 2,381,309 | 0.76% | 3,437,208 | 0.45% | HS05 | 80,927 | 0.03% | 16,000 | 0.00% |
| | | | | | HS06 | 672,227 | 0.21% | 38,342 | 0.00% |
| | | | | | HS07 | 96,049,037 | 30.60% | 24,730,982 | 3.21% |
| | | | | | HS08 | 183,713,369 | 58.53% | 902,318 | 0.12% |
| | | | | | HS09 | 3,295,531 | 1.05% | 642,613 | 0.08% |
| | | | | | HS14 | 1,225 | 0.00% | | 0.00% |
| | | | | | HS18 | 2,759,074 | 0.88% | 1,437,519 | 0.19% |
| | | | | | HS20 | 7,976,541 | 2.54% | 1,233,983 | 0.16% |
| | | | | | HS24 | 8,121,920 | 2.59% | 2,611,751 | 0.34% |
| Total | 2,381,309 | 0.76% | 3,437,208 | 0.45% | Total | 302,669,851 | 96.44% | 31,613,508 | 4.10% |
| **D-2019** | **Export** | **Share in export** | **Import** | **Share in import** | **C-2019** | **Export** | **Share in export** | **Import** | **Share in import** |
| HS01 | 700,200 | 0.22% | 93,353,952 | 12.11% | | | | | |
| HS02 | | | 1,627,780 | 0.21% | | | | | |
| HS03 | 2,500 | 0.00% | 521,672 | 0.07% | | | | | |
| HS04 | 5,443 | 0.00% | 2,859,661 | 0.37% | | | | | |
| HS10 | 12,614 | 0.00% | 403,633,953 | 52.36% | | | | | |
| HS11 | 74,041 | 0.02% | 85,368,519 | 11.07% | | | | | |
| HS12 | 4,585,239 | 1.46% | 82,058,944 | 10.64% | | | | | |
| HS13 | | | 22,589 | 0.00% | | | | | |
| HS15 | 11,244 | 0.00% | 34,514,549 | 4.48% | | | | | |
| HS16 | 7,256 | 0.00% | 253,354 | 0.03% | | | | | |
| HS17 | 2,129,664 | 0.68% | 5,490,394 | 0.71% | | | | | |
| HS19 | 1,020,454 | 0.33% | 5,002,295 | 0.65% | | | | | |
| HS21 | 252,575 | 0.08% | 5488200 | 0.71% | | | | | |
| HS23 | | | 15,634,638 | 2.03% | | | | | |
| Total | 8,801,230 | 2.80% | 735,830,500 | 95.45% | | | | | |

*Source: own processing, 2021*

As already mentioned, Uzbek agrarian trade is focused on the CIS, Asia and Europe. In the analyzed time period (2010 - 2019), a significant increase in the value of exports and imports can be observed in relation to all the main territories representing the main Uzbek trading partners in the agricultural sector. As noted above, a negative feature of Uzbek agrarian trade is a much higher relative increase in the value of imports compared to the value of exports. This tendency was seen in several key areas under the analysis (CIS, EU28, Latin America, North America, Other European countries). The only region – Asian countries (without CIS) recorded the growth of positive export/import coverage ratio.

Uzbekistan's problem is the rather limited heterogeneity of export competitiveness (aggregations HS07 and HS08 represent the key pillar of agri-food export activities). An analysis of comparative advantages based on the LFI index confirmed the existence of comparative advantages at the bilateral level, especially in relation to post-Soviet countries (the most important partners are the Russian Federation, Kazakhstan and the CIS countries), only in the case of a limited number of trade items. The results presented by the product mapping approach provide a more accurate overview of the distribution of the comparative advantages of Uzbekistan's agrarian exports. The problem of Uzbek agrarian trade is its extreme commodity concentration. Just aggregations included into quadrant A represent nearly 92% of total export value. Uzbekistan has been suffering because of constantly decreasing competitiveness of individual trade items and the number of competitive aggregations is constantly decreasing as it could be demonstrated through the last two decades development (for details see Tables 3 - 6). Those changes can be considered as an evidence of an ongoing restructuring process. The commodity structure is still looking for the optimal state. The Republic of Uzbekistan is not competitive at the general level, but rather it has only bilateral comparative advantages, as previously mentioned. Comparative advantages exist, especially with regard to trading partners who apply restrictive trade policies in relation to the world market. Mutual trade is the result not of real price competitiveness, but of political deals.

Significant dynamics of commodity structure development can be seen in relation to both the LFI and TBI indices. The structure of agrarian trade has not yet been stabilized, and agricultural trade is still looking for the ideal state. Significant changes in the competitiveness of Uzbek agrarian trade in the period from 2010 to 2019 can be observed, especially in relation to the Asian countries, other European countries, CIS countries, African countries and EU28 countries.

Table 8. Uzbek agrarian trade value commodity structure – modified product mapping approach (2019)

| **Value 2019 (in USD)** | **A** | | **B** | | **C** | | **D** | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** |
| Asia | 336,798,683 | 34,994,570 | | | 2,812,815 | 2,315,965 | 11,086,121 | 200,363,423 | 350,697,619 | 237,673,958 |
| Africa | 4,242,449 | 437,088 | | | | | | 1,364,882 | 4,242,449 | 1,801,970 |
| EU 28 | 39,403,932 | 2,542,433 | | | | | 5,756,140 | 179,998,491 | 45,160,072 | 182,540,924 |
| Other European countries | 2,357,505 | 61,427 | 9,699 | 13,036 | | | 126 | 9,332,519 | 2,357,631 | 9,406,982 |
| CIS | 302,669,851 | 31,613,508 | | | | | 8,801,230 | 735,830,500 | 311,471,081 | 767,444,008 |
| North America | 7,082,175 | 1,147,531 | | | | | 24,337 | 26,937,593 | 7,106,512 | 28,085,124 |
| Latin America | 949,032 | 129,433 | | 625 | | | | 15,860,870 | 949,032 | 15,990,928 |
| Australia and Oceania | | | | | | | | | | |
| World | 693,503,627 | 70,925,990 | 9,699 | 13,661 | 2,812,815 | 2,315,965 | 25,667,954 | 1,169,688,278 | 721,984,396 | 1,242,943,894 |

*Source: own processing, 2021*

Table 9. Uzbek agrarian trade value commodity structure – modified product mapping approach (2010)

| **Value 2010 (in USD)** | **A** | | **B** | | **C** | | **D** | | **Total** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** | **Export** | **Import** |
| Asia | 17,145,252 | 1,680,468 | 921,768 | 1,116,925 | | | 610,303 | 32,945,937 | 17,755,555 | 34,626,405 |
| Africa | 143,878 | | | | 36,818 | 58,640 | 292,120 | 2,232,203 | 472,816 | 2,290,843 |
| EU 28 | 21,704,099 | 11,082,806 | | | 3,635,828 | 15,256,844 | 3,498,298 | 144,400,886 | 28,838,225 | 170,740,536 |
| Other European countries | 5,086,938 | 35,197 | | | | | 160,732 | 6,125,794 | 5,247,670 | 6,160,991 |
| CIS | 580,284,601 | 19,141,234 | | | | | 4,012,783 | 528,133,968 | 584,297,384 | 547,275,202 |
| North America | 2,329,249 | | | | 219,244 | 97,908 | 8,057 | 381,303 | 2,337,306 | 381,303 |
| Latin America | 346,469 | | | | | | 29238 | 19,531,782 | 375,707 | 19,531,782 |
| Australia and Oceania | | | | | | | | | | |
| World | 627,040,486 | 31,939,705 | 921,768 | 1,116,925 | 3,891,890 | 15,413,392 | 8,611,531 | 733,751,873 | 639,324,663 | 781,007,062 |

*Source: own processing, 2021*

During the analyzed period, the agrarian trade of Uzbekistan changed its structure. The share of agrarian exports realized under group A decreased by 2 percentage points (98% to 96%). The share of the A group in total imports changed from 4% to 5.7%. Group B decreased its share in total agrarian exports and imports from 0.14% to 0.001% and from 0.14% to 0.01%, respectively. The share of exports and imports realized under group C decreased from 0.61% to 0.39% and import from 1.97% to 0.19%, respectively. Exports and imports realized under group D recorded the following changes: The share of exports in total agrarian exports increased from 1.35% to 3.56% and the share of realized imports increased from 93.95% to 94.11%. The conducted analysis also proved the dominant role of CIS and Asian countries as the main trade partners of the Republic of Uzbekistan. Their cumulative share in agrarian exports and imports is a dominant 86.5% respectively 79.2%. In 2010, their cumulative share in total exports and imports reached only 94.8%, respectively 76.5%.

## 4. Conclusion

An analysis of the past nine years gives the following results. The agrarian trade of Uzbekistan is constantly growing, its commodity and territorial structure is changing. The relative value of exports increased 2.5 times faster than the value of imports. Unfortunately, the trade balance is still negative. The problem lies primarily in the very low added value of Uzbek exports, while the added value of imports is much higher. Another negative feature is the constantly decreasing food self-sufficiency. The territorial structure of agricultural trade is becoming more and more concentrated. This makes Uzbekistan's agricultural trade extremely vulnerable and dependent on a limited number of partners (especially the CIS). The development of the commodity structure is the opposite (a tendency towards diversification has been proven). The structure of merchandise exports is based mainly on a variety of low value added products with comparative advantages, especially at the bilateral level. While Uzbek agricultural trade is quite competitive, especially in relation to Asia and the CIS, competitiveness in relation to other territories (European countries, especially developing countries, Latin and North America) is limited. In connection with the current and especially the future Uzbek agricultural trade, it is necessary to increase the volume of production. The combination of TBI, LFI approach analysis and product mapping proved the comparative advantage of the following set of aggregates / trade units: fish, plants, meat products, cereals, live animals, vegetable oils, vegetable juices, dairy products, sugar, juices, weaving materials, food chopping, drinks and alcohol.

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# TOURISM IN THE CZECH REPUBLIC IN THE CONTEXT OF THE GLOBAL PANDEMIC COVID-19

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**Annotation:** Tourism had become one of the most important sectors in the world economy, accounting for 10 percent of global GDP and more than 320 million jobs worldwide. This paper aims to specify the impact of the economic crisis associated with the COVID-19 pandemic on tourism in the Czech Republic in an international context. For the purposes of the paper, economic indicators in the years 2005–2020 are analyzed on the basis of CZSO documents. The impact of the Covid-19 pandemic on tourism in the Czech Republic is addressed in terms of the development and seasonality of domestic, incoming and outgoing tourism. According to research, the largest decline was in outbound tourism. The number of accommodated non-residents decreased the most in 2020 in Q2 and Q4, by 95% compared to the seasonal averages 2005–2019. The total decrease of non-residents accommodated in collective accommodation establishments in 2020 was 8,099,403. The number of accommodated residents also decreased, by a total of 3,107,497. Longer trips of Czech citizens abroad in the 2nd and 4th quarters of 2020 were 98% lower than seasonal averages in the period 2005–2019, shorter trips were 88% lower in Q2 and Q4.

**Key words:** tourism, crisis, COVID-19, economic impact, Czech Republic

**JEL classification:** A12, M20, F63, Z30h

## 1. Introduction

Tourism is one of the largest economic sectors in the world. In the European Union, it represents a key branch of the tertiary sector; it contributes more than 7.8 percent to the GDP of the European Union as a direct and indirect contribution of tourism to GDP. This is a large segment of the European economy. In 2016, one in 10 enterprises (2.4 million) in the European non-financial business economy were in tourism industries, employing 9.5% of the EU workforce, namely 13.6 million workers (Eurostat, 2019a, 2019b). As Eurostat (2019b) reveal, most of these workers were in either the accommodation sector (19.7% of employment in the tourism industry) or food and beverage serving activities (58.7%). In the Czech Republic the number of people employed in tourism achieved 239, 649 thousand in 2019 (CZSO, 2021)

The tourism industry has never thought of such a difficult scenario as it is now. We have experienced the SARS epidemic, the 2008 economic crisis, and now it is COVID-19 (Zhong et al., 2021). Tourism has been shown to be one of the worst affected sectors in the global pandemic of the new coronavirus COVID-19 (Sobaih et al., 2021). For example, damage to large airlines or international hotel chains is estimated at \$ 400 billion (Goodwin, 2020; Nicolás, 2020). The impact on the sector's labour force has been devastating - an estimated 12–14% reduction in jobs in the global tourism sector (Chanel, 2020; UNWTO, 2020). According to the World Tourism Organization, the international number of arrivals fell by 58% to 78% last year. In the worst-case scenario, the global tourism sector could lose \$3.3 trillion or 4.2% of the world's gross domestic product (UNCTAD, 2020).

Border closures, health restrictions and numerous security measures have affected all continents and states, including the Czech Republic. One billion fewer people travelled the world in 2020 than in 2019. About half of this decline was in Europe. Health risks are one of the factors by which people make their decisions when choosing a destination. Navrátilová et al. (2020) evaluated the impact of the security and safety factor on the consumer behavior of young people aged 19–29 in the Czech Republic when choosing a destination for tourism. Health risks in the country are considered as significant ones by less than 70.0% persons.

Many entities that are dependent on tourism, either directly or indirectly, have been forced to suspend or terminate their activities and it is uncertain whether this will be resumed.

## 2. Materials and Methods

This paper aims to specify the impact of the economic crisis associated with pandemics COVID-19 on tourism in the Czech Republic in an international context. For the purposes of the article, indicators between 2005-2020 are analysed and calculated on the basis of Czech Statistical Office documents (CZSO, 2021a). The indicators for the period from 2005 were chosen with regard to the Czech Republic's accession to the European Union in May 2004, so the period after the Czech Republic's accession to the EU was evaluated.

As part of domestic and inbound tourism, the number of guests (residents and non-residents of the Czech Republic) who were accommodated in collective accommodation establishments was analyzed. Within the analysis of the development of the number of accommodated in the period 2005-2020, the absolute increases (decreases) of this indicator in the selected period were monitored:

$$dy_t = y_t - y_{t-1} \quad \textbf{(1)}$$

when $dy_t$ is the first differentiation, $y_t$ is the value of the indicator in the current period, $y_{t-1}$ is the value of the immediately preceding indicator.

The growth rate is expressed by the growth coefficient, which describes the rate of change of values (growth / decrease) in a time series:

$$k_t = \frac{y_t}{y_{t-1}} \quad \textbf{(2)}$$

when $k_t$ j is the first differentiation, $y_t$ is the value of the indicator in the current period, $y_{t-1}$ is the value of the immediately preceding indicator.

Tourism in the Czech Republic shows seasonal fluctuations due to the change of seasons. To express the seasonal effect and its intensity, seasonal indices were used, which inform about the deviation of the value from the trend value:

$$s_t = \frac{actual\ value\ of\ the\ series\ y_t}{balanced\ value\ of\ the\ series\ \ y'_t} \quad \textbf{(3)}$$

The seasonal effect was analyzed for the number of accommodated residents and non-residents in collective accommodation establishments in individual calendar quarters in the period 2014-2020. Data for individual quarters of the analyzed period were obtained from CZSO (2021b).

The analysis of seasonal effects was performed in terms of the number of trips of residents in individual quarters of the analyzed period 2005-2020, with a division into longer and shorter trips. Long trip is a holiday trip (to spend leisure time, for recreation, improvement of health, visiting of relatives and friends), during which a person spent at least four consecutive overnight stays outside the usual location (CZSO, 2021a). Short trip is a holiday trip (to spend leisure time, for recreation, improvement of health, visiting of relatives and friends), during which a person spent at least one and at most three days (CZSO, 2021a).

The development and seasonality of outbound tourism were analyzed in terms of the number of residents' trips abroad. Outbound tourism is tourism realized by residents abroad (CZSO, 2021a). The evaluation was performed for individual calendar quarters in the period 2005-2020, with a distinction between longer and shorter trips. Longer and shorter trips are defined in the same way as for domestic tourism (CZSO, 2021a).

## 3. Results and Discussion

Tourism underwent a development in the analyzed period 2005-2020, which was influenced by the accession of the Czech Republic to the EU (in 2004) and the subsequent entry into the Schengen area (2007). This opened up further possibilities for residents to travel abroad and for non-residents to travel to the Czech Republic. The subsequent development of tourism was affected by the global economic crisis (especially in 2008 and the following years).

### Development and seasonality of domestic and inbound tourism

Within domestic tourism, the number of residents accommodated in collective accommodation establishments showed a constant growth from 2012 to 2019. In 2020, there was a decrease in the number of accommodated residents by a total of 3,107,497 guests compared to the previous year 2019 (Table 1). Based on the analysis of inbound tourism, it was found that the number of non-residents accommodated in collective accommodation establishments in the Czech Republic showed growth in the period 2010-2016. In 2020, the number of accommodated non-residents was 8,099,403 low than in 2019. The effects of measures related to the Covid-19 pandemic affected mainly inbound tourism, in 2020 it decreased by 74.42% compared to 2019 (Table 1).

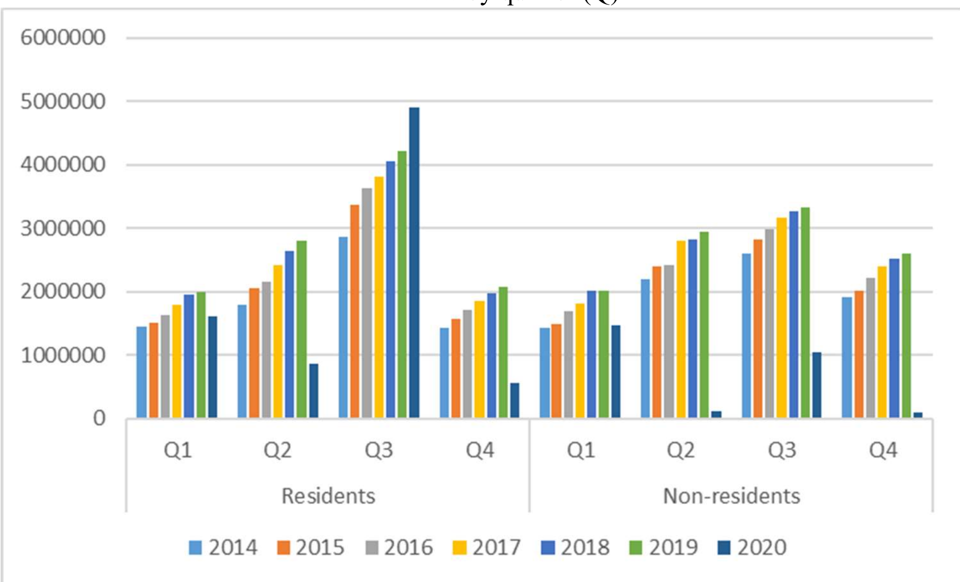
The quantity of residents in collective accommodation establishments in the Czech Republic was the highest in the period 2014-2020, always in Q3 (Figure 1). Here is a clear connection with the summer holidays in July and August. Differences in the number of non-residents in collective accommodation establishments in the Czech Republic are not as obvious in individual quarters as for residents. Nevertheless, seasonality is evident here as well, the highest numbers of non-residents can be observed mainly in the 3rd and 2nd quarters (Figure 1). In 2020, however, there was a significant change in the total quantity of non-residents as a whole in individual quarters. The significant decline in the quantity of non-residents in Q2 was related to the beginning of the Covid-19 pandemic, when a number of countries locked and closed borders.

Table 1. The number of residents and non-residents in collective accommodation establishments (CAE) in the period 2014-2020

| Year | Residents | | | | Non-residents | | | |
|---|---|---|---|---|---|---|---|---|
| | **Numbers of residents in CAE** | **1. difference** | **Relative growth (%)** | **Growth factor** | **Numbers of non-residents in CAE** | **1. difference** | **Relative growth (%)** | **Growth factor** |
| **2005** | 6,025 665 | | | | 6,336,128 | | | |
| **2006** | 6,289 452 | 263,787 | 4.38 | 1.04 | 6,435,474 | 99,346 | 1.57 | 1.02 |
| **2007** | 6,281 217 | -8,235 | -0.13 | 1.00 | 6,679,704 | 244,230 | 3.80 | 1.04 |
| **2008** | 6,042 851 | -238,366 | -3.79 | 0.96 | 6,648,527 | -31,177 | -0.47 | 1.00 |
| **2009** | 6,157 482 | 114,631 | 1.90 | 1.02 | 6,031,759 | -616,768 | -9.28 | 0.91 |
| **2010** | 6,090 214 | -67,268 | -1.09 | 0.99 | 6,325,742 | 293,983 | 4.87 | 1.05 |
| **2011** | 6,080 225 | -9,989 | -0.16 | 1.00 | 6,831,452 | 505,710 | 7.99 | 1.08 |
| **2012** | 6,477 270 | 397,045 | 6.53 | 1.07 | 7,170,385 | 338,933 | 4.96 | 1.05 |
| **2013** | 6,558 480 | 81,210 | 1.25 | 1.01 | 7,309,856 | 139,471 | 1.95 | 1.02 |
| **2014** | 7,518 338 | 959,858 | 14.64 | 1.15 | 8,126,369 | 816,513 | 11.17 | 1.11 |
| **2015** | 8,488 761 | 970,423 | 12.91 | 1.13 | 8,686,726 | 560,357 | 6.90 | 1.07 |
| **2016** | 9,086 342 | 597,581 | 7.04 | 1.07 | 9,288,013 | 601,287 | 6.92 | 1.07 |
| **2017** | 9,885 672 | 799,330 | 8.80 | 1.09 | 10,175,963 | 887,950 | 9.56 | 1.10 |
| **2018** | 10,639 041 | 753,369 | 7.62 | 1.08 | 10,635,645 | 459,682 | 4.52 | 1.05 |
| **2019** | 11,101 558 | 462,517 | 4.35 | 1.04 | 10,883,040 | 247,395 | 2.33 | 1.02 |
| **2020** | 7,994 061 | -3,107,497 | -27.99 | 0.72 | 2,783,637 | -8,099,403 | -74.42 | 0.26 |

*Source: CZSO (2021b), own work*

Figure 1. The number of residents and non-residents in collective accommodation establishments in the period 2014-2020 by quarter (Q)




*Source: CZSO (2021b), own work*

Based on the analysis of the seasonality of domestic tourism, it was found that in 2020 the largest decrease in the number of accommodated residents was recorded compared to the seasonal average 2014-2019 in the second and fourth quarters of 2020, namely by 63% and 68% (Table 2). The analysis of the number of accommodated non-residents (inbound tourism) showed the largest decrease in the number of accommodated non-residents also in the second and fourth quarters of 2020. Compared to the 2014-2019 seasonal average, these quarters showed a decrease of 95% (Table 2).

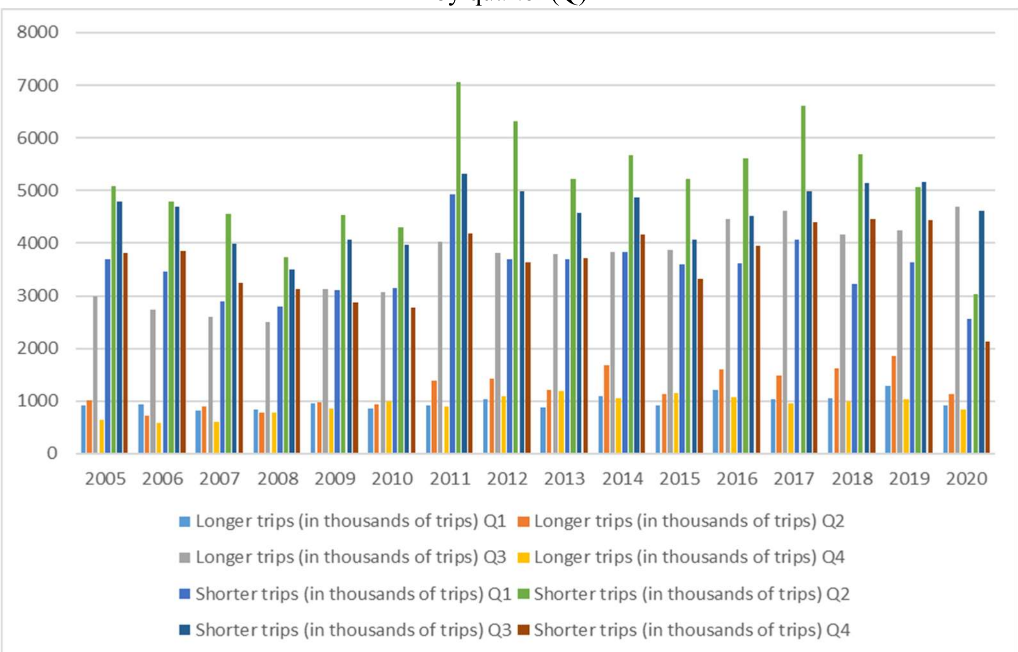
Table 2. The number of residents and non-residents in collective accommodation establishments in the period 2014-2020 by quarter (Q)

| Rok | Residents | | | | Non-residents | | | |
|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Seasonal average 2014-2020 | 1,723,106 | 2,310,058 | 3,662,680 | 1,770,817 | 1,741,596 | 2,604,690 | 3,031,770 | 2,275,001 |
| Seasonal variation | -643,559 | -56,607 | 1,296,015 | -595,848 | -671,668 | 191,426 | 618,506 | -138,264 |
| Seasonal index (v %) | -27 % | -2 % | 55 % | -25 % | -28% | 8% | 26% | -6% |
| Total average | 2 366 665 | | | | 2 413 264 | | | |
| 2020 | 1,620,858 | 860,651 | 4,897,793 | 558,452 | 1,481,928 | 127,356 | 1,047,277 | 104,259 |
| Comparison of 2014-2019 with 2020 | - 6 % | - 63 % | 34 % | - 68 % | - 15% | -95% | - 65% | - 95% |

*Source: CZSO (2021b), own work*

The seasonality of tourism in the Czech Republic is also reflected in the number of longer and shorter trips of residents. The number of longer trips in the observed period was the highest always in the 3rd quarter (Figure 2). This fact is related to the summer holidays in July and August. The sum of shorter trips in the period 2005-2020 was usually highest in the 2nd quarter. However, in 2020, in connection with the pandemic in Q2, there was a significant decrease in these routes (Figure2).

Figure 2. The number of longer and shorter trips of residents of the Czech Republic in the period 2005-2020 by quarter (Q)




*Source: CZSO (2021b), own work*

In the 3rd quarter of 2020, residents made 31% more longer trips in domestic tourism than the average for the 3rd quarter in the period 2005-2019, the number of shorter trips in this quarter corresponded to the seasonal average for the period 2005-2019 (Table 3). This is also the impact of the measures related to the Covid-19 pandemic. In the third quarter, during the summer holidays, residents had limited opportunities to travel abroad. In other quarters, there was a decrease compared to seasonal averages, especially for shorter trips (Table 3).

Table 3. The number of longer and shorter trips of residents of the Czech Republic in the period 2005-2020 by quarter (Q)

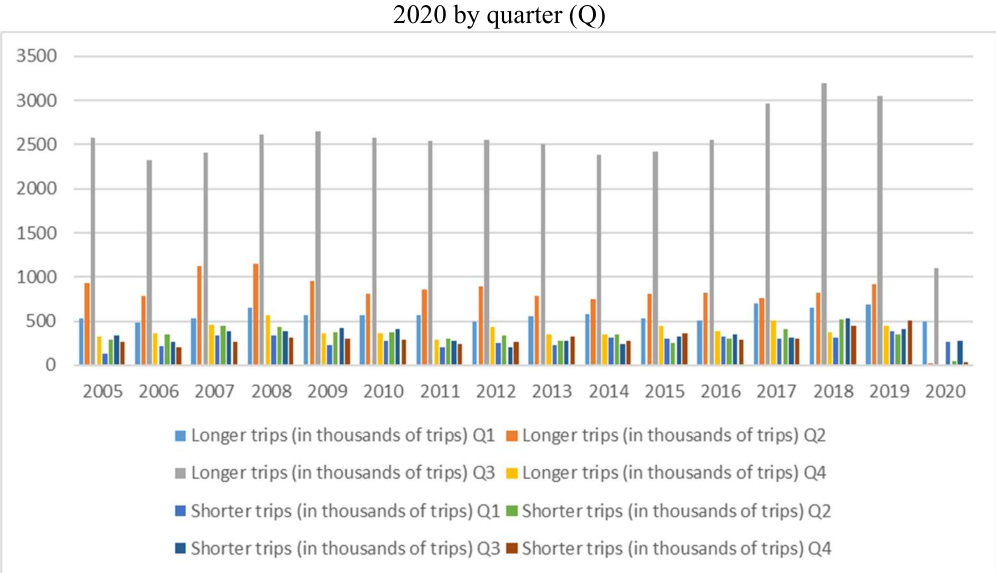
| Year | **Longer trips (in thousands of trips)** | | | | **Shorter trips (in thousands of trips)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Q1** | **Q2** | **Q3** | **Q4** | **Q1** | **Q2** | **Q3** | **Q4** |
| **Seasonal average 2005-2019** | 923 | 1,250 | 3,591 | 928 | 3,558 | 5,296 | 4,576 | 3,731 |
| **Seasonal variation** | **-705** | **-438** | **1,903** | **-759** | **-733** | **1,006** | **286** | **-559** |
| **Seasonal index (v %)** | -42% | -26% | 113% | -45% | -17% | 23% | 7% | -13% |
| **Total average** | 1688 | | | | 4290 | | | |
| **2020** | 919 | 1,123 | 4,701 | 838 | 2,561 | 3,026 | 4,610 | 2,131 |
| **Comparison of 2005-2019 with2020** | -6% | -10% | 31% | -10% | -28% | -43% | 1% | -43% |

*Source: CZSO (2021b), own work*

**Development and seasonality of outbound tourism**

The highest quantity of longer trips of residents of the Czech Republic abroad in the observed period was the highest always in Q3 (Figure 3). This fact is related to the holidays in July and August, when residents of the Czech Republic travel abroad on holiday, most often to the sea. The quantity of shorter trips of residents abroad in the observed period does not differ much in individual quarters. In 2020, a decrease in the number of longer and shorter journeys is evident (Figure 3).

Figure 3. The amount of longer and shorter trips of residents of the Czech Republic abroad in the period 2005-2020 by quarter (Q)




*Source: CZSO (2021b), own work*

The results of the analysis of outbound tourism in 2020 show a significant decrease compared to the seasonal averages for the period 2005-2019. Impact of pandemic Covid-19 are most pronounced at the longer paths in the second and fourth quarter, when decreased by 98% compared to seasonal averages 2005 to 2019 (Table 4). A similar decline in outbound tourism is also evident in shorter trips; in Q2 and Q4 2020, 88% fewer shorter trips abroad were made compared to the seasonal averages for the period 2005-2019 (Table 4).

Table 4. The amount of longer and shorter trips of residents of the Czech Republic abroad in the period 2005-2020 by quarter (Q)

| Year | **Longer trips (in thousands of trips)** | | | | **Shorter trips (in thousands of trips)** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Q1** | **Q2** | **Q3** | **Q4** | **Q1** | **Q2** | **Q3** | **Q4** |
| **Seasonal average 2005-2019** | 574 | 879 | 2,622 | 401 | 277 | 357 | 345 | 310 |
| **Seasonal variation** | -545 | -240 | 1,503 | -718 | -45 | 35 | 23 | -12 |
| **Seasonal index (v %)** | -49% | -21% | 134% | -64% | -14% | 11% | 7% | -4% |
| **Total average** | 1119 | | | | 322 | | | |
| **2020** | 495 | 19 | 1,102 | 10 | 260 | 42 | 280 | 36 |
| **Comparison of 2005-2019 with 2020** | -14% | -98% | -58% | -98% | -28% | -43% | 1% | -43% |

*Source: CZSO (2021b), own work*

**The impacts of the pandemic Covid-19 in tourism and related industries**

Tourism appears to be one of the most sensitive economic sectors in the event of any economic fluctuations (Gössling et al., 2020). The COVID-19 pandemic has halted mobility globally on an unprecedented scale (Ioannides and Gyimóthy, 2020). The effects of the Covid-19 pandemic on tourism in the Czech Republic in 2020 were published by the Czechtourism agency. The largest decrease in consumption associated with tourism in the Czech Republic was caused by a strong weakening of inbound tourism of 74%. Domestic tourism fell significantly less in the same period, by 23%. In terms of services in tourism, travel agencies and guides suffered the most. Their sales fell by 70%. In absolute terms, accommodation services suffered the largest losses. A decline of CZK 30 billion was calculated for them. They are followed by catering services, which reduced turnover by 47% and thus lost CZK 27 billion in the monitored period (Czechtourism, 2021).

While some industries have suffered minor consequences, the hospitality industry has almost completely lost its business for months. (Baum a Hai, 2020). The nature of their products and services prevents the possibility of a catch-up effect to compensate for the lost revenues on a long-term base (Breier et al, 2021). Government roles and support programs are crucial in supporting crisis-stricken tourism companies such as COVID-19 (Ritchie and Jiang, 2019). Travel agencies are aware of the need for restructuring and expect to receive financial support from the government to overcome the crisis. An opportunity to support the development of tourism in the Czech Republic is, for example, congress tourism, where the Czech Republic is one of the favorite destinations in this case (Šilerova, Maneva, Hřebejková, 2013).

The main impacts of the COVID-19 pandemic include reduced revenues, increased costs, and redundancies (Binh et al., 2021). The reduction in revenues and the number of employees brings a reduction in revenues from taxes and insurance premiums, similar to the economic crisis. The analysis of the tax mix after the economic crisis showed significant changes in the tax mix as a result of the slowed down economies in 2008 (Kukalová et al., 2018).

From a certain point of view, the current crisis in the field of tourism can be seen at the same time as an opportunity to direct further development towards more sustainable pathways – and a radically different way of doing things (Loorbach et al., 2017). Sustainable tourism is the direction in which tourism should continue in the next period (Antouskova et al., 2009). COVID-19 can lead to restructuring and transformation in certain sectors in the tourism industry (Hall et al., 2020; Ioannides and Gyimóthy, 2020). It is also believed that the COVID-19 pandemic will have more profound effects on structural and transformational changes in tourism (Dolnicar and Zare, 2020; Sigala, 2020). Policy makers and practitioners in the tourism industry must develop a new crisis-readiness mechanism to fight the current pandemic crisis as well as future pandemic crises. (Škare et al., 2021).

## 4. Conclusion

Tourism is one of the most important economic sectors in the world. It is the third in a row in terms of exports (after fuels and chemicals) and in 2017 its share in global trade was 7% (UNWTO, 2020). Globally, tourism supports 10% of jobs and provides livelihoods for millions of people in both developing and developed economies. In Europe, it supports 27 million jobs and millions of private companies. In some small island developing states, tourism accounts for up to 80% of exports. That also has a significant share in developed countries (Germany 3.9%, France 7.4% or Spain 11.8%). In the Czech Republic tourism employed more people than the agriculture, forestry, fisheries, mining and quarrying sectors combined. The impacts and consequences of COVID-19 on CR can be critical. Without rescue tools and measures, a fall in employment in tourism services can increase unemployment by up to 3.2%. Tourism is one of the most globally affected sectors of the COVID-19 pandemic in all countries, including the Czech Republic. The recovery of the sector can take many months or years, and there will certainly be both quantitative and quantitative changes.

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# THE ROLE OF EU FUNDS IN THE CONTEXT OF AGRICULTURAL POLICY – ADDITIONAL RESOURCES IN RESPONSE TO THE COVID-19 PANDEMIC

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**Annotation:** During this uncertain time while the whole globe faces the pandemic of COVID-19, humanity has become aware of the importance of agriculture in general, as well as of food self-sufficiency. Regardless of huge development in all industry sectors, agriculture is still affected by several adversities and faces the requirements regarding the sustainable eco-system, climate changes, biodiversity, production innovations. Assuming the lack of financial resources is one of the major problems agriculturists face, as well as one that could impact the resolving of other problems, finding a proper source of funding could be crucial for agriculturists, whether individuals (families) or cooperatives. The EU funds have a great role in that context, assuring the vital resources through the common agricultural policy. Standing on the transition from one financial perspective (2014-2020) to another (2021-2027), a fresh capital seeks proposals that are in line with the set objectives. This paper aims to present the success of chosen countries in withdrawing the EU funds from 2014 to 2020 and the analysis among those countries with special emphasis on the EAGF and EAFRD. It also gives some possible areas in agriculture which should be given due attention since they are acceptable for funding. The manuscript deals with available funds intended for agriculture and covers the main objectives of the EU common agricultural policy. To present the former allocations, but also with an emphasis on the new ones, a comparative analysis has been conducted on a sample of 10 selected central and south-east European countries. To get an insight on the allocations from the most significant funds aimed at agriculture, the analysis has been conducted for 6 years from the last financial perspective, as well as for the new 2021-2027 financial perspective. The analysis has been conducted using both absolute and relative values. Research results show that developing countries benefit a lot from the EU cohesion policy and there is a room for further improvements in national agricultural policies.

**Key words:** Multiannual Financial Framework 2021-2027, Next Generation EU – COVID-19 Recovery Package, EAGF, EAFRD, Common Agricultural Policy

**JEL classification:** H81, O13, Q14

## 1. Introduction

Agriculture certainly represents the backbone of life. During this uncertain time, while the whole globe faces the COVID-19 pandemic caused by the SARS-CoV-2 virus, humanity has become aware of the importance of agriculture and food self-sufficiency. Throughout history, agriculture has evolved from manual processing, through machine processing, to digital technologies used in agriculture. Regardless of development, agriculture is still affected by several adversities. Many studies have been observing the impact of weather and climate change on agriculture. Lobell et al. (2007) studied the relationship between 12 crops yield and three climatic variables (minimum temperature, maximum temperature, and precipitation) and concluded that the impacts of climate on yield trends since 1980 were variable among crops, reflecting the diversity of climatic variables important for different crops and emphasized the importance of the crops' diversity. Brown et al. (2015) concluded that there are multiple connections between climate conditions and many different elements of food systems and that climate change can affect food systems in ways that alter food-security outcomes (p. 23). The United States Environmental Protection Agency (2016) raised some examples of the impact of climate change on food security. They emphasize that projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. A study conducted by Čechura et al. (2020) considered changes over time in the temperatures and precipitation effects on cereals yield in the region of Central Europe and proved that climate changes have a significant effect on cereal production.

Despite the negative impact of weather and climate changes, agriculturists who act as individuals, family farms or agricultural cooperatives face additional challenges. They often lack affordable source of funding for investments in production modernization, knowledge on modern crop processing and using new technologies, quality management skills, and face with price risk, administration overload and poor regulatory and supervisory frameworks, feeding a growing population, providing a livelihood for farmers, and protecting the environment (Brooks et al., 2019; Rabobank, 2012; Syngenta, 2021; World Bank, 2005). Assuming that the lack of financial resources is one of the major problems agriculturists face, as well as one that could impact the resolving of other problems, finding a proper source of funding could be crucial for agriculturists, whether individuals (families) or cooperatives. Due to standards and competition set by large corporations, agriculturists need the help of local authorities, governments, and international regulators. Fortunately, when it comes to the European Union (hereinafter: EU), there are plenty of funding possibilities allocated by the European Commission (hereinafter: EC) through the EU funds and programmes.

The EU launched its common agricultural policy (hereinafter: CAP) in 1962, which stands for a partnership between agriculture and society, and between Europe and its farmers, and which aim is to (EC, 2021b):

- support farmers and improve agricultural productivity, ensuring a stable supply of affordable food
- safeguard European Union farmers to make a reasonable living
- help tackle climate change and the sustainable management of natural resources;
- maintain rural areas and landscapes across the EU
- keep the rural economy alive by promoting jobs in farming, agri-foods industries and associated sectors.

The total allocation for the CAP for 2021-2027 amounts to €386.6 billion (in current prices), divided between two funds (often referred to as the "two pillars" of the CAP) (EC, 2021b):

- European agricultural guarantee fund (hereinafter: EAGF)
- European agricultural fund for rural development (hereinafter: EAFRD).

The allocation itself does not mean that all the amounts will be granted. National governments and agriculturists themselves have to invest a lot of effort to establish national strategies regarding the withdrawal of available funds for agricultural purposes. In that context, good informativeness, knowledge about preparing projects' proposals, and proper project implementation are the key to success. The main purpose of this paper is to give an overview of available funds for agricultural purposes, to present the CAP and analyse prior funds allocations, and to give an overview of some possible areas for financing agriculture.

This paper consists of five parts. After the introduction, there is a detailed review of EU funds applicable for agriculture referring to the current financial perspective 2021-2027. The third part is a comparative analysis of EU funds distribution and their impact on chosen EU countries that need additional financial help other than their national sources to improve their economies and, what is most important, the living conditions of their citizens. The final part before the conclusion refers to suggestions for the agriculture sector regarding the EU funds available for the current period.

**EU Funds Intended for Agriculture**

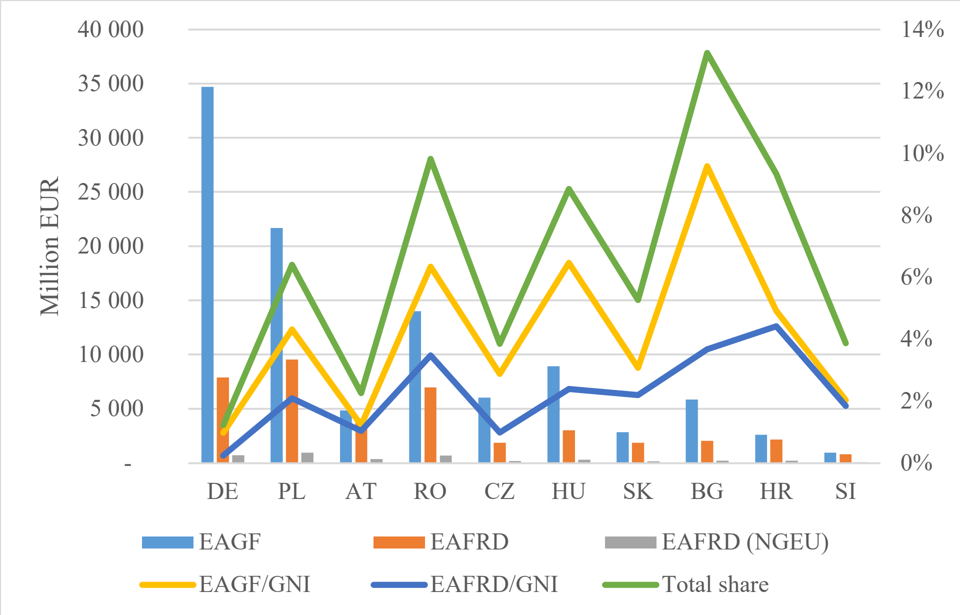
The EU budget is funded by the contributions from the EU member states (which are calculated based on gross national income, increased by shares in import duties on products from outside the EU, and shares in value-added tax) and fines imposed when businesses fail to comply with the EU rules increased by a contribution for the non-recycled plastic packaging waste as of 2021. Each year's budget sets out the amounts agreed in advance according to a plan known as the multiannual financial framework (hereinafter: MFF) which lasts seven years. This enables the EU to plan its funding programmes effectively for several years in advance, as well as its strategy and public policies. The current framework, also known as a financial perspective, runs from 2021 to 2027 which means that currently there are projects in progress from the last MFF 2014-2020, new calls from this period which refer to the MFF, but also to a new instrument for recovery called Next Generation EU which has been established due to the global pandemic COVID-19 and will provide up to €750 billion in 2021 and 2022 (EU, 2020a; EC, 2020b).

As stated in the introduction, there are two EU funds applicable for agriculture, which make a part of European Structural and Investment Funds (hereinafter: ESI Funds) and are currently increased by additional resources coming from the Next Generation EU recovery mechanism. These funds are redirected through national programmes and are considered decentralized sources. Nonetheless, there are centralized EU programmes applicable for agriculture, e.g. Horizon Europe and LIFE. Calls for proposals regarding ESI Funds are initiated nationally according to the national strategies, while the Programmes are initiated by the EC. It is important to emphasize that apart from agriculturists registered as family farms, small and medium-sized enterprises or large corporations, there is an important role of scientists and academic researchers who can and should invest their knowledge and experience to improve and innovate technologies and processes used in the agriculture sector.

The EAGF has a seven-year allocation of €291.1 billion (in current prices as approved by the Council in December 2020). On the other hand, the EAFRD has the allocation of €87.4 billion increased by up to €8 billion from the Next Generation EU Recovery and Resilience Facility instrument to help address the challenges posed by the COVID-19 pandemic (all in current prices). Around 30% of the recovery funds will become available in 2021, with the remaining 70% to be released in 2022 (EC, 2021b). Currently earmarked funds under the EAGF and EAFRD (agreed at the European Parliament and adopted by the Council in December 2020) are summarized in Graph 1 presenting the breakdown from 2021 to 2027 per observed countries.

Bulgaria, Romania, Croatia, and Hungary have the greatest shares of CAP funds allocated per GNI, while the developed countries, specifically Germany and Austria have CAP funds per GNI under 3%, even though they have most funds in absolute amounts. Croatia, Bulgaria, Romania and Hungary also have greater additional resources, among observed countries, coming from the Next Generation EU mechanism calculated as a share of GNI, even though greater absolute amounts are available to Poland, Germany, Romania and Austria.

Graph 1. Breakdown of the EAGF and EAFRD 2021-2027 per countries




*Source: Author's calculation and presentation using the data from the EC, 2020a & EC, 2021a*

*Note: GNI figures are based on ESA 2010; EAGF & EAFRD figures are based on December 2020 decision in current prices*

In addition to the ESI funds, agriculture innovation ideas are applicable for Horizon Europe and LIFE programmes. Horizon Europe's vision presents a sustainable, fair and prosperous future for people and the planet based on European values through tackling climate change (35% budgetary target), helping to achieve Sustainable Development Goals, and boosting the Union's competitiveness and growth (EC, 2019a, p. 3). Horizon Europe is divided into three pillars. The second pillar Global challenges & European industrial competitiveness breaks down into six clusters one of which is Food, Bioeconomy, Natural Resources, Agriculture & Environment (EU, 2020b). The budget of Horizon Europe is €95.5 billion including €5.4 billion from the Next Generation EU instrument (EC, 2021c). Some of the featured projects about agriculture and forestry funded by Horizon 2020 (the Horizon programme from MMF 2014-2020) are Development of high quality food protein through sustainable production and processing, Farms systems management and governance for producing good water quality for drinking water supplies, Developing Innovative Market Orientated Prediction Toolbox to Strengthen the Economic Sustainability and Competitiveness of European Seafood on Local and Global markets, Climate change and European aquatic RESources, Renewable materials and healthy environments research and innovation centre of excellence, Centre of Excellence for Advanced Technologies in Sustainable Agriculture and Food Security, Genetic and molecular priming approaches to increase crop strength and stress tolerance, INtegrated Spatial PlannIng, land use and soil management Research ActTION, Impact of climate change and globalisation on safety of fresh produce – governing a supply chain of uncompromised food sovereignty (Horizon 2020, 2018).

The general objective of the proposed LIFE programme for 2021-2027 is to contribute to the shift towards a clean, circular, energy-efficient, low-carbon and climate-resilient economy, including through the transition to clean energy, to protect and improve the quality of the environment and to halt and reverse biodiversity loss (European Council, 2020). Available funds for the LIFE programme are €5.43 billion (in current prices) (EC, 2021c). Some of the featured projects about agriculture and forestry funded by LIFE 2014-2020 are Sustainable Viticulture for Climate Change Adaptation, Market Awareness Raising for Opportunities in Needed Extensification and Soil-friendly Agriculture, Future Agricultural Management for multiple outputs on climate and rural development, In situ nano-enhanced bioremediation for nitrate impaired aquifers due to agricultural activity, LIFE Farm, Fresh Fruit, Enhance, Nurture and Vitalize the crops to increase yield and healthy plant growth, Boost conventional agricultures confidence: new organic biostimulants to reduce water, nutrients and pesticide demand, Innovative Smart Farming services supporting Circular Economy in Agriculture (EC, 2019b).

All of the abovementioned funds have a significant impact on the development and improvement of agriculture of primarily less-developed EU member states, even though developed countries use them in higher absolute amounts. To get an insight into previous allocations per countries and their usage, the analysis presented below has been conducted.

## 2. Materials and Methods

### 3.1 Methodology and research sample

To analyse trends in withdrawal of the EU funds, a comparative analysis has been conducted. The data were taken free of charge from the EC (2020a). A sample comprised 10 EU countries from central and south-east Europe (Germany, Poland, Czechia, Slovakia, Hungary, Austria, Slovenia, Croatia, Romania, and Bulgaria). The period for which the analysis was performed refers to 6 years, from 2014 to 2019. Trends of total expenditure (hereinafter: TE), total own resources (hereinafter: TOR), and operating budgetary balance (hereinafter: OBB) as percentage shares of gross national income (hereinafter: GNI) are presented and discussed for each country (figure 1) to get an insight of their position in withdrawing the EU funds. After that, a comparative analysis regarding one of the goals of the EC from the period 2014-2020, Sustainable Growth: Natural Resources (hereinafter: SG: NR), nowadays Natural Resources and Environment, which comprises EAGF and EAFRD, was conducted. Trends between countries and over the years were analysed to compare their positions. The objective of the analysis is to get a clear picture of those countries' success in withdrawing the EU funds to be able to improve it, with an emphasis on the agricultural topics.

### 3.2 Statistical analysis and results

Presented graphs start with the country with the highest average share of TE in GNI in the observed period. A higher percentage means the country used more EU funds presented as shares of its GNI what shows the importance of the EU funds, especially for less-developed or transition countries. It is clearly seen that only Austria and Germany vary from the rule that a higher contribution of TE comes with a lower contribution of TOR since these two countries are on a higher level of development. That is an outcome of the EU strategy to promote and support the development of less-developed countries in order to achieve harmonization and cohesion across the EU economies. Accordingly, TOR as a percentage of GNI in 8 out of 10 observed countries is lower than funds coming from the EU what results in positive OBB (the difference between a country contribution to the EU vs. granted funds from the EU).

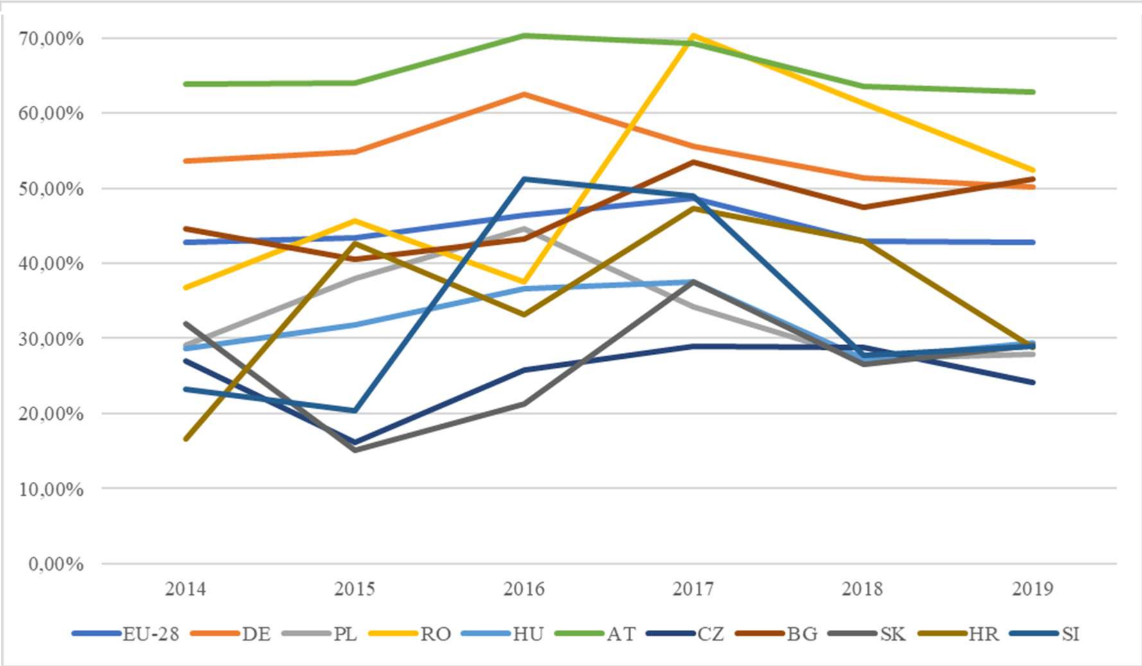
Croatia and Slovenia vary a bit from the other 6 countries. The reason for Croatia is joining the EU in 2013 with the less productive withdrawal of funds at the beginning, but with a visible improvement in 2019, while Slovenia shows trends similar to developed EU countries (it could be verified in the new MMF).

Figure 1. Graphical presentation of trends in withdrawing the EU funds


*Source: Author's calculation and presentation using the data from the European Commission, 2020a*

When it comes to the agricultural policy, the share of funds aimed at agriculture should be observed. One of the goals of the EC from the period 2014-2020 was SG: NR, which was comprised of the EAGF and EAFRD as the most significant funds (over 95% of the SG: NR), but also of European Maritime and Fisheries Fund (EMFF), Regional Fisheries Management Organisations (RFMOs), Sustainable Fisheries Agreements (SFAs), LIFE, and decentralised agencies. The SG: NR has been analysed through its share in the TE (allocated EU funds) per country. Graph 2 summarizes its contributions per countries through the observed period.

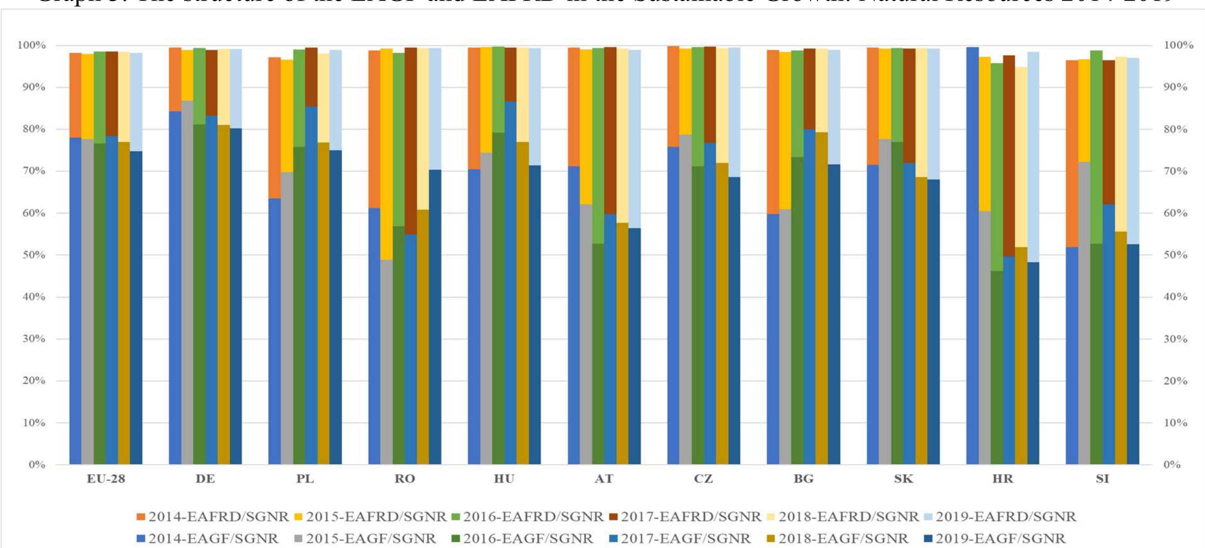
Graph 2. The share of funds from Sustainable Growth: Natural Resources in the Total Expenditure of allocated EU funds 2014-2019




*Source: Author's calculation and presentation using the data from the European Commission, 2020a*

Austria and Germany have the greatest share of the agricultural funds in overall expenditures showing the importance of the agricultural sector in these countries. Romania reached its peak in 2017, exceeding Austria's share in 2017, while Bulgaria is on a good path too. Other observed countries are primarily under the EU-28 average from 2014 till 2019. The structure of the EAGF and EAFRD (graph 3) clearly shows that the EAGF has the majority share in the SG: NR in all countries over the observed period.

Graph 3. The structure of the EAGF and EAFRD in the Sustainable Growth: Natural Resources 2014-2019




*Source: Author's calculation and presentation using the data from the European Commission, 2020a*

Having in mind the importance of the EAGF and EAFRD, national governments must have a clear vision of agricultural development translated into a national strategy.

## 3. Results and Discussion

The EC's proposals on the CAP aim to make the EU's agricultural policy more responsive to current and future challenges while continuing to support the active needs of European farmers, as well as to foster a sustainable and competitive agricultural sector that can contribute significantly to the European Green Deal, especially concerning the farm to fork strategy and biodiversity strategy (EC, 2021b). In particular, the proposals focus on:

- securing a fair deal and a stable economic future for farmers;
- setting higher ambitions for environmental and climate action;
- safeguarding agriculture's position at the heart of Europe's society (EC, 2021b).

In order to achieve set objectives, the EC has set out nine specific objectives: ensure a fair income for farmers, increase competitiveness, rebalance the power in the food chain, climate change action, environmental care, preserve landscapes and biodiversity, support generational renewal, foster vibrant rural areas, and protect food and health quality (EC, 2021b). To meet these objectives, EU member states have plenty of resources available and have to direct all the available capacities to take their advantages. Scientists, academics, and agriculturists should join their capacities and go with relevant proposals which would meet one or more specific CAP objectives through project activities. Even though scientists, academics, and large agriculture and technological corporations should strive to achieve more scientific objectives, smaller agriculturists are those who will use those outcomes and they should apply for modernization and improvement of their production processes and mechanization capacities. All of them should strive to acquire new knowledge and skills to be more competent in their field of interest. ESI funds as decentralized funds are managed by national coordinators (mainly ministries and agencies) so each applicant should follow national calls for proposals, while the Horizon Europe and LIFE as centralized programmes are managed by the EC but also via national agencies for EU programmes so all interested parties apply at unique calls.

## 4. Conclusion

Humanity should more than ever care about the environment, clime, renewals, equality, in one word sustainability. Agriculture policy, hence, has been recognized as a priority. Agriculturists often lack affordable source of funding for investments in production modernization, knowledge on modern crop processing and using new technologies, quality management skills, and face with price risk, administration overload and poor regulatory and supervisory frameworks, feeding a growing population, providing a livelihood for farmers, and protecting the environment (Brooks et al., 2019; Rabobank, 2012; Syngenta, 2021; World Bank, 2005). For all those problems there is a solution. EU member states benefit from the EU community in several ways. One of them is the EU funding mechanism. The observed research showed that developing countries from the sample benefits most since TE as funds coming from the EU overcome the country contribution to the EU, which make positive OBB.

When it comes to agriculture, EAGF and EAFRD are the main funds under the Natural Resources and Environment of the MFF 2021-2027, as well as they were in the previous MFF 2014-2020. Their importance is emphasized by the fact that Austria and Germany as developed countries have the greatest share of the agricultural funds in overall EU funds. Romania and Bulgaria show the awareness of the importance of agriculture from 2017 onwards by exceeding the EU-28 average of that indicator. The MFF 2021-2027 has greater allocations than the previous one meaning that the EU member states should put even more efforts into writing quality, innovative, and sustainable proposals. In this respect, one should be aware that the available allocations do not mean approved resources, but that they have to be contracted and purposefully spent. By implementation of projects that are in line with national and EU strategy, focusing on the specific CAP objectives, EU agriculture will contribute to set EU key targets regarding climate and energy framework that should be reached up to 2030.

This paper for sure has some limitations due to the wide range and possibilities of EU co-financing. Besides, at this time not all allocations have been finalized and minor changes are possible. The amounts are presented in current prices or in 2018 prices depending on which were available. However, the paper may be of help for those who are willing to apply for some call applicable for agriculture and also for national governments and agencies who could get an insight on topics that could be improved. This paper mentions only examples of good practices regarding agriculture-related projects, while future research could be done in their deeper analysing to improve them even more, to translate them to other countries, and to get some fresh ideas for the applications of new proposals.

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# EU REGIONS COMPETITIVE EFFICIENCY AND THE KEY COMPETITIVENESS DETERMINANTS

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**Annotation:** The aim of this paper is the EU27 regions' competitive efficiency assessment together with a competitiveness key determinants identification. 15 input indicators and one output indicator, covering economic, socio-economic, and demographic fields are selected to evaluate competitiveness efficiency.

15 input indicators and one output indicator, covering economic, socio-economic, and demographic fields are selected to evaluate competitiveness efficiency. Data are downloaded from Eurostat for the year 2019 on a NUTS2 level. 234 regions of 27 EU countries are included. Factor analysis is used to eliminate the correlation between input variables and to create competitiveness factors. The parametric frontier approach – Stochastic frontier approach is used to analyze the transformation efficiency between the 4 created factors and the competitiveness output, represented by GDP. The part of the competitive efficiency analysis is the evaluation of the input factors' impact.

4 competitiveness factors, namely: The labor market, The quality of the community, The infrastructure, and The innovative potential, are created from input variables. Among the created factors, factor 2: The quality of the community has the biggest impact on a competitiveness output. This factor consists mainly of Disposable income, Quality and accountability of government services, Corruption in government services, Patent applications, Healthy life expectancy, and Infant mortality. According to efficiency results, no one of the analyzed regions is fully efficient, so all of them could improve their competitiveness output by improving transformation efficiency. The most competitive region in RCI 2019 ranking, region Stockholm could improve its competitiveness output by 11.52% if it would be fully efficient.

**Key words:** competitiveness input factors, competitive efficiency, competitiveness key determinants

**JEL classification:** C10, C67, F60, R11

## 1. Introduction

Competitiveness is one of the basic measures of economic performance and its growth belongs for several years between the main goals of many national governments and national groups, but it does not have a uniform definition yet. Competitiveness takes on a different meaning according to the scale or level at which the term is being used. In general, we distinguish between the macro-level (the competitiveness of a country), the micro-level (the competitiveness of the individual firm), and the meso-level (the competitiveness of local economic systems – clusters or regions). Nowadays regions become central geographical units for competitiveness evaluation because competitiveness indicators differ already at this level. Cellini and Soci (2002) argue, that the notion of regional competitiveness is neither macro (national) nor micro-economic (firm-based). Regions are neither simple aggregations of firms, nor are they scaled-down versions of nations. Regions compete in different ways: the attractiveness of the business environment, the labor, and the capital; the regional competitiveness may be understood as a set of synergies and complementarities that occur within the commercial and other socio-economic activities performed in the region. According to OECD (2019), a competitive region is a region that can attract and retain successful businesses and at the same time maintain or raise the living standards of its people. Indeed, regions compete not only by attracting companies but also through workers as well as markets (Camagni, 2002). The index composition, based on the aggregation of both input and output competitiveness indicators, is the most common approach to evaluate regional competitiveness, e.g. Regional competitiveness Index (Annoni and Dijkstra, 2019). For proper regional competitiveness evaluation, it is important to distinguish between the driving forces of competitiveness, which stand on the input side, and competitiveness outcomes, representing the output side. It is necessary to pay attention not only to the competitiveness outcome but also to the relationship between competitive inputs and outputs. Based on their relationship, which could be expressed by transformation efficiency, we can analyze at the same time not just the competitiveness as a whole, but also the way of its improving. Therefore, we consider the competitiveness assessment based on the index construction to be insufficient. Also, Ručinská and Ručinský (2007) claim that for needs of regional competitiveness determination is suitable to execute a combination of both measurements, outcomes as well as drivers because only then causes of possible low competitiveness can be identified.

The aim of this paper is the EU27 regions' competitive efficiency assessment together with a competitiveness key determinants identification. The research hypothesis: “There are still huge competitiveness disparities inside countries between the region with capital cities or other big industrial cities and the rest of regions.” is established.

## 2. Materials and Methods

15 input variables, namely Disposable income in PPS per inhabitant (DI), Employment rate of the age group 15 – 64 years (EmRate), Unemployment rate (Unemp), Neither in employment nor in education and training rate (NEET), Index of Quality and accountability of government services (Zquality), Index of Corruption in government services (Zcorruption), Total R&D expenditures as a percentage of GDP (GERD), Human resources in science and technology as an active population aged of 15-74 in science and technology (HRST), Patent applications to the European patent office (Patapp), Employment in high-tech sectors as a percentage from total employment (EmpHT), Innovative Small and medium enterprises as a percentage from all SMEs (InnSmes), Healthy life expectancy in years (HLexp), Infant mortality rate (Infmor), Higher education attainment in an age group of 25-64 as a percentage from this group (Heda), and Road accessibility (Roadacc), are selected with regards to capture not just economic aspects but also to capture demographic and social aspects of competitiveness. Just one output variable is selected – Gross domestic product in PPS per inhabitant (GDP). Selected indicators are compiled for 234 regions of 27 EU countries (excluding Great Britain).

Factor analysis (FA) is applied to reduce the number of input variables, to remove multicollinearity between them, and to create competitiveness factors, represent EU27 regional driving forces. It should be noted that the idea under FA is to account for the highest possible variation in the indicators set using the smallest possible number of factors. Therefore, the composite factors no longer depend upon the dimensionality of the dataset, but it is rather based on the “statistical” dimensions of the data. According to FA, weighting only intervenes to correct for the overlapping information of two or more correlated indicators, and it is not a measure of the importance of the associated indicator. Non-overlapping information, which otherwise would be lost, if a correlated variable was excluded from the analysis, is now kept (Goletsis and Chletsos, 2011).

FA assumes that the dependencies between analyzed variables are due to the effect of some immeasurable variables standing in the background (so-called common factors).

The method is based on a set of observable variables. $X_{ij} = 1, 2, \ldots, p$ having a multidimensional distribution with a $p$-membered mean value vector $\mu_X$and a covariance matrix $\sum p$ of rank $p$. The general FA model assumes that there exists $q$ in the background standing common factors $F_1, F_2, \ldots, F_q$, while $q < p$. These factors allow to expressed the $j-th$ observable random variable $X_j$by the following equation:

$$X_j = \mu x_j + a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jq}F_q + e_j \, , \qquad \textbf{(1)}$$

where:$-e_j, j = 1, 2, \ldots, p$ represents the random (error) components referred to as specific factors,

$-a_{jk}$ represents factors` weights, explaining the impact of $k - th$ common factor on variable $X_j$.

Significant common factors are those whose eigenvalue is greater than 1 (4 factors in our paper). Based on the factor weights, the variable that has the highest factor weight is selected for each factor. For better interpretation, varimax rotation is used (Rummel, 1970).

The stochastic frontier analysis is used to estimate the competitiveness technical efficiency of competitiveness inputs (factors) transformation on competitiveness outcome. Part of this method is regional competitiveness key determinants identification. The production function model was first time presented by Aigner, Lovell and Schmidt (1977) and in the paper is expressed by a linear transformation of the Cobb-Douglas production function:

$$lny_i = \beta_0 + \textstyle\sum_n \beta_n lnx_{ni} + (v_i - u_i) \; i = 1, 2, \ldots, N, \qquad \textbf{(2)}$$

$$\varepsilon_i = v_i - u_i \quad u_i \geq 0,$$

where: - $lny_i$ represents a logarithm of the output variable,

-$\beta_n$ is an estimated parameters vector, represents elasticity because both parameters are in a logarithm form and could be interpreted as the average percentage output change in a case of 1 percentage input change,

-$x_{ni}$ is an input quantities vector of the $n - th$ variable for the $i - th$ region,

-$u_i$ represents non - negative random variables that capture technical efficiency (TE),

-$v_i$ represents random variables of the $i - th$ unit reflecting statistical noise.

The simple notation of technical efficiency calculation is:

$$TE_i = exp\{-u_i\} \qquad \textbf{(3)}$$

$TE_i$ refers to the technical efficiency defined as the ratio of the observed performance to the maximum obtained performance. $TE_i = 1$ indicates that the $i - th$ region obtains the maximum realized performance, while a $TE_i < 1$ provides a deficit measure of the observed output from the maximum realizable performance. In production theory, the input cannot take on a negative value, so it is necessary to transform the standardized normally distributed variable by adding a constant to obtain a value of 5.0 (Mutz et al., 2017). This correction is used to transform input variables, which entered the analysis in the form of a factor score and has no influence on the statistical analysis results.

Based on several competitiveness studies results (Surd et. al, 2011; Antonescu, 2012; Koisova et. al, 2019; Melecký, 2011; Annoni and Dijkstra, 2019) we set the following research hypothesis: "There are still huge competitiveness disparities inside countries between the region with capital cities or other big industrial cities and the rest of regions."

## 3. Results and Discussion

To evaluate EU regional competitiveness by focusing not just on a regions' position, but also on the way of its improvement, it is necessary to analyze the relationship between competitiveness driving forces and outcome. 15 chosen input indicators, covering different parts of economic, socio-economic, and demographic fields are used to create competitiveness inputs factors. Because of the strong correlation between input indicators, Factor analysis (FA) is applied to reduce dimension and remove correlation.

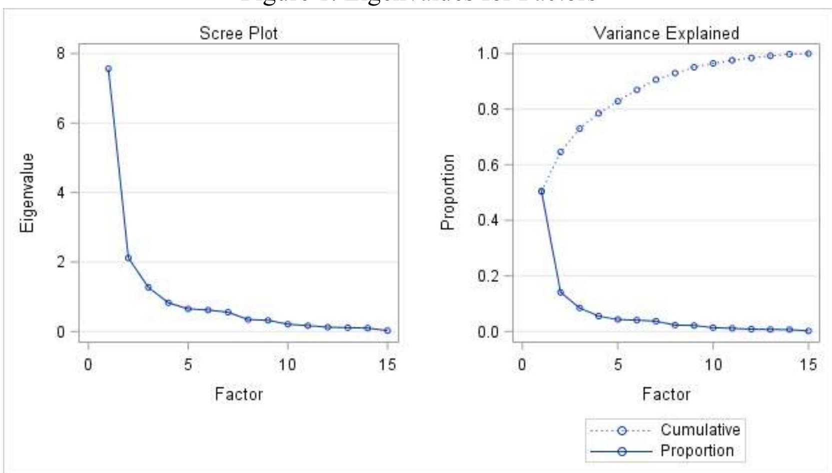
Table 1. KMO statistics

| Kaiser's Measure of Sampling Adequacy: Overall MSA = 0.85180152 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Emprate** | **DI** | **Unemp** | **NEET** | **Zquality** | **Zcorruption** | **GERD** | **HRST** | **Pattap** | **EmpHT** | **InnSmes** | **Hlexp** | **IInfmor** | **Heda** | **Roadacc** |
| 0.86 | 0.84 | 0.71 | 0.91 | 0.92 | 0.86 | 0.91 | 0.78 | 0.91 | 0.91 | 0.93 | 0.88 | 0.87 | 0.68 | 0.88 |

*Source: SAS, own calculations*

Based on the KMO statistics of data suitability (Table 1) we find out that data meet the condition of FA application. According to the Eigenvalues of the Correlation Matrix, 4 individual factors, which together express 78,5% of the total variability of the considered inputs, are created (Figure 1).

Figure 1. Eigenvalues for Factors




*Source: SAS, own calculations*

To get the most meaningful interpretation results, orthogonal rotation Varimax is used. Factor 1 – **The labor market** is correlated positively mainly with the Employment rate (0,89), the Unemployment rate (0,94), and Neither in employment nor in education and training rate (0,81). Factor 2 – **The quality of the community** is created mostly by Disposable income (0,70), Index of quality and accountability of government services (0,54), Index of corruption in government services (0,62), Patent applications (0,65), Healthy life expectancy (0,67), and Infant mortality rate (0,76). Factor 3 – **The infrastructure** is created primarily by

Innovative small and medium entities (0,79) and Road accessibility (0,61). Factor 4 – **The innovative potential** is correlated mainly with Total R&D expenditures (0,56), Human resources in science and technology (0,68), Employment in high-tech sectors (0,82), and Higher education attainment (0,71) (Table 2).

Table 2. Factor Pattern after varimax rotation

| Rotated Factor Pattern | | | | |
|---|---|---|---|---|
| | Factor1 | Factor2 | Factor3 | Factor4 |
| Unemp | 0.93614 | -0.02266 | -0.13430 | 0.09714 |
| Emprate | 0.88516 | 0.20970 | 0.08187 | 0.21612 |
| NEET | 0.80842 | 0.13830 | 0.28177 | 0.29330 |
| Zquality | 0.43548 | 0.54299 | 0.41479 | 0.08043 |
| Infmor | -0.03025 | 0.76066 | -0.03447 | 0.38922 |
| DI | 0.35619 | 0.69187 | 0.41164 | 0.16546 |
| Hlexp | -0.08654 | 0.67437 | 0.57888 | -0.04537 |
| Pattap | 0.45311 | 0.64879 | 0.44516 | 0.19289 |
| Zcorruption | 0.54914 | 0.61855 | 0.16368 | 0.04960 |
| InnSmes | 0.10177 | 0.09989 | 0.78818 | 0.16236 |
| Roadacc | -0.00907 | 0.34681 | 0.60843 | 0.28962 |
| GERD | 0.33392 | 0.48058 | 0.28680 | 0.55926 |
| EmpHT | 0.29582 | 0.17812 | 0.04390 | 0.82460 |
| Heda | 0.07594 | 0.08549 | 0.56706 | 0.70821 |
| HRST | 0.29353 | 0.26259 | 0.54853 | 0.67836 |

*Source: SAS, own calculations*

Also, according to Staníčková (2015) Innovative potential, The infrastructure, and The labor market, consisting of similar indicators as our factors, represent significant driving forces of competitiveness, but she considers Innovative potential and The labor market as output factors.

Regions` standardized factor scores for all 4 factors are corrected to a new mean value of 5 and are used as input variables in a case of competitiveness efficiency evaluation. Just one variable – Gross domestic product stands on the output side. Model of Cobb – Douglas production function and the Stochastic frontier analysis is used to evaluate competitiveness inputs-output transformation efficiency. All variables are adjusted into the natural logarithm.

Table 3. The output of the stochastic frontier production function

| The QLIM Procedure | | | |
|---|---|---|---|
| Variable | Mean | Standard Error | Type |
| lnGdp | 10,18738 | 0,376507 | **Frontier (Prod)** |
| Endogenous Variable | | | **lnGdp** |
| Number of Observations | | | 234 |
| Log Likelihood | | | -158,46 |
| Maximum Absolute Gradient | | | 1107 |
| Optimization Method | | | Newton-Raphson |
| AIC | | | 330,92 |
| Schwarz Criterion | | | 355,10 |
| Sigma | | | 0,54334 |
| Lambda | | | 2,35121 |

| Parameter Estimates | | | | | |
|---|---|---|---|---|---|
| Parameter | DF | Estimate | st. error | t | Pr > \|t\| |
| Intercept | 1 | 7,2684 | 0,1641 | 44,28 | <,0001 |
| l_Factor1 | 1 | **0,4566** | 0,0559 | 8,16 | <,0001 |
| l_Factor2 | 1 | **0,6376** | 0,0584 | 10,91 | <,0001 |
| l_Factor3 | 1 | **0,5291** | 0,0652 | 8,11 | <,0001 |
| l_Factor4 | 1 | **0,5369** | 0,0642 | 8,34 | <,0001 |
| _Sigma_v | 1 | 0,2126 | 0,0216 | 9,81 | <,0001 |
| _Sigma_u | 1 | 0,5 | . | . | . |

*Source: SAS, own calculations*

The production frontier model is significant (Prob > chi2), all estimated parameters are significant (Prob. < 0.01) and the production function is following:

$$lnGDP = 7.27 + 0.46lnFactor1 + 0.64lnFactor2 + 0.53lnFactor3 + 0.54lnFactor4 + (0.21v - 0.5u)$$

Coefficients`values can be interpreted as a percentage change in output caused by the percentage change in the respective input. If factor 1 – The labor market increases by 1%, we can expect an average increase in GDP by 0.46%. If factor 2 – The quality of the community increases by 1%, we can expect an average increase in GDP by 0.64%. The 1% increase in factor 3 - The infrastructure leads on average to increase GDP by 0.53% and if the factor 4 – The innovative potential increases by 1%, we can expect an average increase in GDP by 0.54%. All coefficients are not elastic, because their estimated values are lower than 1. The highest impact on the competitiveness output has factor 2 – The quality of the community. Factor 2 is created by the highest number of input indicators and therefore covers the widest spectrum of different fields – economic, demographic, and socio-economic. Based on the results, we can conclude that regions can increase their competitiveness output mainly by increasing Disposable income, Healthy life expectancy, Patent applications, and decreasing the Infant mortality rate (indicators most involved in factor 2 formation). The impact of factor 3 – The infrastructure and factor 4 - The innovative potential on the competitiveness output is comparable, and factor 1 - The labor market has the lowest impact on the competitiveness output of all factors. According to Szopik-Depczyńska et. al (2020) to improve region position it is necessary to focus on those areas in the region that have the greatest potential for creating innovation. Seitkazieva et al. (2018) also declare that innovations have a really important role in competitiveness improvement.

Rusu and Roman (2018) claim that is crucial to take into account the development stage of the country or region when analyzing factors that impact competitiveness because in a different development stage different factors are the key ones.

Competitiveness technical efficiency with which regions transform competitiveness factors on a competitiveness output is estimated based on the stochastic frontier production function. Technical efficiency (TE) is perceived in the sense that an efficient region is at the same time also a competitive region because it effectively uses its comparative advantages and transforms them into a final level of competitiveness. According to efficiency results, no one of the analyzed regions is fully efficient, so all of them could improve their competitiveness output by improving transformation efficiency. Estimated TE is moving in an interval with borders from 0.9345 to 0.5038. The value of TE indicates how much the region should increase its output to be fully efficient with the given inputs. According to the reached TE value, European regions are compared and divided into five groups:

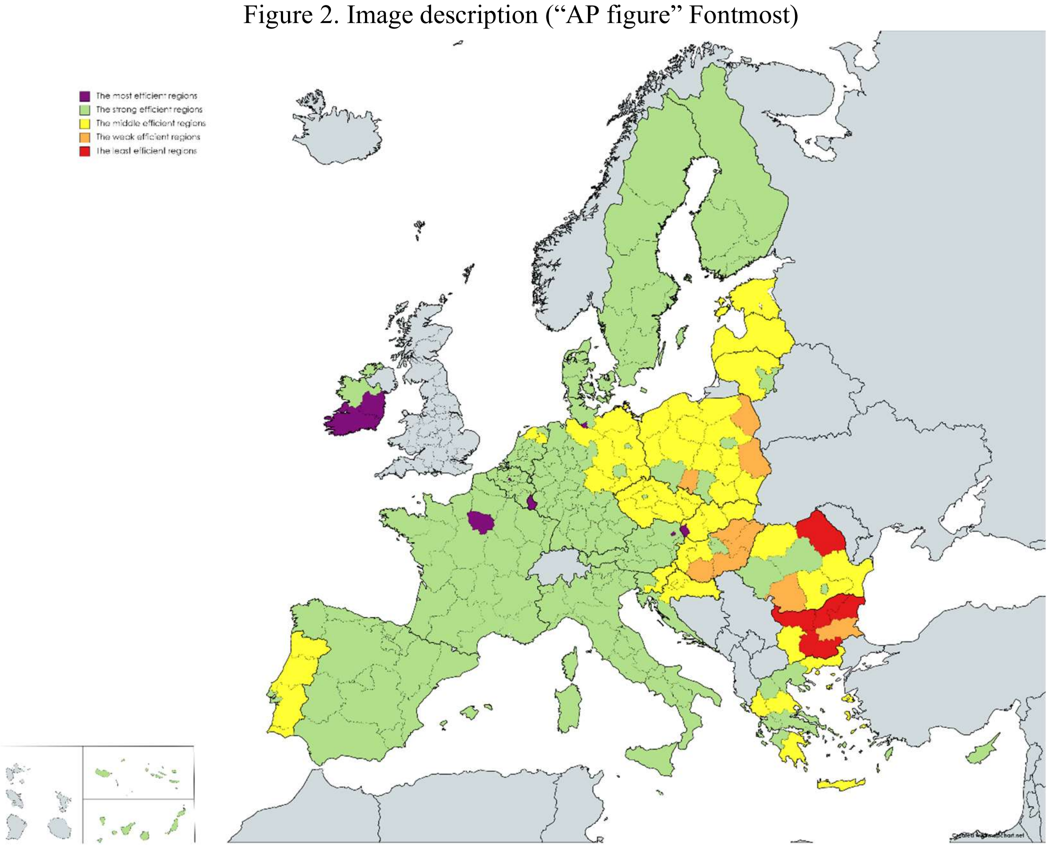
1. The most efficient regions with TE from <1, 0.9) = the most competitive regions,
2. The strong efficient regions with TE from <0.9, 0.8) = the strong competitive regions,
3. The middle efficient regions with TE from <0.8, 0.7) = the middle competitive regions,
4. The weak efficient regions with TE from <0.7, 0.6) = the weak competitive regions,
5. The least efficient regions with TE from <0.6, 0.5) = the least competitive regions.

The first group – "**The most efficient regions**'' consists of 8 EU regions in which usually the capital city is situated (highlighted by purple color in Figure 2). The most efficient region with the maximum TE value is the Belgian region with the capital city Rég. de Bruxelles (BE10), followed by Luxembourg (LU00), Ireland region Southern (IE05), Ireland region with the capital city Eastern and Midland (IE06), French region with capital city Île de France (FR10), German region with the second-largest city Hamburg (DE60), Austrian region with the capital city Wien (AT13), and closed by Slovak region with the capital city Bratislava region (SK01).

The second group – "**The strong efficient regions**'' is the group with the highest frequency. It consists of 151 regions (highlighted by green color in Figure 2). All regions of Sweden, Finland, Denmark, Spain, and Italy are strong efficient. Also, all regions of France, Austria, Belgium with the expectation of the most efficient capital region together with the rest of Ireland regions are strong efficient. Furthermore, almost all regions of the Netherlands with an expectation of 2 middle efficient regions, western regions of Germany plus its capital region, 3 Poland regions (including the region with the capital), Czech capital region, Slovenian capital region, Portugal capital region, Lithuanian capital region, Hungarian capital region, 3 Romanian regions (including the capital region), coastal region of Croatia, 7 Greek regions (including the capital region), and Cyprus region belong to this group too. The Netherlands, Denmark, France, Sweden, and Germany are EU countries with a high level of efficiency and performance trend according to Staníčková (2015) too.

The third group – "**The middle efficient regions**'' is formed by 51 regions (highlighted by yellow color in Figure 2). Namely: the rest of Portugal regions except capital one, 2 Netherlands regions (NL12, NL13), the rest of German regions (eastern regions), the rest of Czech regions, most Polish regions, Lithuanian region without the capital city, Latvia region, Estonia region, the rest of Slovak regions (including capital region), 2 Hungarian regions (HU21, HU22), 3 Romanian regions (RO11, RO22, RO31), the rest of Croatian regions, Slovenian region without the capital city, Bulgarian capital region, and the rest of Greek regions.

Figure 2. Image description ("AP figure" Fontmost)




*Source: European Association, 2014 ("AP source" Font)*

The fourth group – “**The weak efficient regions**’’ consists of 3 Poland regions (PL52, PL81, PL84), 4 Hungarian regions (HU23, HU31, HU32, HU33), the Romanian region RO41, and the Bulgarian region BG34 – together of 9 regions (highlighted by orange color in Figure 2).

The fifth group – “**The least efficient regions**’’ consists just of 4 Bulgarian regions (BG31, BG32, BG33, BG42) and 1 Romanian north-eastern region RO21.

Based on the calculated TE, representing the level of competitiveness achieved, we can conclude, that most regions of the western, northern, central, and south-central countries are strongly competitive. By moving more to the east part of the EU, the competitiveness of regions is decreasing. Szopik-Depczyńska et. al (2020), which grouped EU regions based on similar indicators focused on local development and innovations, consider Finland, Germany, Sweden, Denmark, and Belgium regions as leader regions, on the other hand, Bulgaria, and Romania as modest regions too.

In most of the analyzed countries, there are differences in the competitiveness of the capital region and the rest of the regions, so we can accept our research hypothesis. The marked disparities between the region with a capital city and all others are found also by Surd et. al (2011) and Antonescu (2012) in the case study of Romania and by Koisova et. al (2019) in the case study of V4 regions. Melecký (2011) reaches the same conclusion that economically powerful regions in the agglomeration of major cities achieve the best results. Holúbek et al. (2014) identified significant regional differences between Slovak regions with the existence of one strong peripheral region – the Bratislava region at the expanse of the others. At all the economic analysis, made by Bolea et. al (2018) confirms the structural break in the convergence process in 2008, and this holds in general for all the magnitudes analyzed, which suggests an impact on the structural relationships contributing to increase inequality in Europe in recent years. Results of Alexa et. al (2019) show that there is a divergence process emerging within the EU15 regions and a lack of convergence in the CEE regions. Also, the Regional Competitiveness Index ranking (Annoni and Dijkstra, 2019) shows a remarkable gap between capital/metropolitan regions and the rest of the country. The most competitive region within each country is nearly always the capital region. In a comparison with a Regional Competitiveness Index 2019 ranking, all tops regions in RCI 2019 belong to the group The most efficient and The strong efficient regions, but there are disagreements in their ranking caused by different methodology. Based on the estimated TE value, we find out that the most competitive Sweden region Stockholm (SE11) in RCI2019, could produce even more output, representing its competitiveness if it would be fully efficient. Stockholm could improve its competitiveness output by 11.52%. On the other hand, just two of the bottom regions in RCI 2019, belong also to the group The least efficient regions: Romanian region Sud-Est (RO22), and the Bulgarian region Severozapaden (BG31). Both regions could improve their competitiveness output by more than 40% if they will be fully efficient.

## 4. Conclusion

The most common approach to regional competitiveness evaluation is index construction, based on the aggregation of input and output variables in one value, according to which regions are ranking. This one-dimensional approach does not explain why regions achieve their competitive position or how can they improve their competitive outcome. Therefore we evaluate EU regional competitiveness based on the multi-dimensional approach to analyze not just the regions' competitive position, but also the mutual relationship between competitiveness inputs and outputs. 15 input indicators are used to create 4 competitiveness factors, representing driving forces of competitiveness, namely: The labor market, The quality of the community, The infrastructure, and The innovative potential. Just one variable is standing on the output side – Gross domestic product as an outcome of competitiveness.

The stochastic frontier production function is applied to estimate competitiveness input-output transformation efficiency and to evaluate the competitiveness factors' impact. Among the created factors, factor 2 – The quality of the community has the highest impact on a competitiveness output. If The quality of the community increases by 1%, we can expect an average increase in GDP by 0.64%. Factor 2 is created by the highest number of input indicators and therefore covers the widest spectrum of different fields – economic, demographic, and socio-economic. Based on the results, we can conclude that regions can increase their competitiveness output mainly by increasing Disposable income, Healthy life expectancy, Patent applications, and decreasing the Infant mortality rate.

Estimated technical efficiency (TE) is moving in an interval with borders from 0.9345 to 0.5038 and indicates that no one of the analyzed regions is fully efficient. According to the reached TE value, European regions are compared and divided into five groups: The most efficient regions with TE from <1, 0.9), The strong efficient regions with TE from <0.9, 0.8), The middle efficient regions with TE from <0.8, 0.7), The weak efficient regions with TE from <0.7, 0.6), The least efficient regions with TE from <0.6, 0.5). The first group "The most efficient regions" consists of 8 EU regions in which usually the capital city is situated, in the foreground with the most efficient – the most competitive Belgian region Rég. de Bruxelles (BE10). The second group "The strong efficient regions" grouped mostly the regions of the western, northern, central, and south-central countries (151 regions). The third group "The middle efficient regions" is formed by 51 regions, situated mostly in the eastern part of the EU. "The weak efficient regions" group consists of 9 regions (3 Poland, 4 Hungarian, 1 Romanian, and 1 Bulgarian region), and "The least efficient regions" group consists just of 4 Bulgarian, and 1 Romanian region.

Based on the given results we can conclude, that most regions of the western, northern, central, and south-central countries are strongly competitive. By moving more to the east part of the EU, the competitiveness of regions is decreasing. Because of proved TE disparities between the capital regions and others, we accept our research hypothesis: "There are still huge competitiveness disparities inside countries between the region with capital cities or other big industrial cities and the rest of regions." In a comparison with a Regional Competitiveness Index 2019 ranking, all tops regions in RCI 2019 belong also to the group "The most efficient regions" or "The strong efficient regions".

Further research, based on the findings obtained in this study, will be focused on the longer period analysis to consider whether the disparities between the EU region, especially between regions with the capital city and other regions deepen or not.

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# ON-LINE PURCHASES OF ORGANIC FOOD IN THE CONTEXT OF THE COVID-19 PANDEMIC IN THE CZECH REPUBLIC

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**Annotation:** The Czech organic food market is on the rise. Organic food production has seen a significant boom in terms of sales volumes, which enabled opening of new shopping channels for consumers. In 2020, a number of strict measures was introduced with the intention to curb the outbreak of the Covid-19 pandemic, which also affected the organic food distribution and preferred places of purchase. Due to all the lockdowns and limitations, on-line shopping entered the scene as a new potential tool for organic food market development. The aim of this research is to identify the organic food shopping patterns of internet users during March and April 2020 in the context of freshly introduced governmental measures, and to identify dependencies according to selected socio-demographic respondents' characteristics. The results show that respondents' level of education and their age are the key determining factors when it comes to their on-line organic food purchases.

Key words: Marketing, Organic Food, Online purchase and buying, Correspondence Analysis, Logistic Regression, Consumer Behaviour, Czech Republic

JEL classification: M1, M2, C30

## 1. Introduction

While in 2008 (and 2009, respectively), the Czech organic produce market was rather limited, with total market value of 963 mill CZK (approx. 40 mill USD, in 2008), or respectively 1.2 bill CZK (approx. 50 mill USD, in 2009), (Institute of Agricultural Economics and Information, 2011 and Janssen and Hamm, 2012), the overall organic produce turnover of Czech entities including exports exceeded in 2016 the amount of four billion Czech crowns. The total consumption of organic produce (including imports) in the Czech Republic reached the worth of 2.55 bill CZK (approx. 106 mill USD), indicating a yearly increase of 13.5%, and more than 100% compared to 2009. At the end of 2016, there were over six hundred of registered organic food producers in the Czech Republic, which is 50% more than in 2009, when there were under four hundred of them (Czech Confederation of Commerce and Tourism, 2019). Organic food production is also one of form of alternative agriculture, which is an important topic in some current problematics like water withdrawal (Procházka et al., 2018), soil degradation (Gebeltová, Z. et al., 2019), or food quality and safety (Severová et al., 2021). Organic farming represents an alternative to the intensive production prevailing in Czechia and can reduce the negative anthropogenic impact which represents about 60 % of factors affecting the soil quality (Gebeltová and Malec, 2018). The most popular organic products include milk and dairy products, fruits and vegetables (including fruit and vegetable juices, as well as processed food such as spices, mustard, coffee or tea, plus ready-made baby food. Czech consumers tend to purchase their organic products mainly in retail chains, sometimes also at drug stores and health food stores, at farm or other stores or at on-line retailers (Czech Confederation of Commerce and Tourism, 2019). According to the Czech Ministry of Agriculture, the domestic organic market was worth 3.73 bill CZK (approx. 150 mill USD) in 2019 (http://eagri.cz/public/web/en/mze/organic-production-and-organic-food/the-market-and-trade-in-organic-food/).

Kareklas et al. (2014), Yaday (2016) and Pilař et al. (2018 and 2020) identified two main driving forces that lead consumers to buy organic food. The first group of consumers prefers organic food due to its perceived higher quality, benefits for human health and better nutritional value (compared to non-organic products). This motivation is called "egoistic". This was also confirmed by an analysis of social networks in the field of healthy food on the social networks Twitter (Pilař et al., 2021a) and Instagram (Pilař et al., 2021b).The second group of organic produce purchasers is motivated by environmental reasons or animal welfare – this is the "altruistic" motivation. Živělová and Crhová (2013) pointed out the increase of interest regarding organic food among Czech consumers. Interesting fact: Czech consumers tend to prefer organic produce despite its higher price difference compared to conventional products. The organic/non-organic food price gap in the Czech Republic is significantly higher (400% in 2012) than in the rest of the Western Europe (20–30%). As Živělová and Crhová (2013) present still, the majority of Czech organic produce consumers remain to be driven by egoistic reasons.

The main objective of this study is to explore consumers' behaviour occurring at the Covid-19 crisis outbreak in the context of lockdowns and governmental restrictions imposed on some parts of the retail sector, and to identify the current market trends in on-line shopping. The current observations may serve as a useful starting point for Czech organic farmers and organic food producers.

## 2. Materials and Methods

A survey conducted in March and April 2020 served as a source of primary data. A total of 757 respondents from the Czech Republic took part in the research. The research allowed us to gather a rather unique data from the outset of the Covid-19 pandemic illustrating respondents' on-line shopping behaviours. The on-line questionnaire was filled by a pool of respondents consisting of 65% women and 35% men, 58.4% respondents under 26 years of age, 14% respondents aged between 26-35, 16.6% respondents aged between 36-45, and 11% respondents aged 46 years and over. Their education structure is indicated in Table 1. The questionnaire was distributed to respondents via on-line channels.

Table 1. Education of respondents

| Education | Relative frequency |
|---|---|
| **Primary** | 7.27% |
| **Secondary** | 70.15% |
| **Tertiary** | 22.59% |

*Source: Own research (2020)*

The data were analysed using the contingency tables analysis, correspondence analysis and logistic regression Agresti (2002) and Anděl (2005). Correspondence analysis is a multivariate statistical technique. It is conceptually similar to principal component analysis but applies to categorical rather than continuous data. In a similar manner to principal component analysis, it provides a means of displaying or summarising a set of data in two-dimensional graphical form. Using graphic tools of this method it is possible to describe the association of nominal or ordinal variables and to obtain a graphic representation of the relationship in multidimensional space. The aim of this analysis is to reduce the multidimensional space of row and column profiles and to save maximally original data information (Hebák et al., 2007).

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. Regression model parameters are estimated by the Maximum Likelihood Estimation. The Wald statistics tests the statistical significance of regression coefficients (Hosmer and Lemeshow, 2000). Software STATISTICA and UNISTAT was used for processing of primary data.

## 3. Results and Discussion

As for the response variable (Do you buy organic food on-line?), Yes and No answers were selected for further consideration. We were interested in the driving factors behind a consumer's decision to purchase organic products on-line. The explanatory variables (gender, age, education) were considered as categorical, the values of the variables were coded. Regression model parameter estimates including the Weld statistics values and the significance of individual coefficients are listed in Table 2, indicating clear association between organic produce purchases and the respondents' age and education.

Table 2. Regression Model Parameters

| | Coefficient | Standard Error | Wald Statistics | Significance |
|---|---|---|---|---|
| **Constant** | -1.186 | 0.333 | 12.671 | 0.0004 |
| **Gender** | -0.113 | 0.165 | 0.472 | 0.0923 |
| **Age** | 0.110 | 0.073 | 2.262 | 0.0325 |
| **Education** | 0.223 | 0.145 | 2.344 | 0.0257 |

*Source: own research (2020)*

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 relations between individual categories of pairs of variables are indicated through the correspondence analysis. Table 3 shows that the respondents are not very inclined to make on-line purchases of organic food. If they do, they do so less often (23.12%). Only 2.5% of respondents buy organic food on the internet several times a week.

Table 3. Shopping for organic food on the Internet

| Frequency of purchases | Relative frequency |
|---|---|
| **Several times a week** | 2.51% |
| **Once a week** | 5.02% |
| **Once every 14 days** | 6.08% |
| **Less often** | 23.12% |
| **Never** | 63.28% |

*Source: Own research (2020)*

Table 4. Contingency table – column relative frequencies: Shopping for organic food on the Internet & Gender (p-value > 0.05)

| Frequency of purchases | Men | Women |
|---|---|---|
| **Several times a week** | 1.14% | 3.25% |
| **Once a week** | 5.30% | 4.87% |
| **Once every 14 days** | 8.33% | 4.87% |
| **Less often** | 21.21% | 24.14% |
| **Never** | 64.02% | 62.88% |

*Source: Own research (2020)*

Table 4 illustrates the frequency of organic food purchases made by men or women. The fact that men buy organic food on-line once a week or once every two weeks more frequently than women, comes as a surprise. Women tend to buy organic food on the internet more often several times a week (3.25%).

Table 5 and correspondence map Figure 1 clearly show that the age group of 26–35-year-olds are the most likely to buy organic food on-line once a week. The same goes for organic food purchases that are happening twice a week. Another group who likes to go shopping for organic food on-line, are people aged 36-46. Interestingly, the youngest respondents (under 25) buy organic food almost never - only rarely. Same pattern may be observed when it comes to the oldest group of respondents (over 46), whose organic food online purchases are also very seldom.

Table 5. Contingency table – column relative frequencies: Shopping for organic food on the Internet & Age (p-value < 0.05)

| Frequency of purchases | under 25 years | 26 – 35 years | 36 – 45 years | 46 or more |
|---|---|---|---|---|
| **Several times a week** | 2.71% | 2.83% | 2.38% | 1.20% |
| **Once a week** | 4.75% | 6.60% | 4.76% | 4.82% |
| **Once every 14 days** | 4.07% | 10.38% | 8.73% | 7.23% |
| **Less often** | 20.59% | 30.19% | 28.57% | 19.28% |
| **Never** | 67.87% | 50.00% | 55.56% | 67.47% |

*Source: Own research (2020)*

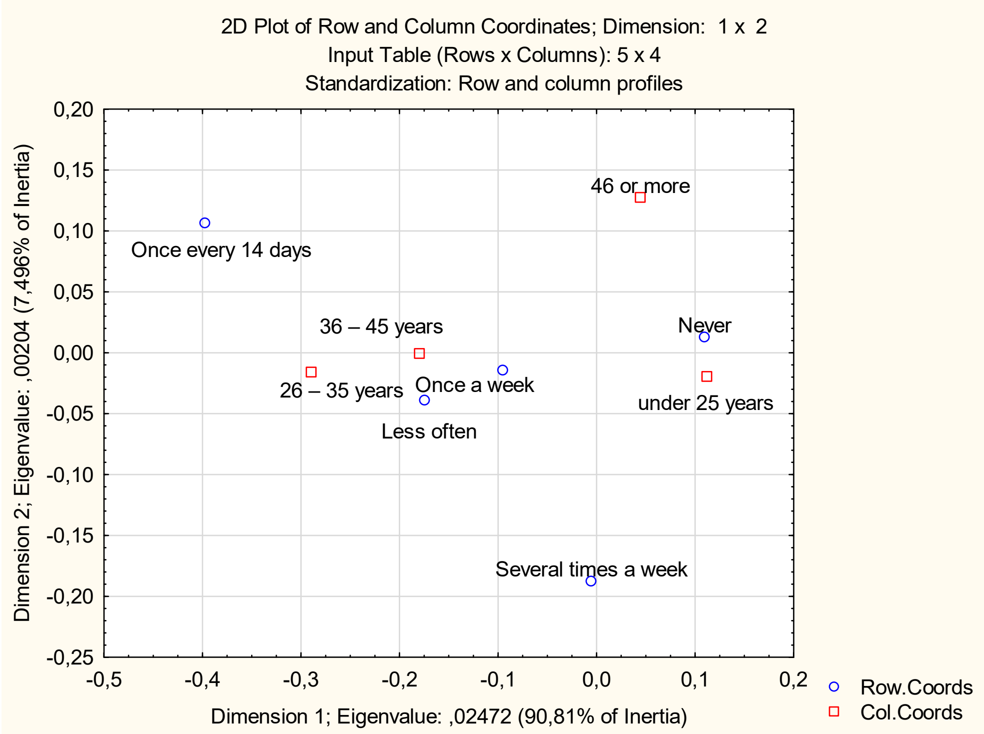
Table 6 and Figure 2 rather interestingly show that respondents with the lowest form of education tend to purchase organic food on-line most often - several times a week (7.27%). University educated respondents buy organic food most frequently once a week (7.02%). Respondents with finished high school buy organic produce on-line most often once every two weeks (6.78%). High school graduates are also most likely to not buy organic food on the internet at all (66.29%).

Table 6. Contingency table – column relative frequencies: Shopping for organic food on the Internet & Education (p-value < 0.05)

| Frequency of purchases | Primary | Secondary | Tertiary |
|---|---|---|---|
| **Several times a week** | 7.27% | 1.88% | 2.92% |
| **Once a week** | 3.64% | 4.52% | 7.02% |
| **Once every 14 days** | 5.45% | 6.78% | 4.09% |
| **Less often** | 23.64% | 20.53% | 30.99% |
| **Never** | 60.00% | 66.29% | 54.97% |

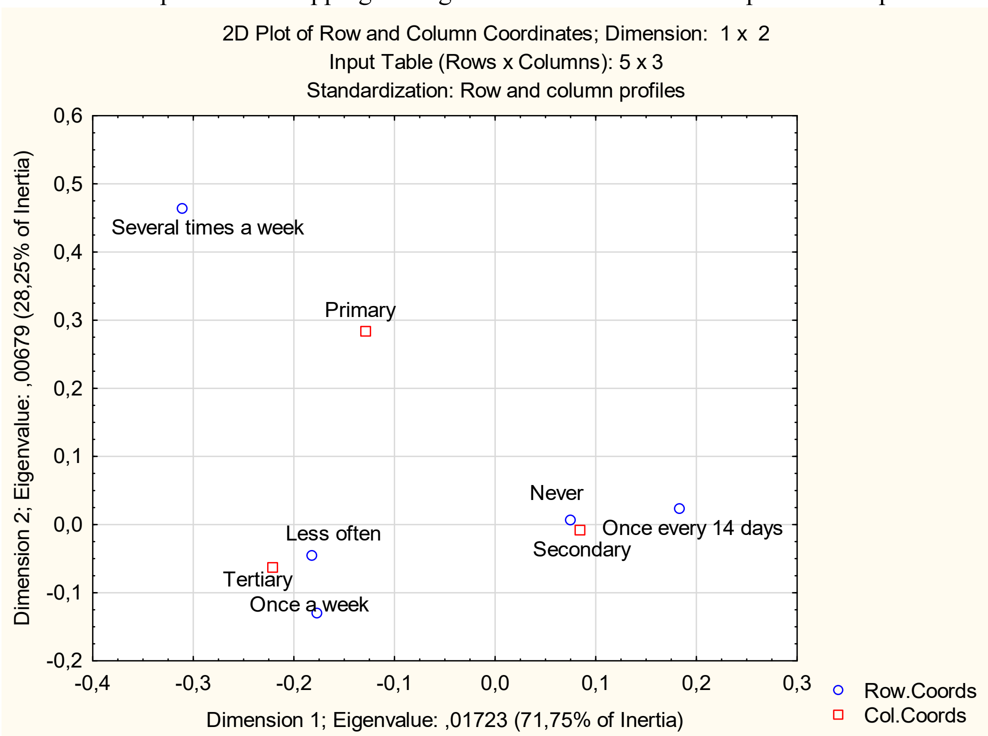
*Source: Own research (2020)*

Figure 1. 2D Model interpretation: Shopping for organic food on the Internet depends on respondent´s Age




*Source: Own research (2020)*

Figure 2. 2D Model interpretation: Shopping for organic food on the Internet depends on respondent´s Education




*Source: Own research (2020)*

The market has significantly grown, which is an interesting development. The growth of the market is reflected in the increased consumer interest in organic produce purchases (compared to the survey conducted in 2013, Zámková, Prokop, 2014), reported even by the youngest group of respondents, who previously showed significantly less interest in organic food than the remaining age groups (Zámková and Prokop, 2014). This development is fuelled also by the fact that the price gap between organic and conventional products is narrowing (compared to 2012, when organic products were almost 4 times more expensive than non-organic, (Živělová and Crhová, 2013). The availability and distribution of organic food on the internet has demonstrably increased (e-commerce boom). Almost 10% of respondents participating in the March–April 2020 survey reported that internet is their first place of choice for organic food purchases. Previous research conducted by the same authors (Zámková and Prokop, 2018) has not singled out the internet as a significant first-choice shopping environment. Finally, this growing popularity of organic food is affected by the increasing number of business entities active in organic agriculture and organic food producers. Their number has grown by 50% over the last 10 years, while the whole market has seen a threefold increase over the same period of time (Czech Confederation of Commerce and Tourism (2019) and Institute of Agricultural Economics and Information (2011)).

## 4. Conclusion

The main objective of this study was to analyse on-line shopping behaviours that occurred on the organic produce market when the Covid-19 pandemic hit. All the data come from an extensive questionnaire survey distributed to respondents via on-line channels in March and April 2020. The data were analysed using multidimensional statistical methods, such as the logistic regression, contingency tables analysis, and correspondence analysis. The questionnaire provided authors with categorical data; monitored factors included gender, age, and education of respondents. Taking into consideration all factors at once, logistic regression revealed a significant statistical dependence between the on-line organic food purchases and respondents' age and education. This was followed by more detailed analysis based on correspondence maps and column relative frequencies. This in-depth research confirmed that on-line organic purchases are not exceedingly popular among the respondents, and if so, they still do not happen very often. Gender-wise: Men buy organic food on-line once a week or once every two weeks more frequently than women. On the other hand, women tend to buy organic food on the internet more often several times a week. Age/frequency analysis showed that respondents in the age of 26-35 are most likely to buy organic food on-line once a week as well as once every fortnight. The similar scenario applies to the group of respondents of 36-45 years. Younger respondents (under 25) apparently almost never buy organic food on-line, and if they do, it is very rare. The same may be said about the age group of 46+. This group buys organic food on the internet not more often than once every two weeks, and more likely even less often. Considering the dependencies on education, the respondents with elementary education were found out to be buying organic products on the internet several times a week, which may come as a surprise. Plus, respondents with college/university education are most frequently purchasing organic food on-line once a week. Similarly, respondents with completed secondary education are most frequently purchasing organic food on-line once every two weeks. It should be interesting to repeat the same survey a year later, in 2021, and to put the results side by side, since the situation may have dramatically changed, considering all the governmental restrictions that were introduced considering the current Covid-19 pandemic.

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# ASSESSMENT OF COMPETITIVENESS FACTORS OF AGRICULTURE IN THE CONTEXT OF THE PANDEMIC

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**Annotation**: The article discusses the state of agriculture in the context of a pandemic, as well as factors that influenced the strengthening of the competitive advantages of the industry. The study compared indicators and factors of agricultural competitiveness in 2020 in comparison with the previous period. The analysis showed that agriculture was less affected by restrictions due to the coronavirus than other sectors of the economy, therefore, the main trends in production and the formation of gross value added remained during the pandemic. The study noted that a 3.5% decrease in real money income of the population in 2020 affected the purchasing power of income and the structure of consumption of certain types of food, which could lead to a redistribution of production resources. The article notes the impact of the devaluation of the national currency, which contributed to the rise in the cost of imported food and the strengthening of the competitive advantage of domestic producers in the domestic market and the export of agricultural products. As a result, despite many negative trends, Russian agriculture has demonstrated high stability and positive dynamics of development, strengthening its position in the world market. Positive factors were inelastic demand for food and significant government support, favorable weather conditions, which contributed to agricultural production and an increase in export volumes. As the analysis has shown, the competitive advantages of the industry manifested themselves not only in comparison with other types of economic activity, but also in strengthening the country's position in the world food market, where the country is becoming one of the leading exporters.

**Key words**: agriculture, coronavirus infection, competitiveness, export

**JEL classification**: Q01, Q18, Q51

## 1. Introduction

The outbreak of COVID-19 has had a serious impact on global markets and the development of economies in many countries (Nicola et al., 2020; Lopez-Ridaura et al., 2021). A decrease in GDP was observed in most countries of the world. At the same time, the fall in oil prices and the devaluation of the national currency also became a test for the Russian economy during this period.

International efforts to control the virus by limiting human movement is inevitably causing economic shocks and social costs that will affect the functioning of agricultural and food systems worldwide. (Stephens E.C. et al., 2020). For the agriculture of any country, the pandemic has made serious changes in the process of production and sales of products, disrupted economic and logistical ties, led to interruptions in the supply of material resources. The assessment of influence, as well as the consequences of the direct impact of COVID-19 on agricultural and food systems, has been considered in many publications. For example, Haqiqi and Horeh (2021) built an economic model that estimates the change in agricultural production under the influence of the crisis in the short term. In contrast, a survey of the impact of coronavirus infection on the environment showed improvements in air and water quality (Elsaid, 2021). At present, agriculture in Russia, like any other country, functions under the restrictions caused by COVID-19, although the industry has not been officially recognized as affected.

In accordance with the Forecast of the socio-economic development of the Russian Federation for the period up to 2036[3] for the progressive development of the agro-industrial complex, the most important goal of the implementation of state support measures is to increase the competitiveness of Russian agricultural products in the domestic and foreign markets. Therefore, the study of the dynamics of the development of the agricultural sector, as well as its efficiency and competitiveness, not only in comparison with other types of economic activities of the country, but also in terms of strengthening positions in the world food market is currently an urgent task (Romantseva and Kolomeeva, 2021).

The aim of the study is to analyze the competitive advantages of the agricultural sector in Russia, as well as the factors that influenced the competitiveness of agriculture in the context of the COVID-19 pandemic.

Research objectives:

- assessment of the main trends in the industry in recent years, its sustainability;

- analysis of the volume and structure of agricultural production for 2014-2020, during the period of coronavirus infection;

- study of the competitive advantages of the industry in the domestic and foreign markets;

- study of changes in factor indicators that influenced the competitive advantages of agriculture.

## 2. Materials and Methods

The study is carried out mainly for 2014 - 2020, which is associated with the beginning of new conditions for the functioning of both the Russian economy as a whole, and agriculture in connection with the economic sanctions introduced by the United States and supported by the EU countries, Canada, Australia, and Japan. The analysis is focused on comparing industry development indicators and factors of its competitiveness for 2019 and 2020. The system of indicators includes the main indicators of the results of agricultural development: gross output, gross value added, profit, as well as indicators that are factors of the competitive advantages of the industry, both in the domestic and foreign markets.

In the process of research, general scientific methods of cognition were used: analysis, synthesis, systematization and generalization of the results obtained.

Also there were used economic and statistical methods; abstractly logical; monographic research methods, as well as methods for analyzing time series with the calculation of indicators: absolute growth, growth rate.

The absolute growth is the difference between two levels of the time series, one of which is considered as the value of the current period, and the other is taken as the comparison base (indicator of the previous or base period):

$$A_i = y_i - y_{i-1} \tag{1}$$

[3] Forecast of the socio-economic development of the Russian Federation for the period up to 2036 [Electronic resource ]. - Access mode: http://www.consultant.ru/document/cons_doc_LAW_312165/

$$A_i = y_i - y_0 \quad (2)$$

where $y_i$, $y_{i-1}$, $y_0$ – current, previous and base levels of time series respectively.

The growth rate expresses the relationship between two levels of the series - current and basic, expressed as a percentage:

$$K_i = \frac{y_i}{y_{i-1}} * 100 \quad (3)$$

$$K_i = \frac{y_i}{y_0} * 100 \text{ (Zinchenko, 2013)} \quad (4)$$

The official data of the Federal State Statistics Service of Russia for the study period were used as data sources: collections of the "Russian Statistical Yearbook", "Appendix to the Yearbook", "National Accounts of Russia", "Agriculture in Russia", monthly information and analytical materials, and the data of the National Report on the progress and results of the implementation in 2019 of the state program for the development of agriculture and regulation of markets for agricultural products, raw materials and food.

## 3. Results and Discussion

At present, agriculture is one of the few sectors of the economy showing an upward trend even in an unstable economic situation, and the development of the industry as a whole is assessed positively. (Ushachev and Chekalin, 2020; Romantseva, 2020)

While the real volume of GDP over the past 7 years has grown by 2.2 percentage points after the crisis of 2014, for the type of economic activity (TEA) "Agriculture, Forestry, Hunting, Fishing and Fish Farming", this period, taking into account significant government support, was generally favorable: the GVA of the industry increased by 13.5%. However, the impact on economic growth turned out to be insignificant due to the low share in the structure of GDP (3.6%).

Table 1. Dynamics of indicators of Gross Value Added by type of economic activity in Russia

| Type of economic activity | Growth rate, % | | Share in GDP, % |
|---|---|---|---|
| | 2014-2020 | 2019-2020 | |
| Agriculture, Forestry, Hunting, Fishing and Fish Farming | 113.5 | 100.2 | 3.6 |
| Professional, Scientific and Technical Activities | 100.4 | 97.6 | 3.9 |
| Financial and Insurance Activities | 139.6 | 107.3 | 4.2 |
| Building | 96.1 | 100.0 | 5.2 |
| Transport and Storage | 94.4 | 89.4 | 5.4 |
| Public Administration and Military Security; Social Insurance | 109.0 | 102.3 | 7.1 |
| Real Estate Activities | 113.8 | 101.2 | 8.8 |
| Mining | 101.2 | 90.5 | 10.5 |
| Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles | 90.4 | 97.1 | 12.3 |
| Manufacturing Industries | 110.4 | 100.0 | 13.5 |
| Gross Domestic Product at market prices | 102.2 | 97.0 | 100.0 |

*Source: calculated by the authors using FSSS data.*

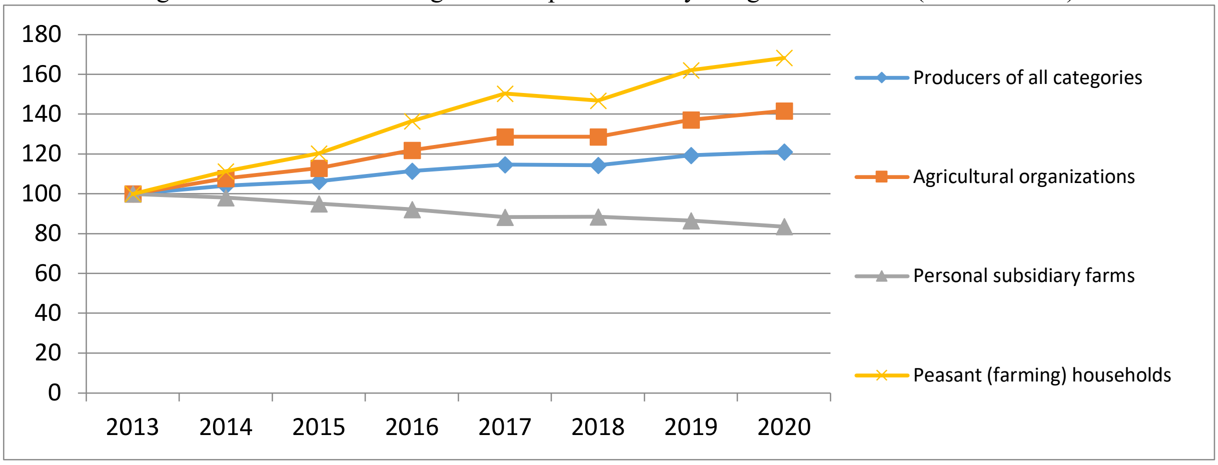
Note: data are presented by types of economic activities that make the greatest contribution to the formation of the added value of the economy

Also, agriculture, forestry, hunting, fishing and fish farming in terms of the volume of the balanced financial result by organizations showed the highest growth among all sectors of the economy. (+ 86.0%).

The current situation influenced the forecasts for the development of the industry, made by the Ministry of Agriculture, regarding the agricultural and products produced and the Gross Value Added in the industry. Thus, the forecast value of the added value created in agriculture was adjusted in 2025 to 4.56 trillion rubles, while earlier it was supposed to reach 5.77 trillion rub.

In 2020, when a rapid increase in the number of cases began, borders were closed and many logistical connections were disrupted, the issue of the possibility of providing the population with food also became quite acute. Despite a number of problems, at the end of the year, agriculture showed resistance to the impact of the consequences of the pandemic: the growth of gross production for the year amounted to 1.5% (Figure 1).

Figure 1. Growth rates of agricultural production by categories of farms (2013 – 100%).




*Source: Constructed by the author on the base of Federal State Statistical Services, 2020*

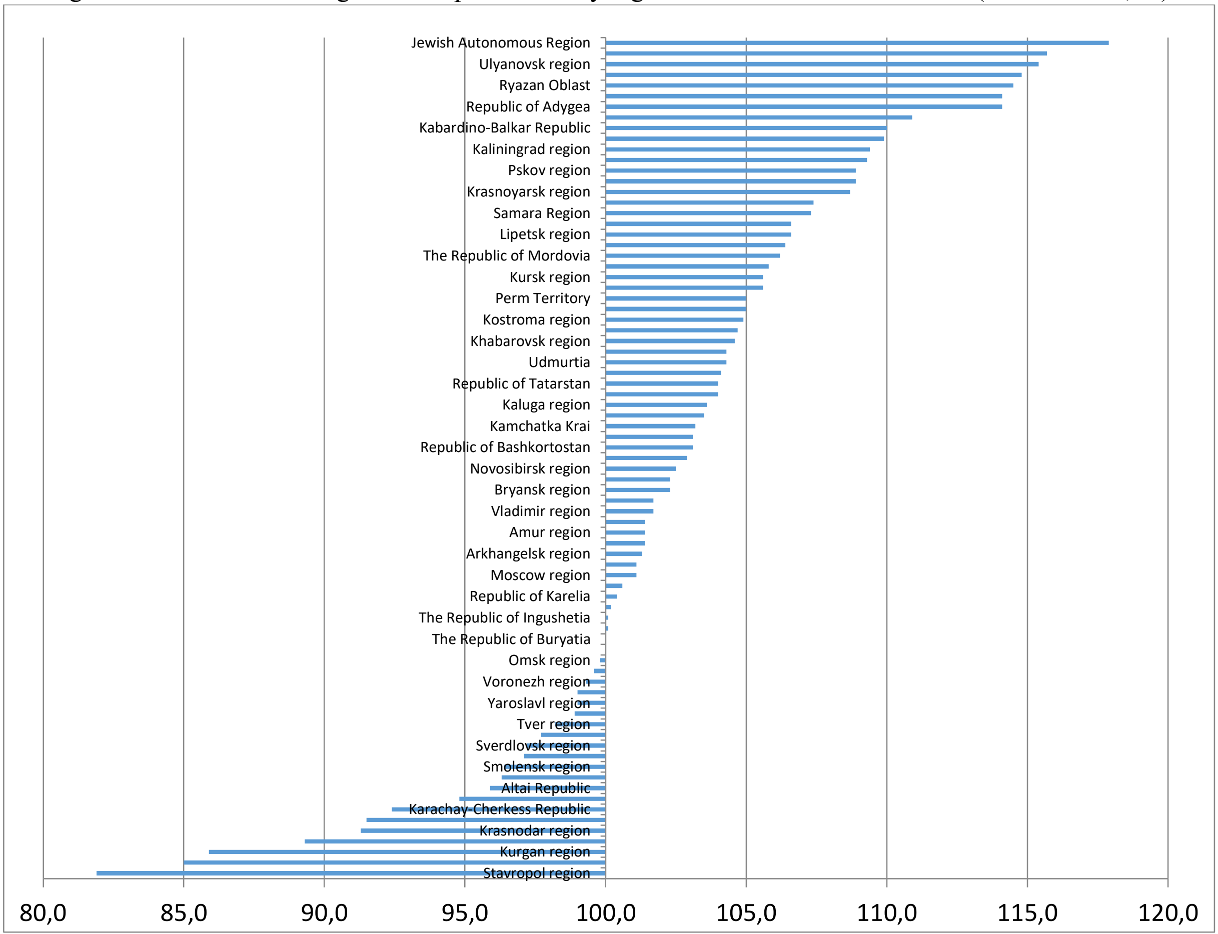
Despite a decrease in the growth rate of gross output in 2020, after 2014 the growth amounted to 21.1% for farms of all categories. The largest growth was observed in peasant (farming) households - 68.3%, in second place are agricultural organizations (41.7%), personal subsidiary farms showed negative dynamics (-16.4%). There is a steady trend in the production of agricultural products (the coefficient of determination of trends for each category of farms and in general is not less than 0.968), and the last year has confirmed the main trend, which has not changed due to stressful conditions of management.

Analysis by regions showed that 58 out of 79 constituent entities of the Russian Federation in 2020 showed a positive growth in production.

The main increase in agricultural products was observed in grain (+ 10.1% compared to 2019), livestock and poultry (+ 3.1%) and milk (+ 2.7%). For most types of products, the dynamics were negative. Sugar beet broke the anti-record (-37.7%) due to a decrease in productivity by 22.9%. A decrease in production was also observed for sunflower (-13.4%), potatoes (-11.3%) due to a drop in productivity by 13.1 and 6.7%, respectively.

The relatively stable development of agriculture in a difficult economic situation is largely determined by the fact that in Russia it is multi-structured, and both large enterprises and farmers are engaged in the production of agricultural products (Table 2).

Figure 2. Growth rates of agricultural production by regions of the Russian Federation (2020 to 2019, %)




*Source: Constructed by the author on the base of Federal State Statistical Services, 2020*

Table 2. Structure of agricultural production by categories of farms for 2014-2020, % of the total

| | | | | | | | | **Change in structure in 2020 compared to, ±** | |
|---|---|---|---|---|---|---|---|---|---|
| | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2014** | **2019** |
| Producers of all categories | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | | |
| agricultural organizations | 51.7 | 54.0 | 55.1 | 55.2 | 56.5 | 57.7 | 58.3 | 6.6 | 0.6 |
| personal subsidiary farms | 38.2 | 34.5 | 32.5 | 32.4 | 31.0 | 28.6 | 27.4 | -10.7 | -1.2 |
| peasant (farming) households, individual entrepreneurs | 10.2 | 11.5 | 12.4 | 12.4 | 12.5 | 13.7 | 14.3 | 4.1 | 0.6 |

*Source: calculated by the authors using Federal State Statistical Services data, 2020*

Today, agricultural organizations account for 58.3% of all gross production with a steady growth trend. Peasant farms are strengthening their positions, increasing their share from 10.2 to 14.3% in 7 years. But the contribution of personal subsidiary farms in recent years has decreased by 10,7 percentage points. At the same time, it is necessary to understand that concentration in the agricultural sector of production in large agricultural holdings can disrupt the sustainability of agricultural development due to the displacement of small forms of agricultural business by large-scale production. This implies the implementation of measures of state support in relation to such farms.

The weather conditions for the summer of 2020 were generally favorable for the production of grain crops, the yield of which increased by an average of 7.1%. This made it possible to realize the export potential of the agricultural sector. Russia, providing itself with basic food products, is consistently strengthening its position in the world food market, competing with leading exporters.

In 2020, according to customs statistics, in the economy as a whole, the volume of foreign trade turnover decreased: the value of exports by 20.7%, imports - by 5.3%. For food products and agricultural raw materials, with a slight decrease in imports (-0.8%), exports increased significantly (by 19.3%). This was mainly due to an increase in the sales of cereals by 27.7%, which occupy a large share in the export structure (34.2%), fats and oils of animal or vegetable origin by 24.1%, which account for 14.4% of exports. A significant increase was also observed in oilseeds and fruits (+ 70.8%) and sugar and confectionery (+ 41.7%). It should be noted that the export situation has not worsened in other countries either. (Ben-xi LIN, 2020; Weersink, 2021). In general, since 2014, with a decrease in food imports by more than a quarter, exports increased by 56%. This led to the fact that the share of food products and agricultural raw materials over the past 7 years increased from 3.7 to 8.8% of the country's total exports, amounting to $ 29.6 million in 2020. It is important to note a very small share of agricultural products with high added value. For example, the specific weight of the products of the flour and cereals industry is 1.21%, products from meat, fish or crustaceans, mollusks or other aquatic invertebrates - 0.78% of this food. It is obvious that it is necessary to systematically move away exclusively from grain exports and strengthen other areas with higher added value (Kagirova, 2018).

An important advantage of domestic agriculture by the beginning of the pandemic was the fact that since 2014, in response to the economic sanctions imposed on Russia, the import of certain types of food was restricted and import substitution became the main course of Russia's agricultural policy.

Table 3. Indicators of self-sufficiency in basic agricultural products

| Type of products | 2014 | 2019 | Doctrine target | 2019 to, ± | |
|---|---|---|---|---|---|
| | | | | 2014 | doctrine target |
| Grain | 153.8 | 155.5 | 95 | 1.7 | 60.5 |
| Potatoes | 98.0 | 94.9 | 95 | -3.1 | -0.1 |
| Milk and dairy products | 78.1 | 84.4 | 90 | 6.3 | -5.6 |
| Meat and meat products | 82.8 | 96.7 | 85 | 13.9 | 11.7 |
| Vegetables and melons | 84.1 | 88.4 | 90 | 4.3 | -1.6 |
| Fruits and berries | 32.5 | 39.5 | 60 | 7.0 | -20.5 |

*Source: calculated by the authors based on the data of the National Report on the progress and results of the implementation in 2019 of the state program for the development of agriculture and regulation of markets for agricultural products, raw materials and food [Electronic resource]. - URL: https://mcx.gov.ru/upload/iblock/98a/98af7d467b718d07d5f138d4fe96eb6d.pdf*

In accordance with the Doctrine of Food Security, the level of self-sufficiency is defined as the ratio of the volume of domestic production of agricultural products, raw materials and foodstuffs to the volume of their domestic consumption. By the end of 2019, grain production exceeds the required level of consumption by more than 50% (Table 3). The supply of milk and dairy products (by 6.3%), meat and meat products (by 13.9%), vegetables and fruits (+4.3 and + 7.0%, respectively) has significantly improved compared to 2014. However, despite the positive trend in production volumes, the threshold level for fruits and berries (by 20.5%), milk (by 5.6%) has not yet been reached.

The fundamental factor in domestic demand for food is the income of the population, which significantly decreased during the pandemic. In 2020 real money income decreased by 3.0% and disposable income – by 3.5%. The share of the population with incomes below the subsistence level increased from 18.1 to 19.6%. The purchasing power of income for most products also decreased, for example, for beef by 3.8%, milk - 2.9%, potatoes - 4.0%, apples - 15.2%, etc. This leaves an imprint on the structure of consumption of certain types of food (Table 4).

Table 4. Share of food consumption in household consumption expenditures, %

| | 2019 | | | III quarter 2020 | | | 2020 . to 2019, % | | |
|---|---|---|---|---|---|---|---|---|---|
| | **All households** | **including** | | **All households** | **including** | | **All households** | **в том числе** | |
| | | **in urban areas** | **in rural areas** | | **in urban areas** | **in rural areas** | | **in urban areas** | **in rural areas** |
| Expenses for: food and soft drinks | 29.7 | 28.5 | 35.5 | 32.5 | 31.6 | 36.4 | 2.7 | 3.0 | 0.9 |
| including: food | 28.1 | 27.0 | 33.6 | 30.6 | 29.8 | 34.4 | 2.5 | 2.8 | 0.8 |
| of which: bakery products and cereals | 4.6 | 4.3 | 6.2 | 5.1 | 4.8 | 6.5 | 0.5 | 0.5 | 0.3 |
| meat | 8.3 | 8.0 | 9.6 | 8.7 | 8.5 | 9.5 | 0.4 | 0.5 | -0.1 |
| fish, seafood | 2.0 | 2.0 | 2.2 | 2.0 | 2.0 | 2.1 | 0.0 | 0.0 | -0.1 |
| dairy products, cheese and eggs | 4.6 | 4.5 | 5.0 | 5.3 | 5.3 | 5.3 | 0.7 | 0.8 | 0.3 |
| fruits | 2.2 | 2.1 | 2.4 | 2.7 | 2.6 | 2.7 | 0.5 | 0.5 | 0.3 |
| vegetables | 2.5 | 2.6 | 2.5 | 2.4 | 2.4 | 2.1 | -0.2 | -0.1 | -0.3 |

*Source: calculated by the authors using FSSS data*

Analysis of the structure of household expenditures shows that over the past year, the share of household expenditures on food products increased by 2.7%, and to a greater extent in urban areas (by 3.0%). The population of rural areas with lower incomes on food spends 4.8% more in the structure of expenditures, but there are no significant changes in food consumption over the year. Nevertheless, a retrospective analysis shows that with a decrease in income, there is a shift towards the consumption of cheaper types of food, which will lead to a redistribution of production resources in agriculture in the future.

The competitiveness of the industry in the context of the pandemic was influenced by the devaluation of the national currency. According to the Bank of Russia, the official exchange rate of the dollar increased over the past year by 19.3%, and the euro - by 30.8%. This, on the one hand, contributed to the rise in the cost of imported food and the strengthening of the competitive advantages of domestic producers in the domestic market. Moreover, export-oriented industries have benefited to a greater extent, since their products are becoming cheaper on the world market. On the other hand, imported capital goods also increased in price, which increased costs.

The stability of the agrarian sector in crisis conditions is also evidenced by the fact that in agriculture, forestry, hunting, fishing and fish farming, there was an increase in the number of employed people by 1%, while a decrease in the economy as a whole by 1.9%. In the informal agricultural sector, the number of employed decreased less than the average for all other sectors (-3.2 and 4.6%, respectively)

Currently, due to the spread of COVID-19, the world economy is experiencing a global crisis, affecting agriculture. Therefore, it needs effective government support. Moreover, the volume of investments in fixed assets in agriculture decreased by 7%, and in the structure of the economy does not exceed 3.0%. The weakening of the ruble and the need to find additional funds to overcome the coronavirus crisis amid falling oil revenues due to falling oil prices will affect the level of financing of the agro-industrial complex. State support for the agricultural sector next year, according to the Deputy Minister of Agriculture, will decrease by 17 billion rubles. compared to 2020 and will amount to 287.7 billion rubles. At the same time, the reduction did not affect the support for the export of agricultural products.

However, it should be emphasized that the state of the agricultural sector does not allow to fully speak about the competitiveness of domestic agriculture at the world level. Low technical, technological and digital level of development, relatively weak state support, weak investment attractiveness, low labor productivity, a significant share of small-scale forms of entrepreneurship (households and the farming sector), high production costs, persisting price disparity, monopoly of the first and third spheres of the agro-industrial complex - all this affects the competitiveness of agricultural producers, hinders the development of the industry and does not allow to fully realize the huge resource potential.

## 4. Conclusion

Thus, agriculture in general was less affected by restrictions due to the coronavirus epidemic than other sectors of the economy. For example, in the United States, according to a study by Haqiqi et al. (2021) COVID-19, although it did not have a dramatically negative impact on agricultural production, but affected small farms, due to the fact that their level of technological and digital equipment is lower than at large enterprises. These conclusions are confirmed by the analysis of the state of the economy and agriculture of a number of other countries of Central America (Lopez-Ridaura et al., 2021) and Europe (Meuwissen, 2021). In Russia, data on the results of economic activities of various categories of farms for 2020 have not been published, however, small-scale agricultural producers, which account for just over 40% of total gross output, are also the most vulnerable in times of crisis and require the implementation of government support measures for their sustainable development.

Despite many negative trends, agriculture in Russia as a whole has demonstrated high stability and positive trends. This is primarily due to the inelastic demand for food, government support, and favorable weather conditions. In 2020, despite the growth in production and export of agricultural products, it became obvious for agricultural producers to develop automation and digitalization of the agricultural sector. The need for digital transformation in agriculture and rural areas is a priority policy area at the global level (Trendov et al., 2019; World Bank, 2019), which will invariably lead to an increase in labor productivity, an increase in the industry's resilience to risks in the face of the uncertainty of the modern world, and strengthening the country's competitive advantages in the world food market. Investments and stable government support will allow modernizing the industry and moving to a new digital level of development and will fully realize the huge export potential of the agricultural sector, as well as increase resilience in crisis period.

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# COMPARATIVE STUDY OF TWITTER COMMUNICATION DURING THE COVID-19 PANDEMIC

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**Annotation**: The new coronavirus pandemic (COVID-19) has placed a huge burden on many countries around the world and the management of the global crisis significantly relies on the use of social media platforms to communicate and organize civil responses. The goal of the project is to compare the communication of users on Twitter during the pandemic and with communication in the event of social phenomena such as elections. To compare these, we collected and analyzed over 400 million tweets related to the COVID-19 topics. [1]If this true, then the distribution of hashtags should be different.

**Key words**: Twitter, hashtags, crisis management, communication cascade, semantic network, COVID-19

**JEL classification**: D38, C31, O33

## 1. Introduction

Disasters are complex in nature, which may have disproportionate effects at varying speed; the COVID-19 pandemic especially is an unprecedented global disaster that will require the public’s attention for years to come. Information exchange is pivotal during the disaster management processes (i.e., prevention, preparedness, response, and recovery), particularly in the response phase, as the dynamic and complex nature of disasters increases the rate of communication between stakeholders. Twitter, in particular, has gone beyond being simply a social networking apparatus to a strategic communication tool during disastrous events all over the world. Stakeholders that are responding to crises are able to quickly coordinate their efforts and disseminate important safety information to public audiences. However, it has also enabled some users to spread counter-productive rumors and disinformation that impede the effectiveness of formal efforts.

The World Health Organization has not only signaled the health risks of COVID-19, but also labeled the situation as an infodemic, due to the amount of information, true and false, circulating around this topic. An infodemic may be defined as an excessive amount of information concerning a problem, such that the solution is made more difficult. The end result is that an anxious public finds it difficult to distinguish between evidence-based information and a broad range of unreliable misinformation. Research shows that, in social media, falsehood is shared far more than evidence-based information (Shangguan et al., 2020). However, there is less research analyzing the circulation of false and evidence-based information during health emergencies. Thus, the present study aims at shedding new light on the type of tweets that circulated on Twitter around the COVID-19 outbreak, in order to analyze how false and true information propagated during the course of the pandemic.

Generally speaking, governments play an important role in crisis management, and respond to crises efficiently by formulating a unified response policy. If the government fails to formulate a response in time, it will cause the public to panic and lose confidence in the government (Peres, 1968). In the 'post-truth' era, audiences are likely to believe information that appeals to their emotions and personal beliefs, as opposed to information that is regarded as factual and or objective. This poses a major global risk and a threat to public health. Thus, it becomes vital to educate people generally, and youth in particular, about the nature of fake news and the negative outcomes of sharing such news. Fighting this infodemic is the new front in the COVID-19 battle.

## 2. Materials and Methods

Crisis management involves multiple disciplines (Bowonder and Linstone, 1987) including psychology, sociology, political science, and management science (Pauchant and Douville, 1993) that work together to prepare for, handle and recover from crisis situations. In public health crisis management, five factors are usually considered: (1) information disclosure or control; (2) assessment of dangers and threats; (3) establishment of crisis information communication channels and health education platforms; (4) the making of and implementation of strategic crisis response plans; (5) overall mobilization of critical resources (Shangguan et al., 2020).

The overabundance of data and knowledge is one of the characteristics of the information society. Power no longer resides in having access to information but in managing it. Indeed, the arrival of the internet and social media has undeniably facilitated the circulation and outreach of information, opening up the possibilities that users have to access, interact, and produce content (Del Vicario, Holmberk and Ek, 2016). This situation has led to a democratization of the relationship between knowledge and citizens. Social media platforms have increasingly been part of disaster response (Sarcevic et al., 2012). These platforms, such as Facebook and Twitter, were previously used during disasters and emergencies by the general public to communicate. Presently however, they are regularly utilized by governments, and non-governmental organizations to manage disasters and control official responses. During natural disasters, social media provides access to relevant and timely information from both official and non-official sources which can help to facilitate a feeling of connectedness (Starbird., Muzny, and Palen, 2012). This enables connectivity to loved ones and brings comfort for the community as well as support and assistance to potentially distressed individuals and populations (ibid).

At the same time however, social media and online sites have also become the primary platforms from which to disseminate false and misleading information (Lazer et al., 2018). Such disseminations spread rapidly due to large-scale sharing (Vosoughi, Roy and Aral, 2018) and the lack of traditional mechanisms of quality control and 'gate-keeping'. Indeed, the presence of fake news found and distributed in online settings has increasing significantly in recent years (Vosoughi, Roy and Aral, 2018). The abundance of information on social media frequently without any check on its authenticity makes it difficult for an individual to distinguish between what are facts, and what are opinions, propaganda, or biases. There is a huge increase in stories on social media that may initially appear credible but later prove false or fabricated; however, by the time they are proven to false, the damage may be irreversible. In this vein, we investigate how false and mixed news were differentially diffused on Twitter over the course of the COVID pandemic.

The dataset was collected between 1 April 2020 to 30 January 2021. The tweets were collected if they contained hashtags related to the pandemic, e.g., #nCov or #covid hashtag. The tweets were also focused on the English language to maximize the saturation of tweets containing political and non-political connotations related to the handling of the pandemic. It must be stated that we were not able to collect all the possible tweets available due to restrictions from Twitter and the scope of our research. Thus, the study is based on a collection of 400 million content rich tweets, whose hashtags were filtered for political expression in connection to milestones in the pandemic. The data was longitudinally analyzed in three phases: the twitter communication during first wave in early 2020, the second wave in late 2020, and in early 2021, concerning the emergence of the British and South African COVID-19 mutations. The data was analyzed with descriptive statistics, which are brief coefficients that summarize a given data set. For instance, the mutual coefficient between x and y is defined by the comparison between the probability of observing x and y together and observing them independently:

$$\mathbf{I(x,y) = log(p(x,y) / p(x)\ p(y))} \qquad \mathbf{(1)}$$

By extension, this formula provides a way to measure the degree of co-occurrences of two words by comparing the number of co-occurrences to the number of individual occurrences (Bordag, 2018). A central question in text mining and natural language processing is how to quantify what a document is about. One measure of how important a word may be is its term frequency (tf), how frequently a word occurs in a document. Another approach is to look at a term's inverse document frequency (idf), which decreases the weight for commonly used words and increases the weight for words that are not used very much in a collection of documents (Sulaksono, Ramadhani and Niswatin, 2020). We can use this approach for the analysis to quantify how important various terms are in a document that is part of a collection.

The purpose of performing a term frequency (tf) check, followed by the inverse document frequency (idf) is to compare the number of times a word or term appears within a body of text. Thus, our analysis made use of 'word occurrences' that involve estimating word similarities and the frequency with which one or more similar words appear in a text (Church and Hanks, 1990; Turney, 2001). In our case, Twitter hashtags are often accompanied with similar hashtags that supposedly have different meanings, yet lead to the same information, then we may deduce what topics users are clustering around selected problem, in our case, the COVID pandemic.

All descriptive statistics are either measures of central tendency or measures of variability, which are also known as measures of dispersion. For our analytical framework we will measure the spread or dispersion of the data points. A descriptive analysis was performed on selected datasets using an in-house algorithm. Each dataset will be analyzed according to how many tweets was published in each milestone, how many tweets was favorited, replied and quoted. This comparison will be done against information which accounts are verified and non-verified. After the descriptive analysis, a textual analysis was also performed on the hashtags. The target of textual analysis is to detect most used hashtags during selected milestones and a correlation between them.

## 3. Results and Discussion

The semantic network reveals the connection between individual keywords and their frequency of mutual use. In this way, the article presents a semantic network that reveals which keywords are the most commonly used together and can be visualized to show their topic density. We set up three milestones in the form of quarters to denote the variable of time between March 2020 – January 2021. We illustrate this in the table below:

Table 1. Number of tweets in the milestones

| | Q1 – Mar - Apr 2020 | Q2 – Sep – Oct 2020 | Q3 – Dec 2020 – Jan 2021 |
|---|---|---|---|
| Number of tweets | 59 088 330 | 95 206 137 | 87 630 622 |

As part of the Term frequency (tf) analysis we transcribed non-ASCII represented tweets, however, 2% of the hashtags had to be discarded because their transcription was not possible. All hashtags were tokenized, converted to uppercase letters, and we removed all nonstandard and white characters to narrow the comparisons and duplication detection. Term frequency (tf) analysis was performed on keywords. Table 2 shows the total number of tweets collected and compared for word occurrence similarity.

Table 2. Total number of tweets collected and analyzed

| # | Q1 – Mar - Apr 2020 | | Q2 – Sep – Oct 2020 | | Q3 – Dec 2020 – Jan 2021 | |
|---|---|---|---|---|---|---|
| 1 | CORONAVIRUS | 34459315 | CORONAVIRUS | 65347605 | CORONAVIRUS | 66962885 |
| 2 | COVID19 | 6620790 | COVID19 | 16976835 | COVID19 | 24137410 |
| 3 | COVID 19 | 1011945 | COVID | 2504790 | COVID | 4706020 |
| 4 | CHINA | 935770 | TRUMP | 2207970 | IRAN | 2884420 |
| 5 | LOCKDOWN | 738320 | IRAN | 1609020 | VACCINE | 2559590 |
| 6 | TRUMP | 581185 | PANDEMIC | 1215360 | COVID_19 | 2098030 |
| 7 | COVID | 503360 | COVID 19 | 1187910 | CHINA | 1736460 |
| 8 | BREAKING | 458535 | WUHAN | 901755 | PANDEMIC | 1688995 |
| 9 | IRAN | 406010 | CHINA | 896040 | LOCKDOWN | 1393810 |
| 10 | COVID—19 | 383405 | COVID 19 | 876555 | CORONAVIRUSPANDEMI C | 1190145 |
| 11 | STAYHOME | 358765 | BREAKING | 814095 | CORONAVIRUSUPDATE | 1153845 |
| 12 | PANDEMIC | 308495 | LOCKDOWN | 690840 | CORONA | 1148015 |
| 13 | STAYATHOME | 288035 | INDIA | 642825 | COVID—19 | 1098790 |
| 14 | SOCIALDISTANCIN G | 267685 | CORONAVIRUSPAN DEMIC | 587385 | BREAKING | 1086855 |
| 15 | INDIA | 251625 | CORONAVIRUSUK | 575010 | INDIA | 806520 |
| 16 | WUHAN | 222200 | VACCINE | 533835 | UK | 773520 |
| 17 | FILMYOURHOSPIT AL | 221320 | CORONA | 530415 | TRUMP | 727320 |
| 18 | NIZAMUDDIN | 211200 | COVID—19 | 526500 | COVIDVACCINE | 711425 |
| 19 | QUARANTINE | 199925 | CORONAVIRUSUPD ATE | 524520 | HEALTH | 706695 |
| 20 | CORONA | 181170 | USA | 400455 | NEWS | 701140 |

Table 2 shows the numbers of COVID related hashtags that unsurprisingly take a dominant position, especially during the second milestone where we observed the hashtags expressing political connotations, e.g., the 2020 US elections, most notably the keyword ‘Trump’ and other politically motivated hashtags. These surfaced in tandem with the COVID hashtags around roughly the same time. On the other hand, the hashtag ‘Vaccine’ surfaced in third milestone, coinciding with the end of the US elections. This indicates a significant shift away from hashtags connecting ‘Trump’ and ‘COVID’ immediately following the close of the elections in December 2020/January 2021 which could have been artificially motivated. Table 3 provides a display of the highest hashtag pairs between Q1-Q3.

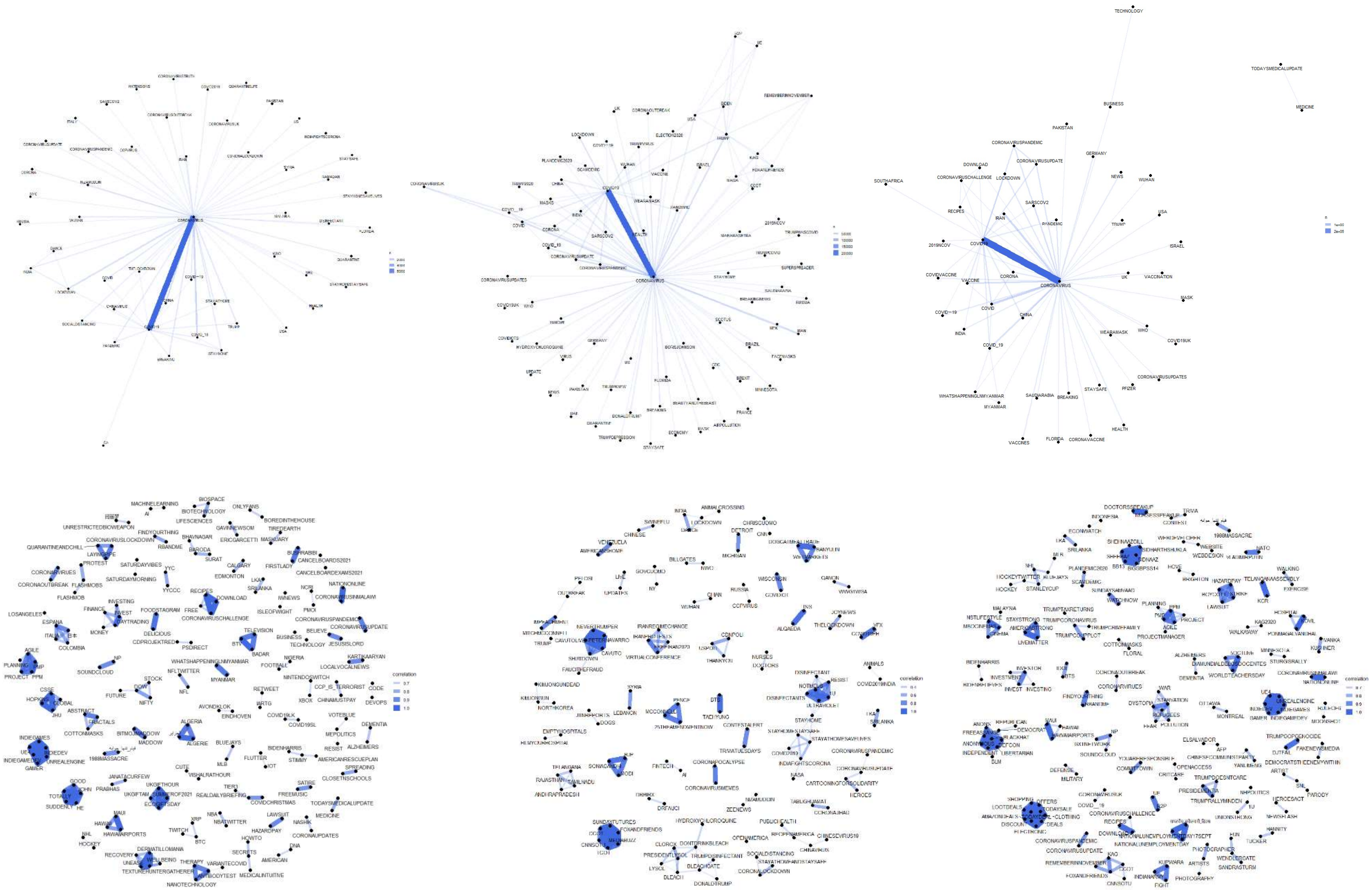
Table 3. Top hashtags in selected milestone periods

| | Q1 – Mar - Apr 2020 | Q2 – Sep – Oct 2020 | Q3 – Dec 2020 – Jan 2021 |
|---|---|---|---|
| 1 | CORONAVIRUS - COVID19 | COVID19 - CORONAVIRUS | CORONAVIRUS - COVID19 |
| 2 | CORONAVIRUS - COVID_19 | CORONAVIRUS - IRAN | CORONAVIRUS - COVID |
| 3 | CORONAVIRUS - CHINA | CORONAVIRUS - TRUMP | CORONAVIRUS - IRAN |
| 4 | CORONAVIRUS - LOCKDOWN | COVID - CORONAVIRUS | CORONAVIRUS - VACCINE |
| 5 | CORONAVIRUS - TRUMP | CORONAVIRUS - PANDEMIC | CORONAVIRUS - COVID_19 |
| 6 | CORONAVIRUS - COVID | CORONAVIRUS - COVID_19 | COVID19 - COVID |
| 7 | CORONAVIRUS - BREAKING | CORONAVIRUS - CORONAVIRUSPANDEMIC | CORONAVIRUS - PANDEMIC |
| 8 | CORONAVIRUS - STAYHOME | CORONAVIRUS - BREAKING | CORONAVIRUS - CORONAVIRUSPANDEMIC |
| 9 | CORONAVIRUS - IRAN | COVID19 - COVID | CORONAVIRUS - CORONAVIRUSUPDATE |
| 10 | CORONAVIRUS - COVID—19 | COVID - COVID__19 | COVID19 - CORONAVIRUSPANDEMIC |
| 11 | CORONAVIRUS - PANDEMIC | CORONAVIRUS - CHINA | COVID19 - CORONAVIRUSUPDATE |
| 12 | CORONAVIRUS - INDIA | COVID19 - CORONAVIRUSPANDEMIC | CORONAVIRUSPANDEMIC - CORONAVIRUSUPDATE |
| 13 | CORONAVIRUS - STAYATHOME | CORONAVIRUS - CORONAVIRUSUPDATE | CORONAVIRUS - LOCKDOWN |
| 14 | CORONAVIRUS - WUHAN | CORONAVIRUS - LOCKDOWN | CORONAVIRUS - CHINA |
| 15 | CORONAVIRUS - SOCIALDISTANCING | COVID - CORONAVIRUSUK | CORONAVIRUS - CORONA |
| 16 | CORONAVIRUS - NIZAMUDDIN | COVID__19 - CORONAVIRUSUK | VACCINE - COVID19 |
| 17 | COVID_19 - COVID19 | CORONAVIRUSPANDEMIC - CORONAVIRUSUPDATE | CORONAVIRUS - BREAKING |
| 18 | CORONAVIRUS - QUARANTINE | COVID19 - CORONAVIRUSUPDATE | CORONAVIRUS - COVID—19 |

Table 3 shows hashtag pairs that cooccurred frequently in Twitter feeds relating to the coronavirus in Q1, but gradually became intermixed with other, more political topics between Q2-Q3. This can be attributed to the role of the public in disseminating speculations about the origins of the Coronavirus in Q1, as well as the bias in the politically charged climate of the US elections and other global issues in Q2. These then progressed to a focus on vaccine production interlaced with updates regarding safety measures being instituted during the lockdown between in Q3. To show the strength in connection between the hashtag pairs, we illustrated them with a cloud analysis to see which hashtags occurred together the most (see tables 2 and 3). Figure 1 below, illustrates the correlations between hashtags from Q1/2020 to Q3/2020. These are illustrates as hashtag clouds or co-occurrence networks.

All hashtag clouds showed a strong connection between covid hashtag variants, e.g., COVID and Coronavirus, that is expected. However, there was no observable political involvement in those cloud connections, meaning it is unlikely they were artificially induced to cooccur. In the first set of hashtags, it is evident that at the start of the pandemic there was considerable speculation regarding the potential origin of the virus – e.g., WUHAN and ITALY. In Q2 we observed some political bias due to the presidential elections. These had a higher probability of being influenced artificially.

*Figure 1 Correlations between hashtags (left Q1/2020, middle Q2/2020, right Q3/2020)*



The third hashtag cloud (Q3) also shows a strong correlation between the hashtags MYANMAR and VACCINE. In all three correlation diagrams we can see only a slight probability of political bias, either deliberate or indirect. For instance, social influencers and media personalities can often contribute to significant Twitter traffic in times of crisis or political events. The correlation between the diagrams for Q1-Q2 show strong cooccurrences in politically loaded hashtags during the 2020 US presidential elections (TRUMP-BIDEN-MICHEL, BLEACHGATE). Whereas Q3 contained many correlations in the post-election period switching focus to more global issues associated with the pandemic, as with the emergence of such hashtag pairs as COVID-IRAN.

The description of results shows the observable change in political bias between the milestones (Q1-Q3). Generally, there is strong correlation between COVID related hashtags and the US elections, which is somewhat surprising as the two are not mutually exclusive topics. For instance, hashtags such as IMPEACHMENT-TRUMP-PENCE or IVANKA-KUSHNER strongly correlated to the hashtag COVID in Q2. We expected a higher correlation between political and non-political tweets, but we did not expect a strong correlation to a specific event, e.g., the 2020 US elections.

To date, co-occurrence networks had been more scarcely applied in the analysis of Twitter than other methods (Da Silva, Hruschka and Hruschka Jr., 2014; Eriksson-Backa et al., 2016; Kang et al., 2017, as cited in Puerta et al., 2020). The most direct and simplest method to analyze Twitter content is the study of the frequencies of mentioned words and using word clouds to visualize its relevance (ibid). Visualization of keyword correlations can easily disclose trending topics especially in regions with lower Twitter traffic such as Czech Republic (Sabou et al, 2019). As demonstrated by Vidal et al. (2015) qualitative analysis of text is necessary to interpret each word in its context, avoiding misinterpretation and providing full meaning of ideas. Thus, co-occurrence networks that show the frequency of mentions of a word and the connections with the co-mentioned words, can play the role of qualitative analysis and place words into their context automatically (Puerta et al., 2020).

Similarly, some researches studied cooccurrences in political and non-political tweets in the Czech language and found that there was a significant difference between keyword correlations due, in part, to the assistance of social media management tools. For instance, the rates of messages emerging from social network management tools were 13% for political tweets and 9% for non-political tweets (within a saturation of 250,000 tweets targeting agricultural trends). In comparison to our findings, the rate of cooccurrences between event-specific tweets, e.g., the U.S. presidential election, and crisis-related tweets, e.g., COVID lockdowns, were higher in the event-specific tweets. This suggests that the connections between the hashtag pairs may be artificially propagated as they were in the same study. However, more research is needed to account for the possibility of such artificial propagation.

## 4. Conclusion

The results of our work suggest that the cascade of Twitter traffic during the course of the pandemic (as indicated in Q1-Q3) shows that there are similarities in how Twitter communication cascades in crises and political events. Similarly, the density of the hashtags between Q1-Q3 progressively became denser and interlaced, making it more difficult to separate COVID related topics from the political topics. None of the co-occurrent themes could be said to have been artificially propagated as most of the hashtag pairs showed relatively similar densities regardless of their associated topic (political hashtag vs. disaster hashtag). Therefore, we can conclude that hashtag pairs are relatively identical in political versus nonpolitical situations. However, the increase in density between the milestones does indicate that the bias of the political hashtags can affect evidence-based hashtags related to COVID, likely due to a combination of factors that attribute increased Twitter traffic during quarantine measures, e.g., redirection of feelings towards public outlets.

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# HOW THE BLOCKCHAIN DISRUPTS THE AGRICULTURAL SECTOR: A SYSTEMATIC LITERATURE REVIEW AND AN OVERVIEW OF START-UPS TRANSFORMING THE INDUSTRY

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**Annotation**: Agriculture is still one of the most minuscule digitalized industries, with many new possibilities and inefficiencies. The blockchain, which is prominently used in many sectors - mostly in banking & finance – could be a gamechanger to the agricultural industry as the applications are vast and are becoming more and more popular. Most current applications deal with food safety and transaction times, but other benefits are also rising. Based on past literature reviews and the growing importance and interest in this topic, this up-to-date systematic literature reviews' primary goal is to figure out the latest research directions, investigate research gaps for further research, and examine the benefits of applying the blockchain in agriculture. What is more, this systematic literature review is extended with a systematic overview of start-ups and companies which are already operating in the agricultural sector and are concerning themselves with the application of the blockchain and are therefore digitally transforming the industry. This study revises all significant studies, which can be found on the Web of Science Platform from 2018 to 02/2021. Based on a predefined keyword search and exclusions criteria, just state of the art papers was chosen for more profound research and comparison. Subsequently, those papers and reviews were investigated, sorted, and classified in a predefined scheme to overview the actual research and find gaps for further research. Furthermore, through online research, the most prominent start-ups and companies currently implementing blockchain solutions in the industries were also listed, sorted and reviewed. This systematic literature review gives a good and essential up to date overview of the most recent primary studies and companies – primarily start-ups - around the topic of blockchain and the agricultural sector. The literature is structured in different applications of the blockchain. Although the scientific and managerial interest in this topic is on the rise, still some cases need further research

**Key words**: Agriculture, Blockchain, Systematic literature review, AgTech

**JEL Classification**: O13; Q16

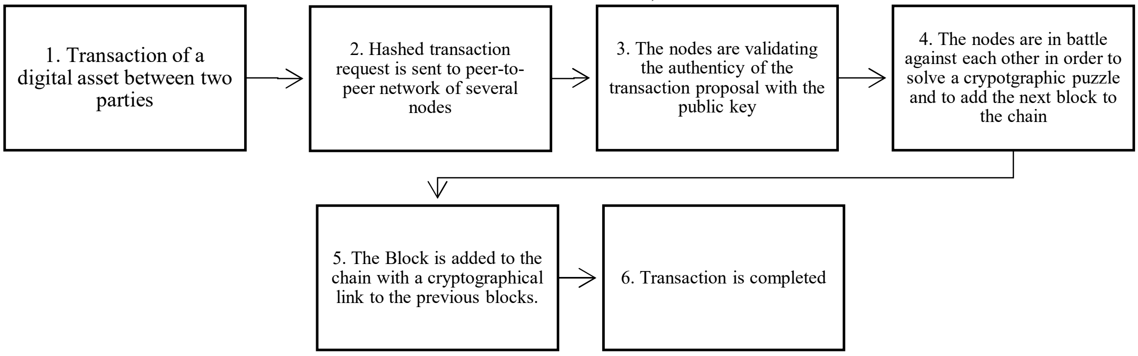
## 1. Introduction

Since the groundbreaking invention of the peer to peer electronic cash system (Bitcoin) in 2008 (Nakamoto, 2008), Blockchain Technology (BCT) has seen an enormous rise in academic and practical significance for various applications. This interest might be fueled by vast and valuable applications paired with the fairytale-like rise of Bitcoin and other cryptocurrencies (*coinmarketcap.com*, 2021). Moreover, commerce on the internet is dependent on controlling institutions like banks or exchange platforms. The reason behind that is that people cannot trust each other without a mediating third party (Oracle Developers, 2018). According to Marc Andreessen – an American entrepreneur - BCT enables, for the first time, a way for one internet user to transfer a unique piece of digital property to another internet user, such that the transfer is guaranteed to be safe and secure. Everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer. "(…) the consequences of this breakthrough are hard to overstate" (D'Aliessi, 2019).

Initially, the BCT was used as a decentralized platform to validate transactions in financial applications without the need for any third party. The cryptocurrency Bitcoin is the most famous example but is just one of a blockchain's many applications (Bitpanda, 2021b). Gradually, applications in non-financial industries are on the rise as well (Nofer et al., 2017). The BCT is applicable for every business which relies on an intermediary between two parties. Therefore the BCT can challenge existing business models in almost every industry (Morkunas, Paschen and Boon, 2019). The rising relevance of BCT is mainly motivated by the profound changes which the blockchain is expected to cause, i.e., changes in how business is organized and how business is regulated. Furthermore, BCT can also change the roles of individuals within the business society. Until now, societies needed to put trust into intermediaries to conduct business. For money, the only exchange platform are banks, and supermarkets are the main exchange platform for agricultural products. However, processes where third parties are involved are time-consuming and risky if the third party fails (Nofer et al., 2017). With BCT, the trust can be shifted from third parties to math (Antonopoulos, 2014).

The agricultural sector is still one of the most minuscule digitalized industries, with many unused possibilities and inefficiencies (Gandhi, Khanna and Ramaswamy, 2016). In addition, data and information are becoming increasingly crucial for the sector to improve its productivity and sustainability (Xiong et al., 2020). The food supply chain has become a worldwide, multi-actor, distributed supply chain, where many stakeholders, like farmers, shipping companies, wholesalers, retailers and end customers, are included (Kamilaris, Fonts, and Prenafeta-Boldύ, 2019). Through BCT, there is a reliable approach for tracing all transactions and managing all stakeholders. This reduces the space for fraud and malfunctions along the supply chain, and inefficiencies will be detected quicker. Hence, BCT technology can provide solutions to food-quality and food-safety issues, which are concerns of both customers and governments (Xiong et al., 2020). With the rising interest in this topic in general, and the great outlook of the implementations in the agricultural sector in particular, the need for a new literature review (Bermeo-Almeida et al., 2018; Kasten, 2020; Yadav and Singh, 2019) which is categorizing the existing literature is apparent. This review explains blockchain technology, shows its possible applications in the agricultural sector, gives a holistic review and an outlook for future research. The blockchain has its fame due to its decentralization, transparency as well its immutability. (Blockgeeks, 2016). A blockchain can be described as a distributed database in encrypted so-called "blocks". These blocks are cryptographically linked together and can be verified by all parties at any time (Antonucci et al., 2019; Nakamoto, 2008). To be able to do so, the blocks are stored with reference to the previous block, forming an indefinite ever-growing chain of blocks. The blocks are created by miners, who get rewarded for their contribution (Chitchyan and Murkin, 2018). Figure 1 illustrates the steps that comprise the exchange of an asset between two parties by using blockchain technology. First, there is the transaction of an ownership right that a digital asset can represent.

Figure 1. How a Blockchain is working – simplified version (Bitpanda, 2021b; Blockgeeks, 2016; Morkunas et al., 2019)




To be able to do so, each of the transaction parties owns digital storage, which is called the wallet. Each wallet is linked to a private and a public key. The transaction is then transformed into a hashed[4] transaction proposal with the use of the private key. The hashed transaction protocol can then be verified by the use of the public key. The transaction includes basic information like the sender and the receiver, the time, the asset type, and the quantity. The transaction proposal is sent to a peer-to-peer network consisting of many participants (nodes). Those nodes validate and authenticate the proposed transaction and put it together with a definite number of transactions from other parties into a block. Each block is linked with a cryptographical code to the block before. Therefore, each block consists of data from transactions, a derived hash and the previous block's hash. All the transactions that are not yet in a block are considered unverified and will be verified by integration into the next block (D'Aliessi, 2019). As any node on the network could suggest the next block, there is a need for collective consensus on who can decide on the next block. In that way, it is ensured that only legitimate transactions are verified. This process is called" mining" (Bitpanda, 2021a). Miners get rewarded when their block is added to the chain. Consequently, they compete against each other, and several blocks from different miners would be ready at any given time. Collective consensus algorithms achieve the agreement on which block is chosen to be added to the blockchain. The most famous ones amongst others are "Proof of Work" and "Proof of Stake" (Chitchyan and Murkin, 2018). By the former miners, must spend a lot of computing power to solve a cryptographic puzzle. The node that solves the puzzle first can add the block to the chain. Contrary with the latter, a node is randomly chosen to form the next block and add it to the chain. The node must put something at stake as insurance if the transaction is not valid (Bitpanda, 2021a). Blockchains do not have to be always open to the public; some blockchains are just operated internally in companies with no access for external parties. This makes sense if there is sensitive data on the blockchain, which should not be public knowledge (Vaughan, 2015). Although the blockchain had its primary usage in the financial industry and is also known mainly because of digital currencies like Bitcoin, Ether and many other altcoins, the blockchain in agriculture has its justification. The fields of applications are vast but can be categorized mainly around the supply chain of food (Kamilaris, Fonts, and Prenafeta-Boldú, 2019). Like many other industries, supply chains in an agricultural transaction have never undergone a digital transformation. The main challenges that need to be tackled in the future

[4] A hash function is turning a random input of data into a string of bytes with a fixed length. A slightly change of the input value changes the hash completely. (Bitpanda, 2021)

are the rising food demand, changing consumer preferences, environmental issues & sustainability, costs, food safety, and fair trade (Schmidhuber, 2018). Similarly, the available literature on the agricultural supply chains' issues can be separated into solutions to food security, safety, integrity, better supervision, and waste reduction along the supply chain. The blockchain has proven its advantages in environments with many stakeholders like the cryptocurrencies industry, likewise is the agricultural supply chain also international and multi actor-based (Kamilaris, Fonts, and Prenafeta-Boldύ, 2019; Niknejad et al., 2021). Besides the applications on the food's supply chain, applications for smart agriculture (data and information systems that support all forms of farming) and applications on e-commerce of farming products that would help small farmers, there are many more fields of application for BCT in the agricultural sector (Xiong et al., 2020).

## 2. Materials and Methods

Following the introduction to the technology and a small excursion to the applications in the agricultural sector, the available literature and companies that are implementing BCT in the agricultural sector are reviewed. A literature review should explain concisely findings that have emerged from prior research efforts and conclude how accurate that knowledge is. By doing so, gaps in the current research can be identified. Consequently, the methodology part is split into two different subsections. The first subsection analyses the available literature on the BCT in agricultural applications, and the second part devotes itself to start-ups and companies which are implementing the BCT in the agricultural sector and are therefore digitally transforming the industry. Following the literature process model, used by Engert, Rauter and Baumgartner (2015) the literature review follows four steps. First, material for the review is structurally collected. After that, descriptive statistics of the gathered literature is presented. Subsequently, the chosen literature – which is all about the application of BCT on agriculture - was categorized into different content categories, and finally, the literature – based on the categories is evaluated.

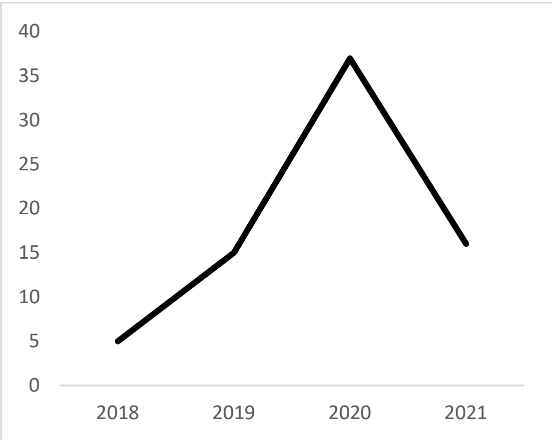
The literature for the review was extracted from the Web of Sciences Database. As search terms, the keywords "Agriculture" and "Blockchain" were used. What is more, to have just the latest research on this topic, the research period was narrowed down from literature written from 2018 until February of 2021. The literature from 2021 also included 50% early access papers which were not excluded from the review. Altogether 110 papers, conference proceedings and book chapters could be found, which fit the predefined search terms. After a close evaluation, only 73 papers were chosen for further research. Papers were excluded from the review if the paper's main topic was not entirely related to blockchain and If the main research field was not about the agricultural sector.

Additionally, papers were deleted if duplicates were found. The Companies which are implementing the BCT into the agricultural sector (AgTechs) were searched via basic internet research. Altogether 17 companies were found which are still operating and are devoting themselves to agriculture and BCT.

## 3. Results and Discussion

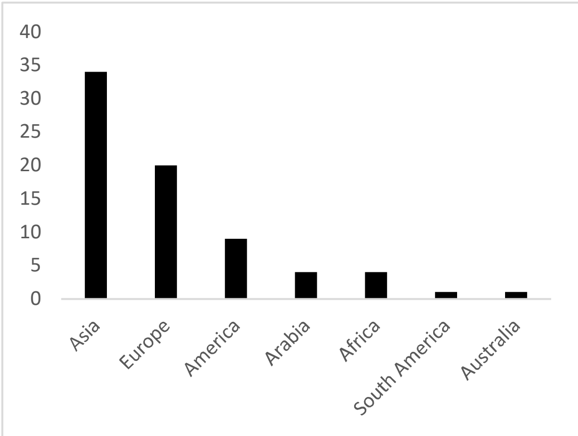
The literature was organized based on publications per year and the country of origin. As can be seen in Figure 2, there is a yearly increase in publications from 2018 to 2021. Bearing in mind that solely 2 Months of 2021 were taken into consideration, this would lead to a calculated amount by the end of the year of 96 papers (ceteris paribus). This underlines the rising interest and importance of this topic. The Asian region is leading the publication activity, followed by Europe, North America, Africa, Arabia, South America, and Australia (Figure 3). China is leading with 11 papers before India (nine Papers), followed by the U.S with eight papers.

Figure 2. Publications per Year




*Source: Own processing*

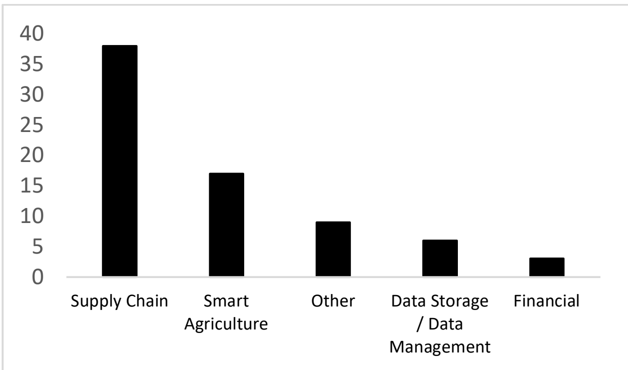
Figure 3. Publications per Region




*Source: Own processing*

During the analysis of the literature, five different main research topics emerged, which were put into categories. Although as expected, some overlaps would justify categorizing the literature into different categories, it was categorized based on the primary research topic. The resulting categories are: Supply Chain, Smart Agriculture, Data Storage/Management, Financial and Other and will be explained in more detail in the next section. The categories were also used for classifying the AgTechs companies, where most companies (10/17) are devoting themselves to improving the agricultural supply chain.

Figure 4. Publications per Category




*Source: Own processing*

In the following four subsections, the literature is reviewed according to the before defined categories. The majority of the literature deals with improvements in the supply chain (Figure 4) followed by blockchain adaptions on smart agriculture. Data storage and data management, other as well as financial applications accounted only for about 25% of all reviewed literature.

The agricultural industry is unique because most food products are perishable. This requires close attention to an efficient flow through the supply chain (Lakkakula, Bullock and Wilson, 2020). The supply chain for food and agricultural products is characterized by many global stakeholders, including producers, suppliers, transporters, wholesalers, and many other stakeholders. Each stakeholder is striving to reach their individual goals without talking to each other (Rana, Tricase and De Cesare, 2021). Hence, many agricultural supply chains are substantially inefficient, impacting all actors. According to estimations, the cost of operating these supply chains make up to two-thirds of the final costs of the goods in the agricultural and food sector (Schmidhuber, 2018). Furthermore, supply chains are slow and unstable. For instance, the origins and the carbon footprint of agricultural products are mostly not known by people (Gupta, Mahapatra and Attibudhi, 2020).

Besides, many people do not have trust in food quality, which is tackled by marketing and lavish food labelling, which does not solve trust issues entirely (Eden, Bear, and Walker 2008). The application of BCT on the supply chain could tackle issues about food safety, food security, food integrity and could support small farmers along the supply chain (Gupta, Mahapatra and Attibudhi, 2020). Also, traceability is a big topic, as traceability is crucial to ensure the consumers' experienced food safety. BCT can support to ensure that food provenance is always assured (Arena et al., 2019; Lin et al., 2018). Customers are increasingly demanding high quality and safe food, paired with the wish for a smaller environmental footprint of agricultural products, which is also fostering the need for new innovative technology to trace food along the supply chain in an effective manner (Rana, Tricase and De Cesare, 2021). Many proposals on how to tackle those issues with the use of BCT are discussed in the literature. One solution could be an IoT-Blockchain- enabled intelligent provenance system, where the provenance and the processing of food is tracked with smart sensors and decisions are made automatically by a predefined smart contract (Khan, Byun, and Park, 2020).

Smart Agriculture is the application of many modern technologies like IoT, Big Data, GPS, Cloud Computing, Drones, and Artificial Intelligence on traditional agriculture (Lin et al., 2018) and can be seen as an analogy to "Industry 4.0", namely "Agriculture 4.0" (Lezoche et al., 2020). The BCT can be applied to many fields where IoT Applications are involved; also, the BCT can be combined with machine learning to secure smart agriculture. Agriculture 4.0 has the potential to transform the sector. It will have an impact on food security, and as well as on the ways how agricultural production systems are designed and operated (Klerkx and Rose, 2020).

The BCT technology applied to big data in agriculture presents many challenges and opportunities (Griffin et al., 2021). All the agricultural data which is gathered by many IoT devices should be securely stored as any malicious tampering or change in the data could lead to wrong decision making resulting in immeasurable losses (Ren, Wan and Gan, 2021). Storing agricultural data reliably and safely has become a research problem. As a solution, by the use of BCT, it is possible to store data securely and retraceable. Therefore existing literature is proposing BCT as a data storage solution (Zhaoliang, Huang and Wang, 2021). However, the data search in the blockchain can be long and complex (Ren, Wan and Gan, 2021).

BCT can increase efficiency in international sales of agricultural products by accelerating payments. Hence the costs for agricultural products could be reduced (Lakkakula, Bullock and Wilson, 2020). What is more, the prices of agricultural goods depend on many factors, with the uncertainty about the crop yields considered as the most significant factor. A solution based on BCT that could carry out early yield estimations of agricultural products, would help all agricultural participants (Osmanoglu et al., 2020). Due to its ability to store, validate and secure data, BTC can solve many agricultural problems like agricultural business financing. If banking and insurance companies would be connected to the agricultural industry in real life, banks could create better credit ratings, and therefore farmers would have a greater chance of getting financing from banks (Rijanto, 2020).

In this section, papers are described which did not fit in any of the previous categories. Here the vast application possibilities of BCT come to light. For example, BCT can be used for transparency between farmers and the government in developing countries. Due to the mediating role of governments, data may be altered to the governments' advantages, and therefore, the development of agriculture may be hindered (Sowmya, Seema and Srinivasa, 2020). For example, in Kenya, over 2 million people are generating their income in the dairy sector. Most of them are small farmers who rely on the local milk collection centres, whose are manually recording every milk transaction in hardcopy inventory files. In recent years these records have been susceptible to modifications and deletions to cut down the payments to the farmers (Rambim and Awuor, 2020). Chen, Li and Li (2020) argue that BCT could lead to a democratization of agriculture which would bring freedom to information and therefore would improve agricultural production and its efficiency.

Many companies - primarily start-ups - in the agricultural sector are working on how BCT can improve normal business processes in the agricultural industry. The fields of application range - similar to the literature – from improvements on the efficiency of supply chains to financial applications like financial help for smallholder farmers in developing countries. Table 2 depicts various AgTecs – categorized in the previous logic. All companies are dealing with the adoption of BCT in the agricultural industry. A majority of the AgTechs are trying to improve global supply chains by making them more transparent, fair, and sustainable. This is conducted by small start-ups like Agri Chain or Ripe and huge companies like the Food Trust from IBM (*IBM Food Trust,* 2021) – where big retail chains like Walmart are part of. Also, the BCT on the improvement of the efficiency and therefore better access to financial funding of agricultural production has a valuable role. Companies like Agriledger are enabling small farmers - by proving their identity and their income via the blockchain - access to funds in order to enhance their agricultural production. What should be added here is that some of the companies received funding lately and are backed up by larger institutions. By looking at other companies it is not clear whether their business model is sustainable, and they are able to operate continuously on the market.

Table 4. AgTech overview

| Name | Description | Category |
|---|---|---|
| Agri Chain | More efficient supply chain | Supply Chain |
| AgriDigital | Simple way how to buy, sell, move, store and report grain | Supply Chain |
| Agriledger | Efficient and traceable supply chain | Financial |
| Agunity | Diverse services for fair trade agricultural products | Other |
| Bext360 | Supply chain management | Supply Chain |
| Binkabi | Supply chain financing | Finance |
| Centaur | Smart agriculture from the farm to the fork | Smart Agriculture |
| Demeter | Microfield renting for farm fields and an online marketplace | Other |
| Etherisc | Crop insurance to farmers | Finance |
| Farmer Connect | Fair sustainable and traceable supply chain | Supply Chain |
| Hara | Data exchange for the agricultural sector | Other |
| IBM Food trust | Benefits on the whole supply chain | Supply Chain |
| Provenance | Transparency in food supply chains | Supply Chain |
| Ripe | Transparent Food Supply Chain | Supply Chain |
| Sawtooth Seafood | Seafood supply chain traceability | Supply Chain |
| Te-food | End to end food traceability solution on the blockchain | Supply Chain |
| Verfied Organic | Provides complete transparency of the organic food provenance | Supply Chain |

*Source: Own processing*

## 4. Conclusion

This article presented an overview of the BCT in the agricultural sector. The article focused first on an introduction of the technology. After that, a literature review of the latest literature about BCT in the agricultural sector and a review of companies that are applying BCT in the sector is presented. The uses for the technology in the sector are vast: BCT can help the agricultural sector to build a trusted, self-organized smart agriculture system that involves all parties along the agricultural supply chain, even those who may not trust each other (Lin et al., 2018). What is more, the potential of BCT to record, store and validate data in a decentralized way is very important to enhance the development of the agricultural industry (Rijanto, 2020). Due to that, BCT is well researched by the scientific community. Publications on this topic are rising steadily with a regional focus of the Asian region. By looking at the recent trends within the agricultural sector, impacts from the BCT have already started to take place in the agricultural sector, and it seems that the benefits are apparent both from the business as well as sustainability side. It appears that many more applications will emerge soon, and companies in the agricultural sector will adapt BCT for various purposes. Future articles could, amongst others, investigate whether companies (AgTechs) who are implementing the BCT into the industry or agricultural food companies who are integrating the technology into their operations are economically successful by doing so. What is more, future research could also look more closely at the real impact of BCT across the whole industry measured by specific KPI's

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# TWENTY YEARS OF RESEARCH IN AGRICULTURE BUSINESS MODEL, DIRECTIONS FOR FUTURE

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**Annotation:** Modern agriculture businesses must reflect emerging visions and strategies that can be formalized through business models. During the last 20 years, many themes were addressed in the literature on business models in agriculture, which can confuse the proper understanding of this issue. However, neither study was interested in the key themes of this area. The presented paper systematically reviews the domain of business models in agriculture, aiming to provide information about key themes and show areas for future research. The authors analyzed 1204 articles with the use of bibliometric analysis, multiple correspondence analysis, and clustering to create a thematic map, which represents the importance and expansion of themes. The results of this paper indicated the key themes in the domain of business models in agriculture in the last 20 years - sustainability, food security, circular economy, innovation, urban agriculture, rural development, climate change, blockchain, precision agriculture, internet of things and profitability. To develop a full picture of business models in agriculture, additional studies will be needed to: investigate the influence of the triple bottom line on the change in agriculture business models; determine how the business model adjusts to urban agriculture; use of IoT, precisions agriculture, and blockchain in agriculture business models; explore the effect of changing business model on profitability in agriculture; more precisely define terms and classifications used in agriculture; study the application of new technologies and methods to different crops and identify their effectiveness within precision farming; and study the changes of the business model in the context of ongoing Covid-19 pandemic.

**Key words:** bibliometrics, sustainable agriculture, innovation, precision agriculture, smart agriculture

**JEL classification:** Q13

## 1. Introduction

Entrepreneurship covers the activities of entrepreneurs, leading to business survival in the long term. Business survival is tightly connected with positive economic results, i.e., profit generation. An entrepreneur has the potential to choose from various paths, delivering hereabove mentioned goal successful replenishment. Researchers and professionals frequently inflect terms like strategy, competitive advantage, however, since the last decade of the previous millennium a new term declination has risen. Business model theory saw the light of day. According to Magretta (2002) importance and interest in the business model has risen since 1990. In the beginning it was tightly connected with the Internet boom and companies operating in the Internet environment. Magretta (2002) defines a business model as describing how a company is doing a business. Some researchesd efine business models as a framework or architecture, characterizing activities of a company when generating value for customers. Chien-Hsing, et al. (2019) defines business models as successful business operations, capable to target and manage customer base and products, respecting precise financials treatment.

Term business model and strategy are frequently mixed or not properly used. Richardson (2008) states, business model is an instrument, transforming business strategy into business activities and thus leads to business strategy implementation. A simple explanation is following. Business strategy defines company competitive advantage. Business model describes the business strategy execution. De Reuver et al. (2013) describes a framework approach to develop or renew existing business models, using a roadmap of nine business model building blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. This framework is based on Alexander Osterwalder Business Model Canvas framework (Osterwalder and Pigneur, 2010). Björklund (2018) states, business model shall cover following areas: value proposition, market segment identification and revenues generation scheme.

Schweizer (2005) emphasis a new approach of business analyses delivered by business model theory and compares it with traditional theoretical concepts. First: focus on particular steps, performed when aiming to complete particular task, not flow of products through a company. Second: relationships emphasis. Third: revenue generation accent. Four: resource-based approach. Poláková, Koláčková and Tichá (2015) deal with business models in agriculture, emphasizing the approach capability of value creation in organization facilitation and understanding business fundamentals. The authors have not spotted any comprehensive review of the agriculture business models theory summary. That is the cause of presented paper genesis.

Authors stated major research question as following: to spot key themes, dominating research in agricultural business models for the last 20 years. Authors believe, results of this research have potential to identify gaps between already executed research and the potential one. The results can be beneficial for anyone concerned in agricultural business model research history and future.

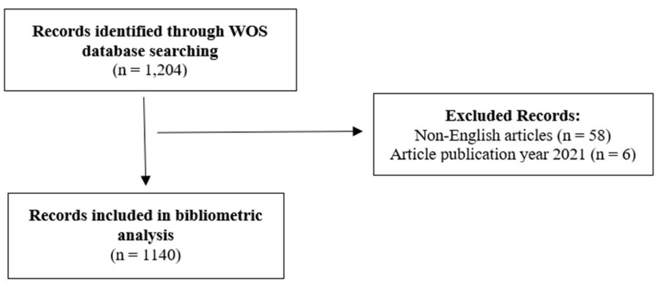
## 2. Materials and Methods

Bibliometric approach was used to cover the key themes in the domain of business models in agriculture. Data was obtained from Web of Science on March 13, 2021, with the following search query:

*TS = (business model AND agriculture) AND PY = (2000-2020)*
*Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, CCR-EXPANDED, IC*
*Timespan=All years*

The search returned 1,204 bibliographic references. Authors removed non-English articles (n=58) and references with the publication year 2021 (n=6). To bibliometric analysis was included 1140 references. Process of searching can be seen at the Figure 1.

Figure 1. PRISMA Flow diagram




*Source: Own calculation based on Moher et al. (2009)*

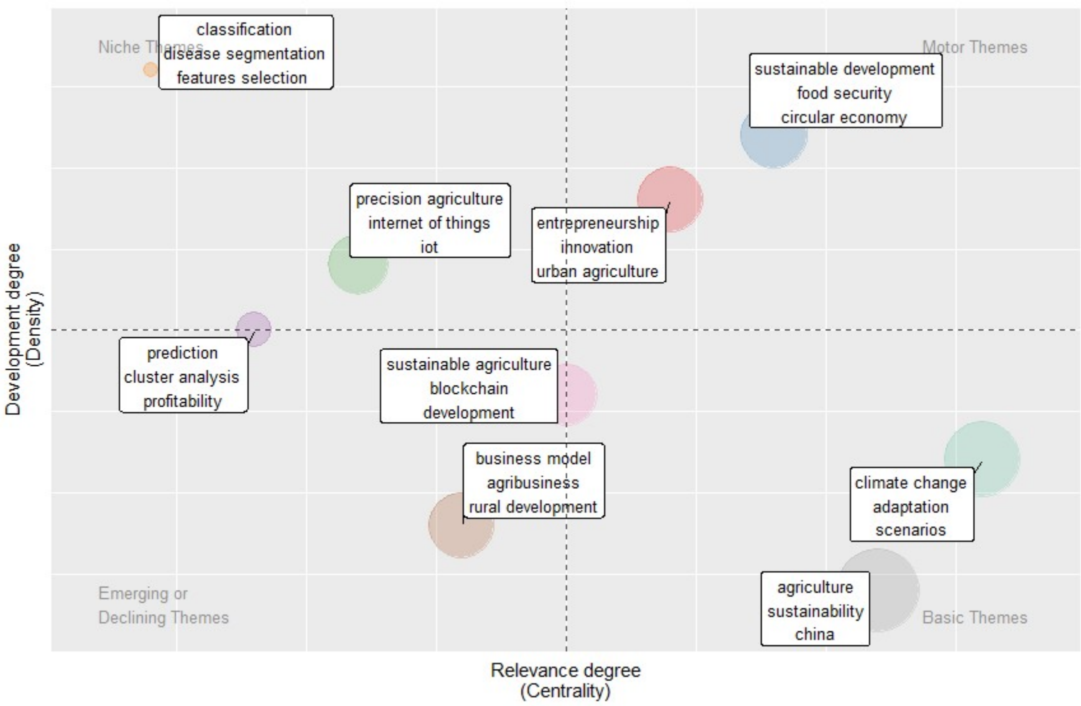
Bibliometric analysis was conducted in RStudio. Authors used Bibliometrix package by Aria and Cuccurullo (2017). To describe the key themes of business models in the agriculture domain in the last 20 years authors created thematic map (Figure 2). K-means clustering algorithm on the author´s keyword co-occurrence networks was applied, to emphasize the different themes, and to create a thematic map. The thematic map is divided into four quadrants that represent the importance (centrality) and expansion (density) of the themes (Aria and Cuccurullo, 2017). Each quadrant contains a bubble that represents a network cluster. Depending on the number of words in the cluster, the bubble size is determined. Each bubble is described by the three most used words in the cluster.

Authors contribute to the transparency, reproducibility and robustness of this paper and all supporting materials (script, data, PRISMA flow diagram) can be found at Open Science Framework (2021).

## 3. Results and Discussion

Motor themes in the agriculture business models are represented by blue and red bubbles (Figure 2). The three most common themes within the blue bubble cluster are sustainable development, food security and circular economy. Results of the paper confirm that sustainable development in agriculture is associated with a circular economy, as was suggested by Jun and Xiang (2011) and Toop et al. (2017). In accordance with the present results, previous studies have demonstrated that food security is an important part of the circular economy theme (Jurgilevich et al., 2016; Irani and Sharif, 2018; Segneanu, 2018). Authors agree that sustainable development in agriculture emphasis on three pillars – social, environment and economic (Schoneveld et al., 2015; Panait and Cucu, 2020). Results support the idea of these three pillars and suggest that future research should be undertaken to investigate the influence of the triple bottom line on the change in agriculture business models.

Figure 2. Thematic map




*Source: Own calculations*

As expected, entrepreneurship and innovation are the two most common themes within the red bubble cluster. Already Chesbrough and Rosenbloom (2002) have defined the business model as a process of converting innovation into value. This claim was further confirmed by other authors such as George and Bock (2011), Danarahmanto et al. (2020) or even results of this study. Interestingly, urban agriculture is the third most common theme within the red bubble cluster. Urban agriculture has been studied for its benefits such as food security, economic development, well-being or sustainability (Brown and Jameton, 2000; Mok et al., 2014) but not too many researchers focused on urban agriculture as an opportunity for the business model. However, in recent years there has been growing interest in urban agriculture particularly in connection with high-tech business-oriented solutions (Sanyé-Mengual et al., 2018; H. Farhangi et al., 2020) and in connection with changing the business model - low-cost specialization, differentiation, and diversification (Pölling, Mergenthaler and Lorleberg, 2016). Still there is abundant room for further progress in determining how the business model adjusts to urban agriculture.

In the basic themes, the turquoise bubble indicated the most important themes, such as climate change, adaptation, scenarios. Climate change, according to Luo and Yu (2012), is perhaps the greatest economic and environmental challenge humanity has ever faced. Pearson et al. (2011) states that agriculture is one of the key economic sectors which is most at risk from these changes. Therefore, researcher study the impacts of these changes on agricultural production (Mauritzen et al., 2017; Parry et al., 2005), water management (Henderson et al., 2015; Fischer et al.,2014), and risk and damage assessment (Hsiang et al., 2017; Guan et al., 2017). On the other hand, the authors also examine the effects of agricultural production on climate change, focusing on greenhouse gas emissions (Mosnier et al., 2017; Mahowal d et al., 2017) and carbon sequestration (Ramachandra and Bharath, 2020). The solutions, as well as areas suitable for research are: increasing productivity from limited fertile land and natural resources (Mosnier et al., 2017; Grieve et al., 2009), increasing the efficiency of the food system (Benis and Ferrão, 2017), innovation or adapting businesses to change (Fleming et al., 2015; Dinh et al., 2017). Future changes, their limits and barriers are estimated on the basis of forecast (Guan et al., 2017; Kansiime and Mastenbroek, 2016), adaptation strategies are being developed towards profitability, resilience and food security of conventional and alternative farming systems (Rodriguez et al., 2014; Gosnell et al., 2019). Mechler et al. (2010) highlight the need in forecast to take into account not only climate change but also socio-economic change in forecast. Adapting production and non-production functions to society's requirements for sustainable values, business development, business systems and urban policies (Ma et al., 2020; Recasens et al., 2016) leads to the application of urban farming models (see above). Identifying and implementing these new agricultural approaches requires a thorough understanding of future customer needs (potential market attractiveness) and knowledge of new technological opportunities arising from parallel industrial and non-agricultural research sectors (Grieve et al., 2009). Zhai et al. (2018) adds that farmers' perceptions, beliefs, adaptive strategies and obstacles to climate change are essential to promote sustainable ecosystems and social stability. The frequent use of the scenario themes indicated more of the authors' approach to the problem under consideration than of a variable that would influence the structure of business models in agriculture. Among the frequent topics covered by the scenarios are the impact of climate change (Zhao et al., 2020) on agricultural production (Mosnier et al., 2017; Bocchiola et al., 2013; Luo and Yu, 2012), water (Whitehead et al., 2015; Singandhupe et al., 2008), land use (Gago-Silva et al., 2017; Ramírez-Mejía et al., 2017; Han et al., 2015) and carbon (Albers et al., 2020; Borah et al., 2018)

The gray bubble includes agriculture, sustainability, and China. It stands to reason that the themes of agriculture must have a significant presence in the subject under consideration, but it is irrelevant to the search for research opportunities, as is the word China. The word China also is in the grey bubble due to the fact that Chinese authors are the second most productive authors of a publication on a given search query (411 articles have corresponding authors from China). Sustainability has already been addressed above, (triple bottom line concept). Sustainable business models thus provide an integrated approach and interface between intermediary and actor to deliver better economic values with an ethical decision towards environmental protection (Saswat et al., 2020). The complexity and multidisciplinarity of this concept offer considerable scope for research (e.g. setting sustainability metrics).

On the edge of basic and emerging themes it can be seen a pink bubble that contains the themes of sustainable agriculture, blockchain and development. As is mentioned above, sustainability is a theme that greatly influences agriculture. Blockchain offers itself as one way to achieve development and sustainable agriculture. Blockchain has several potential uses in the agriculture sector – it is being applied in supply chain management (Leng et al., 2018), in IoT and smart agriculture (Lin et al., 2018), in smart greenhouse farms (Patil et al., 2018) and many other areas. Consistent with the results of Mirabelli and Solina (2020) who claims that blockchain in agriculture is still in its early stage, this research recommends future investigations of blockchain and its connection to agriculture business models.

Niche themes can be found in the left top quadrant (Figure 2). The green cluster consists of precision agriculture and the internet of things (IoT). Khanna and Kaur (2019) defined precision agriculture as a way of managing farms with the use of information technology to ensure profitability, sustainability and environmental protection. As the size of the bubble suggests, precision agriculture has been studied by many scientists. This finding confirms that the internet of things is a popular subject as has been suggested by Kiani and Seyyedabbasi (2018). But there is a relatively small body of literature that is concerned with business models and precisions agriculture or IoT applications. Ruan et al. (2020) presented an IoT-based business model of intelligent vegetable greenhouse. Lu et al. (2010) design an innovative business strategy model with the use of IoT. Consistent with the findings of Lin et al. (2017), Farooq et al. (2019) and Dobermann et al. (2004), this research found that IoT and precisions agriculture is an important and promising theme for future research.

Orange bubble depicts other niche themes, which only a handful of scientists are dedicated to (as the size of the bubble suggests). Classification is a general word and there's a whole range of classification used in agriculture. For example Therond et al. (2017) states the classification of farming systems which „are based on external inputs or ecosystem services and are integrated into globalised commodity-based food systems or territorial socio-economic contexts such as circular economies, alternative food systems and integrated landscape approaches“. Bocken (2014) proposed eight classifications describing technological, organisational and social innovation as the main innovation options for a sustainable business model. Donner (2020) provide a classification for circular business models with the use of the value from agro-waste. As mentioned by Therond et al. (2017) and Wezel et al. (2015) classification in agriculture must be defined with greater precision. A further study with more focus on precision in defining terms and classification is therefore suggested.

The orange bubble also consists of themes disease segmentation and features selection. These two themes are closely related. Khan et al. (2020a), Khan et al. (2020b) and Khan et al. (2018) highlights the issue of crop diseases that reduce both the quality and volume of agricultural production on a global scale. They propose new technologies and methods that can detect and classify different diseases at an early stage based on discriminatory traits, and thus can help make food systems more efficient. Opportunities for future research can be seen in applying these technologies and methods to different agricultural crops or in identifying the effectiveness of individual technologies within precision farming.

The purple bubble illustrates emerging themes, which are only covered by a small amount of research, which is why they tend to become niche themes. Prediction and cluster analysis are methodological practices that, as in other fields, find their application in agriculture. But the position of this cluster, purple bubble, suggests that these two methodologies still have potential for future research. Third most common theme in the purple bubble is profitability. Profitability is one of the key components of successful business models (Tallman, Luo and Buckley, 2018). Long et al. (2018) adds that profitability is also very important for the business model's transition to sustainability. Several researches have shown the determinants of profitability (Levi et al., 2020; Kryszak, Guth and Czyżewski, 2021), have deal with profitability in urban agriculture (O´Sullivan et al., 2019) or study effect of product differentiation on profitability (Chocholoušek et al., 2021). Other research looked at the issue of profitability in crop production (Klima et al., 2020), livestock production (Sorathiya et al., 2014). But there are still many unanswered questions about profitability and its connection to business models in agriculture.

Declining themes are shown by the brown bubble. Business model, agribusiness and rural development are well known themes which were studied by many researchers. In the introduction authors provide an overview of business models in agriculture. Agribusiness has been a popular topic since the 1960s (King et al., 2010) so it is obvious that much research has already been done on this theme. Rural development is not a novice concept as well – the first concepts and policies started appearing in the mid-1950s (Calatrava, 2016). As the bubble's position suggests, a lot of research has gone into these topics, which makes it difficult to find room for more research. However, there is scope for future research from a combination of themes from this brown bubble e.g., with some niche themes.

## 4. Conclusion

The results of this paper indicated the key themes in the domain of business models in agriculture in the last 20 years. As motor themes were detected themes such as sustainable development, food security, circular economy, innovation, and urban agriculture. Basic themes were climate change, adaptation, scenarios, and sustainability and blockchain. Niche themes are precision agriculture, IoT, classification, disease segmentation, features selection and profitability. Scientists are paying less attention to themes like rural development, agribusiness, or business model by itself. Within the paper, authors also identified directions for future research - (1) investigate the influence of the triple bottom line on the change in agriculture business models, (2) determine how the business model adjusts to urban agriculture, (3) use of IoT, precisions agriculture and blockchain in agriculture business models,

(4) the effect of changing business model on profitability in agriculture, (5) more precise definition of terms and classifications used in agriculture, (6) application of new technologies and methods to different agricultural crops and identify their effectiveness within precision farming.

An interesting result is also that scientists have paid very little attention to changing the (7) business model in the context of the ongoing Covid-19 pandemic (only 7 articles from dataset have addressed this issue). This may have been due to the date of downloading references from the Web of Science (March 13, 2021), perhaps not all articles have been indexed in the Web of Science yet. However, even this finding opens possibilities for future research into the Covid-19 effect on business models in agriculture.

The limitation of this paper is the bibliometric approach itself. Only author´s keyword from only on databases (Web of Science) were used for the bibliometric analysis. Considering the limitation of the paper the results can be beneficial for anyone concerned in agricultural business model research history and future

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# CZECH FOOD RETAIL PRICES ANALYSIS

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**Annotation:** This paper aims to specifically explore the development of prices of selected food items in the Czech Republic in 2011 - 2020 at the level of individual retail chains operating in the CR: Albert, Billa, Kaufland, Lidl, Penny Market and Tesco. The general food price level development in the CR is compared to EU countries' level development. The authors of this paper collect data on food prices in individual retail chains operating in the CR for the last ten years. The subject of this research is foodstuffs: carrots, onions, bananas, potatoes, oranges, watermelon, apples, edam cheese, bread, sugar, rice, chicken, milk, butter, eggs. The collected data is compared with aggregated data sets provided by the Czech Statistical Office and also by Eurostat. Basic methods of statistical and comparative analysis at the level of primary and secondary data are used for individual data analyzes. The highest average price level for the observed period 2011 - 2020 was recorded for Billa and Lidl (both almost CZK 43), while the cheapest foodstuffs were in Tesco and Kaufland (both less than CZK 39). As for purchasing power, we would buy the most for the average wage in the cheapest Tesco and Kaufland - over 1.3 tons of food. Food basket prices were the most scattered in Kaufland for the period 2011-2020 (standard deviation 8.53), while Tesco is the most stable in pricing policy (6.97). The highest average rate of price growth had Tesco (+0.09), the lowest the Penny Market (+0.06). Food prices in the CR did not deviate in any way from the average price trend of EU food in the monitored period (the average growth rate of food prices in the CR and in the EU was 0.01), Czech prices were only slightly more volatile than European prices (EU 3.18; CR 3.52).

**Key words:** Food prices, European Union, Czech Republic, retail, development.

**JEL classification:** F60, J30, Q10

## 1. Introduction

The Czech Republic has a small open market economy that does not have excessive internal, external or financial imbalances (Čermáková, Jašová, 2019). Until the beginning of 2020, the growth of Czech GDP was at a very good level (Horák et al., 2020). In 2020, there was a short and deep recession due to the global coronavirus pandemic. In response to the spread of a new pandemic, countries around the world were forced to alternately close and open their economies during 2020. Economic activity has fallen sharply in most of the world (Niavis et al., 2021). The growth rate of the global economy in 2020 was about -4%. The euro area showed a decline in GDP of around -8% on average (Germany around -6%, France -9%). Interestingly, China's GDP grew by +2% in 2020 (World Bank, 2021). In 2020, the year-on-year decline in household consumption in the Czech Republic deepened significantly to 8.1%, which was due to the closure of a large part of shops and service establishments, and to high savings due to increased population uncertainty (drastic anti-epidemic measures significantly reduced opportunities to spend) (Shortanov, 2021). Consumption in the general government sector was reflected in increased spending on health care and government anti-crisis programs. It was an increase of about +7% (CZSO, 2021). It can be expected that the growth of the Czech potential product will resume after the global pandemic subsides. The standard of living of the Czech Republic (measured by GDP per capita according to purchasing power parity) reaches about 90% of the EU average. The average GDP growth rate for the last two decades without 2020 is about 3%, and if we include 2020, the value of GDP is one percentage point lower. Foreign trade plays a key role in the development of the Czech economy (Kovárník, Hamplová, 2020). The share of exports of goods and services in GDP reaches about 70% and has been growing for a long time. Last year, however, it fell by 4 percentage points (CZSO, 2021). The Czech Republic trades mainly with EU countries, especially with Germany, Slovakia, Poland and France (Kovárník, Hamplová, 2019). The stable macroeconomic situation (and relatively low government debt) is reflected in the favorable assessment of the Czech economy by international rating agencies. The development of the global economy in 2021 will be influenced mainly by the situation in international trade, the coronavirus pandemic, vaccination and government debt. The growth rate of the global economy and the euro area could increase to around 4%. In 2021, we can expect the growth of the Czech economy by about 3% of GDP and the return of GDP to the pre-pandemic level at the earliest in 2023 (CNB, 2021). The general government deficit in the euro area increased from 0.5% (2019) to 7% of GDP in 2020. According to the ECB's forecast (2021), the budget deficit will fall to around 6% of GDP in 2021 and to around 2% in 2023. Public sector debt in the euro area will increase to 95% of GDP in 2023, about 11 percentage points more than before the crisis (ECB, 2021). The indebtedness of Czech public finances is likely to increase from 40% of GDP in 2020 to 45% of GDP by the end of 2021. In 2022, the effects of the pandemic should be minimal. In 2022, government debt can be estimated at more than 48% of GDP (CNB, 2021).

Retail trade in the Czech Republic is currently experiencing the deepest decline in the history of monitoring due to the extraordinary pandemic situation (Dvořák et al., 2021), when operations in a large part of the economy, including retail, have been suspended or curtailed. Sales of both non-food and food products decreased. According to CZSO statistics from 2019, approximately 2.2 million kg of food is consumed daily in the Czech Republic (including losses and waste) (CZSO, 2021). Sales in food retail were lower by about 3%, although food prices rose. Consumers pre-stocked themselves with food and avoided panicking. Revenues from the sale of non-food goods decreased by only about 1%, mainly due to the sale of household products. Recent consumer surveys indicate a slight deterioration in confidence and continued caution. Consumers fear a deterioration in their own financial situation, rising unemployment and rising prices. Consumers save on a certain assortment - they buy less clothes, shoes, food and fuel (MPO, 2020). The trend of future development in retail will depend on the development of the epidemiological situation. Retail turnover in the countries of the European Union in the 2nd quarter of 2020 decreased by about 6% year-on-year (in the 2nd quarter of 2019 it increased by 3%). Turnover in the euro area fell by 7% (in the same period of 2019 it was about 3% higher year-on-year). The highest declines were in Luxembourg, Bulgaria, Spain, Italy and Slovenia. The Czech Republic deteriorated year-on-year and fell from ninth to eleventh in the ranking of countries (Eurostat, 2021).

The data of the Czech National Bank show that household savings increased during the 12 months with a pandemic by an average of almost 27 thousand crowns per capita. Which is about 4-5 times higher than how much the Czechs have been able to save per year in the previous twenty years. Before the covid (between 2015 and 2019), people saved an average of 12 percent of their income. During 2020, according to data for the first to third quarters of 2020, the savings rate rose to 16.7 percent. But it mainly concerns the middle and upper class (CNB, 2021). There was nowhere to spend income for most of the year. At the same time, in many industries, employees' wages grew (Tichá et al., 2020). The lifting of government bans will mean a small "harvest" for restaurants, hotels, baby goods retailers, booksellers, travel agencies and other industries. It is largely unknown what part of the savings people will spend now and how much they will keep in stock for a possible return of worse times.

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 especially by European market development, the food price analyses cover those retail chains which are a part of international retail groups (will be specified by name below). This paper aims to specifically explore the development of prices of selected food items within a ten-year period. The goal is to identify significant price changes at the level of individual food items and identify / describe the main developmental characteristics of the monitored indicators. Furthermore, the food price development is also analysed with respect to individual retail chains. The general food price level development in the Czech Republic is compared to EU countries' level development.

## 2. Materials and Methods

Food price analysis is performed through a unique data collection process. The authors of this paper collect data on food prices in individual retail chains operating in the Czech Republic for the last ten years (2011 – 2020). These are the following retail chains: Albert (Ahold), Billa (Rewe Group), Kaufland (Schwarz Gruppe), Lidl (Schwarz Gruppe), Penny Market (Rewe Group) and Tesco (Tesco). See summary Table 1 for more details.

Table 1. Overview of monitored retail chains and defined food basket items

| retail store | owner | country of origin | food basket (1kg) |
|---|---|---|---|
| Albert | Ahold | Netherlands | carrots (unpackaged / packaged),<br>onions (unpackaged / packaged),<br>bananas,<br>potatoes (unpackaged),<br>oranges,<br>watermelon,<br>golden del. apples (unpackaged),<br>edam 45% (box),<br>edam 30% (box),<br>Šumava bread (1,200gr),<br>sugar (crystal),<br>long grain rice,<br>chicken (standard),<br>the cheapest milk (1 liter),<br>the cheapest butter (250gr),<br>eggs (10 pcs) |
| Billa | Rewe Group | Germany | |
| Kaufland | Schwarz Gruppe | Germany | |
| Lidl | Schwarz Gruppe | Germany | |
| Penny Market | Rewe Group | Germany | |
| Tesco | Tesco | Great Britain | |

*Source: Own processing, 2021*

The subject of research is foodstuff (1 kg): carrots, onions, bananas, potatoes, oranges, watermelon, apples, edam 45%, edam 30%, bread (1,200gr), sugar, rice, chicken, milk (1 liter), butter (250gr), eggs (10 pcs).

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 2011 to the present.

The collected data is compared with aggregated data sets provided by the Czech Statistical Office and also by Eurostat. The development of food prices is also influenced by purchasing power (concept inspired by Malakhov (2021) in the Czech Republic. Basic methods of statistical and comparative analysis at the level of primary and secondary data are used for individual data analyzes: average indicators (wages, food prices), average food price growth rate, standard deviation (to detect food price volatility), purchasing power (in a very simplified concept, we determined the volume of foodstuff (food basket of monitored foodstuff), which can be bought for an average wage in the observed year).

## 3. Results and Discussion

The highest price level of the set of monitored foods for the observed period 2011 - 2020 had the retailer Billa (average price of goods 42.62 CZK) and Lidl (42.49 CZK), cheaper food was in the retailer Albert (40.63 CZK) and Penny (CZK 40,37), the cheapest were Tesco (CZK 38.96) and Kaufland (CZK 38.67). The price level is influenced by the fact that the monitored retail chains tend to create oligopolistic entities on the market, as pointed out in their article Severová and Šrédl (2010). If we look at this issue from the point of view of purchasing power (concept inspired by Malakhov (2021)), ie if we want to find out how much volume of the monitored food basket in kilograms we can buy for the average wage (Table 2), which was recorded in the Czech Republic in a particular monitored year, then we would conclude that the largest volume of food for the period 2011 - 2020 we would buy in the cheapest Tesco (average 1356 kg), the second largest volume (1344 kg) would be bought in Kaufland.

Table 2. Average wage in the Czech Republic (CZK)

| year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| av. wage | 24,319 | 25,109 | 25,128 | 25,686 | 26,467 | 27,589 | 29,504 | 31,885 | 34,125 | 35,611 |

*Source: CZSO, 2021*

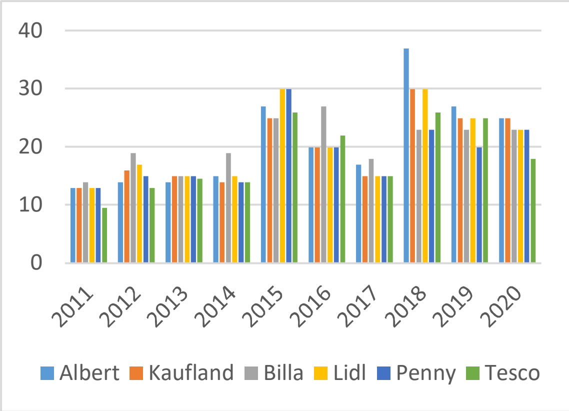
Next in terms of purchasing power would be retailers Albert (1282 kg), Penny (1259 kg) and Billa (1157 kg). In terms of purchasing power, we would buy the least in Lidl on average for the average wage (1046 kg). However, this result is greatly skewed by the fact that Lidl has a more limited range than other retailers (for example, it does not sell unpackaged carrots, unpackaged onions, unpackaged potatoes at all), which statistically has the effect of strengthening extreme price fluctuations.

Regarding the standard deviation of prices from the average, prices were fluctuating mostly in retail stores Kaufland (8.53) and Billa (8.13), relatively more stable prices were in Albert (7.69), Lidl (7.49), Penny (7.22), the most stable in Tesco (6.97).

If we focus on the average growth rate of food prices, we can say that the highest average growth rate was shown by Tesco (0.09), followed by Albert and Kaufland (both 0.08), Billa and Lidl (both 0.07), the lowest growth rate was shown by Penny (0.06).

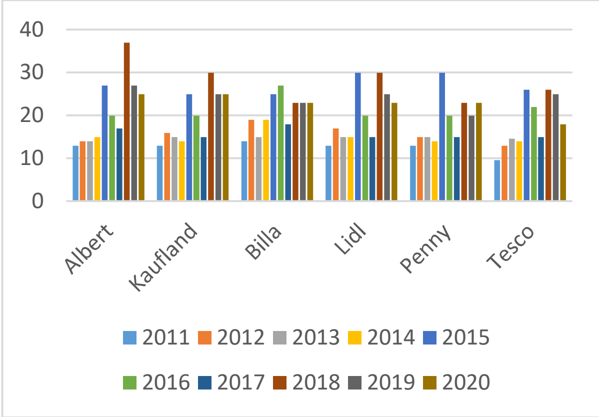
The highest rate of price growth was recorded for carrots (see Figures 1 and 2) and apples (Figures 3 and 4).

Figure 1. 1kg carrot price (CZK)




*Source: Own research, 2021*

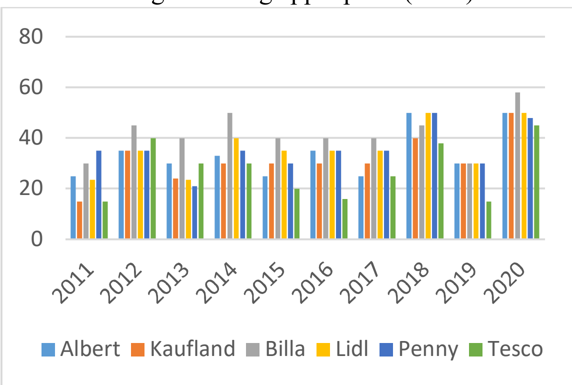
Figure 2. 1kg carrot price (CZK)




*Source: Own research, 2021*

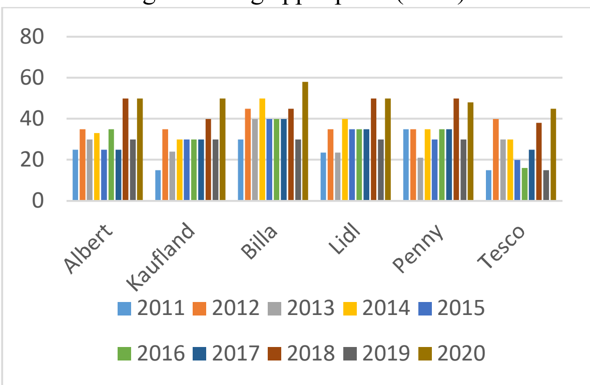
For retail Albert, the average growth rate of the price of carrots was 0.21, for apples it was 0.17. At Tesco, the growth rate of apples was even 0.38, carrots 0.17. In Kaufland, the average growth rate of apple prices was 0.23, carrots 0.20.

Figure 3. 1kg apple price (CZK)




*Source: Own research, 2021*

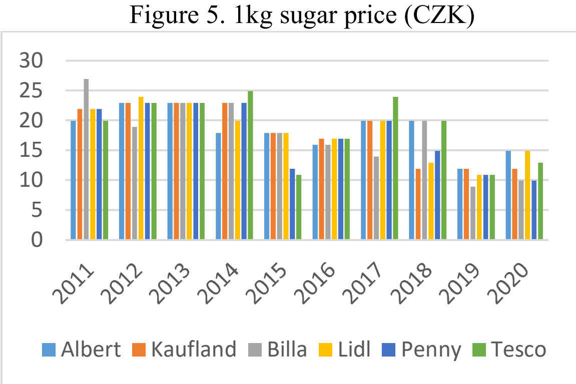
Figure 4. 1kg apple price (CZK)




*Source: Own research, 2021*

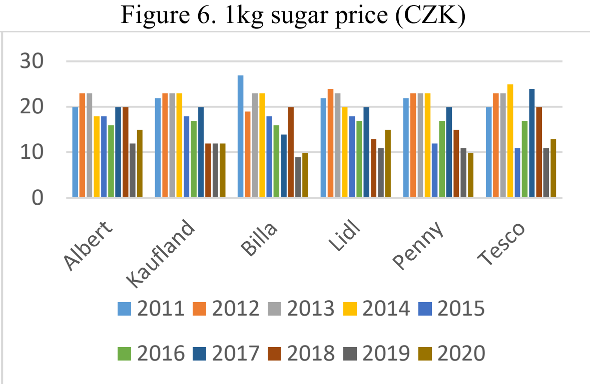
On the other hand, the price of sugar reached a negative average growth rate in stores: Billa -0.06, Kaufland and Penny both -0.05, Lidl -0.02 and Albert -0.01. The only retailer that did not show a negative average rate of sugar price growth was Tesco (+0.02). More can be seen in Figures 5 and 6.

Figure 5. 1kg sugar price (CZK)




*Source: Own research, 2021*

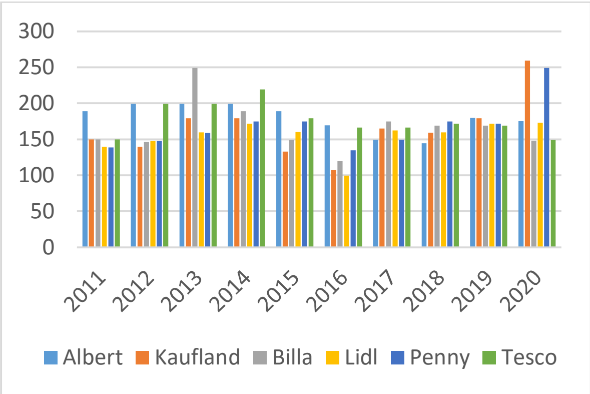
Figure 6. 1kg sugar price (CZK)




*Source: Own research, 2021*

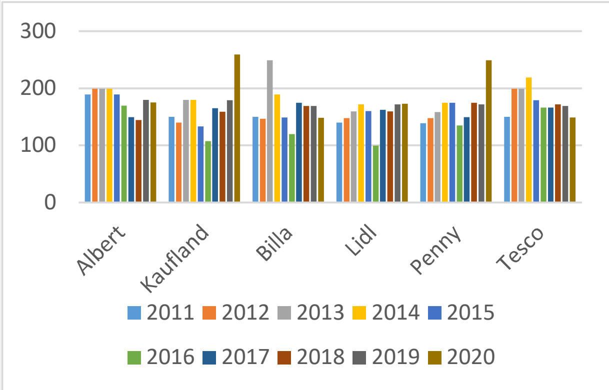
The highest standard deviation was recorded for edam 45% (price development is in Figures 7 and 8) and edam 30%, which is understandable due to their high unit price. The price of 45% edam fluctuated the most in Kaufland (standard deviation 38.35), Billa (33.04) and Penny (30.87), less in Tesco (21.38), Lidl (20.86) and Albert (18, 88). As for edam 30%, the highest standard deviation of this price was recorded in Albert (29.51), followed by Kaufland (22.92), Lidl (20.77), Billa (20.50). The lowest standard deviation was in Penny (16.66) and Tesco (15.71).

Figure 7. 1kg edam 45% price (CZK)




*Source: Own research, 2021*

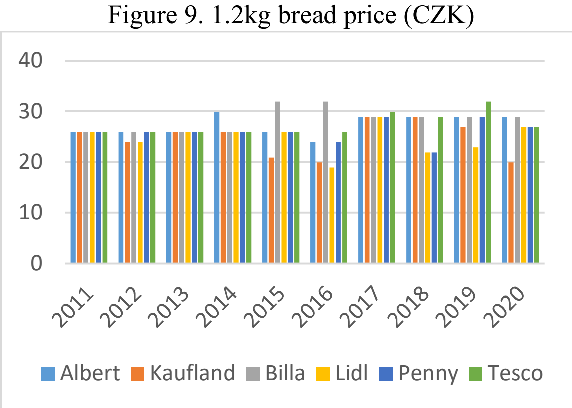
Figure 8. 1kg edam 45% price (CZK)




*Source: Own research, 2021*

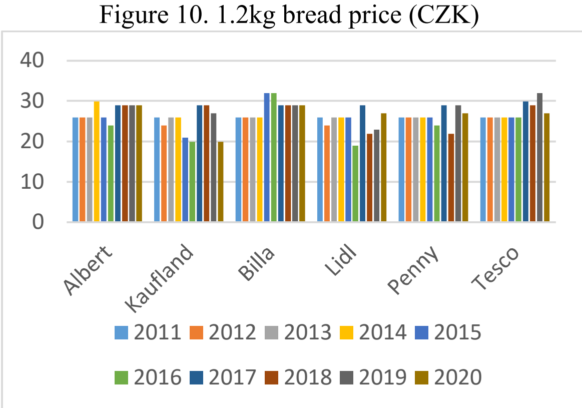
For the observed period 2011 – 2020 the lowest standard deviation of prices was recorded for Šumava bread (more in Figures 9 and 10): Albert (1.91), Penny (1.97), Tesco (2.06) and Billa (2.24). In Lidl, the standard deviation of the price of bread was 2.71 and this value was higher than the deviation for potatoes (1.28). Similarly, by Kaufland for the reference period 2011 - 2020, the lowest standard deviation was not recorded for bread (3.25), but for watermelon (1.43) and rice (1.96). Kaufland and Lidl are owned by the German retail group Schwarz, which is reflected in the similar pricing policy of both retailers.

Figure 9. 1.2kg bread price (CZK)




*Source: Own research, 2021*

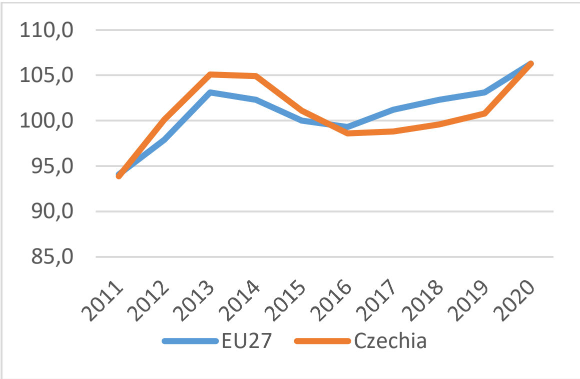
Figure 10. 1.2kg bread price (CZK)




*Source: Own research, 2021*

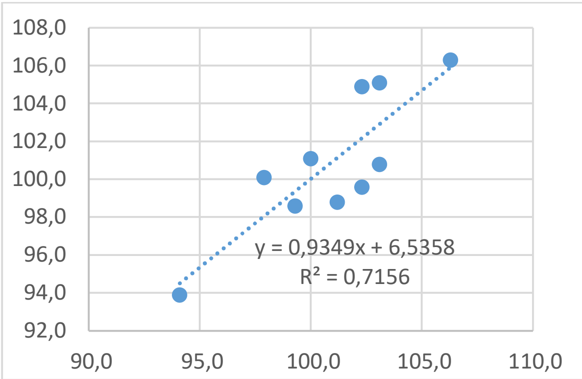
During the period 2011 - 2020, average food prices rose throughout the EU. This basic price trend is de facto also confirmed in research by Kaňková (2018). The average growth rate of food prices in the EU was 0.01, with the standard deviation of prices from the EU average being 3.18 (the average deviation from the average was 2.51). In this respect, the Czech Republic did not deviate in any way. Food prices in the Czech Republic rose at the same average growth rate of 0.01. - Austria also showed the same value. However, food prices in the Czech Republic fluctuated slightly more than in the EU - the standard deviation was 3.52, while in Austria a standard deviation of 2.74 was recorded, ie the lowest of all the neighboring states of the Czech Republic. On the other hand, the highest standard deviation, and thus the highest volatility of food prices, was recorded in Hungary (7.61), where there was also the highest average growth rate of food prices, which was recorded at the level of 0.03.

Figure 11. Food price indices (2015 = 100)




*Source: Eurostat, 2021; own research, 2021*

Figure 12. Correlation of food price indices (CR, EU)




*Source: Eurostat, 2021; own research, 2021*

To complete the overview, we can show Figures 11 and 12 above - it can be seen that food prices in the Czech Republic almost exactly copy European prices (a simple linear regression equation expressing the dependence of Czech food prices on European prices is $y = 0.9349x + 6.5358$; reliability correlation coefficient is $R^2 = 0.7156$).

## 4. Conclusion

The presented article builds on years of research by authors who collect the prices of various food products in selected six retail chains in the Czech Republic since 2011. In this partial part of the research presented, the price levels of selected retailers within a defined food basket were analyzed (see Table 1 in the article methodology). The highest average price level for the observed period 2011 - 2020 was recorded for Billa and Lidl (almost CZK 43), while the cheapest foodstuffs were in Tesco and Kaufland (less than CZK 39). As for purchasing power, it can be stated that, of course, we would buy the most for the average wage in the cheapest Tesco and Kaufland - over 1.3 tons of food. We would buy the smallest volume of the monitored food basket in Lidl - only about 1 ton. This is probably a consequence of the more limited assortment in Lidl, which focuses on relatively cheaper, but recently also higher quality goods, which also advertises to consumers, so Lidl leaves its image in the minds of customers as cheap retail and tries to be a retailer with primarily quality assortment, which is still at a relatively low price level.

The issue of price fluctuations was discussed at the level of standard deviation and it was found that food basket prices were the most scattered in Kaufland for the period 2011-2020 (standard deviation 8.53), while Tesco is the most stable in pricing policy (6.97).

Regarding the average price increase / decrease, it can be said that the highest average rate of price growth had Tesco (+0.09), the lowest the Penny Market (+0.06). A more detailed examination of prices at the level of individual foods revealed that carrots (the rate of price growth in Albert 0.21) and apples (in Tesco 0.38) rose the most in price on average.

On the contrary, a slightly negative rate of price growth was achieved for sugar (most significantly in Billa -0.06).

Price fluctuations expressed by the standard deviation at the level of the food basket were most pronounced for edam 45% (Kaufland 38.35) and edam 30% (Albert 29.51), which is obviously due to the high unit price of this foodstuff. On the contrary, the most stable price in the period 2011 - 2020 was maintained by Šumava bread (most significantly in Albert 1.91). For bread, this pricing policy is fine, because it is an essential and important food.

If we leave a conception focused on individual items of the examined food basket and on individual monitored retail stores, we can state that food prices in the Czech Republic did not deviate in any way from the average price trend of EU food in the monitored period (the average growth rate of food prices in the Czech Republic and in the EU was 0.01). Czech prices were only slightly more volatile than European prices (EU 3.18; Czech Republic 3.52), which is probably due to the smaller size of the local food market and its lower competitiveness on the food market compared to the more developed EU market on average.

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# COMPETENCES AND HIERARCHY OF SUBSYSTEMS OF THE 1ST ORDER OF ORGANIZATIONAL SYSTEM

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**Annotation:** Recently, only such management, which is based on soft elements, is often considered correct. However, the consistent application of the system approach does not confirm these trends. The authors of this paper understand the enterprise as an organizational system in which the 1st order subsystems are defined. Their conditionality and continuity make it possible to identify the principal and supporting subsystems and to determine their hierarchy and competence. Competence is understood as the logical part of the sphere of competences of subsystems and their competences. Correct determination of the hierarchy and competence of subsystems allows managers to be better oriented in determining the importance of problems and determining the order of their resolution according to the effect on the resulting behavior of the organizational system. The higher position of the subsystem in the hierarchy is, the greater the impact of the unresolved problem on the behavior of the entire organizational system is. The greatest attention must therefore be paid to the behavior of the principal subsystems with the competence Cij = 0,166. The principal subsystems are CSS at the 1st hierarchical level, OSS at the 2nd hierarchical level and PSS at the 3rd hierarchical level. Supporting subsystems at other hierarchical levels with the competence Cij = 0.083 MTS, EIS, EES, TS1, LSS and TS2 are also important for the behavior of the organizational system, but always have only a supporting role. The determined hierarchy was checked and confirmed by data from the questionnaire survey. The basic group consisted of 212 managers of tangible production enterprises and the "agricultural group" represented by 109 managers of agricultural enterprises.

**Key words:** Management, organizational system, subsystems of the 1st order, hierarchy, hierarchical level, principal level, interlevel, competence, supporting subsystems, principal subsystems, the sphere of activity, authority

**JEL classification:** E19, M11, L20

## 1. Introduction

This paper is focused on the company as an organizational system within the system understanding of the organization. Hron (1986) described OS as a certain abstraction of a real object, which can be defined while respecting the stated goal by certain elements (properties) and the links between them. Davenport (1998) explores a kind of anatomy of the corporate system as part of his approach. According to the author, the core of this system is a central database that draws data and supplies data to several applications that support various company functions. Using a single database streams the flow of information throughout the enterprise. Hieronymi (2013) considers systemic thinking as a much-needed ability to better deal with the growing interconnected and complex world. Boulding (2009) describes the hierarchy of systems analogy to the hierarchy of military ranks. According to Karpavicius, Cvilikas and Gatautis (2007), from a systemic point of view, the structure of the organization is first characterized, which is the basis for further examination of the organizational system in the field of management. Organizational management in the context of systems theory can be considered as a complex process of information in which employees of the management structure monitor the functions of management by regulating all the processes that take place in the organization. Jafari, Songhori and Javad (2019) state that product development requires the company to deconstruct this product into subsystems and create an organizational structure aligned with the product architecture. Structured organizational system improves business environment (Appiah-Kubi et al, 2020). Ahmady, Mehrpour and Nikooravesh (2016) state in the study that the manifestation of systemic thinking is the conceptualization of organizational structure. The structure is represented by a combination of relationships between organizational elements that shape the existential philosophy of organizational activity. From this point of view of the organizational structure, hard and soft elements can be defined. According to the authors, organizational structure is the way or method by which organizational activities are divided, organized and coordinated. Organizations create these structures to coordinate activities and control people's performance. Entrepreneurship since ancient times was connected, whether in terms of economic or psychological aspects, with exploration and implementation of new forms of development and the change of social status by the active individuals (Betáková, Haviernikivá and Okręglicka et al., 2020). Khilwani, Harding and Tiwari (2011) deal with enterprise competence organization schema. They consider ontology to be an effective tool for understanding structured competence. Competence, according to the authors, is a standardized way to define a company profile. Competences in relation to the company's reputation are dealt with by Andriushchenko et al. (2019). They focus on a modern approach to managing the reputational risk of a business, focusing on the use of appropriate methodology and tools for a competence-based approach. A system for assessing the reputational risks of an enterprise is designed, based on a combination of five system components: Management Effectiveness, Quality of service, Reputation of top managers, Corporate Governance and Ethics in relations with external partners. Nešić et al. (2020) deal with the competence of an organization in relation to trust in the organization, which it measures through the dimensions of competence, predictability, integrity and benevolence. Employee engagement is then measured through energy, commitment and absorption dimensions. The research identified a significant correlation between dimensions of trust: benevolence/integrity and competence with all dimensions of work engagement. Osterlund (1991) considers the competence of an undertaking to be able to carry out a particular type of task-based on knowledge and experience in the use of means, methods, and resources. Yu, Biqing and Wenhuang et al. (2000) examined a competency management system based on a common enterprise competence model that includes a product, process, and resource model of enterprise competence. These competencies are then divided into tangible and intangible. A company that interacts with a competitive environment better must understand and continuously improves its competencies. Information about corporate competencies is valuable for potential cooperation between different companies. An enterprise can miss a great opportunity to create value because it does not know its existing competencies. On the other hand, a company without basic competence cannot remain competitive in the long term. The enterprise competence model is the basis for formulating a strategy for the enterprise. Mc Bride (2016) considers hierarchy theory to be a basic systems approach. This approach offers rich perspectives in understanding the flow of matter and information between different levels of control. He uses the hierarchy theory to explore complex organizational situations where there are multiple boundaries and within them, he attempts a complex effective activity. Yu (2019) used the questionnaire survey method to examine the impact of corporate competence, trustworthiness, and the system environment on the autonomous upgrade of the enterprise This study confirms that the system environment can regulate the influence of momentum and modernize the company´s functions. According to Sanchez (2004), the perspective of competencies brought significant theoretical expansion and important practical advantages to current management. While understanding sectoral structures may have been the primary concern of strategic management theory in the 1970s, for example, and while in the 1980s it became an important perspective for characterizing companies as unique bundles of resources, conceptualization, and analysis of organizations' competencies became a key focus of thinking management in the 1990s.

## 2. Materials and Methods

The main method, which is used in the theoretical part of this paper is a system approach. The hierarchy of Subsystems of the 1st order was determined as a logical product of mutual conditionality (logical sequences) and competencies of the individual subsystems. The competence of the subsystems depends on the power of the subsystem and its scope. The main subsystems were identified and the main hierarchical levels and the supporting subsystems together with defining the hierarchical intermediate levels was defined. After defining these levels, it was possible to determine the powers and scope of the individual subsystems.

Overall competence OS --> $C_{ov} = 1$.

*$C_{i,j} = A_i \times SA_j$ where: $C_{i,j}$ stands for competence of a certain subsystem on a certain hierarchical level, $A_i$ means authority for an i hierarchical level*

$$A_i = \frac{1}{number\ of\ hierarchical\ levels} \tag{1}$$

*$SA_j$ sphere of activity on an identical hierarchical level*

$$SA_j = \frac{1}{number\ of\ subsystems\ on\ the\ given\ level} \tag{2}$$

After determining the sequence and competencies, the control hierarchy was determined, which corresponds to the importance and competencies of the subsystems of the 1st order of the OS. The determined hierarchy was verified by data from a questionnaire survey. The survey sample consisted of 212 managers (respondents) of enterprises with material production and the "Agricultural sample" represented by 109 managers (respondents) of agricultural holdings. The frequency of responses was determined and will be expressed in the paper as a percentage.

$$\sum_{i=1}^{T} u_i = \frac{\alpha^2}{\beta_x} \tag{3}$$

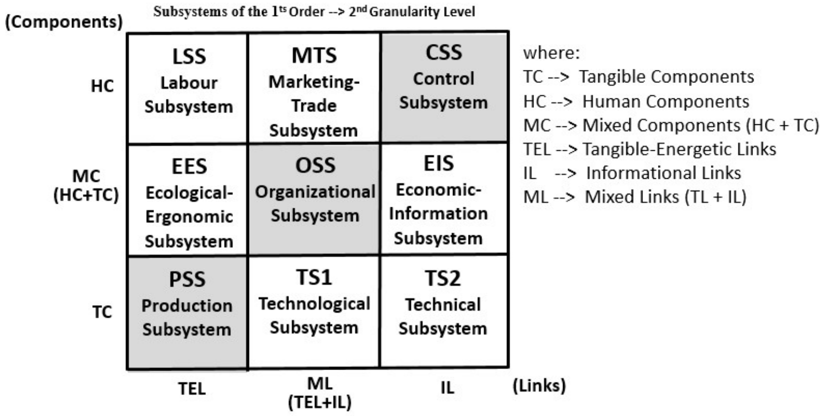
## 3. Results and Discussion

Author(s) should use this chapter to describe results as clearly as possible. The author(s) should An organizational system (OS) represents the systematic approach of a company. OS can be characterized as a defined set of tangible components (TC) and human components (HC) connected through tangible-energetic links (TEL) and informational links (IL) to examine the resulting behaviour. In the case of the tight connection between HC and TC, we speak about mixed components. In the connection between IL and TEL, we use the term mixed links.

### 3.1 Subsystems of the 1st order organizational system

When talking about OS as a set of elements and connections between them, we can define subsystems of the first order on the second granularity level, see Scheme 1. Listed subsystems are irreplaceable, mutually conditioned, in mutual proportionality, with different stability and competence, in the relation of disjunction and conjunction. Subsystems have a hierarchical arrangement, which sets the importance and influence of the individual subsystems on the resulting behaviour of the OS.

Scheme 1. Structure of the OS – definition of subsystems of the 1st order




*Source: Authors (2020)*

### 3.2 Hierarchy of 1st order subsystems

Hierarchy expresses one of the basic levels of the interdependence of the subsystems. On the top of the hierarchy stands the control subsystem (CSS), which is the subject of management for all the other subsystems and also belongs among subsystems in the main diagonal of the OS. Subsystems of the main diagonal represent essential subsystems on the main diagonal OS, and also have the most significant influence on the behaviour of the OS. Mutual conditionality can be represented as follows: *CSS --> PSS --> OSS --> (CSS)*

Control subsystem (CSS) forms a strategy, which sets production which will OS implement (OSS à CSS). We need to allocate resources: tangible and human components[5], financial resources (FR), time and space resources (PSS --> OSS) to the activity due to implementing production. By allocating resources, an organizational unit (OU) is created, in which own production takes place. OU is managed by an appointed manager (OSS --> CSS).

The stated conditionality and continuity determine the hierarchy of the main subsystems. Main subsystems define the main hierarchical levels (Principal Levels 1, 2, 3), see Scheme 2.

Marketing-Trade Subsystem (MTS) and Economic-Information Subsystem (EIS) represents support subsystems and are strongly influenced by subsystems CSS and OSS. At the same time, they significantly affect (improve or worsen) the resulting behaviour of the OS and are defining hierarchical interlevel. (Interlevel 1) see Scheme 2.

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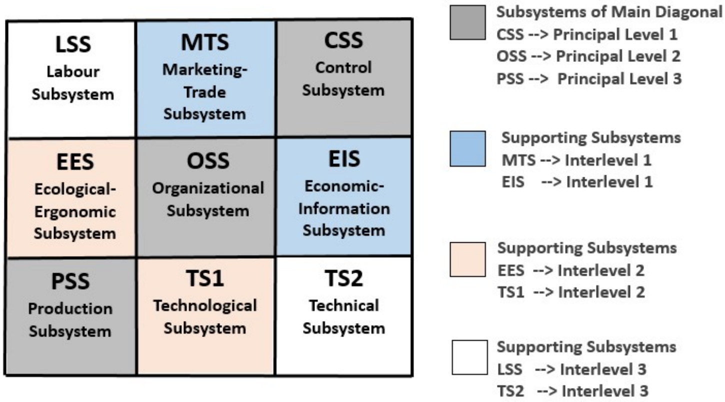
[5] Some authors mention not only human capital (human components) but also intellectual, which they usually divide into human, social and organizational capital ( e.g. Youndt and Snell, 2004 or Fiala and Borůvková, 2011).

Scheme 2. Main and supporting subsystems of the 1st order




*Source: Authors (2020)*

It follows from the above:

*(CSS --> MTS --> CSS) --> OS* *(OSS --> MTS --> OSS) --> OS*
*(CSS --> EIS --> CSS) --> OS* *(OSS --> EIS --> OSS) --> OS*

Ecological-Ergonomic Subsystem (EES) a Technological Subsystem (TS1), the support subsystems, are strongly influenced by the subsystems OSS and PS1. When talking about OS with material production strongly influence the resulting behaviour of the subsystem TS1, because it determines the quality of the production. EES and TS1 are defining hierarchical Interlevel 2, see Scheme 2. Interlevel 3 is defined by Labour Subsystem (LSS) and Technical Subsystem (TS2), which has the lowest importance from the point of view of competencies and hierarchy, see Scheme 2.

*(PSS --> TS1 --> TS2) --> OS* *(PSS --> EES --> LSS) --> OS*

### 3.3 Competencies of 1st order subsystems

Competence of the subsystem is the ability to handle and secure the realization of requested activity in the way, that the resulting behaviour of the subsystem corresponds to the target behaviour.

It is necessary to realize how many and which subsystems are located on the corresponding hierarchical level for determining the competence of each subsystem. Since competence of particular subsystem can be characterized as mutual interaction of the sphere of influence (SAj) and powers of the given subsystem, see chapter Materials and Methods.

The competence of each subsystem OS ensures the competence of the whole OS. It is measured proportionally from (0 – 1). The Sum of competence subsystem equals 1 if the system is set up correctly. If the sum of system competence Cov is < 1, it means that there are dead spots without competencies. Contrary if the sum of competence Cov is >1, it means that the competencies of each subsystem are overlapping.

In both cases, their powers are incorrectly set.

The calculated values of competencies according to the mentioned dependencies (formulas) illustrates Table 1. It follows from the above that in terms of competencies, the most important subsystems are on the main diagonal, and are representing almost half of all competencies (0,496).

Supporting subsystems have due to their lower scope half the impact on the overall competence of the OS despite their importance. The actual hierarchy of 1st order subsystems of OS is given by the logical product of mutual connections of subsystems (sequences) and competencies of individual subsystems.

Table 1. Establishing of parameters for the calculation of subsystem competence

| Hierar-chical Levels | Competence Authority (Decision-making) | Supporting Subsystems (distant) | Supporting Subsystems (close) | Principal subsystems (Main Diagonal) | Supporting Subsystems (close) | Supporting Subsystems (distant) | Sphere of Activity (Influence SS on an identical hierarchical level)) |
|---|---|---|---|---|---|---|---|
| Pricipal Level 1 | Principal Subsystem (0,166) | | | 0,166 CSS | | | $SA_1$= 1,000 |
| Inter-level 1 | Supporting Subsystems (0,166) | | 0,083 MTS | | 0,083 EIS | | $SA_2$= 0,500 |
| Pricipal Level 2 | Principal Subsystem (0,166) | | | 0,166 OSS | | | $SA_3$= 1,000 |
| Inter-level 2 | Supporting Subsystems (0,166) | | 0,083 EES | | 0,083 TS1 | | $SA_4$= 0,500 |
| Pricipal Level 3 | Principal Subsystem (0,166) | | | 0,166 PSS | | | $SA_5$= 1,000 |
| Inter-level 3 | Supporting Subsystems (0,166) | 0,083 LSS | | | | 0,083 TS2 | $SA_6$= 0,500 |
| $C_{ov}$ | 1,000 | 0,083 | 0,166 | 0,496 | 0,166 | 0,083 | |

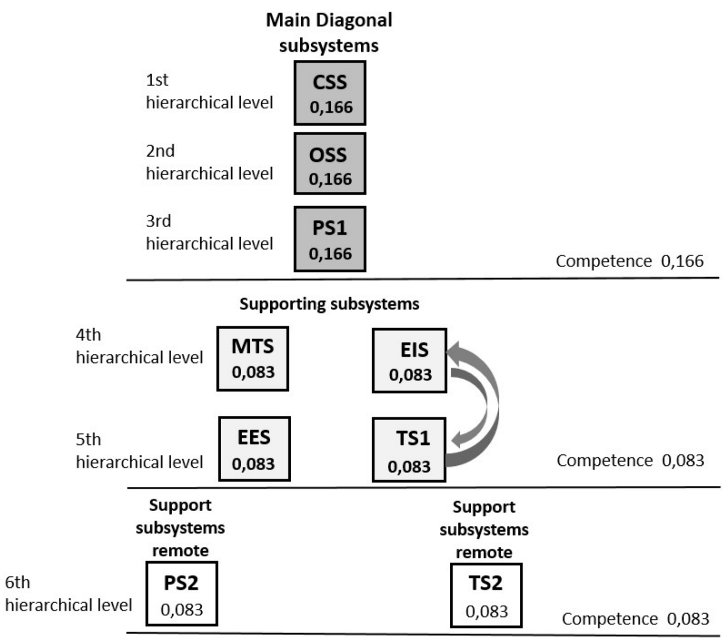
SS – Subsystem
SA – Sphere of Activity
$C_{ov}$ – Overal Competence
CSS – Control Subsystem
MTS – Marketing-Trade Subsystem
EIS – Economic-Informaiton Subsystem
OSS – Organizational Subsystem
EES – Ecological-Ergonomic Subsystem
TS1 – Technological Subsystem
PSS – Production Subsystem
LSS – Labour Subsystem
TS2 – Technical Subsystem

*Source: Authors (2020)*

## 3.4 Hierarchy of the 1st order subsystems as a result of the logical product of conditionality and competence

The result of this logical product is shown in Scheme 3.

Scheme 3. Hierarchy of subsystems 1st order of OS




*Source: Authors (2020)*

Scheme 3 shows the possibility of change of hierarchical level in the case of Economic-Information Subsystem (EIS) a Technological Subsystem (TS1). In the case of enterprises with tangible production will be TS1 at the 4th hierarchical level. In the case of enterprises with mixed and intangible production, the EIS will be at this hierarchical level.

### 3.5 Questionnaire survey

The questionnaire survey confirmed the theoretical conclusions of the system approach in determining the hierarchy of subsystems of the 1st order OS.

Managers answered questions that were indirectly finding out the validity of the links and competencies. The results are presented in the format:

a) X% (Managers of enterprises with agricultural production)/X% (Managers of enterprises with material production)

b) Order (enterprises with agricultural production)/ Order (enterprises with material production)

The information that CSS is at the top of the hierarchy was confirmed by 100% of managers.

CSS (owners and members of the Board of Directors) also decides about the production strategy 56,8% / 54,3% direct managers 32,8% / 33,2% and only 10,4% / 12,5% specialists.

This confirms the continuity CSS --> PSS. Both subsystems can also be referred to as main subsystems.

Realization of the new production programs affects resource allocation and also creation of new business units as follows: establishing an operation of the business 63,2% / 48,7%, new production plant 4,6% / 10,6%, new location 17,2% / 15,3%, new shifts 15% / 25%. This implies that new establishment will arise as a result: new production in 85,0% / 74,6% new business units. By this, continuity PSS --> OSS is confirmed. Each new business unit has appointed a new manager, ie vice versa OSS --> CSS. This closes the cycle on the main diagonal and at the same time defines the first three hierarchical levels. Sales and marketing were described by 84,9% / 78,4% as very important, but support activity. That means MTS has the character of the support activity and is placed on the 4th or 5th hierarchical level, respectively at the 1st hierarchical intermediate level. The influence of technology on the quantity and quality of production is indicated by 99,1% / 95,2% as a very important factor of a supportive nature, that means TS1 has the character of a supporting character and is placed on the 4th or 5th hierarchical level, or the 1st or 2nd hierarchical intermediate level, depending on the type of production. Managers of tangible production enterprises set a higher hierarchical level of TS1 than EIS, as indicated in Scheme 3.

Managers have assigned a role to economics and motivation: significant active 56,0% / 49%, significant passive 14,0% / 20,0%, mildly active 20,6% / 20,1%, medium passive 4,7% /6,6% and insignificant 4,7% / 3,3%. It follows from the above that the EIS is an important supporting subsystem, which will be located at the 4th or 5th hierarchical level, or at the 1st or 2nd hierarchical intermediate level.

Confirmation of the main and supporting subsystems and their hierarchical levels enabled the calculation of the competencies of the individual subsystems, according to the procedure given in the methodology and the results in Table 1.

*CSS --> PSS --> OSS --> (CSS)*

*(CSS --> MTS --> CSS) --> OS*

*(CSS --> EIS --> CSS) --> OS*

*(PSS --> TS1 --> TS2) --> OS*

*(OSS --> MTS --> OSS) --> OS*

*(OSS --> EIS --> OSS) --> OS*

*(PSS --> EES --> LSS) --> OS*

## 4. Conclusion

Recently, it has become almost fashionable to consider as proper management only management that builds on the soft elements of management and which overestimates the role of marketing, i.e. marketing puts higher than its own business and management. However, the consistent application of the systemic approach does not confirm these trends. The questionnaire survey confirmed that practitioners are not so much subject to these trends as management theorists. If an enterprise is considered as an organizational system, then it is necessary to identify the components and the links between these components. By using components and links, it is possible to define the 1st order subsystems, and using a higher level of resolution, also higher-order subsystems. It is valid for the 1st order subsystems that they are unique, consecutive, mutually conditioned with a defined hierarchy and competence.

Determining the hierarchy of 1st order subsystems is necessary to determine the order of solving problems that affect the behavior of the OS (the emergence of deviations from the dynamic balance of the OS). The higher position of the subsystem in the hierarchy is, the greater the impact of the unresolved problem on the behavior of the entire OS is.

For this reason, the correct behaviour of the main competence subsystems Cij = 0,166) should be taken into care as much as possible. The hierarchy of the main subsystems is determined by the importance of Human Components (HC) and Information Links (IL), where the presence of Human Components (HC) and Informational Links (IL) increases the hierarchy. Schematically, it can be represented: CSS (1st hierarchical level) --> OSS (2nd hierarchical level) --> PSS (3rd hierarchical level). Supporting subsystems of the 4th and 5th hierarchical level with competence Cij = 0.083 can be schematically illustrated: MTS and EIS (4th hierarchical level) --> EES and TS1 (5th hierarchical level). The 6th hierarchical level supporting subsystems with competence Cij = 0.083 are LSS and TS2. Supporting subsystems are important for the behavior of the entire organizational system, but they will always have only a supporting role.

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# TYPOLOGY OF AGRICULTURAL ORGANIZATIONS ACCORDING TO THE DATA OF ALL-RUSSIAN AGRICULTURAL CENSUSES

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**Annotation:** The purpose of the study is to develop a typology of agricultural organizations in the Russian Federation based on the data of All-Russian Agricultural Censuses, taking into account the experience of the EU countries and the USA, where typologies of agricultural enterprises have been officially approved and successfully introduced into statistical practice. The research was carried out on the basis of microdata from the All-Russian Agricultural Census of 2016. The object of the research is a population of agricultural organizations of the Lipetsk region - one of the regions of the Russian Federation with a rapidly developing agriculture. Approaches to the typification of agricultural organizations based on the census data were developed using multivariate methods of statistical analysis (factor and cluster analysis), conclusions about the reliability of differences between clusters (types) were made on the basis of ANOVA, calculations were made using R. For the cluster analysis, characteristics of the size of labor and land resources, livestock and agricultural machinery were selected. The classification was carried out on the base of 227 enterprises. Four types of agricultural organizations have been identified: 1 - small, 2 - medium, 3 - large enterprises specializing in crop and dairy farming, and 4 - large enterprises specializing in intensive livestock farming (pig and poultry farming). The results of the study can be used in the development of a typology for the general population of agricultural organizations, as well as other categories of farms in the Russian Federation, in decision-making by the state administration of agriculture, in the development and adjustment of the current agricultural policy.

**Key words:** agricultural census, typology, agricultural organization, cluster analysis

**JEL classification:** Q10, Q12, C10, C38

## 1. Introduction

An important stage of any statistical research is a summary of primary data, including grouping, analysis and presentation of its results. The grouping determines the quality of the obtained mean values of indicators and the possibility of analyzing the presented data.

In the Russian Federation, an official typology of agricultural enterprises has not been developed, as is done in the USA and the European Union. In accordance with the law "On the development of small and medium-sized businesses in the Russian Federation," all enterprises, regardless of the type of activity, are divided into large, medium and small once, while the upper boundaries of the standards for attribution to the group are clearly overestimated for agriculture, which inevitably leads to a mixture of different types of agricultural producers.

A typology of agricultural enterprises in the European Union (EU) is developed on the basis of a Farm Structure Survey (FSS), which is carried out using a common methodology and on a regular basis by all member states of the EU. Every 3-4 years FSS is conducted as a sample survey, once every ten years – as a census (Ukolova, 2019).

The main classification characteristic is the standardized output of products (SO), the production direction is determined according to its structure. EC Regulation 1242/2008

(European Parliament and of the Council, 2014) establishes criterion values for the share of SO of a particular industry (group of industries) in total SO for the purposes of classifying enterprises. Separate production areas are combined into classes, which in turn are consolidated and form 9 classes of the general production direction. The second method for classifying agricultural enterprises (by economic size) is based on the total amount of standardized output, which measures the productive capacity of the enterprise and gives an approximate estimate of its possible income (Figure 1).

Figure 5. European classification of agricultural organizations

| Type | Border, thousand euros |
|---|---|
| I | Less then 2 |
| II | from 2 to 4 |
| III | from 4 to 8 |
| IV | from 8 to 15 |
| V | from 15 to 25 |
| VI | from 25 to 50 |
| VII | from 50 to 100 |
| VIII | from 100 to 250 |
| IX | from 250 to 500 |
| X | from 500 to 750 |
| XI | from 750 to 1000 |
| XII | from 1000 to 1500 |
| XIII | from 1500 to 3000 |
| XIV | more then 3000 |

- Specializing in crop production;
- Specializing in gardening;
- Specializing in perennial plantings;
- Specializing in animal husbandry;
- Specialized in pig and poultry breeding;
- Mixed crop production;
- Mixed animal husbandry;
- Mixed crop production-animal husbandry;
- Non-farm.

*Source: Constructed by the authors*

The basis for typing in the United States is the data of the agricultural census. The typology classifies all farms into unique groups based on Gross Cash Farm Income (GCFI). After the Census 2017, the previously adopted typology was changed (Figure 2) (Ukolova, 2015; USDA, 2021).

Figure 6. American Typology of Agricultural Organizations

Until 2017

- Small family farms
  - Retirement
  - Off-farm occupation
    - With income less then $150 000
  - With income from $ 150 000 to 349 999
- Medium-sized family farms with income from $350 000 to $999 999
- Large family farms
  - With income from $1 000 000 to $4 999 999
  - With income more then $5 000 000
- Non-family farm

After 2017

- Small family farms
  - With income less then $150 000
  - With income from $ 150 000 to 349 999
- Medium-sized family farms with income from $350 000 to $999 999
- Large family farms
  - With income from $1 000 000 to $4 999 999
  - With income more then $5 000 000
- Non-family farm

*Source: Constructed by the authors*

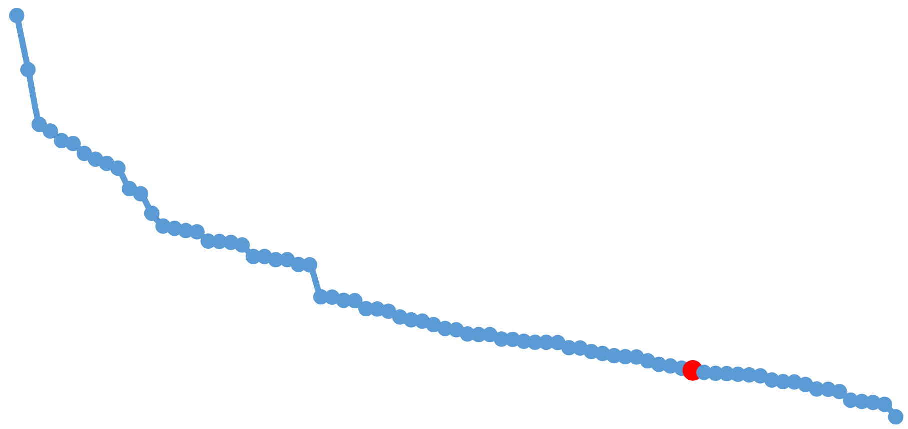
An attempt to develop a classification of agricultural organizations according to the data of the All-Russian Agricultural Census of 2016 (ARAC-2016) was made in the study.

## 2. Materials and Methods

Agricultural organizations of the Lipetsk region were chosen as the object of the study as a typical representative of the Russian regions with actively developing agriculture.

In terms of the size of the resource potential, the Lipetsk region ranks 23rd in the ranking of regions, in terms of the Gross Value Added (GVA) of agriculture - 22nd place, and in terms of the share of GVA in the Gross Regional Product (GRP) - 23rd (Figure 3).

Figure 3. Rank of the Lipetsk region in a ranked number of regions of the Russian Federation by the share of GVA of agriculture in GRP



*Source: Constructedbytheauthors*

The resource potential rating was determined on the basis of calculating multidimensional averages for indicators of the availability of labor, land resources, farm animals and machinery in agricultural organizations according the results of census (Federal State Statistics Service, 2018). Four types of multivariate means were calculated (depending on $x_j^{'}$) using the formula:

$$\overline{p}_i = \sum_{j=1}^{k}(\frac{x_{ij}}{x_j^{'}}): k(1)$$

where $\overline{p}_i$ - multidimensional average for the i-th unit of the population;

j – serial number of the feature;

k – amount of features;

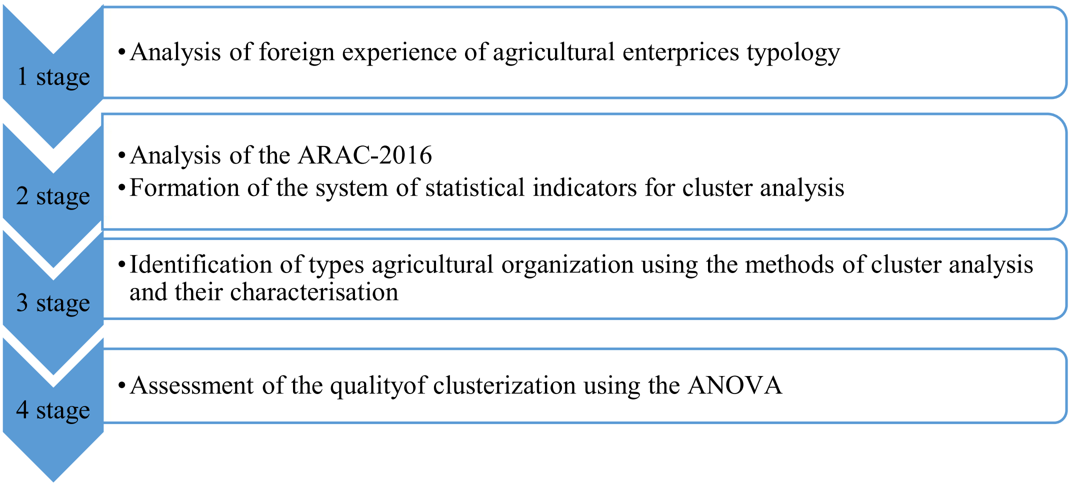
$x_{ij}$ – the value of the j-th feature for the i-th unit;

$x_j^{'}$– maximum value, minimum value, mean value, or standard deviation, depending on the calculation method.

And then the arithmetic simple mean of four multivariate means for each region was calculated and the ranks were determined (Zinchenko and Demichev, 2016).

The main stages of the proposed methodology for typing agricultural are presented in Figure 4.

Figure 4. Scheme for the typology of agricultural organizations based on the results of the ARAC-2016




*Source: Constructed by the authors*

The results of ARAC-2016 contain detailed data on the availability and composition of resources: labor, land, livestock, agricultural machinery, received loans and government subsidies, etc.

For cluster analysis of agricultural organizations, the following characteristics were selected:

1. Average annual number of employees, people
2. Agricultural land area, hectare
3. Livestock of farm animals in terms of conventional heads (the calculation was made on the basis of conversion coefficients: cows – 1.0, pigs – 0.3, poultry – 0.02, etc.)
4. Number of agricultural machinery, units

Within the study, the methods of multivariate statistical analysis were applied - cluster analysis and ANOVA to assess the quality of clustering. For statistical processing of the data, the free software environment R was used.

The reliability of conclusions and interpretation of research results depend on the functionality of applied software products. R is the most complete, reliable and dynamically developing statistical software environment, combining a high-level programming language and powerful libraries of software modules for computational and graphical data processing. A significant section of the R environment is devoted to machine learning and statistical processing of large data sets.

Clustering, presented in the R environment, is a set of unsupervised learning methods, usually based on the analysis of the distances between all possible pairs of objects in the space of observed independent characteristics. The most popular non-hierarchical algorithm is the k-

Cluster analysis includes 2 separation algorithms: hierarchical and non-hierarchical. In the course of this study, it was decided to use non-hierarchical methods, since non-hierarchical division algorithms decompose a data set consisting of *n* observations into *k*groups (clusters) with previously unknown parameters. In this case, the search for centroids is performed – the centers of point clusters $C_k$ that are as far away from each other as possible with the minimum spread within each cluster.

The k means method performs clustering as follows:

1) the number of groups (*k*) that the data should be divided into is assigned. *K* objects of the original set are randomly selected as the initial cluster centers.

2) each observation is assigned a group number based on the closest centroid, i.e. based on the smallest Euclidean distance between the object and the point $C_k$.

3) the coordinates of the centroids $\mu_k$ of all k clusters are recalculated and the intra-group spreads are calculated:

$$W(C_k) = \sum(x_i - \mu_k)^2 \qquad (2)$$

4) the total intra-group spread

$$W_{total} = \sum W(C_k) \qquad (3)$$

is minimized, for which steps 2 and 3 are repeated until the group assignments stop changing or the specified number of iterations is reached.

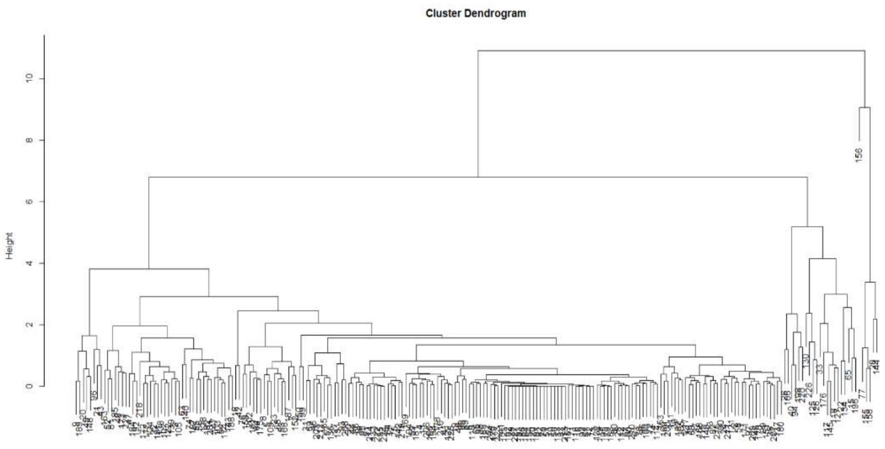
A similar procedure of cluster analysis is often used for conducting agroeconomic research, for example, in works (Szafrańska, 2018; Hloušková and Lekešová, 2020; Platania, 2014).

There are several approaches to assess the quality of clustering; in this study, the ANOVA method based on F-statistis was used (criticality level – 5%).

## 3. Results and Discussion

The problem of determining the required number of clusters can be solved based on the analysis of the dendrogram of the association (Figure 5), in the Lipetsk region there are three clusters of agricultural organizations.

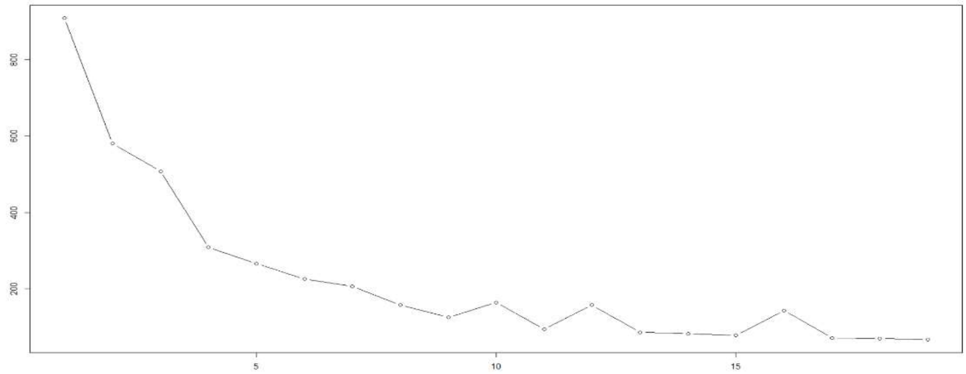
Figure 5. Unification dendrogram




*Source: Constructed by the authors*

However, by calculating the sum of the squared distances within the clusters and displaying them on the graph, 4 clusters can also be distinguished (Figure 6).

Figure 7. Screeplot




*Source: Constructed by the authors*

When the population is divided into 4 clusters, the differences in all factorial characteristics are significant according to the results of ANOVA (Table 1), when only 3 clusters are identified, the differences in the average annual number of employees are not significant. It was decided to select 4 clusters of organizations using the k-means method.

Table 1. Probability of F-statistic

| Indicator (per 1 organization) | 3 Clusters | 4 Clusters |
|---|---|---|
| Average annual number of employees | 0.99 | 0.0004 |
| Agriculturallandarea | $< 2\cdot10^{-16}$ | $7.26\cdot10^{-8}$ |
| Conventionallivestock | $<2\cdot10^{-16}$ | $2.85\cdot10^{-5}$ |
| Numberofagriculturalmachinery | $1.74\cdot10^{-4}$ | 0.0008 |

*Source: Constructedbytheauthors*

The indicators of the size and intensification of organizations of each of the 4 clusters (types) are presented in Tables 2 and 3.

The classification was carried out on the base of 227 enterprises. Four types of agricultural organizations have been identified: 1 – small, 2 – medium, 3 – large enterprises specializing in crop and dairy farming, and 4 – large enterprises specializing in intensive livestock farming (pig and poultry farming). Cluster 3 included 14, 4 – 10 organizations, possibly agricultural holdings. The area of agricultural land per 1 organization of type 3 exceeds 30 thousand hectares, in cluster 4 the number of pigs per organization reaches almost 30 thousand heads, poultry – almost 90 thousand heads. Cluster 2 includes enterprises of average size in terms of resources: the area of agricultural land per enterprise is almost 10 thousand hectares; the number of cattle is about 700 heads, which indicates the same specialization as in enterprises of type 3. Two-thirds of agricultural organizations in the Lipetsk region are small in size: with an average number of employees of about 50 people, an area of agricultural land – about 2,000 hectares, this type of enterprise has limited access to credit resources and state support. Only 30% of small organizations received loans and 60% received subsidies from the federal budget, compared with 70 and 90%, respectively, for large and medium-sized organizations.

Table 2. Indicator of size (per 1 organization)

| Indicators | Types of organizations | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Number of organizations | 151 | 52 | 14 | 10 |
| Average annual number of employees, people | 48 | 133 | 283 | 359 |
| Agricultural land area, ha | 2112 | 9721 | 31118 | 747 |
| Of which: arable land | 1830 | 8711 | 27273 | 726 |
| hayfields | 111 | 279 | 723 | - |
| pastures | 135 | 641 | 2621 | 21 |
| perennial plantings | 30 | 70 | 148 | - |
| Conveniitional livestock, heads | 636 | 755 | 560 | 26828 |
| Numberof animals, heads | | | | |
| cattle | 179 | 690 | 538 | 151 |
| pigs | 1421 | 338 | - | 29329 |
| sheeps | 3 | 110 | 320 | 22 |
| poultry | 9153 | - | - | 879314 |
| Number of agricultural machinery, units | 7.6 | 21.7 | 55.9 | 5.7 |
| Percentage of organizations receiving: | | | | |
| credit funds | 0.34 | 0.62 | 0.86 | 0.80 |
| subsidies from the federal budget | 0.63 | 0.90 | 0.86 | 1.00 |

*Source: Calculated by the authors*

The highest level of production intensity is observed in agricultural holdings (Table 3). The population density indicators confirm earlier conclusions about the specialization of types of organizations.

Table 3. Indicators of intensification of organizations

(per 100 hectares of agricultural land)

| Indicators | Types of organizations | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Average annual number of employees, people | 2.3 | 1.4 | 0.9 | 48.1 |
| Conveniitional livestock, heads | 30.1 | 7.7 | 1.7 | 3592.5 |
| Numberof animals, heads | | | | |
| cattle | 8.5 | 7.1 | 1.7 | 20.2 |
| pigs | 67.3 | 3.4 | - | 3927.4 |
| sheeps | 0.1 | 1.1 | 1.0 | 2.9 |
| poultry | 433.4 | - | - | 117750.5 |
| Availability of agricultural machinery, units | 0.36 | 0.22 | 0.18 | 0.76 |
| Plowingratio | 0.87 | 0.90 | 0.88 | 0.97 |

*Source: Calculated by the authors*

Many works have been devoted to the typification of agricultural enterprises using multivariate statistical methods. In studies (Chocholousek et al., 2021; Hloušková and Lekešová, 2020; Chocholousek and Huml, 2019), in contrast to this work, not only resource indicators, but also production results were used to conduct cluster analysis.

The use of this approach is undoubtedly more preferable, but its implementation in Russia is possible only according to the reporting data of agricultural organizations submitted to the Ministry of Agriculture of the Russian Federation.

## 4. Conclusion

Based on the study of the experience of countries with developed economies and agriculture, a methodology for the typology of agricultural organizations was developed and tested on the materials of the ARAC-2016 for the Lipetsk region. The methodology involves the following stages: selection of indicators for cluster analysis, cluster analysis by the k-means method, assessment of the quality of the model through analysis of variance, complex characteristics of types of agricultural organizations and identification of clusters.

Four types of agricultural organizations have been identified: 1 - small, 2 - medium, 3 - large enterprises specializing in crop and dairy farming, and 4 - large enterprises specializing in intensive livestock farming (pig and poultry farming). The Analysis of Variance confirmed the significance of the differences between the identified types (clusters) at a significance level of less than 0.1%, for all the criteria based on which the classification was made.

The results of the study can be used in the development of a typology for the general population of agricultural organizations, as well as other categories of farms in the Russian Federation, in decision-making by the state administration of agriculture, in the development and adjustment of the current agricultural policy.

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# CONTENT

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