CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE
FACULTY OF ECONOMICS AND MANAGEMENT

AGRARIAN PERSPECTIVES XXXI.

GREEN DEAL – FUTURE PERSPECTIVES

PROCEEDINGS
of the 31st International Scientific Conference

September 14 – 15, 2022
Prague, Czech Republic

Czech University of Life Sciences Prague
Faculty of Economics and Management

PROCEEDINGS - of the 31st International Scientific Conference Agrarian Perspectives XXXI. Green Deal – Future Perspectives

Publication is not a subject of language check.
Papers in individual sections are sorted by authors' names in alphabetical order.

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

Agrarian perspectives XXXI. Green Deal – Future Perspectives

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

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

ISBN 978-80-213-3211-9; ISSN 2464-4781 (Online); ISSN 1213-7960 (Print); ISSN 1213-7979 (CD-ROM)

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FOREWORD

The tradition of organizing annual international conferences is a part of long-term history of the Faculty of Economics and Management, Czech University of Life Sciences Prague. We are proud to organize already 31st Agrarian Perspectives conference. The traditional conference is planned for 14th and 15th September, 2022. The conference is considered to be a platform for researchers to share their knowledge and experience and to enhance their scientific performance. The topic of conference is "Green Deal – Future Perspectives". In the context of the European Green Deal, the European Commission and the European Parliament proposed to intensify Europe's ambition for its 2030 climate targets. Taking into consideration EU's post-pandemic recovery plans – Green Deal is still considered to be a flagship to reach aligning growth and sustainable development agenda, to rebuild not only European but also the global economy and society. The Green deal is not only about ambitious actions influencing the character of the global economy, but it is also focused on the ability of individual key stakeholders to cooperate and find a necessary compromise. Nowadays, Green Deal is heavily criticized as it is considered to be extremely ambitious and non-realistic. The upcoming economy and society crisis, together with increasing political tension both at the regional and global level must be considered as the challenge for future Green Deal perspectives. However, the Green Deal is still considered to be a key driver to reach sustainable economy and society – many people consider this plan as a fatal mistake turning the European and also global economy into even more deep crisis as Green Deal concept is not well developed. On the other hand, there are existing also opportunities and possible advantages related to the proposed Green Deal. The whole concept is heavily discussed in nowadays and there are many cons and pros related to Green Deal concept. The Agrarian perspectives conference (2022) could be considered as the platform suitable for both scientific and expert discussion focused on Green Deal issues and future perspectives.

We hope our conference will be an excellent opportunity for all participants and broad audience to enjoy an interesting and inspiriting time.

prof. Ing. Luboš Smutka, Ph.D.
Vice-Dean FEM CZU Prague

THE IMPACT OF COVID 19 ON THE CZECH STOCK MARKET

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Annotation: COVID-19 has increased suffering in various sectors of life and affected people's daily lives worldwide. It has significantly impacted the health, economic and social fields. The Czech Republic is one of the countries hit hard by the epidemic, which led to its closure several times. This paper empirically examines the impact of COVID-19 on stock prices in the Czech Republic with the help of the Autoregressive-Distributed Lag (ARDL) Bounds Test. The daily closing prices of the stock index, P.X., from 22/03/2020 to 21/02/2022 were used for the Analysis. The results reveal that the Czech stock market was negatively affected during the pandemic; this effect was short-term and long-term.

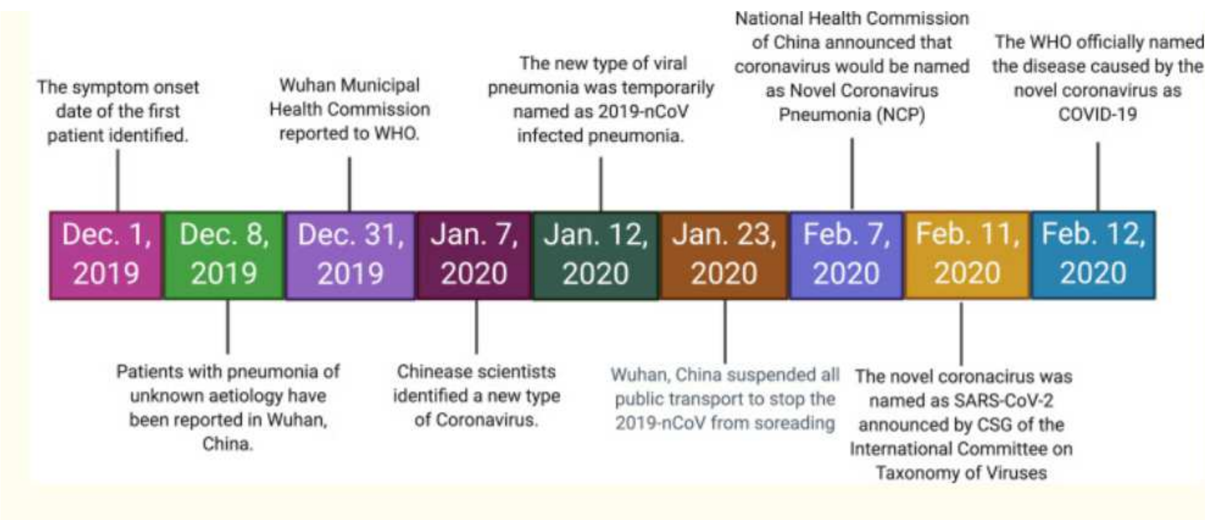
Keywords: Stock Market, COVID-19, ARDL Bounds Test, Czech Republic

JEL Classification: I10, G15, C32, E44, O52

1. Introduction

The infectious Coronavirus (SARS-CoV-2) appeared in the Chinese city of Wuhan and spread in December 2019, from which it began to spread from China to other countries worldwide (Zhou et al., 2020; Kabir et al., 2020). The disease passed through several stages until the World Health Organization (WHO) declared an "international public health emergency," The organization warned countries to take appropriate measures to control the spread of the virus. The figure below shows the disease's stages until it reached its well-known global abbreviation COVID 19. (Yan et al., 2020).

Figure 1. The initial stage development timeline for COVID-19



Source: Yan et al., 2020.

Covid-19 was spreading fast, and the numbers were very high in countries such as China, Italy, and the United States at first. Then it began to spread in the countries of the world, as shown (Yan et al., 2020)

Figure 2. The spread of COVID-19 worldwide

Source: Yan et al., 2020

Based on the recommendations of the World Health Organization, countries, including the Czech Republic, have taken multiple measures to limit the spread of the epidemic, such as total closures several times and for several months. Since the beginning of March 2020, the government has closed schools and declared a state of emergency for the first time in the modern history of the republic on March 12. On March 16, the country closed its borders to non-residents of its territory (McEnchroe, 2020). The Czech Republic was the first European country to make wearing face masks mandatory. The series of procedures continued to be issued weekly until the present time (Prague Morning, 2020).

This closure has an impact on the economy in general, as per Czech Statistical Office. It can be seen through the high rate of inflation to an unprecedented extent since the beginning of the new century, where it reached 9.9% in Jan 2022, while it was 3.2% at the beginning of the pandemic Dec 2019. Besides, GDP Deflator increased to 119.20 points in the third quarter of 2021 from 111.2 points in the first quarter of 2020. (Trading economics, 2022)

GDP and inflation have been affected, as well as unemployment rates. As per the Czech Statical Office and Trading Economics, the unemployment rate was 2% at the beginning of 2020, reached the peak of 4.4% in Feb 2021, then moved down in Nov 2021 to 3.3%, and started rising till it reached 3.6% in Jan 2022.

The stock market around the world has been hit hard by this pandemic, and many Corporates are struggling to survive in COVID-19 times. (Mofijur et al., 2021).

The Prague Stock Exchange (PSE) is the oldest and largest stock market regulator in the Czech Republic and has been trading since 1871. The Prague Stock Exchange competed with the Vienna Stock Exchange during the First and Second Wars. However, the Prague Stock Exchange stopped operating from World War II until the collapse of communism. The Prague Stock Exchange was relaunched on April 6, 1993. The Prague Stock Exchange determines the price of securities or commodities based on supply and demand. Like any global stock exchange, it brings together investors who want to increase the value of their money with companies that want to obtain capital, which adds to the national economy. Stock exchange activities and capital market operations are supervised by the Czech National Bank (Prague Stock Exchange, 2022).

The economic changes resulting from the epidemic did not stop at what was mentioned previously but affected the stock markets. As the epidemic spread, the P.X. index fell by 383 points between December 2019 and March 2020. By the beginning of March 2020, the financial markets had reached a lower stage than they had reached at the end of 2008. However, the economy is witnessing a continuous recovery from October 2020 until the end of January 2022. It is faster than the recovery after the 2008 global financial crisis. (Trading economics, 2022)

This paper aims to investigate the impact of the spread of COVID-19 on stock market volatility in the Czech Republic between March 2020 and Feb 2022.

The crisis was discussed from different points of view. Some discuss the effect of a single stock market, while others discuss different financial markets. Every paper analyzed the current situation, and others added the financial markets' response to some government interventions and support.

(Rahman, Amin, and Al Mamun, 2021) Discussed the impact of the COVID-19 pandemic on Australian stock markets using event study methodology for the Australian stock market. This study found that the announcement of the epidemic had a negative impact on the stock market. In addition, the cross-sectional results confirmed that smaller, less profitable, and valuable portfolios were affected more than others during the epidemic. (Panjwani and Riaz, 2021) conducted research between March 1, 2020, and December 6, 2020. The study's main objective was to investigate the impact of the COVID-19 pandemic on the performance of the Saudi stock market. The authors tested the data using the Granger causality test.

Moreover, they concluded that the Saudi stock market was affected by the Covid-19 epidemic.

The study found that the Saudi market was quickly affected by the Covid epidemic, with the impact differing according to the stage of the epidemic (over time). (Chaouachi and Slim, 2020) studied the same market for a shorter period from March 2, 2020, till May 20, 2020, by using ARDL and Toda-Yamamoto causality test. They concluded that there is a negative impact of COVID-19 on the stock market only in the long run. Over the period from March 11, 2020–to April 30, 2021 (Hatmanu and Cautisanu, 2021), Measured the impact of COVID-19 on the stock market in Romania. The study was divided into two sub-time periods. After carrying out the ARDL analysis, it was found that the pandemic's negative impact on the stock market in the long term in both periods. A research paper (Elsayed and Abdelrhim, 2020) attempts to investigate the effects of the spread of COVID-19 on multiple indices sectors in the Egyptian Stock Exchange. The research paper exceeded studying the total number of cases of covid 19 infection; It added the new cases and deaths caused by the virus and their impact on the Egyptian stock market. The "multiple regression test" was applied, resulting in the Coronavirus negatively affecting the stock exchange. Moreover, the different sectors are more sensitive to cumulative indicators of deaths than daily deaths from the Coronavirus, and cumulative cases of the virus are more minor than new cases.

With the same divisions related to the numbers of Covid in the previous study (cumulative cases, new cases, cumulative deaths, and new deaths), (Alber,2020) conducted a study to verify the effects of the spread of Covid 19 on stock markets in the six countries most exposed to Corona during the period from March 1, 2020, until April 10, 2020. (Alber,2020) concluded that Coronavirus had a negative impact on stock market returns in China, France, Germany, and Spain. However, this has not been confirmed regarding the U.S. and Italian financial markets. He added that returns are more sensitive to cases of coronavirus infection than deaths and cumulative indicators of Coronavirus than new indicators. (Al-Awadhi et al., 2020) used the coefficients of the panel regressions to investigate the effect of infectious diseases on stock market outcomes, taking into account the total confirmed cases and deaths caused by COVID-19. The researchers concluded that Coronavirus has significant adverse effects on stock returns in all companies in the markets under study. The study (Kartal, Kiliç Depren, and Depren, 2021), which compared the pre-pandemic and epidemic periods using the number of cases and deaths caused by Covid-19, confirmed the same results that the indicators have a significant negative impact on the financial markets in East Asian countries (China, Hong Kong, Japan, Korea, Mongolia, and Taiwan).

To assess the short-term reaction of the financial markets of Visegrad countries (Czech, Hungary, Poland, and Slovakia) to the COVID-19 pandemic in 2020, (Czech et al., 2020) studied that by using the TGARCH model. It revealed a critical and negative correlation between the four countries' Visegrad stock markets indices and COVID-19. In addition, the positive relationship between the number of cases of COVID-19 and the exchange rates of the four currencies compared to the euro was confirmed. As the number of cases increased, the value of Visegrad currencies decreased.

Previous studies were not satisfied with discussing the impact of the virus on the financial markets. However, some studies discussed several countries' economic measures to try to save the stock markets in their countries. When Australia implemented a package called JobKeeper, the stock market had a positive reaction, as indicated by (Rahman, Amin, and Al Mamun, 2021).

According to (Hatmanu and Cautisanu, 2021), the Romanian National Bank reduced monetary policy interest rates on the BET index from 2.5 in March 2020 to 1.25 in April 2021, stimulating the financial markets and reaching the expected result.

2. Materials and Methods

The study relies on secondary data sources. Data on daily closing prices for the P.X. indices were collected from the country economy website (https://countryeconomy.com). The data is collected from 22/03/2020 to 21/02/2022. The period covers the era starting from the first death case resulting from COVID 19 in the Czech Republic until the study's data, from 22/03/2020 to 21/02/2022. Regarding Corona data, data from (https://ourworldindata.org) was used. REVIEWS 12 software was used to perform the econometric computations. The variables used to perform the Analysis included the Prague stock market, the Total number of covid cases in the Czech Republic, and the Total number of deaths caused by Covid in the Czech Republic. The variables were converted to logarithms. The general formation of our model is:

$$\text{PX} = \text{F}(\text{Total\_cases}, \text{Total\_deaths}) \qquad \textbf{(1)}$$

Where P.X., total cases, total deaths represent the Prague stock market, Total/accumulative number of covid cases in the Czech Republic, and Total/ accumulative number of deaths caused by Covid in the Czech Republic. The stochastic form of the model is:

$$PX = \alpha_0 + \alpha_1 Total\_cases + \alpha_2 Total\_deaths + \mu_t \quad (2)$$

Where = α_0, α_1, and α_2, are coefficients for intercept, Prague stock market, Total/accumulative number of covid cases in the Czech Republic, and Total/ accumulative number of death cases caused by Covid in the Czech Republic, respectively; and μ_t = the stochastic term/unobserved.

The Analysis was started by checking unit roots for each variable. The widely used Augmented Dickey-Fuller (ADF) test was applied to check for the existence of a unit root (Nelson, and Plosser, 1982). As a result, the general form of the ADF test is indicated below:

$$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \Delta Y_{t-i} + E_t \quad (3)$$

Where ΔYt = related variable; $\beta 1$, $\beta 2$ parameters in the model; i = lag order to which the Dickey-Fuller equation is augmented; t time trend; Et is Gaussian white noise with zero mean and possible autocorrelation represented by time t.

The stationary results that will appear from ADF determine the next steps. The Autoregressive-Distributive Lag (ARDL) Bounds Tests is an appropriate Analysis when the variables have an order of integration I(0), I(1), or a combination of both, but without I(2) or higher I (Nelson, and Plosser, 1982).

The model representation for the ARDL is:

$$\Delta PXt = \alpha 0 + \sum_{I=i}^{P} \alpha 1t\, \Delta PX_{t-1} \sum_{I=i}^{P} \alpha 2t \Delta TotalCases_{t-1} + \sum_{I=i}^{P} \alpha 3t \Delta TotalDeaths_{t-1} + + \lambda 1 PX_{t-1} + \lambda 2 TotalCases_{t-1} + \lambda 3 TotalDeaths_{t-1} + + Et \quad (4)$$

Where Δ is the difference operator, p denotes lag length; α_0 is the constant term; α_{1i}, α_{2i}, α_{3i}, and α_{4i} are error correction dynamics; λ_1, λ_2, and λ_3 are long-term coefficients; and E_t is the White noise disturbance term.

The cointegration and the long-term effect were tested via the ARDL test. The F-statistic in the ARDL Bounds tests the cointegration. The null hypothesis of no cointegration is where the F-statistic lies below the lower bound I(0). In contrast, the rejection of the null hypothesis indicates the presence of cointegration with an F-statistic lying above the upper bound I(1) values. Inclusiveness of the cointegration test is indicated by the F-statistic value lying between I(0) and I(1) (Wooldridge, 2015).

3. Results and Discussion

Descriptive statistics

The descriptive statistics of the variables used are shown in Table 1 as follows.

Table 1. The descriptive statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations	Jarque-Bera	Probability
PX	1097.418	1075.430	1481.680	738.2800	197.6991	701	52.53146	0.000000
TOTAL_CASES	1110349.	1321331.	3506076.	1120.000	920296.1	701	28.94243	0.000001
TOTAL_DEATHS	18007.96	21717.00	38226.00	1.000000	14181.92	701	86.33082	0.000000

Source: EVIEWS 12

Unit Root Results

Table 2 below shows the results for stationarity using the ADF test.

Table 2. ADF test

Variable	Level		First deference	
	ADF Statistics	**Result**	**ADF Statistics**	**Result**
PX	-4.439515	Stationary	-	-
TOTAL_CASES	-2.972943	Stationary	-	-
TOTAL_DEATHS	-2.797843	Stationary	-	-

Source: EVIEWS 12

As per table (2), all the variables of interest seemed to have I0. Hence, the ARDL test is the proper test to be implemented.

ARDL Test

Then a short-run ARDL estimation was conducted to examine the short-run impact. The results indicated that total covid cases, as well as total deaths due to covid, do impact the stock market in the short run.

Table 3. ARDL test

Dependent Variable: LPX
Method: ARDL
Date: 02/25/22 Time: 22:25
Sample (adjusted): 3/25/2020 2/20/2022
Included observations: 698 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): LTOTAL_CASES LTOTAL_DEATHS
Fixed regressors: C
Number of models evaluated: 100
Selected Model: ARDL(1, 2, 3)
Note: final equation sample is more significant than the selection sample

Variable	Coefficient	Std. Error	t-Statistic
LPX(-1)	0.992946	0.003058	324.6866
LTOTAL_CASES	0.123689	0.045926	2.693248
LTOTAL_CASES(-1)	-0.359323	0.078884	-4.555075
LTOTAL_CASES(-2)	0.236333	0.045978	5.140172
LTOTAL_DEATHS	0.075373	0.017356	4.342704
LTOTAL_DEATHS(-1)	-0.109432	0.028601	-3.826202
LTOTAL_DEATHS(-2)	0.039615	0.017136	2.311821
LTOTAL_DEATHS(-3)	-0.005940	0.007548	-0.786850
C	0.045230	0.020533	2.202757

R-squared	0.998219	Mean dependent var
Adjusted R-squared	0.998198	S.D. dependent var
S.E. of regression	0.007546	Akaike info criterion
Sum squared resid	0.039232	Schwarz criterion
Log-likelihood	2425.059	Hannan-Quinn criteria.
F-statistic	48268.59	Durbin-Watson stat
Prob(F-statistic)	0.000000	

*Note: p-values and any subsequent tests do not account for model selection.

Source: EVIEWS 12

As the cointegration results in Table 4 reveal, P.X., total cases, and total deaths converge to a long-run equilibrium at the speed of –0.007 (in absolute value) or 0.7%, which is statistically significant with a probability of less than 5%. This, when converted to time, means that these variables converge to a long-run equilibrium within 134.8 days.

This was confirmed by the bound test results, where the F statistic of 3.97 was more significant than the I(1) bounds of 3.2 and 3.67at 10 and 5%, respectively.

Table 4. ARDL Error Correction Regression

ARDL Error Correction Regression
Dependent Variable: D(LPX)
Selected Model: ARDL(1, 0, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 02/25/22 Time: 10:16
Sample: 3/22/2020 2/20/2022
Included observations: 698

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LTOTAL_CASES)	0.134797	0.041271	3.266154	0.0011
D(LTOTAL_CASES(-1))	-0.238080	0.041795	-5.696441	0.0000
D(LTOTAL_DEATHS)	0.075029	0.016876	4.445793	0.0000
D(LTOTAL_DEATHS(-1))	-0.034933	0.012742	-2.741666	0.0063
D(LTOTAL_DEATHS(-2))	0.005167	0.007355	0.702518	0.4826
CointEq(-1)*	-0.007415	0.001658	-4.471191	0.0000

R-squared	0.068027	Mean dependent var	0.000846
Adjusted R-squared	0.061293	S.D. dependent var	0.007766
S.E. of regression	0.007525	Akaike info criterion	-6.932713
Sum squared resid	0.039181	Schwarz criterion	-6.893617
Log-likelihood	2425.517	Hannan-Quinn criteria.	-6.917598
Durbin-Watson stat	2.077156		

* p-value incompatible with the t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels of relationship

Test Statistic	Value	Sign in.	I(0)	I(1)
F-statistic	3.975198	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: EVIEWS 12

Both (Rahman, Amin, and Al Mamun, 2021) and (Panjwani and Riaz, 2021) agreed that the epidemic had a negative impact on the stock market in Australia and KSA. Similarly, Alber (2020) concluded that 4 of the six countries studied negatively impacted the stock market.

(Chaouachi and Slim, 2020) Moreover, (Hatmanu and Cautisanu, 2021) emphasized that the negative impact is in the long-term only for Romania and KSA. The result of (Czech et al., 2020) regarding the Visegrad group showed only a short-term effect.

The studies of (Elsayed and Abdelrhim, 2020), (Al-Awadhi et al., 2020), and (Kartal, Kiliç Depren, and Depren, 2021) added deaths to cases of COVID infection. They concluded that each of them has a negative impact on the stock market for the countries under study. In principle, our general results also agreed with the studies that divided the Corona epidemic into more than one variable, even though they did not discuss both the short- and long-term impact.

Given the epidemic's influence on the stock market, which was corroborated by the study's findings, the Czech Republic implemented a series of government actions to help the economy. One of the most visual medium- and long-term responses to the COVID-19 pandemic is participation in the European Green Deal. According to the European Commission, the green pact contains 1.8 trillion euros in investments, with a third of that amount going toward supporting countries as part of a plan to recover from the European Union's pandemic.

Our study was distinguished by discussing the impact of both accumulative COVID cases and deaths caused by the virus on the Czech stock market. In addition, both the short-term and long-term effects were evaluated. Besides, the period covered by the study was the largest.

4. Conclusion

While the Coronavirus has become familiar to everyone and is widely spread in most countries now, many countries have closed altogether, affecting those countries at various levels and aspects. This closure was not limited to a specific country, as it included developed and developing countries and the Czech Republic was one of those countries. Moreover, the economy sector, like others, was not spared from that.

Meanwhile, an empirical paper assessing the impact of the spread of the Corona epidemic on the stock market in the Czech Republic.

By studying the impact of the Coronavirus on the Czech stock market. The study proved that there is an effect of the spread of the virus in the short and long term. The ARDL limits test was used to quantify the effect of the abovementioned indicators. The results indicated that the stock market variables, the cumulative confirmed numbers of corona infections, and confirmed deaths due to the virus converge to a long-term equilibrium at 0.7%. Moreover, this study's results showed a short-term relationship between the variables, as mentioned above.

Future research on the impact of the virus should focus on the various joints of the Czech economy. Concerning the impact of the virus on the stock market, the impact should be studied by extending the period to include adding the Ukrainian crisis and the refugee wave as auxiliary variables in the study.

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MACROECONOMIC MODEL OF PORK MEAT PROFITABILITY 2016-2021 IN THE CZECH REPUBLIC

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Annotation: The epidemic of African swine fever, which broke out in China in 2018 and gradually spread to other Asian countries, also affected some European countries. The Chinese market is a huge market for European countries, especially German farmers have lost the opportunity to export, and so their excess production ended up on the European market. This has resulted in price depression in European countries, including the Czech market, which is closely linked to the German market. The price of pigs in the Czech Republic decreased by almost 30% during 2020, and in 2021 a further decline in prices followed. It would be expected that the fall in farmers' prices will also have an impact on final consumers. In reality the price of pork in stores has fallen by an average of 10-12% in the past period. The consequence is the fact that traders and retail chains are making money and Czech breeders are moving on the verge of existential danger. The macroeconomic LP model (30 variables, 32 restricting conditions) simulates the development of costs and prices at the beginning and the end of the pig production chain. The processes of herd turnover are modelled, starting with the production of sows, piglets and their subsequent fattening, further processing in slaughterhouses to the final sale of produced meat products. Currently, the 5 variants of the model include data from 2017 till 2021. The costs of meat production and import of piglets gradually decreased during the 5 years 2017-2021, they have increased slightly since the beginning of the corona crisis. In contrast, meat prices fell. The presence of turbulence in the monitoring of profit at the beginning of the production chain signals the influence of externalities that disrupt the normal course of the production process. Experiments simulating a reduction in farm production costs, have not shown a real possibility of higher profit increase, as most cost items are slightly around EU averages. Several variants of the subsidies for primary production were verified on the models, which would enable farms to survive in the period of the greatest turbulence.

Keywords: Pork Meat Price, Live Weight Price, Linear Programming Model, Pork Production, Profit of Farms, Subsidies.

JEL classification: C61, H25, Q11.

1. Introduction

Global meat production is constantly growing. World meat production in 1961 reached 71.36 million tons, of which production was 40.3% beef, 34.7% pork, 12.5% poultry and 12.5% fell on other types of meat. Over the next six decades, meat production increased almost fivefold to 336.6 million tons in 2019. Poultry production rose to 39.1% and the share of beef fell to 21.6%. Pork production gradually increased to 32.7% in 2019. In 2019, China was the world's largest pork producer with 42.55 million tones, representing 38.6% of world production. This was followed by the USA with a production of 12.54 million tones (11.4%) and Germany with a production of 12.54 million tones (4.8%). In 2019, pork production in China, the USA and Germany covered 55% of world production. Spain (4.2%), Brazil (2.6%), Russia (3.6%) and Vietnam (3.0%) also achieved significant shares in world pork production higher than 2%, EUROSTAT (2019 - 2021).

The epidemic of African swine fever, which broke out in China in 2018 and gradually spread to other Asian countries, also affected some European countries, including large pork producers in Germany and Poland. Since 2019, due to the swine fever in China, there have been changes in pig production on the EU market. As part of anti-virus measures, China, as well as some other neighboring countries, stopped receiving supplies from European producers, and the consequences of an oversaturated pork market were felt in Europe. The Chinese market is a huge market for European countries, especially German farmers have lost the opportunity to export, and so their excess production ended up on the European market. This has resulted in price depression in European countries, including the Czech market, which is closely linked to the German market. The coronavirus closure of restaurants, which reduces the demand for meat, also contributed to the fall in prices during 2020 and 2021. According to ČSÚ (2019 – 2021) during this period the price of pigs in the Czech Republic decreased by almost 30% during 2020, and in 2021 a further decline in prices followed. While the price at which pig farmers sell fell by almost a third, the price of industrial producers fell by only around 10%. Thus, there was a demonstrable increase in the processing margin. The consequence of the outbreak of swine fever in China and the world coronavirus pandemic is the fact that traders and retail chains are making money and Czech breeders are moving on the verge of existential danger.

The authors Utnik-Banas and Z´mija (2018) and Utnik-Banas at al., (2022) show that time series of pork prices in the period 2010-2021 were subject to significant fluctuations with a long-term trend as well as medium-term and short-term seasonal fluctuations. The long-term trend in this period shows three cycles: 2010 - February 2016, March 2016 - June 2018, July 2018 - December 2020. During these three cycles, the price of pork increased from 137 to 160 EUR/100 kg (carcas E). Irregular price fluctuations ranged from 2% to 6%. Seasonal effects on price changes were most pronounced in Spain, Portugal, Greece, and the Czech Republic. Price dynamics and transmission in the pork markets were also studied by Bakucs and Fertö (2009); Liu (2011); Abdulai (2002); Babula and Miljkovic (2016); Hamulczuk (2016); Holst and Cramon-Taubadel (2013). The authors agree that due to cylindrical price fluctuations over a long ten-year period and a sharp decline in prices and changes in production, price forecasts are burdened with potential unexpected risk.

Concerning food prices Steininger and Smutka (2021) found out that in the Czech Republic did not deviate in any way from the average price trend of EU food in the monitored period 2011-2019. Czech prices were only slightly more volatile than European price due to smaller size and lower competitiveness compared to EU market on average. Naglova et all. (2020) confirms that in terms of the share of the production value of the food industry in the total manufacturing industry there were significant differences in the analyzed indicators between individual countries. In this sector was of great importance Cyprus, on the contrary, this share was lowest in the Czech Republic, Germany or Slovakia. The number of businesses in the EU has a declining trend but leading to business concentration. Szymanska (2017) has analyzed the development of the world pork market as globalization progresses. Despite the existence of an integrated market within the European Union, there are significant spatial differences in pork prices between Member States. Pork prices in the EU are seasonal; prices are higher in summer (peaking in June-August) and lower in winter (January-March).

Mach and Malec (2021) and Siche (2020) deal with the relationship between shares and agriculture, and energy commodity prices under the impact of the financial crisis in the EU. 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 corona crisis. Beranová and Navrátilová (2020) evaluated the preferences of the general Czech population in terms of purchasing Czech domestic plant production and animal production. The trend for fruit and vegetables it is 41.17 of respondents and for meat and sausages 40.71 % of respondents. These results confirm the current trends in consumer behavior in the market of plant and livestock production.

The implementation of the Green Deal, the Farm to Fork Strategy, the Biodiversity Strategy and other environmental instruments presented by the European Commission will lead to increased costs and a reduction in agricultural production and a fall in pig farmers' incomes. It will be a difficult and demanding period for breeders. Investment in farming and new technologies will reduce emissions and make production more environmentally friendly. All measures are costly and will be implemented with difficulty and in the longer term. Introduction of technologies 4. Industrial Revolution, i.e., digital technologies and fully automated systems of precision agriculture in plant and animal production will have to be implemented in the horizon of 7 - 10 years. “To measure is to know”- implying that pig producers can make strategic decisions only if they know their position, can benchmark their farms, and discover opportunities for improvements. The decision-making by providing digital tools and enabling benchmarking within the sector is the way to the pillars of sustainability economy, environment, animal health and welfare. It combines social, environmental, economic, and animal welfare indicators into aggregated scores. The inputs come from management information systems, financial bookkeeping, feeding records, direct observations of pigs and pens and personal information about management and attitude. Pig farmers can use it to monitor and realise their ambitions on sustainable farming, see the project ITFARM (2022). The Green Deal ambitions will get a boost through positive encouragement of the pig production chain towards sustainable production.

The corona crisis and swine pandemic did not affect the costs of primary pork producers in the Czech Republic. Havlíček (2020) et al. compared the performance of EU pigmeat producers in terms of input production costs and realized prices using the DEA model on data for the period 2012-2017. The feed costs, other variable costs, labor costs, depreciation and financial costs per sow/year were on the average of EU states. Čechura at al. (2021), based on a questionnaire survey among small farms, found that the covid affected almost two-thirds of respondents both in production and sales. However, also positive factors were registered: increased demand for local foods, contactless payment methods and online IT technologies in the sale of products were introduced to help in the crisis. The authors Masner at al. (2019) find similar conclusions in their research: Internet was used by various smart applications in agriculture, more small-scale farms were selling and promoting own products through own web sites.

2. Materials and Methods

The aim of the article is to analyse the situation described above. Using the macroeconomic model of *Linear Programming*, the situation on the pork market in the Czech Republic during the years 2017-2021 is described. The model compares the costs and profits of pig producers at the beginning of the production chain with the final profit of selected meat products for the end consumer. The analysis of the model allows us to estimate the critical situation of the manufacturer, when he is no longer able to produce further and shows what external resources the manufacturer has at its disposal in the form of indirect subsidies that will allow it to overcome the crisis and continue production.

It would be expected that the fall in farmers' prices will also have an impact on final consumers, who should benefit from the fall in the form of reduced cut meat prices. However, the price of pork in stores has fallen by an average of 10-12% in the past period. This means that pork traders, processors and retailers and other final sellers increased their margins during the period 2020-2021.

Two *research questions* will be answered in the model analysis: 1) How would it be necessary to reduce the production costs of Czech pig producers so that their profit reaches the level of profit from the sale of final meat products in shops? 2) What amount of direct subsidies would compensate for the difference between the income of Czech pork producers on farms and the income of sellers of final meat products in shops?

3. Results and Discussion

The Linear Programming Model (LP) is used to simulate the development of costs and prices at the beginning of the pig production chain and the development of prices of final pork products at its end in shops. Each simulation experiment is calculated separately for the data for the years 2017 - 2021, i.e., a total of 5 models are evaluated. Possible real or hypothetical changes in production costs and profits at the beginning and the end of the product vertical chain are mimicked by model experiments consisting in gradual changes of input data.

The macroeconomic model of LP makes it possible to compare the costs and profits at the top of the pork product vertical with the corresponding costs and profits at the end of the implementation of meat products in the retail chain. The processes of herd turnover are modeled, starting with the production of sows, piglets and their subsequent fattening, further processing in slaughterhouses to the final sale of produced meat products. The processes are aggregated to the level of production in the Czech Republic and the model allows the simulation of development for any period. Currently, the 5 variants of the model include data from 2017 till 2021 using LINKOSA SW. The user can freely change the input data in the form of an interactive table and calculate a new solution for this option. The model uses 30 variables, Table 1.

Table 1. List of variables

<table>
<tr><th colspan="6">Agricultural production - pigs turnover</th></tr>
<tr><th>No.</th><th>Name of the variable</th><th colspan="4">The meaning of the variable</th></tr>
<tr><td>1</td><td>Sows</td><td colspan="4">Number of sows registered in the calendar year</td></tr>
<tr><td>2</td><td>Piglets born</td><td colspan="4">Number of weaned piglets in an average weight of 27 kg produced in</td></tr>
<tr><td>3</td><td>Fattening pcs</td><td colspan="4">Number of units of slaughtered pigs in the average weight of 110 kg JUT from the turnover of the herd in the calendar year</td></tr>
<tr><td>4</td><td>Meat produced</td><td colspan="4">Production of produced pork JUT in kg from herd turnover in the calendar year</td></tr>
<tr><td>5</td><td colspan="4">Feed</td><td rowspan="9">Balance of costs per kg of live weight produced in EUR per calendar year</td></tr>
<tr><td>6</td><td colspan="4">Medicines, disinfectants and other materials</td></tr>
<tr><td>7</td><td colspan="4">Water, gas energy, fuel, veterinary services</td></tr>
<tr><td>8</td><td colspan="4">Total wages and personnel costs</td></tr>
<tr><td>9</td><td colspan="4">Depreciation of DNHM (excluding depreciation of animals)</td></tr>
<tr><td>10</td><td colspan="4">Repairs and maintenance, internal transport</td></tr>
<tr><td>11</td><td colspan="4">Other costs - rent, insurance, financial and administrative costs</td></tr>
<tr><td>12</td><td colspan="4">Recalculated costs of piglets entering fattening</td></tr>
<tr><td>13</td><td colspan="4">Total costs of fattening pigs</td></tr>
<tr><td>14</td><td>Costs of fattening pigs</td><td colspan="4">Revenues achieved on agricultural holdings for the sale of pork, including export of piglets in EUR per calendar year</td></tr>
<tr><td>15</td><td>Sales fattening pigs</td><td colspan="4">Costs incurred on agricultural holdings for the production of pigmeat, including imported piglets in EUR per calendar year</td></tr>
<tr><td>16</td><td>Carcas</td><td colspan="4">Total sales per carcas in EUR per calendar year in the Czech Republic</td></tr>
<tr><td>17</td><td>Neck</td><td rowspan="6">Share of sales per kg in total sales in EUR</td><td>23</td><td>Profit neck</td><td rowspan="6">Total sales in EUR</td></tr>
<tr><td>18</td><td>Leg</td><td>24</td><td>Profit Leg</td></tr>
<tr><td>19</td><td>Roast</td><td>25</td><td>Profit Roast</td></tr>
<tr><td>20</td><td>Flank</td><td>26</td><td>Profit Flank</td></tr>
<tr><td>21</td><td>Shoulders</td><td>27</td><td>Profit Shoulders</td></tr>
<tr><td>22</td><td>Others</td><td>28</td><td>Profit meat products + canned food</td></tr>
<tr><td>29</td><td>Total meat profit</td><td colspan="4">Balance of sales of other meat products for the calendar year EUR</td></tr>
<tr><td>30</td><td>Total profit
Objective function</td><td colspan="4">Total profit in EUR for sales of meat products in the Czech Republic per calendar year</td></tr>
</table>

Source: Own research

Data for the LP model were taken mainly from Czech sources ČSÚ (2021), VUZE (2021), VÚŽV (2022), and, if possible, were verified from central European sources EUROSTAT (2022). All financial indicators were converted at the rate EUR/CZK = 1/26. Tables 2a, 2b and 2c show data for individual simulations for the years 2017 - 2021.

Table 2a. Input values to the model over the years 2017–2021 Herd turnover

	2017	**2018**	**2019**	**2020**	**2021**
Numbers of sows	94000	89000	91000	92000	90000
Number of piglets born / sows.year	31.2	31.6	32.4	32.4	32.8
Piglet deaths %	10.8	11	11	10,9	10.9
Slaughter weight kg	116	115	116	118.4	118

Table 2b. Input values to the model over the years 2017–2021 Fattening costs and sales

EUR/ kg live weight	2017	2018	2019	2020	2021
Feed costs	0.5924	0.6140	0.6307	0.5991	0.6410
Drugs, disinfectants and other materials	0.0389	0.0337	0.0331	0.0343	0.0343
Water, gas, energy	0.1044	0.0915	0.1019	0.1075	0.1151
Salary and personnel costs	0.0875	0.0807	0.0907	0.0823	0.0823
Depreciation (excluding animal depreciation)	0.0249	0.0312	0.0406	0.0473	0.0473
Repairs and maintenance, internal transport	0.0114	0.0083	0.0095	0.0091	0.0091
Other costs - rent, insurance, financial, administrative	0.0617	0.0441	0.0509	0.0473	0.0473
Costs of piglets	0.3950	0.3985	0.3724	0.3604	0.3856
Own fattening costs per 1 kg gain in fattening	0.9214	0.9036	0.9575	0.9268	0.9762
Sales EUR/kg live weight	1.2508	1.0488	1.224	1.2169	1.0181

Table 2c. Input values to the model over the years 2017–2021 Prices of meat parts

EUR/kg meat part	2017	2018	2019	2020	2021
Neck	4.659	4.649	4.983	5.139	5.042
Leg	4.735	4.760	5.069	5.395	5.042
Roast	4.552	4.507	4.894	5.242	5.042
Flank	3.613	3.506	3.667	4.073	3.995
Shoulder	4.495	4.432	4.654	4.861	4.965

Source 2a,2b,2c: ČSÚ (2021), eAgri (2022), VÚŽV (2022)
Corrections EUROSTAT (2022)

The costs and revenues of meat processors and sellers are not disclosed. No one is able to determine and differentiate the margins of processors and retailers. Only final prices of meat for consumers can be found. For this reason, the processing and retail of meat parts were combined into one. Thus, two stages of the production chain were investigated: 1) production of pork on farms, and 2) processing and retail of meat.

The model contains 32 restricting conditions, which are compiled into 5 blocks: 1) Herd turnover, 2) Fattening costs, 3) Sales, 4) Production of meat products and profit from meat products, 5) Total profit, see Table 3 – Table 8. The construction of the model is illustrated on the dates of 2017.

Table 3. Block 1: Herd Turnover

B1	Herd turnover	x_1	x_2	x_3	x_4		
1	Sows	1				>	94 000.00
2	Weaned piglets	-31.2	1			=	0.00
3	Fattening		-0.89	1		=	0.00
4	Meat produced kg			-116	1	=	0.00

Source: Own Research, data ČSÚ (2021), eAgri (2022)

Restricting conditions:

1) $x_1 > 91\ 000$. The number of sows may be greater than the current situation.

2) The condition $x_2 = 32.4\ x_1$ represents the number of piglets produced per sow in 1 year, assuming a maximum of 10.8 % piglets' deaths.

3) Transfer of piglets into fattening pcs: $-0.89\ x_2 = x_3$. The coefficient 0.89 reflects the percentage of the piglets' deaths: 89% survived (different number for each year).

4) Production of meat in kg (live weight) $x_4 = 116\ x_3$ passes to block "Meat production and profit from the meat".

Table 4. Block 2: Fattening costs

B2	**Fattening costs (EUR/kg live weight)**	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}		
7	Feed costs	-0.5924	1									=	0.00
8	Medicines, disinfectants, other	-0.0389		1								=	0.00
9	Water, gas energy, fuel	-0.1044			1							=	0.00
10	Total wages, personnel	-0.0875				1						=	0.00
11	Depreciation costs (excluding animals)	-0.0249					1					=	0.00
12	Repairs, maintenance, internal transport	-0.0114						1				=	0.00
13	Other costs	-0.0617							1			=	0.00
14	Recalculated costs: piglets fattening	-0.3950								1		=	0.00
15	Total costs of fattening		-1	-1	-1	-1	-1	-1	-1	-1	1	=	0.00

Source: Own Research, data ČSÚ (2021), eAgri (2022), VÚŽV (2022)

Loading costs per 1 kg of meat produced $x_{13} = x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12}$ which transfers the value of total costs to the sales block.

Table 5. Block 3: Sales

B3	**Sales**	x_4	x_{13}	x_{14}	x_{15}		
16	Sales of meat production	1.06			-1	=	0.00
17	Costs meat production		-1	1		=	0.00

Source: Own Research, data ČSÚ (2021), eAgri (2022), VÚŽV (2022)

The condition $1.06\ x_4 = x_{15}$ changes the production of meat (kg) into sales EUR – calculated with 1.06 EUR per kg JUT. The condition 17 changes the total costs of the fattening pigs into sales. The coefficient 1.06 varies every year according to actual prices.

Table 6. Block 4: Meat production and profit from the meat

B4	Production	x_4	x_{16}	x_{17}	x_{18}	x_{19}	x_{20}	x_{21}	x_{22}	x_{23}	x_{24}	x_{25}	x_{26}	x_{27}	x_{28}		
18	Carcas	1	1,27													=	0.00
19	Neck kg		0.111	1												=	0.00
20	Leg kg		0.289		1											=	0.00
21	Roast kg		0.187			1										=	0.00
22	Flank kg		0.108				1									=	0.00
23	Shoulder kg		0.140					1								=	0.00
24	Other parts kg		0.164						1							=	0.00
25	Neck profit			3.28						1						=	0.00
26	Leg profit				3.36						1					=	0.00
27	Roast profit					3.177						1				=	0.00
28	Flank profit						2.238						1			=	0.00
29	Shoulder profit							3.12						1		=	0.00
30	Profit other parts								0.625						1	=	0.00

Source: Own Research, ČSÚ (2021), eAgri (2022), VÚŽV (2022)

The limiting condition $x_4 = 1.27\, x_{16}$ transfers the meat produced to the processing industry and trade. Other balance conditions then divide the meat into meat parts and changes the production into profit.

Table 7. Block 5: Total profit

B5	Objective	x_{14}	x_{15}	x_{23}	x_{24}	x_{25}	x_{26}	x_{27}	x_{28}	x_{29}	x_{30}		
31	Profit meat			-1	-1	-1	-1	-1	-1	1		=	0.00
32	Total profit	1	-1							-1	1	=	0.00
	Objective function										-1		

Source: Own Research

The total achieved profit from all meat parts has been summarized (line 31): $x_{23} + x_{24} + x_{25} + x_{26} + x_{27} + x_{28} = x_{29}$.

Line 32 summarizes the profit from fattening pigs and profit from meat parts. The objective function is the total profit from pigs fattening and meat parts final sales.

The model allows to change most input values and calculate different variants of solution. The simulation runs in the form of an interaction between the model and an interactive table, which is used to transport new values to the model. The model is tuned to calculate "reasonable values", i.e., real values that we may encounter in practice, in the case entering extremely large or small values or negative numbers will not work.

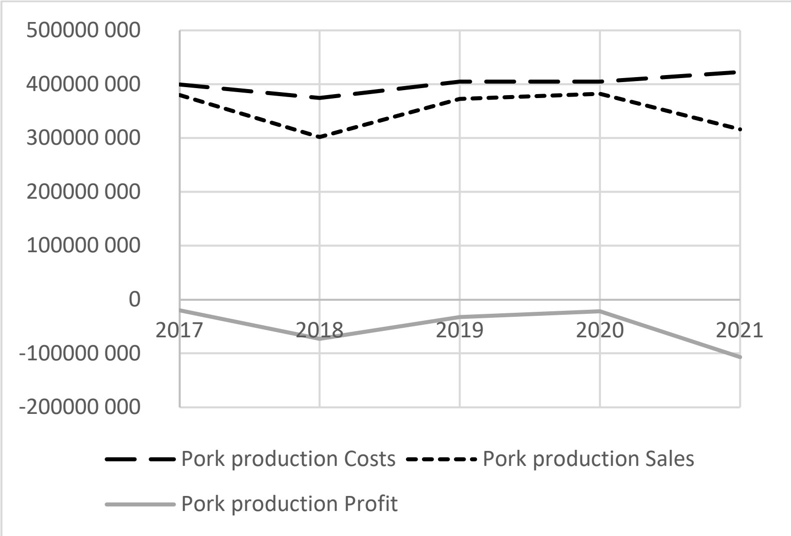
Significant simulation results for the period 2017-2021 are shown in Table 8 and in Figure 1 and Figure 2.

Table 8. Total profit – farmers and final production (EUR)

	2017	2018	2019	2020	2021
Costs of fattening	399 468 689	374 802 267	404 801 516	404 764 783	399 499 776
Sales of fattening	379 561 785	301 909 463	372 529 977	382 670 841	315 977 863
Profit production	-19 906 904	-72 892 803	-32 271 539	-22 093 942	-83 521 913
Gain meat	49 617 496 316	52 133 085 646	55 105 177 556	63 043 360 600	66 580 260 516

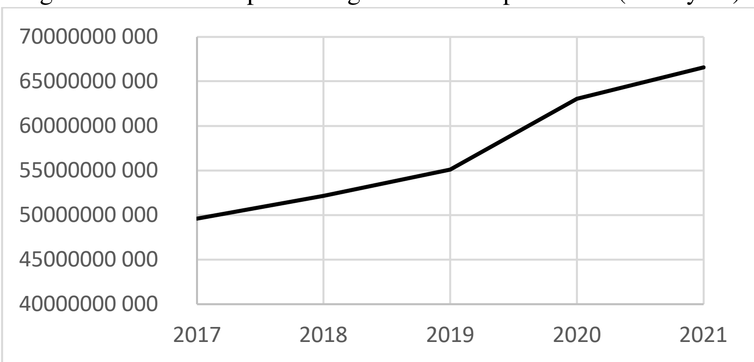
Results of 5 simulation experiments. Source: Own Research

Figure 1. Pork production costs, sales, profit (EUR/year)



Source: Own Research

Figure 2. Profit from processing and retail of pork meat (EUR/year)



Source: Own Research

The data in Table 8 show that fattening costs increased slightly, except for 2018. Sales in 2018 fell to their lowest level in the five-year period under review, probably due to the African swine fever crisis. After that, sales grew slightly until 2020, followed by a sharp fall. The profit was negative throughout the five-year monitoring period 2017-2021, its sharpest decline was recorded in 2021. During the five-year period, turbulence occurred both in monitoring costs and sales, as well as negative values of the achieved profit. This finding corresponds well with the study of Utnik-Banas and Z´mija (2018) and Utnik-Banas at al., (2022), Mach and Malec (2021) and Siche (2020).

The profit of pork producers in the Czech Republic was negative and declining throughout the period under review. Processors' profits, on the other hand, continued to increase over the same period: from 2017 to 2021, they increased by 34%.

4. Conclusion

Pork production in the Czech Republic is permanently non-profitable, Czech farmers are not able to influence either the prices of inputs or the purchase prices of piglets, because these are European prices. There are no barriers to imports and exports within the EU. Should Czech breeders demand higher prices, processors will easily buy goods from other EU producers. In the pork market, prices are essentially at the same level throughout the EU.

How can the situation of Czech farmers be solved? Czech breeders achieve comparable parameters of production efficiency, including biological indicators as other producers in the EU, CEVEMA (2020). Therefore, reducing costs will not lead to the goal, especially if the increase in the prices of basic production factors such as feedings and energy during the period 2021, and the expected further increases in the following year 2022, will not allow it. The only option here is a direct subsidy program. What goals should the subsidy policy pursue? Table 9 shows the calculation of own costs per kg live weight in comparison with the realization prices:

Table 9. Calculation of own costs and realization prices

EUR/1 kg live weight	2017	2018	2019	2020	2021
Own cost per live weight	1.316	1.302	1.323	1.287	1.362
Average realization price	1.251	1.049	1.224	1.217	1.018
Excess of costs over sales	0.07	0.25	0.11	0.07	0.34

Source: Own Research

The realization price of EUR/1 kg live weight is on average 0.17 EUR (4.36 CZK) lower than the own production costs + piglet costs. The differences between costs and sales are not diminishing but widening - and can be expected to widen further in 2022. As price levels are turbulent, the subsidy per 1 kg live weight should be different each year according to the development of production costs and realization prices. E.g., for the year 2021 it should be in the amount of 0.34 EUR = 8.80 CZK to ensure a zero profit, to make the profit of at least 10% the subsidy would have to reach at least 0.48 EUR = 12.5 CZK. This value also corresponds well with the statement of the President of the Agrarian Chamber of the Czech Republic in the “Radiožurnál Praha” (November 30, 2021) that "the purchase price of pork would have to be 15 CZK higher" in order for production to pay off for farmers.

The rise in energy prices and the conflict in Ukraine will be crucial for change in the subsidy policy in the period after 2021. The production costs of farmers are rising sharply, and yet the European Commission has not launched any subsidy action. Without subsidies, Czech farms will be paralyzed, overpressure in the pork market may result in pork production being concentrated in only a few European countries. More and more companies are heading to stop pork production, no entrepreneur can do business with zero or negative profit. On the contrary, the crisis has also brought new experience to Czech farmers, especially in making better use of and mastering the most modern ICT tools and technologies of the 4th Industrial Revolution, Čechura at all. (2021), Masner at all. (2019).

Short-term support will be key to keeping farmers from the current crisis, to prepare them for a more sustainable future and to meet Green Agreement commitments. The pig sector is already restructuring it is diversifying products, production is more responsive to consumers, animal welfare and the environment are improving. Feed producers welcome the ambitions of Green Deal, because it can have a positive impact on the feed industry, which is able to ensure feed production, ensure animal welfare, reduce emissions, and strengthen the economy, provided that pig farming is ensured at a level for sustainable food production in the Czech Republic. Pig farmers will only be able to overcome the crisis through rapid, direct support. They need a financial break to avoid bankruptcy and ensure the ability to adapt their business to market conditions, sustainability requirements and ambitions, and public expectations. European support is the only way to give farmers and their families the opportunity to contribute to the future of this Green Agreement.

It should be the interest of the Czech Republic to maintain a reasonable, diversified pork production that is in line with the principles of sustainable agriculture. It is necessary to increase self-sufficiency, not to rely on imports. And subsidy programs must be opened as soon as possible because changes in the scope of production cannot be made overnight, in pork production it is at least 6 months, but rather 1 year in advance. The submitted models for the years 2017-2021 offer specific instructions for verifying the amount of the subsidy provided for a given calendar year.

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ANALYSIS OF THE DEVELOPMENT OF IT SOLUTIONS TO INCREASE THE COMPETITIVENESS OF HUNGARIAN MEAT ENTERPRISES

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Annotation: Legislation and regulations for companies in the meat supply chain are getting tighter and tighter, and public concern about this area of the food industry has multiplied in recent years. These issues are placing a heavy burden on companies in the meat industry, and there is a growing interest and demand for IT solutions, which are essential to increase competitiveness. Furthermore, the effective use of information systems is no longer just a means of improving the efficiency of business operations but a prerequisite for staying in the market. Our research aimed to assess modern IT technologies and information systems in Hungarian meat processing companies. As there are no comprehensive and accessible statistics on the subject, we have mapped the situation in Hungary in 2021 using a questionnaire survey. For the segmentation, we chose cluster analysis, a multivariate statistical method often used in scientific research, which is the summary name for the methodology of grouping and clustering. As a result, we classified the companies into 3 clusters (Underdeveloped, Star and Promising) based on the examined characteristics.

Keywords: Information systems, Cluster analysis, Food industry

JEL classification: O14, O32

1. Introduction

Today, increasingly stringent legislation and trade regulations and reduced consumer confidence in food products due to food problems are creating ever more significant challenges for companies in the meat industry. In addition, consumer preferences are constantly changing, with more and more consumers insisting on specific eating habits (e.g., the use of organic ingredients, GMO-free, sustainable farming). Thus, food companies that want to meet the demands of our modern world are forced to continuously improve their processes, increase their efficiency, and provide more information to consumers about their products.

Over the past decade, it has become clear that these tasks can only be achieved through continuous IT development and the effective use of information technology techniques. Undoubtedly, many solutions, trends, and research areas have emerged to address the problems mentioned above.

One solution could be improving product traceability and publishing this information to consumers. A survey in the US found that 58% of respondents were confident that meat products could be traced back to a processing plant or even to a specific herd of animals. Not surprisingly, 74% identified traceability with quality itself, saying traceable meat is better. The same survey found that buyers overwhelmingly (91%) favor paying more for traceable meat. Nearly 67% said they would even buy more if traceability were guaranteed (Cunningham, 2008). According to another study on willingness to pay in the US, Canada, Japan, and the UK, traceability alone does not encourage consumers to pay the extra premium. Still, the additional benefits may provide the necessary motivation (Dickinson and Bailey, 2005). A survey in China found that, despite consumers' association of traceability with food safety, they are mostly unwilling to pay for it or would accept only a minimal (~10%) increase in costs (Zhao, Qiaoa, and Chena, 2010). Industry experience has shown that such a premium is not sufficient to operate a system that could provide customers with a continuous and efficient demand for information (Cebeci, Guney, and Alemdar, 2008). A similar survey on consumer perceptions of traceability has been carried out in the food industry in Hungary. The results showed that Hungarian consumers have more confidence in traceable food products, but due to low levels of information, a large proportion of consumers do not understand the importance of traceability. A significant proportion of consumers are not able to precisely decide whether the traceability of a product is a guarantee or a functional quality attribute and equate it mainly with food safety (Füzesi et al., 2018).

To achieve more accurate product traceability, meat companies and other actors in the supply chain need to develop a joint strategy to link their databases. Industry 4.0 and the Internet of Things (IoT) (Tóth, Felföldi, and Szilágyi, 2019, Herdon et al., 2018) can be of significant help in this regard. The IoT solutions (radio frequency identification tags (RFID), barcodes, chips) can be used to precisely and continuously record the location of products and shipments. This can guarantee enhanced, real-time tracking of goods (Kshetri, 2018, Botos et al., 2018), leading to inevitable developments in related supply chains (Srai and Lorentz, 2019). Supply chain and logistics experts also expect further IT developments to lead to cost reductions and revenue increases (Pakurár et al., 2019, Botos et al., 2019). However, if product manufacturers share information and knowledge with their partners to facilitate strategic decisions, their competitiveness may be jeopardized. This can be remedied by blockchain technology, which is becoming increasingly widely available with digitalization development and has enormous potential to revolutionize data storage and sharing (Babich and Hilary, 2019; Treiblmaier, 2018). Just as the web has transformed the way global information is exchanged and made available to all, blockchain could change how data is shared. Its application can increase the transparency and immutability of data and revolutionize the way both physical and digital products and services are transacted (Elmasri and Navathe, 2015). Forecasts are currently quite optimistic about this technology, despite the fact that the payback and the costs of implementing such a system are uncertain or, in many cases, very difficult to estimate.

In any case, implementing and using modern business management systems are essential for applying the information technology solutions mentioned above. In fact, it can be said that the effective use of information systems is nowadays a prerequisite for staying in the market (Sadrzadehrafiei et al., 2013). Integrated ERP systems are software that offers complex solutions that model a company's physical material and information flows, filter the data, and make them available to managers properly organized, thus facilitating the more rational use of resources and more efficient production. The usability of such a system does not depend on the size of the company: the solutions can be used by retail companies as well as by any giant. When a company decides to implement an ERP system, it is not just buying tools and software, as the system also brings strategic and business benefits to the company. ERP systems significantly impact productivity and the economical use of materials, which improves logistics processes. Thus, the development and implementation of information systems are also essential for enhancing competitiveness in meat companies, as only with adequate information can managers make good economic decisions and react to the continuous changes in the market (Herdon, Szilágyi, and Várallyai, 2011; Horváth, 2014).

For the above reasons, the main objective of this study is to analyze the use of information systems in Hungarian meat enterprises. The structure of the paper is as follows: after a review of the current situation and literature on the food industry (and within this the meat industry), the second part describes the data collection process, the methodology and the sample. The third section illustrates the application of the method described earlier to shed light on the IT readiness of Hungarian meat companies, and on this basis, we classify and characterize the companies. In the fourth section, the research results are discussed in the light of the findings of international publications, conclusions are drawn and recommendations are made for industry players.

2. Materials and Methods

To examine the research, we designed a survey from which we could get answers to questions relevant to the topic from a larger group of companies. In our work, we visited several companies to prepare a case study, but these are still unique cases and do not necessarily reflect the general situation. As there are no comprehensive and accessible statistics on the topic, we mapped the situation in Hungary with a questionnaire survey. The questionnaire survey was carried out by Szinapszis Kft on behalf of the Institute of Applied Informatics and Logistics of the University of Debrecen by random sampling by telephone at the end of 2021 among meat processing enterprises. With this survey, we examined the usage patterns of information and communication technology (ICT) services that facilitate the flow of information. Our goal was to answer the following questions, among others:

• How the development of corporate infrastructure affects competitiveness?
• Do they use any ERP system to support their processes?
• Are electronic data interchange (EDI) used in economic processes?

As a result of the questions, we worked with a sample of 106 items. The distributions of the sample by major background variables are shown in Table 1.

Table 1. Distribution of samples by major background variables (N=106)

Name	Distribution
Number of employees (person)	
2-9	30.2%
10-49	39.6%
50-249	23.6%
250	6.6%
Annual net sales (million HUF)	
12 -100	29.2%
100 - 500	26.4%
500 – 1000	12.3%
1000 <	32.1%
Region of activity	
Southern Great Plain	15.1%
Southern Transdanubia	8.5%
Northern Great Plain	19.8%
Northern Hungary	21.7%
Central Transdanubia	4.7%
Central Hungary	16.0%

For the segmentation, we chose cluster analysis, a multivariate statistical method often used in scientific research, which is the summary name for the methodology of grouping and clustering (Kettenring, 2006). Since cluster analysis is susceptible to outliers, we first detected them using a simple chain method and removed them using the SPSS program. Since we knew how many clusters we would like to create, we used the non-hierarchical model. K-means cluster analysis is a statistical technique used to partition a dataset into K subsets. All the objects in any given subset are closer to the centroid of that subset than to the centroid of any other subgroup (Wu, 2012).

We used ANOVA test to compare the explained variance (caused by the input fields) and the unexplained variance (caused by the source of the error). If the explained and unexplained variance ratio is high, the means are statistically different. Our SPSS cross-tabulations showed how much real data from the existing cases were included and how many data were excluded.

3. Results and Discussion

The market demand for sector-specific software solutions is mainly at the mid-market level. Standard software has already been implemented in almost all large companies, and demand in this segment is declining strongly. Medium-sized companies require systems close to the real world and free of redundant functions, which standard software designed for large enterprises usually does not provide. In this market segment, software vendors tailored to the sector can gain a competitive advantage because their systems mirror specific processes without adding unnecessary functionality.

We used cluster analysis to classify enterprises into homogeneous groups based on three relevant variables (Table 2). The three variables were the number of employees, the company's annual net sales, and ICT development. As a result of the examination, three clusters were obtained. The first cluster includes small companies with medium net income and a medium level of ICT development. The second cluster included medium-sized and large companies with many employees, high net income, and good ICT development. Finally, the third group had medium-sized companies with medium net income and extremely high ICT development. Most companies were classified in cluster 2, accounting for 44.33% of the sample.

Table 2. Final cluster centers

	Cluster		
	1	**2**	**3**
Number of employees category	2.45	3.71	2.75
Annual net income category	2.52	4.76	2.54
Level of ICT development	2.55	3.67	4.36
Number of cases	32	47	27

Source: own construction

We found by analysis of variance (Table 3) that the entry into the clusters was most influenced by the company net income (F=241.233), but also the level of ICT development contributed significantly to the formation of the clusters (F=59.903).

Table 3. Variance analysis (ANOVA)

	Cluster Mean Square	df	Error Mean Square	df	F	Sig.
Number of employees category	16.931	2	.492	103	34.412	<.001
Annual net income category	64.449	2	.267	103	241.233	<.001
Level of ICT development	25.945	2	.433	103	59.903	<.001

Source: own construction

We examined the correlations between the companies classified in each cluster and their main characteristics. Two variables were included in the characterization. The first is whether the company uses an ERP system. The second is whether it uses the electronic data interchange (EDI). ERP system used mainly by large companies in the second cluster (Table 4). EDI is used by most companies in clusters 2 and 3. However, only 45.45% of small companies in the first cluster take advantage of EDI in their ordering processes (Table 5).

Table 4. The relationship between company groups and ERP System usage. Cluster number of case cross-tabulation

			Cluster Number of Case			
			1	2	3	Total
ERP usage	Yes	Count	5	33	13	51
		% within ERP usage	9.8%	64.7%	25.5%	100.0%
		% of Total	4.7%	31.1%	12.3%	48.1%
	No	Count	27	14	14	55
		% within ERP usage	49.1%	25.5%	25.5%	100.0%
		% of Total	25.5%	13.2%	13.2%	51.9%
Total		Count	32	47	27	106
		% of Total	30.2%	44.3%	25.5%	100.0%

Source: own construction

Table 5. The relationship between company groups and EDI usage. Cluster number of case cross-tabulation

			Cluster Number of Case			
			1	2	3	Total
EDI usage	Yes	Count	22	44	25	91
		% within EDI usage	24.2%	48.4%	27.5%	100,0%
		% of Total	20.8%	41.5%	23.6%	85.8%
	No	Count	10	3	2	15
		% within EDI usage	66.7%	20.0%	13,3%	100,0%
		% of Total	9.4%	2.8%	1.9%	14.2%
Total		Count	32	47	27	106
		% of Total	30.2%	44.3%	25.5%	100.0%

Source: own construction

The formed clusters were characterized based on the ERP and EDI usage included in the analysis, and the company groups per cluster were named accordingly (Table 6).

Table 4. Characterization of clustered companies

		Cluster 1	Cluster 2	Cluster 3
Variables involved in the clustering procedure	number of employees	low	large	medium
	net income	medium	high	medium
	level of ICT development	medium	high	extreme high
Variables involved in the characterization	ERP usage	low	high	medium
	EDI usage	medium	high	high
Cluster name		*Underdeveloped*	*Star*	*Promising*

Source: own construction

According to the variables included in the characterization, we named the 3 clusters as follows: Underdeveloped, Star, and Promising. *Underdeveloped* companies are typically small companies with low levels of ICT use, so they do not use an ERP system. They could increase their competitiveness by using higher levels of ICT. In addition, *Promising* companies are medium-sized companies with high ICT levels. This is accompanied by high EDI usage and medium ERP usage. These companies have the opportunity to grow rapidly and increase their income by developing an ERP system. Finally, the *Star* companies are leading large enterprises with an ERP system. All that matters to them is maintaining their leadership in the market by keeping pace with technological developments and continuous improvement.

Large companies are largely successful in adopting ICT infrastructure, but small companies, which are relatively slower, face difficulties (Gupta and Kamar, 2018). Based on our results and the findings of Gupta and Kamar (2018), the use of ICT benefits not only large companies but also smaller companies, necessitating immediate policy action to improve them.

4. Conclusion

The fastest way to optimize your business is to control and verifiable all of your subtasks from a single interface. Collecting data can consume unnecessary time and energy if an integrated corporate governance system is not available. CRM, inventory management, purchasing, sales, warehousing, accounting, and invoicing are also part of ERP. If we know the internal operation of our company better, it will be much easier to see the mistakes that stand in the way of innovation. Continuous renewal is essential for competitiveness, and tackling problems will accelerate progress. Of course, the reverse is also true: once we have discovered the strengths of our company, we can put more and more energy into shaping them. And if we come across gaps, it’s time to face new challenges and catch up.

Our results show that companies with higher turnover and higher revenue use ERP systems to implement and track workflows. Hopefully, the trend will continue, helping the growth of lower-revenue businesses, as there is a statistically significant relationship between revenue and the use of information systems.

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ARE THE QUALITY OF AGRICULTURAL LAND AND ITS ENVIRONMENTAL CONDITION SUFFICIENTLY REFLECTED IN THE MARKET PRICE?

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Annotation: The main objective is to verify the relationship between the quality of the land (given by the official price of agricultural land), and the market valuation, which may not fully respect its qualitative and environmental condition. A sub-objective is to characterise the species structure and quality of the land in the selected region as a basis for sustainable management and to demonstrate the role of the land market in maintaining soil quality. In the Central Bohemian Region, 45 % are cambisols, 10 % chernozems, 8 % luvisols and 7 % brown soils. It is the 3rd region with the highest soil quality in the country (excluding Prague), based on the average official price per region. Other quality characteristics of the region (2021) are based on the analysis of the ESEU code. Agricultural soil in the region contains 2.4 % humus. The weighted average of soil moisture by soil type is 34.59 % (the average in the Czech Republic is 34.62 %). In the region, 71.79 % of soils are moderately heavy and 18.47 % are light. The analysed district in the Central Bohemian Region has 302 cadastral territories. 92.8 % of the district is located in a moderately warm and moderately humid climate region and 7 % of the area has a moderately warm and dry climate. The price analysis shows that the market price of land is still the most influenced by the ESEU price value. Statistical dependence at 5 % significance level was demonstrated ($r = 0.78613$ and $R^2 = 0.59$, $p<0.00$). Official prices (2021) in the district range from 1.33 to 7.74 CZK/m2 (district average = 5.75 CZK/m^2, Czech average = 7.13 CZK/m^2) and market prices range from 22-39 CZK/m^2 (as of 31.12.2021).

Keywords: Market price, Official price, Agricultural land, Quality, Correlation, Příbram, Czech Republic

JEL classification: Q15, Q24

1. Introduction

The main objective is to verify the ESEU relationship between the quality of land (given by the official price of agricultural land), and the market valuation, which may not fully respect its quality and environmental condition. A sub-objective is to characterise the species structure and quality of the agricultural land in the selected region as a basis for sustainable management and to demonstrate the role of the land market with regard to maintaining soil quality.

Historical land valuation is based on the monitoring of yield parameters (land rent). Land rent varies not only with the fertility of the land but also with its location, whatever its fertility. Land near large cities yields a higher rent than equally fertile land in a remote region (Smith, 1776, In Smith 2001). The Physiocrats, like Cantillon (1755, 2022 online), believed that rent arises from the natural fertility of the soil: the more fertile the soil, the greater the net product farmers will produce on it. Alongside this, Ricardo, (1821) recognized that the cause of differential rent is the simultaneous difference of soils in quality and quantity. Marx (1956) defines the concept of 'capitalisation of rent' which is still used in economic terminology today. Any monetary income can be capitalized. Capitalized land rent constitutes the purchasing power or value of land.

Current research still overwhelmingly considers land rent as the basis for the economic valuation of land. Research on the value of farmland in the last century was then extended by Bean (1938), Wallace (1926), Pope and Goodwin, 1984. The authors contributed their research studies by attempting to explain the importance of various attributes (such as the existence of buildings, crop yields, distance to urban centres) in explaining land value. For example, the value of agricultural production on land is addressed by the NPV method (Ustaoglu et al., 2016). According to this method, farms can be considered as an investment option that provides future returns with the required investment. The rental value of farmland can then be represented as the discounted value of the net expected future returns over the costs associated with the land in a particular location. Ustaoglu et al. (2016) believe that the VNP method is able to reveal the operational production value of land rather than the market value of real estate. Koomen et al. (2015) address the willingness of social sectors to buy or lease land in a specific location. The bid prices are assumed to be the result of the net profit that a farmer can obtain from land with maximum yield and average cost.

Despite more than 30 years of analysis of land valuation, progress in developing methods, according to Johnson and Cramb (1996), is still disappointing. The authors state that a shortcoming of current land valuation techniques is the inability to predict crop yield and the inability to reflect changing technology and economic conditions. Moreover, the systems do not provide information on production and price risk, which are essential for farmers' survival.

Even in the Czech Republic, the economic valuation of the productive capacity of land is based on the yield assessment of soils. Specifically, the valuation of the difference in the efficiency of soil inputs in specific agro-ecological conditions, characterised by the Estimated soil-ecological units (ESEU). The ESEU is derived from the relationship between the price of parameterised production and parameterised costs (rent). The rent can be the normative profit including the land subsidy received or rent (Nemec, 2001).

On the other hand, there are authors who also support the valuation of non-productive land functions. For all cities, the optimal development objective is to fully exploit the value of land resources while pursuing the progress of the economy, society and the ecological environment. The authors of Peng et al. (2021) attempt to measure the value of urban land resources based on sustainable environmental space management. According to Liu et al. (2019) and Zhou et al. (2017), land resources are not only spatial carriers of social and economic development, but also function as carriers of environmental and ecological services. Participatory methods (Kim et al., 2021) or the RAWES approach (McInnes and Everard, 2017) can be used to assess the ecosystem services provided by specific areas and to identify development and conservation preferences. In addition, the ESA methodology that assesses the contribution of ecosystems to human well-being through the provision of ecosystem services (ES) (Gómez-Baggethun et al., 2010). To provide aggregate estimates of land values, Wentland et al. (2020) use a hedonic approach that employs fine-grained microdata containing detailed information from hundreds of millions of real estate transactions and their corresponding physical characteristics. The authors of Tezcan et al. (2020) developed a multi-criteria evaluation model.

The market price is generated by the intersection of supply and demand. Land markets act as a medium to transfer farmland from passive farmers to active farmers, or more generally from less efficient farmers to more efficient agricultural producers (Deininger et al., 2004). According to Novotny (2015), when investing in land, it is important to consider: the size, the content of the tenancy agreement, the degree of consolidation, land improvements, accessibility of the land, the production value of the land, the distance from the border of neighbouring countries, the use of agricultural land and the share of the subsidized area in the total area. In addition, e.g. proximity to higher class roads or building land. In general, the larger the area, the higher the price per m2. It is more difficult and time-consuming to find larger blocks of agricultural land.

2. Materials and Methods

Decree No. 298/2014 Sb., on establishing the list of cadastral areas with assigned average basic prices of agricultural land, as amended by Decrees No. 344/2015 Sb., No. 432/2016 Sb., No. 403/2017 Sb., No. 288/2018 Sb., No. 318/2019 Sb., No. 548/2020 Sb., and No. 453/2021 Sb. This decree lists the official prices of agricultural land, which are publicly available for each territorial unit in the Czech Republic. These prices reflect the qualitative assessment of the land for the territorial unit (cadastral area) and are used for tax purposes. According to these prices, sales and purchases of state-owned land are also carried out. The article finds out how market prices for a territorial unit (cadaster) are affected by this official price. The official price will be marked in the regression analysis as a dependent variable (x).

Decree No. 441/2013 Sb., (Price Decree) with effect from 1.1.2014. Specifically: Annex No. 4 with the listed basic prices of agricultural land according to the ESEU. Official ESEU prices are assigned to each ESEU code. ESEU prices reflect the quality of each rated land block (rated area).

Decree No. 227/2018 Sb., on the characteristics of the Estimated soil-ecological units and the procedure for their maintenance and updating. (This information explains the relationship between the geological characteristics of the soil and the ESEU code).

Information on the occurrence of ESEU (code, area) on agricultural land in individual regions of the Czech Republic - internal data of the Ministry of Agriculture of the Czech Republic (LPIS, MoA, 2021, internal data). These data will help to identify the quality of the land (Table 4, qualitative characteristics: 1-4 column) within the selected region with respect to its area.

Aggregate values of land types by cadastral area as of 31 December 2021 (COSMC, 2021, internal data). These data (area, code, name of the cadastral area) will enable the calculation of average market prices for the monitored region (region) with regard to the size of the cadastral area. Data for 2020 (COSMC, 2020) are the basis for calculating average official prices for the regions of the Czech Republic (Table 4, 5 and 6 column).

Market prices for 302 cadastral territories of Příbram district. Prices are valid as of 31.12.2021. The prices were provided by a Czech real estate agency focusing on the agricultural real estate market (www. farmy.cz). Market prices will be identified as dependent variable (s) in the regression analysis.

For example, compaction information will be used to evaluate the soil in the locality. Pedocompaction (compaction) increases the risk of water erosion and flooding. Lhotský and Damaška (1989) compiled a table categorising soils according to the degree of risk of degradation of their ecological functions due to soil structure degradation based on the ESEU code.

Table 1. Categorization of soils according to the degree of risk of degradation of their ecological functions (Lhotský, Damaška,1989)

<table>
<tr><th rowspan="3">Grade Risk</th><th rowspan="2">Main soil unit</th><th colspan="2">Distinguishing characteristics</th></tr>
<tr><th>Climate region</th><th>Slope</th></tr>
<tr><th>(2nd and 3rd digits of ESEU code)</th><th>1st digit of the ESEU code</th><th>4th digit of the ESEU code</th></tr>
<tr><td rowspan="4">weak</td><td>02, 03, 04, 05, 06</td><td rowspan="4">< 5</td><td>> 1</td></tr>
<tr><td>19</td><td rowspan="3">≤ 1</td></tr>
<tr><td>55, 56, 58, 59</td></tr>
<tr><td>57</td></tr>
<tr><td rowspan="5">mild</td><td>09, 10, 11, 12, 13</td><td rowspan="5">< 5</td><td>≥ 1</td></tr>
<tr><td>19</td><td rowspan="4">> 1</td></tr>
<tr><td>25, 30, 31, 33, 34, 36</td></tr>
<tr><td>60, 61, 62, 63, 64, 65, 68, 69, 70, 71, 72, 73, 75, 76</td></tr>
<tr><td>66, 67</td></tr>
<tr><td rowspan="4">medium</td><td>9, 10, 11, 12, 13</td><td rowspan="3">≥ 5</td><td>> 1</td></tr>
<tr><td>8, 14, 15, 20, 21, 22, 23</td><td rowspan="3">≤ 1</td></tr>
<tr><td>25, 30, 31, 33, 34, 36, 55, 56, 58, 59</td></tr>
<tr><td>42, 43, 44, 47, 48, 50, 51, 52, 53, 54</td><td>< 5</td></tr>
<tr><td rowspan="2">strong</td><td>37, 38, 40, 41</td><td rowspan="2">≥ 5</td><td rowspan="2">> 1</td></tr>
<tr><td>42, 43, 44, 47, 48, 50, 51, 52, 53, 54</td></tr>
</table>

Source: Sáňka and Materna (2004)

The skeleton content is expressed by the total volume content of gravel (solid particles of rocks from 4 to 30 mm) and stone (solid particles of rocks over 30 mm).

Table 2. Characteristics of the skeleton code

ESEU numeric code	**Skeleton code**	**Characteristics of the skeleton code**
0	0	skeletonless, with admixture
1	0- 1	skeletonless, admixed, weakly skeletal
2	1	weakly skeletal
3	2	medium skeletal
4	2	medium skeletal
5	1	weakly skeletal
6	2	medium skeletal
7	0-1	skeletonless, admixed, weakly skeletal
8	2-3	moderately skeletal, strongly skeletal
9	0-3	skeletonless, admixed, weakly skeletonized, moderately skeletonized, strongly skeletonized

Source: Decree No. 227/2018 Sb.

Humus (organic matter) content is a very important parameter affecting soil fertility and soil function in the ecosystem. It is determined by determining the oxidisable organic carbon (C_{ox}) and multiplying it by a conversion factor of 1.724 to humus. This conversion is valid assuming that humus contains 58 % carbon. The C_{ox} values for each (predominant) species (Cambyses, chernozems, luvised soils, brown soils, pseudoclays, fluvised soils) were taken from Sáňka (2001) In: Sáňka and Materna (2004). Characteristics of the territory of the Czech Republic in terms of soil types were taken from soil maps (MoE, 2021 online).

Soil moisture data: there are only indicative values for the ranges of hydrolimits (see Table 3).

Table 3. Average values of soils in the Czech Republic for maximum capillary water capacity for individual soil types.

Soil horizon	**Type of soil**						
	sandy	Clay sandy	Sandy clay	Clay	Clay clay	Clay	Clay
	Maximum capillary water capacity (%)						
topsoil	Non-def.	30.73	34.87	35.24	37.77	41.26	46.48

Source: Kňákal, 2000, In: Sáňka and Materna (2004)

The classification of agricultural land in the CR by grain size is based on knowledge of ESEU codes. The ESEU codes of agricultural soils registered in the LPIS database will be used. Its scope is in line with the records of sown areas kept with the Czech Statistical Office. The methodological basis for the assessment of the grain size will be the ESEU code (Annex 3 to Decree No 227/2018 Sb.) In each climatic region (code 0-9), main soil unit will be filtered by software for each region of the Czech Republic (ESEU double numbers: 1-78) depending on the characteristics of the type of agricultural soil, i.e. with regard to its soil grain size (sandy, sandy loam, clay, clay loam, clay).

The exogenous variable (x) will be the average official price for the cadastral territory. The endogenous variable will be the market price for the cadastral territory of the Příbram district. A simple regression analysis of the form y = f(x) will be used. In the regression analysis, a test of the null hypothesis (no relationship, H0: $b_1 = 0$) is performed using Student's t-test (simple regression model). This tests the statistical significance of the absolute term and the 'b' coefficient of the function ($y = bx + a$) at the $\alpha=0.05$ significance level. "Deciding whether or not the null hypothesis is valid is done by comparing the resulting p-value of the test with the chosen significance level α, with the null hypothesis being rejected when the p-value of the test falls below this level." (Holčík and Komenda, 2015) Thus, if the significance level reached is $p<0.05$, then the whole model is statistically significant.

3. Results and Discussion

Soil quality in the Czech Republic is normally assessed according to the characteristics included in the ESEU codes (climate, soil unit, stonyness, land slope, soil profile, etc.) The characteristics given in the article are information on soil type, soil water content, compaction risk, gravel and humus content in soil. These properties are also based on ESEU values, but their comprehensive quantification is based on other normative (biological, chemical, geological) indicators. The district of Příbram is located in the Central Bohemian Region. The Central Bohemian Region has an area of 5,579,411,000 agricultural land (2021). It is the 3rd region (after the South Moravian and Olomouc regions) with the highest soil quality in the Czech

Republic (excluding Prague). The information is based on a study of the average official price for the region. 92.8 % of the district is located in a moderately warm and moderately humid climate region and 7 % of the area has a moderately warm and dry climate.

According to the characteristics of the main soil unit – ESU (Decree No. 227/2018 Sb.; LPIS, MoA, 2021) it was found that the region has 18.47 % light soils (sandy, loamy), 71.49 % medium-heavy soils (sandy loam, clay) and 9.74 % of heavy soils (clayey clay, clayey, clay). The distribution land corresponds to the national average.

In Central Bohemia there are 45 % of cambizems, 10 % of chernozem, 8% of luvisol, 7 % of brown soil (authors according to MoE, 2021 online). Cambizem is generally the most widespread soil type in the Czech Republic. In these soils there is a strong internal weathering, the soil is enriched with a large amount of clay. Soil particles are colored brown due to iron compounds (Němeček et al, 2008). According to the affiliation to the soil type (according to ESEU), water capillarity was calculated in the region (Kňákal, 2000), which corresponds to 34.59 % by volume. This value is at the level of the Czech average. The content of the skeleton in the soil is expressed by the total volume content of gravel (solid particles of rocks from 4 to 30 mm) and stone (solid particles of rocks over 30 mm). According to the ESEU code, the extent of without skeletal soils (45.30 % of the territory) and weakly skeletal soils (39.22 % of the territory) was determined. Compaction is a widespread phenomenon of physical damage to the soil, mainly due to heavy mechanization or excessive grazing. There is a degradation of the soil structure, which carries with it a potential threat to other soil functions: the soil has reduced porosity, infiltration capacity, plant growth and biological activity is limited. The analysis of the ESEU code (stone content) and the categorization of soils according to the degree of risk of degradation of their ecological functions (Lhotský, Damaška, 1989 In: Sáňka and Materna, 2004) calculated that 64.17 % of the area suffers from compromise risk. This value is slightly below the Czech average (66.67 %).

Table 4. Selected additional quality indicators (%)

	Water capacity	Skeletal content in soil up to 10 %	Risk of compaction (moderate to severe)	Humus	Average official land price (2020)	Size of agricultural land in the territory
	% in topsoil	% of the area of the region	% of the area of the region	% in soil	CZK/m^2	ha
District Vysočina	33.49	11.26	44.68	2.4771	4.90	407 771
Plzeňský District	34.16	13.23	50.34	2.4613	7.72	376 919
Jihočeský District	34.00	14.47	51.13	2.5558	4.68	488 747
Moravskoslezský District	34.44	39.40	58.80	2.4549	5.63	272 901
Středočeský District	34.59	45.30	64.17	2.4338	8.95	657 928
Prague	34.55	61.80	64.38	2.4338	10.80	19 573
Jihomoravský District	35.07	63.45	68.55	2.5483	10.71	422 497
Karlovarský District	33.74	5.09	69.39	2.5558	3.87	124 314
Ústecký District	35.17	40.74	76.33	2.5515	7.39	274 592
Olomoucký District	34.37	56.48	80.46	2.4638	9.60	276 887

Liberecký District	34.21	36.86	82.89	2.3889	5.19	139 503
Zlínský District	36.95	45.31	89.64	2.4481	7.77	192 368
Pardubický District	34.69	39.84	89.68	2.4436	7.42	369 898
Královehradecký District	35.18	46.52	92.67	2.3491	8.41	276 306

Source: authors according to Decree No. 441/2013 Sb., No. 227/2018 Sb., No. 298/2014 Sb., LPIS, MoA (2021), COSMC *(2021), Sáňka.and Materna (2004)*

Note: Percentage of humus in the soil calculated according to the knowledge of 60-90 % of the predominant soil type (cambizem, chernozem, brown soil, luvisol, etc.)

The average official price per territory was calculated as the weighted average price of ESEU (CZK / m^2) according to the price decree and the size of the cadastral area within the region (m^2)

According to the representation of soil species (MoE, 2021) in the Central Bohemian Region, the amount of humus in the soil was estimated according to the Cox index (Sáňka, 2001). This corresponds to 2.43 % (corresponding to the medium supply of humus in the soil). Slightly higher values were found, for example, in the South Moravian Region, where there is about 38 % chernozem (% humus: 2.54 %) or in the Ústí Region, where the percentage of quality chernozem is at the level of 20 %.

The whole set of cadastral territories of the Příbram district includes 302 cadastral territories. Official prices (2021) in the district are in the range of 1.33 - 7.74 CZK /m^2 (district average = 5.75 CZK/m^2, Czech Republic average = 7.13 CZK/m^2) (COSMC, 2021; LPIS, 2021) and market prices in the range of 22 - 39 CZK/m^2 (farmy.cz, 2021). The regression and correlation analysis quantified and confirmed a statistically significant relationship between the official and market price of agricultural land. Confirmation of this relationship was expected because the official price is one of the basic guidelines for setting market prices. There are a number of other important factors that affect the market price (see research). The relationship between the two types of prices had to be quantified statistically. Access to comprehensive market price data for a basic territorial unit (cadastral area) is relatively complex. The output of this study is all the more valuable. Both the market price (dependent variable; y) and the official price (dependent variable; x) are metric variables (i.e., they are measured at the interval level). There are no outliers in the data that can seriously disrupt the equation parameter estimates. A functional relationship between variables has been generated. The function has the form: $y = 21.70079 + 1.70995x$. The relationship was confirmed at the level of significance $\alpha = 5$ %. That is, it is possible to reject the null hypothesis (the relationship does not exist). 95 % of this relationship was confirmed. P-values (Table 5) are less than 0.05. The linear dependence between the variables is strong, resp. tight (regression coefficient = +0.77 and correlation index R2 = 0.59). The value of the market price (y) is 59 % explained by the size of the average official price (x). A regression coefficient of 1.7 indicates how much the market price will rise on average when the official price rises by one. The standard deviation of the independent variable (x) is 0.036 CZK. It is a low value. The individual cases in the file do not differ much from each other. (resp. does not differ from the average of x values). The values of the set are not very variable, which is better than in the case of high heterogeneity of values.

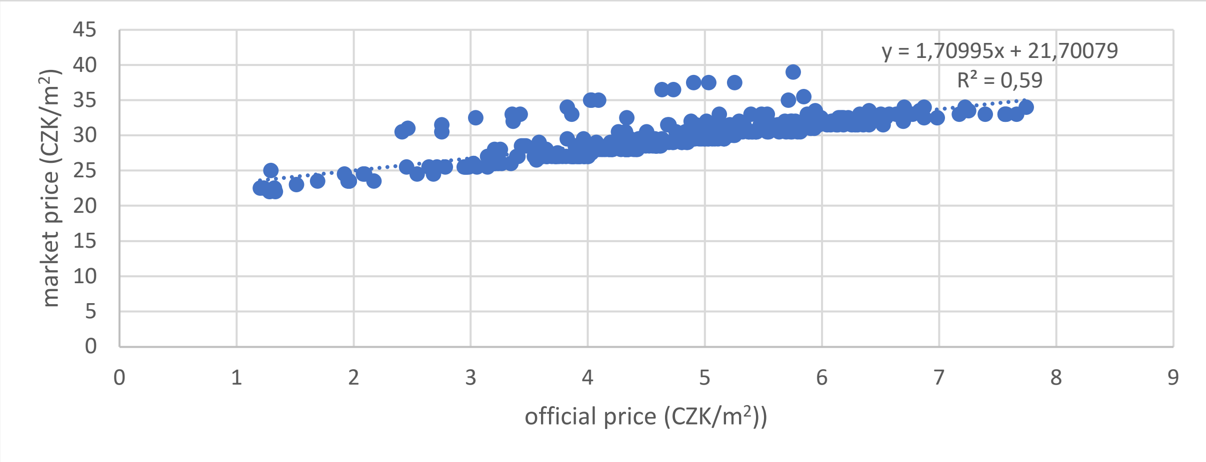
Table 5. Description of the regression relationship between official and market land prices

N=215	Regression results with the dependent variable: Market price in Příbram district, $R=0.23264842$, $R^2= 0.05412529$, adjusted R^2 = ---- F(1,11)=0.62945, p<0.44434 standard error of estimate: 380.26					
	b*	Standard error z.b.*	b	Standard error z.b	t (300)	p-value
Absol.			21.70079	0.398270	0.723743	0.00
Official land	0.768148	0.036966	1.70995	0.082289	20.77977	0.00

Source. Authors according to Decree No. 298/2014 Sb., market prices of agricultural land in Příbram district (farmy.cz, 2021 online), STATISTICA, version 14

Figure 1 shows the relationship between the official price and the market price (in CZK/m^2).

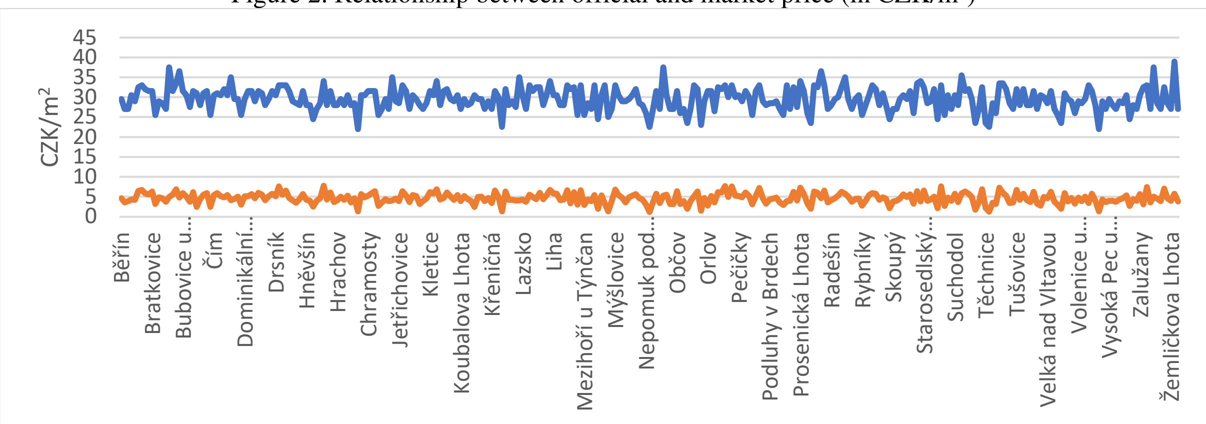
Figure 1. Relationship between official and market price (in CZK/m^2)



Source. Authors according to Decree No. 298/2014 Sb., market prices of agricultural land in Příbram district (farmy.cz, 2021 online).

Figure 2 shows the stable development of the price interval between the variables (official and market price) for 302 cadastral territories (the territory of Příbram).

Figure 2. Relationship between official and market price (in CZK/m^2)



Source. Authors according to Decree No. 298/2014 Sb., market prices of agricultural land in Příbram district (farmy.cz, 2021 online).

In the context of valuation, the importance of sectoral policy in relation to agriculture needs to be given particular attention in the future. The importance of this factor is not clear.

The current EU policy on financial support for agriculture (CAP), by limiting farming intensity and introducing decoupling, increases the variability of agricultural prices (Kułyk, 2016; Monge et al., 2016), and thus of land prices. Higher land price variability has an adverse effect on farmers' long-term decision-making and reduces their willingness to purchase land for agricultural production purposes. On the other hand, the value of agricultural land is enhanced by various government programs. Land markets in transition countries are characterized by higher levels of transaction costs, which represent a barrier for agricultural enterprises wishing to expand their operations (Luca and Alexandri, 2010). Nevertheless, a dynamic growth in agricultural land trade is observed in these countries, leading to an increase in land prices. This process leads to large disparities between regions. This should be noted in the Czech Republic as well, and in the future the authors plan to assess the relationship between official and market land prices in other districts.

4. Conclusion

The case study showed that the official price of agricultural land has a significant effect on the market price. The official price in the selected area of the district of Příbram (34,781 ha, agricultural land, COSMC, 2021) correlates with the market price of 59 %. Statically, this relationship was confirmed and tested at a significance level of $\alpha = 5$ %. The relationship between the variables is logically justifiable. The official price informs about the quality of agricultural land. One of the factors that affect the market price is its quality. Other factors are the distance of the land from the city, size, shape, property relations.

The availability of market prices for individual regions in the Czech Republic is very limited. Real estate agencies do not normally provide more data. They do not provide their know-how even for a fee. For these reasons, the authors (Medonos et al, 2011; Curtiss et al, 2013; Hruška and Vilhelm, 2015) work only with smaller territorial units and are based on their own surveys and COSMC data. Insufficient database in the area of market prices is negatively reflected in the proposals of new methodologies for the valuation of agricultural land. New methodologies of market valuation of land (e.g., NAZV QK1910299) want to build on production characteristics and enrich them with non-production approaches. In the absence of market data (tightness of the relationship between market and official prices), this handicap must replace the starting points of previous partial research.

We are currently facing a climate and environmental crisis. According to Green Deal, the solution lies in the transition of European agriculture to agroecology. The Biodiversity and Farm to Fork strategies are important for strengthening landscape resilience and soil quality. On the other hand, organic farming cannot form the food base for a densely populated Europe. It is appropriate to promote the retention of quality agricultural land in the agrarian sector, to seek trade-offs between intensive farming and farmland protection, including increasing the allocation of carbon in the soil. A functioning market for agricultural land can support market pricing, particularly with regard to its quality. Significant inputs into high quality agricultural land will provide incentives to maintain its high quality. For example, expenditure on soil improvers (lime, peat, sludge, sand and synthetic foams) or investment in soil (land reclamation or flood protection) is suggested.

Acknowledgements
This paper was created within the framework of the project NAZV QK1910299 - Sustainable management of natural resources with emphasis on non-productive and productive capabilities of soil.

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MARKETING POSITIONING OF CULTIVATED MEAT

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Annotation: Cultivated meat, as a product that can be characterized as a paradigm innovation, must be characterized for customers in terms of its marketing position before it can be marketed. The analysis of communication on the social network Instagram was chosen for this area in this research. Based on extracted data, which contained 2 264 messages created by 423 individual users - 97% of the posts which are published k on Instagram in connection with the hashtag #cultivatedmeat to 5th March 2022. An analysis of communication on the Instagram social network in the field of cultivated meat identified five main areas that define cultivated meat: 1) sustainable meat 2) future food 3) alternative protein 4) clean meat 5) vegan food. The fifth very important area is the area of vegan food, which is an area that is widely discussed on social networks and is just raising the question for qualitative research. Is cultivated meat alternative meat for vegan?

Keywords: Cultivated meat, Marketing positioning, Sustainable food, Future food, Clean meat, Vegan food

JEL classification: Q13, Q15, O13

1. Introduction

Cultivated meat refers to the meat produced through *in vitro* cell cultures as part of the efforts to bridge the gaps in demand and supply of proteins to the growing global population (Ong *et al.*, 2021). Thanks to the innovations that this meat production process has seen in recent years, it is possible to produce this meat without added antibiotics and steroid hormones. This shift in meat production without added antibiotics and steroid hormones has created a whole new perspective on cultivated meat and has attracted a large number of investors who have invested over $ 1.2 billion in this technology in 2021 (Janice Bitters Turi, 2021). At the same time, the area of cultivated meat has reached areas that are supported by the European University's research plan. Specifically, these are interventions in the Farm to Fork Strategy a flagship initiative under the new European Green Deal. Social media analysis is a tool that identifies values, attitudes and experiences with selected area by analyzing large data that are created through active and passive tracks by social network users (De Veirman, Cauberghe and Hudders, 2017; Pilař *et al.*, 2017; Childers, Lemon and Hoy, 2019; Zhang *et al.*, 2020). This analysis is necessary to identify and set up the marketing positioning of Cultivated meat.

Theoretical background

According to (Stephens, Sexton and Driessen, 2019), the first study on cultivated meat was through NASA-funded laboratory research. Over the years, the technology of cell-based meat has matured, attracting more studies as part of the efforts to address the nutritional needs of the global population.

Proponents of cultivated meat, however, project it as a safe, environment-friendly, and humane alternative to slaughtering animals (Datar and Betti, 2010). Some of the fears surrounding the adoption and consumption of cultivated meat are attributed to the associated myths. In their analysis of the myths about cultivated meat, (Chriki and Hocquette, 2020) observed that there are uncertainties about the long-term effects of these products. The researchers further noted that dysregulation of cell multiplication as occurs in cancer cells is possible in these *in vitro* products. However, (Chriki and Hocquette, 2020) indicated that it is possible to control the nutritional quality of cultivated meat. The researchers further outlined the possibility of increasing their composition of omega-3 fatty acids. However, it could be a challenge to control the micronutrient composition of cultivated meat.

Other studies propose cultivated meat as the solution to the ethical and environmental issues associated with conventional meat. (Bryant, 2020), for instance, indicated that besides cultivated meat helping to overcome ethical and environmental issues, it could be exploited to improve public health. However, their use may present a new set of challenges ranging from social issues to economic impacts. Among the social issues of concern include consumer appeal, negative media coverage, and consumer acceptance of cultivated meat as an alternative to conventional meat (Bryant, 2020). The sentiments are echoed by (Treich, 2021) in his analysis of the promises and challenges of cultivated meat. According to (Treich, 2021), it is difficult for the public to embrace cultivated meat without an evidence-based understanding of its long-term safety. Nonetheless, the author also affirms that cultivated meat could be a significant moral improvement to conventional meat, particularly in the conventional meat harvesting practices.

Mainstream adoption of cultivated meat is unlikely soon according to (Stephens *et al.*, 2018). The researchers noted that while the technology is promising in its early stages, it is bound to face technical impediments which may include the sources of the cells and the need to mimic *in vivo* myogenesis. Also, bioprocessing of the cultivated meat for commercial-scale may be a major challenge that could be further complicated by ethical concerns and lack of consumer acceptance (Stephens *et al.*, 2018). The fears over the commercial viability of the technology are also expressed by (Dolgin, 2020) who observed that lab-grown meat is currently stuck in the experimental stage. (Dolgin, 2020) further pointed out that the commercial viability of this technology will depend on the ability to grow the tissues efficiently on a large scale. Based on a study at Newcastle University, (Dolgin, 2020) noted that it may not be possible to achieve the growing cells at a large scale using the types of batch bioprocessing that exist currently. Therefore, it will be necessary to fine-tune culture conditions and characterize the potential social and ethical constraints before this technology can be expanded to feed the global population (Kadim *et al.*, 2015). Besides, it will be essential to restore the confidence of consumers in *in vitro* products such as cultivated meat. This will make it possible not only to produce the product on a large scale but to market it to receptive consumers as well (Sergelidis, 2019). It will equally help to eliminate the ethical concerns of having to kill animals to harvest their organs to satisfy the protein needs of humans (George, S, 2020)**.** The author further notes that cost-effective production of the cultivated meat could lead to cheaper meat that could lure more people from conventional meat if the ethical issues around *in vitro* food products are addressed.

Fears over consumer acceptance of the products are further outlined in the article by (Rolland, Markus and Post, 2020)**.** The study showed that limited information could be a contributing factor to the perceived consumer skepticism over cultivated meat. The study by (Rolland, Markus and Post, 2020) revealed a willingness of some consumers to pay premium prices for cultivated meat which they evaluated as having better taste than conventional meat. Part of the campaign to promote the food could focus on the significant role that biotechnology has played in prompting food security as outlined by (Wurgaft, 2020). In his review, (Wurgaft, 2020) suggested that a core objective of cultivated meat is to develop an alternative to the environmentally damaging animal-sources meat. This could be cited as a key driver for the development of alternative meat. It could thus help to popularize cultivated meat. By sharing positive information about the technology, (Rolland, Markus and Post, 2020) believe that the consumers may be receptive to the technology and its products. This could also boost its competitiveness against conventional meat.

In terms of the long-term viability of the project, (Kamalapuram, Handral and Choudhury, 2021) noted that the projected growth in the global population will be associated with a concurrent increase in demand for meat. In India, for instance, the researchers established that 35% of the total protein requirements are sourced from meat. Such high meat intake to meet the protein needs of individuals will necessitate alternative sources to supplement animal-sourced proteins. However, the success of the proposed technology requires that consumer concerns are adequately addressed through effective and transparent communication (Rolland, Markus and Post, 2020; Pakseresht, Ahmadi Kaliji and Canavari, 2022). More importantly, it is necessary to guarantee the safety of the products consumed by humans (Ong *et al.*, 2021). This necessitates further research on both the short-term and long-term safety of cultivated meat products before they can be commercialized as alternatives to conventional meat.

Cultivated meat is projected to revolutionize the meat industry by providing a sustainable alternative to killing animals (Arshad *et al.*, 2017). According to (Merck, 2021), global demand for meat is projected to increase by 70% while a 92% potential reduction in the impacts of global warming on climate change is also projected. In terms of pricing, (Merck, 2021)projects that cultivated meat will retail at $5.66 per kilogram by 2030. This will make the meat products competitive and sustainable. The reviewed studies thus affirm that despite the existing challenges, cultivated meat technology could be fine-tuned to address the global protein needs. This is more critical in the wake of the projected growth of the global human population which will result in a surge in the demand for meat products.

2. Materials and Methods

The data analysis was based on the SMAHR framework (Pilař *et al.*, 2021). SMAHR is a framework that is focused on Social media analysis based on hashtag research, which has already been used successfully in areas Farmers market (Pilař *et al.*, 2018), Sustainability (Pilař *et al.*, 2019), Healthy food (Pilař, Kvasničková Stanislavská and Kvasnička, 2021), Corporate Social Responsibility (Kvasničková Stanislavská *et al.*, 2020) or Gamification (Pilař *et al.*, 2019). The data analysis process was based on the SMAHR framework, which is consisted of four main steps:

1) ***Data acquisition:*** the Instagram social network was used for data. Instagram Scraper was used to obtain data. The software extracted messages that used the hashtag #cultivatedmeat. The extracted data contained 2 264 messages created by 423 individual users. It is 97% of the posts which are published on Instagram in connection with the hashtag #cultivatedmeat (relative to March 5, 2022).

2) ***Content transformation:*** All letters were transformed into lower-case letters to prevent potential duplicates. The dataset was imported into Gephi 0.9.2 software via the default import module. Hashtag network was created based on hashtag interdependence.

3) ***Data mining:*** The following methods were used to describe the hashtag network: (a) Degree: The number of links incident upon a hashtag, (b) Eigenvector centrality: This is an extension of degree centrality, which measures the influence of hashtags in a network. Eigenvector centrality is calculated based on the premise that connections to hashtags with high values of degree centrality values have a significant influence than links with hashtags of similar or lower values of degree centrality values.

Eigenvector centrality was calculated as follows:

$$x_v = \frac{1}{\lambda}\sum_{t\in M(v)} \quad x_t = \frac{1}{\lambda}\sum_{t\in G} \quad a_{v,t}x_t, \tag{1}$$

where $M(v)$ denotes a set of adjacent nodes and λ is the largest eigenvalue. Eigenvector x can be expressed by Equation (2):

$$Ax = \lambda x. \tag{2}$$

4) ***Knowledge representation:*** a procedure that uses visualization tools to represent the results of data mining. Knowledge representation is based on the synthesis of individual values and outputs from the data evaluation phase.

3. Results and Discussion

The analysis revealed the use of 2 806 unique hashtags.

Based on the eigenvector centrality, the 5 most important hashtags that social network users associate with cultivated meat were identified: 1) #sustainability 2) #futurefood 3) #altproteing 4) #cleanmeat 5) #vegan (see table 1).

Table 1. Top hashtags sorted by Eigenvector-centrality

No.	Hashtag	EVC	Degree	No.	Hashtag	EVC	Degree
1	#cultivatedmeat	1	2805	11	#vegan	0,371132	617
2	#culturedmeat	0,570914	1143	12	#alternativeprotein	0,365988	593
3	#cellbasedmeat	0,470935	833	13	#plantbased	0,364172	640
4	#sustainability	0,464598	830	14	#sustainablefood	0,347135	521
5	#foodtech	0,460038	802	15	#climatechange	0,336911	527
6	#cellularagriculture	0,410873	708	16	#labgrownmeat	0,328957	550
7	#futurefood	0,407574	655	17	#innovation	0,319427	504
8	#altprotein	0,407271	664	18	#cellag	0,31903	508

9	#futureoffood	0,397715	704	19	#meat	0,31036	530
10	#cleanmeat	0,388026	673	20	#foodinnovation	0,298603	417

Source: Own calculation based on Instagram social network data
Note: EVC – Eigenvector-centrality

Similar results can be identified based on the degree value (see table 2).

Table 2. Top hashtags sorted by Degree

No.	Hashtag	EVC	Degree	No.	Hashtag	EVC	Degree
1	#cultivatedmeat	1	2805	11	#plantbased	0,364172	640
2	#culturedmeat	0,570914	1143	12	#vegan	0,371132	617
3	#cellbasedmeat	0,470935	833	13	#alternativeprotein	0,365988	593
4	#sustainability	0,464598	830	14	#labgrownmeat	0,328957	550
5	#foodtech	0,460038	802	15	#meat	0,31036	530
6	#cellularagriculture	0,410873	708	16	#climatechange	0,336911	527
7	#futureoffood	0,397715	704	17	#sustainablefood	0,347135	521
8	#cleanmeat	0,388026	673	18	#cellag	0,31903	508
9	#altprotein	0,407271	664	19	#innovation	0,319427	504
10	#futurefood	0,407574	655	20	#foodinnovation	0,298603	417

Source: Own calculation based on Instagram social network data
Note: EVC – Eigenvector-centrality

Based on the value of Eigenvector Centrality, it is possible to identify 5 main hashtags (except #cultivatedmeat and #cultured meat, which were targeted).

In the first place, it is possible to identify the hashtag #cellbasedmeat, which is a synonym for use with cultivated meat or cultured meat (Reis et al., 2020). A very important result of this research is the identification of the hashtag #sustainability in second place. Based on this finding, it can be argued that the main value identified by users on the Instagram social network in connection with cultivated meat is sustainability. This is a connection with the environmental area, which is currently highly important for young generations in terms of their shopping behavior. This is followed by hashtags #foodtech, which is a categorization hashtag in terms of Food technology, and hashtag #cellularagriculture, which is another associated hashtag to #cellbasedmeat. There are highly interesting hashtags on the seventh and eighth bowls. It's a hashtag #futureoffood and #cleanmeat. #Futureoffood implies a belief in the future of this product and #cleanmeat, which refers to meat grown from animal cells rather than rearing animals (Bryant et al., 2019), in terms of reducing the global problem of climate change, animal cruelty and antibiotic resistance (Garnett, 2009; Lavon, 2022). This is followed by the hashtag #vegan, which is a hashtag associated with the vegan diet (the absence of animal abuse not only for food but for entertainment). Here, a debate begins on social networks as to whether cultivated meat is acceptable to vegans.

Results focusing on hashtags by Degree yielded similar results. In addition to the hashtags listed in Table 1, there is a #sustainablefood hashtag in Table 2, which again refers to the value of this product (Nobre, 2022).

Future research:

Based on the identified hashtags - #sustainability, #cleanmeat and #vegan, it will be interesting in further research to focus on individual categories of vegans, according to their reasons for choosing this diet in connection with potential customers of cultivated meat.

4. Conclusion

An analysis of communication on the Instagram social network in the field of cultivated meat identified five main areas that define cultivated meat: 1) sustainable meat 2) future food 3) alternative protein 4) clean meat 5) vegan food. These results suggest that the most associated value with cultivated meat is sustainability, which is in line with the principle of the product. Another important aspect is the area of future food, which indicates that social network users consider cultivated meat to be the meat of the future, so it can be assumed that they believe in the success of this product. There is also the area of alternative protein and clean meat, which indicates a positive attitude in terms of environmental perspective. The fifth very important area is the area of vegan food, which is an area that is widely discussed on social networks and is just raising the question for qualitative research. Is cultivated meat alternative meat for vegan?

Acknowledgements
This study was supported by the Internal Grant Agency (IGA) of FEM CULS in Prague, registration no. 2020B0004—Use of artificial intelligence to predict communication on social networks.

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EVALUATION OF INVESTMENT IN PHOTOVOLTAIC POWER PLANT IN THE AGRICULTURAL SECTOR

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Annotation: The European Union is forcing itself to reduce non-organic production due to its commitments in the field of CO2 reduction. Modern society is looking for and must look for new sources of energy. Factors influencing the consumption trend clearly indicate future growth in energy consumption and prices. It is therefore appropriate to look for new ways to save energy. Especially recently, the need for effective savings in energy consumption by households and companies has been growing. Photovoltaics is a technology for the direct conversion of solar radiation into electricity without moving parts. It is the most affordable renewable energy source on earth - solar radiation. This article deals with the evaluation of the energy performance of an investment in a photovoltaic power plant with a focus on the industrial use of decentralized energy production. A photovoltaic power plant was designed on a selected agricultural enterprise in the Czech Republic. Maximum capacity utilization of roofs is considered. The result is a power plant with an output of 397.9 kWp and the annual energy production is evaluated.

Keywords: Photovoltaic power plant, Agricultural enterprise, Green Deal, Energy, Investment

JEL classification: Q42

1. Introduction

Until 1989, the Czech Republic was a highly energy-intensive country. With the change of regime after 1989, the situation improved noticeably due to the transformation of the structure of the economy, in particular by reducing the share of heavy industry. The high energy intensity of the Czech Republic has its historical origins in the focus on solid fuel-intensive industries, which have been reinforced by a period of high emphasis on heavy industry. Unfortunately, the Czech Republic today remains a highly energy-intensive country, more than double the EU average. The current energy policy of the Czech Republic is to a large extent influenced by the EU, resp. EU energy targets that Member States are obliged to meet. In 1992, the Energy Policy of the Czech Republic was adopted as the defining document of energy policy, focusing on the transformation of the Czech economy from a centrally managed to a market-based economy. The State Energy Policy of the Czech Republic of 2000 already defines the direction of energy policy more specifically. The problem was that the given conceptual documents had no support in the law, which changed with the adoption of the key energy laws, Act No. 406/2000 Coll., on Energy Management (hereinafter referred to as the Energy Management Act) and Act No. 458/2000 Coll., on the Conditions of Business and the Exercise of State Administration in Energy Sectors and on Amendments to Certain Acts. (European Commission, 2011; European Commission, 2014; European Commission, 2019; European Commission - Europe 2020)

The Czech Republic is considered a highly energy-intensive country due to its high share of industry and fossil fuel combustion. On the other hand, according to the IEA Czech Republic 2010 Review, the Czech Republic is one of the countries with the largest decrease in energy intensity in the period 1990-2010. In the Czech Republic, energy is obtained mainly by burning solid fuels, followed by nuclear energy and then renewable energy. The energy intensity of the Czech Republic is more than double the EU average (per capita), so there is considerable potential for reducing energy intensity. However, it should be noted that the scope for increasing energy efficiency, especially through renewable energy sources, is considerably limited in the Czech Republic due to its unfavourable geographical location.

If the Czech Republic wants to meet its commitments, it is clear that it is necessary to abandon this stagnation and be more progressive in relation to the production of electricity from renewable energy sources, for example by promoting energy decentralisation. A defining trend in the future will be the decentralisation of energy production through domestic micro-power plants, through so-called self-consumers or associations of self-consumers (renewable energy communities, which could be considered as a kind of energy cooperatives). There is a clear trend towards involving citizens in the energy sector and making them active consumers who are not merely passive recipients but actively participate in the energy market. (Špička and Jelínek, 2008).

If the Czech Republic wants to meet its commitments, it is clear that it is necessary to leave this stagnation and be more progressive in relation to the production of electricity from renewable sources, for example by supporting energy decentralization. The determining trend for the future will be the decentralization of energy production through domestic micro-power plants, through so-called self-consumers or self-consumer associations (renewable energy communities, which could be considered a type of energy cooperatives). There is a clear trend to involve citizens in the energy sector and to make them active consumers who are not only passive beneficiaries but are actively involved in the energy market. (Špička and Jelínek, 2008).

Energy sectors

1. production;
2. energy transport;
3. transformation;
4. Production of secondary fuels;
   - refineries, power plants, heating plants, coking plants, ...
5. Consumption.
   - Energy
     1) energy sector
     2) industry - NACE
     3) transport
     4) other - households, services, agriculture
   - non-energy - fuels as raw materials

Energy policy can be seen as a fundamental pillar of contemporary European integration to reduce dependence on energy imports and minimize possible energy and economic crisis, together with the principle of sustainable development. This effort is reflected in the target of reducing energy consumption by 20 % by 2020 as part of the Europe 2020 strategy. Within the EU and its policies, the EU energy policy is considered one of the key policies of European integration, the focus of which lies precisely on improving energy efficiency and can be expected to grow in importance in the future. Energy savings should be seen in a broader framework, in that the aim of increasing energy efficiency is generally built on the following three aspects:

- economic;
- environmental;
- social.

(European Parliament, 2021; Renewable energy in Europe 2017, 2017)

- The EU imports more than 2/3 of its oil products and 26% of its gas from outside the EU;
- The EU takes around 30% of all its oil and gas consumption from Russia;
- Six Member States are entirely dependent on a single external supplier for their gas imports;
- 75% of residential buildings in the EU do not meet energy efficiency requirements;
- Energy consumption in the EU fell by 5.9% between 2005 and 2017;
- 94% of transport depends on oil products;
- Wholesale prices are 30% higher for electricity and more than 100% higher for gas than in the US.

(Euroskop.cz, 2022)

Main trends in the energy sector

- Energy efficiency
  (1) a major source of energy for growing demand
- Low and emission-free technology
  (2) RES are already the fastest-growing sources, but the pace is insufficient to meet global climate goals, while they are the cheapest sources
  (3) how other low and zero-emission sources can help
- Digitization
  (4) a tool for the implementation of modern and decentralised resources
  (5) a tool for new business opportunities
- Electricity is a "mass commodity"
  (6) transported through networks, similar to gas and water;
  (7) the method of collection is similar (as opposed to regular goods, where the supplier delivers the quantity just ordered and the order cannot be changed at the time of receipt);
  (8) network commodities are "taken" from the network by the consumer, so that the consumer is constantly deciding on his order in real time by his actual consumption;

(9) building networks is demanding both in terms of investment, material, time and demands on the surrounding area (public space);

(10) the return on investment in the power sector environment is usually above 10 years, while the physical and economic lifetime is usually well in excess of 20 years (up to 60 years for nuclear power plants).

(International Energy Agency, 2020)

The aim of this paper is the calculation and design of a photovoltaic system for a farm.

2. Materials and Methods

A photovoltaic power plant converts light energy (photons) into electricity. The basic elements are solar panels and inverters. The following technologies and outputs are considered for the system design:

Inverters: SUN2000-60KTL-M0 (400)

Strings: 10 AWG (Copper)

Module: Longi Solar, LR4-72HPH-460M (460 W)

The technical design of the solution was modelled in the HelioScope software based on the object parameters. The first step of the modelling was to set the design of the solar system. Using an interactive map, the areas of the roofs on which the solar panels would be placed were first laid out. In the next step, the types of panels and inverters were specified based on the technical documentation.

In the case of solar panels, additional parameters were entered into the software that specified how the panels would be placed on each roof (mounting system), azimuth (south-facing orientation in degrees clockwise), slope depending on the roof slope and distance of the panels from me. Additional design configurations were then calculated in terms of the number and distribution of inverters in the system and the number of panels in parallel per string.

In the next stage of the modelling, the environmental parameters that impact the potential of the panels to generate electricity were set. The Metronome climate database was chosen to simulate solar radiation over the year. Another factor affecting the efficiency of solar panels is the level of pollution. A negative impact on the efficiency of 2% is considered standard, so the same value was used in the model. In addition, a 0.4% loss rate was set for the number of losses incurred by the transmission of electricity within the AC system, i.e. all devices (e.g. conductors or transformers) carrying the alternating electric current after its transformation in the inverter. The other variables (standard deviation of the amount of solar radiation, total temperature range of each solar cell, among others) were at the standard recommended values used.The above procedure was used to generate the data used as a basis for the amount of electricity produced in each year.

The resulting balance of produced and consumed electricity is a determining input for the economic assessment of the investment.

3. Results and Discussion

From 2021 onwards, we could see a significant increase in electricity prices (and not only electricity). This is partly due to the European Union's strategy in the form of the Green Deal for Europe and the burden of emissions permits on fossil fuel electricity generation. At the same time, the second trend in the sector is the requirement to switch to renewable energies with sub-targets for 2020, 2030 and a carbon neutral economy in 2050.

Based on the usable capacity of the roofs, a power plant with an output of 397.9 kWp was designed (Figure 1-3, Table 1-3). The northern roofs were not counted for their reduced capacity.

Figure 1. Roof capacity

Source: Own processing

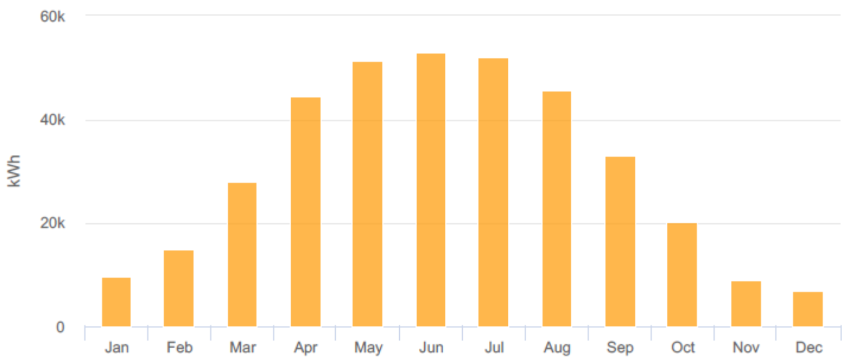
Table 1. Calculation outputs

Module DC Nameplate	397.9 kW
Inverter AC Nameplate	300.0 kW, Load Ration1.33
Annual Production	368.7 MWh
Performance Ratio	80.8 %
kWh/kWp	926.6
Weather Dataset	TMY, 10 km Grid, meteonorm

Source: Own processing

Rising energy prices in the strategy of emission allowances is a direct tool to support the transition to renewable energy sources and the decarbonisation of electricity. The reason is to force the industrial and agricultural sectors and households to produce their own electricity using photovoltaic panels.

Figure 2 Monthly production



Source: Own processing

However, the age of the transmission system in the Czech Republic is also a challenge for such a solution. It was built in the 1970s, but its load is increasingly significant. In recent decades, significant investment has been made in the construction of various logistics centers or satellite developments, but only minimal investment has been made in the transmission system to meet the demand in the localities. As a result, the network is overloaded and the distributor often fails to allow e.g. an increase of production and consequently an increase in consumption.

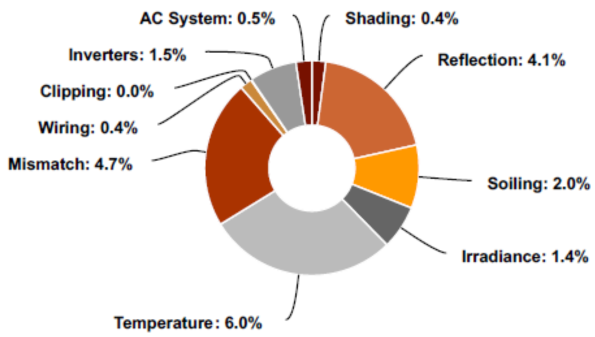
Table 1. Monthly production

Month	**GHI (kWh/m²)**	**POA (kWh/m²)**	**Shader (kWh/m²)**	**Nameplate (kWh)**	**Grid (kWh)**
January	25.1	29.0	28.9	10,597.3	9,717.6
February	39.8	44.2	44.0	16,254.4	14,939.2
March	77.7	83.7	83.4	31,040.0	27,981.9
April	131.6	136.7	136.2	51,145.1	44,620.2
May	159.6	162.0	161.3	60,632.5	51,554.4
June	167.8	168.7	167.8	63,176.5	53,087.1
July	164.0	165.0	164.2	61,732.4	51,903.3
August	140.7	144.6	144.0	54,032.0	45,505.9
September	97.4	103.0	102.6	38,294.3	33,078.4
October	56.6	61.8	61.6	22,806.4	20,319.3
November	25.2	27.7	27.6	10,138,5	9,144.3
December	17.1	20.8	20.7	7,535.3	6,828.3

Source: Own processing

The third issue is the forthcoming taxonomy framework for the agricultural and industrial sectors. The agricultural sector, for example, is a direct producer of greenhouse gases (methane, nitrogen oxides, carbon dioxide) in addition to energy consumption. Thus, the assessment of the overall carbon balance of the farm will be introduced in the form of a taxonomy and the assessment of electricity consumption will be an integral part of it. Other sectors are already assessed in a similar way in Western European countries.

Figure 3. Source of system loss



Source: Own processing

The Czech Republic is highly energy-dependent and the transition to RES can at least partially strengthen the balance of self-sufficiency or independence.

It can be said that the energy sector before and after the Green Agreement, before and after the pandemic situation of COVID-19, and before and after the conflict in Ukraine will be different.

Table 2. Annual production

	Description	**Output**	**% Delta**
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,103.2	
	POA Irradiance	1,147.3	4.0%
	Shaded Irradiance	1,142.3	-0.4%
	Irradiance after Reflection	1,095.8	-4,1%
	Irradiance after Soiling	1,073.9	-2,0%
	Total Collector Irradiance	1,073.9	0,0%
Energy	Nameplate	427,357.6	
	Output at Irradiance Levels	424,433.9	-1.4%
	Output at Cell Temperature Dearate	396,221.0	-6.0%

	Output After Mismatch	377,710.9	-4.7%
	Optimal DC Output	376,186.7	0.0%
	Inverter Output	370,542.8	-1,5%
	Energy to Grid	368,690.1	-0,5%
Temperature Metrics			
	Avg. Operating Ambient Temp.		22.6°C
	Avg. Operating Cell Temp		25.1°C
Simulation Metrics			
	Operating Hours		4562
	Solved Hours		4562

Source: Own processing

The values generated by the software represent only the first year of operation, it is necessary that the level of production in each month of each subsequent year of operation decreases linearly in accordance with the manufacturer's guaranteed level of performance. It reaches 97.5% in the first year and decreases by 0.6% in each subsequent year to the final 83.1% in the 25th year - the last year when the level of performance is guaranteed by the manufacturer. In the following years, a more conservative rate of performance degradation of 10% compared to the previous period can be considered. At 35 (the last year of the solar system's life), a performance level of 73% can be estimated, as confirmed by other studies (Gulkowski, Zdyb and Dragan, 2019; Chen et al., 2018; Venkateswari and Sreejith, 2019; Zeb et al., 2018).

At a price of EUR 840/kWp and 35% of the National Renewal Plan subsidy, the return on investment can be expected to be around 4 years. The price development of energy cannot be predicted objectively, and the price development of materials and structural elements of a PV plant is equally difficult to predict. The model is based on prices for April 2022. Physical implementation can be expected at the earliest with a six-month delay when prices will already be different.

Self-generation of electricity is the solution to energy savings (in view of price increases). In the case of the industrial sector, it can be said that competitiveness in its current form will no longer be possible. It will no longer be about competitiveness + eco, nor will it be just business in production, it will be business + eco. In the case of households that also use electricity for heating, it is absolutely necessary, in view of the rise in energy prices, to invest in photovoltaics, possibly in combination with a heat pump.

Especially on an industrial scale, decentralized electricity production will also relieve the transmission and distribution system. On the other hand, both systems can be strengthened by possible overflows.

Within the taxonomy, self-decentralized energy production will be one of the key indicators for the resulting positive impact classification. For example, the assessment of access to bank loans (eg interest rates) or access to subsidy incentives will be a manifestation of the inclusion in the taxonomy model.

4. Conclusion

For the Czech Republic, increasing energy efficiency is a unique opportunity to reduce its high energy intensity, which has its historical origins in its orientation towards heavy industry, as well as its energy dependence on imports of raw materials. The Czech Republic aims to make renewable energy sources a major energy source alongside nuclear power, but this may be limited to some extent by its geographical location. According to the OECD evaluation report, the Czech Republic has been successful in contributing to better environmental protection. The main recommendations of this report are directed toward the area of economic instruments and waste, where the Czech Republic has the greatest potential for improving energy efficiency. The deficit of the Czech Republic's energy policy is incomprehensible or insufficient legislation. However, it is not possible to say without further information which Member State has more appropriate or more stringent energy efficiency reduction requirements due to complicated comparability.

The years 2009 and 2010 marked an infamous photovoltaic boom for the Czech Republic. PV plants were implemented on agricultural land with the right to purchase energy at prices many times higher than the market value. Due to this boom, the development of photovoltaics in the Czech Republic was overlooked and in the new conditions, it became uneconomical to sell electricity to the grid.

At present, the opportunity to invest in PV power plants for the sale of surplus electricity at conditions close to market prices is opening up again. At the same time, it is again possible for PV power plants under the RES+ subsidy to be implemented on the ground in addition to the roof of the buildings. However, in any case, this must not be on agricultural land, but e.g. on brownfields or land for industrial development, if the zoning plan or potential environmental impact is in accordance with Act of the Czech Republic 100/2001 Coll.

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AGRI-FOOD MARKET SHOCKS AND THEIR IMPACT ON THE EU GREEN DEAL

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Annotation: The main aim of the paper is to identify significant price shocks in the markets of basic agri-food commodities, which are currently very closely reflected in the ability to implement the EU Green Deal. Based on the economic-statistical analysis of selected markets, a comparison of the development of world and domestic prices of selected commodities will be performed to identify the absorption of world market impulses into the Czech environment. Finally, the effects on the common market will be implied, which will conditionally interfere with the implementation of the Green Deal. To achieve the primary goal, the methods of statistical research are used. Basic data are drawn from the databases of the Czech Statistical Office, Eurostat and accredited identities for stock exchange or commodity transactions. The purpose of the proposed procedure is to identify significant shocks in the markets of major agri-food commodities and their projection into the market equilibrium mechanism with implications for the implementation of the EU Green Deal. The analysis results into the identification of shocks in major agri-food commodity markets and the evaluation of their impact on the partial equilibrium mechanism in conjunction with the set objectives of the Green Deal.

Keywords: Agri-food sector, Green Deal, Farm to Fork Strategy, EU, CAP, Price, Shock

JEL classification: Q17, Q18, C01

1. Introduction

European Green Deal defines a green growth strategy for European Union (EU) until year 2050 with the climate and environment in the spotlight. In this context the necessity of agri-food systems transformation is obvious. As (Scuderi *et al.*, 2021) mention the agriculture is one of the main producers of greenhouse gas emissions (GHG). The agriculture produces 10 % of CO_2 emissions of EU (Solazzo *et al.*, 2016). According to (Maréchal, Hart and Baldock, 2020) while food production is essential, the scale of the current food-footprint is causing increasing concern, and is in tension with achieving higher levels of environmental and climate delivery in EU. Thus, EU member states should be forward thinking and proactive in taking action to stimulate a transition towards more sustainable agri-food systems.

(Sikora, 2020) argue that even European Green Deal can be considered as a great opportunity, concept of solidarity, sustainable development and high level of protection is also required. (Tsironi *et al.*, 2021) emphasize that food security must incorporate both, sustainable production as well as the reduction of food waste. Moreover, as (Wrzaszcz and Prandecki, 2020) say the goals of European Green Deal require a complex multi-threaded approach to agricultural policy and change of farmer processes since the non-economic consequences of actions taken must be considered as well. Besides, economic impact on various aspects of agri-food market must be expected as was counted for different scenarios e.g. by (Bremmer *et al.*, 2021). When the green growth strategy is considered the eco-efficiency of farms and agriculture should be focused as well. (Richterová, Richter and Palkovič, 2021) show that even we could expect that biggest agricultural producers are eco-efficient, the truth is elsewhere. (Baum and Bieńkowski, 2020) argue that neither the environmental balance nor the social balance is addressed if the economic viewpoint and maximum profit level is priority. (Rybaczewska-Błazejowska and Gierulski, 2018) show that the agricultural sectors of 10 of former EU-28 member states are eco-efficient while the agricultural sectors of the rest 18 member states are eco-inefficient.

According to (Guyomard et al., 2020) the modifications of current state of agri-food sector in accordance with the requirements of Green Deal can be seen in the technical changes, dietary changes and waste reduction. All these processes are closely related with the environmental aspects of agri-food production and biodiversity. Moreover, farming intensity and land-use changes should be considered as key factors to calculate gross and net greenhouse gas emissions. (Montanarella and Panagos, 2021) see the incorporation of coherent sustainable soil management framework as one of the key points of the Farm to Fork Strategy. (Blake, 2020) add doubts about the possibility of utilization of agricultural land in context of growing population and sustainable agriculture. For sure, Green Deal commitments have been affecting the strategy of all EU countries. However, different starting position and possibilities of individual EU member states should be considered (Zlaugotne *et al.*, 2020). Among others, Common Agriculture Policy (CAP) reform in context of Green Deal is required. As (Jambor and Szerletics, 2022) show, direct CAP subsidies affect labour and land productivity of agriculture as well as its efficiency. Moreover, the difference in the impact of direct payments between the old and new EU member states does exist. Moreover, it is obvious that EU Green Deal policy implementation affects also the main EU neighbors and trading partners (see e.g. (Lucini *et al.*, 2022), (Shevchenko *et al.*, 2021), (Brkljača *et al.*, 2021)). On the other hand, (Wolf *et al.*, 2021) see the mission of Europe to become the first climate-neutral continent as the opportunity for uniting the European people. Overall, the goal and the main strategy of European Green Deal is done. No doubts about its direction. But what about unpredictable events, shocks, political changes, health issues, pandemics, wars? How these unexpected situations affect the plans and strategies? How they affect the agri-food market and its transformation in accordance with the requirements of Green Deal? Few years ago, it was a hypothetic question that could be examined and answered using proposed scenarios, just for sure. These days, there is no one who could believe that unexpected and unbelievable events do not occur. Currently, the possibility of shock and occurrence of unexpected events must be considered.

Thus, the aim of the paper is to identify significant price shocks in the markets of basic agri-food commodities, which are currently very closely reflected in the ability to implement the EU Green Deal.

2. Materials and Methods

In the presented article, data from the Chicago Mercantile Exchange (CME) for the period from January 1, 2020 to April 22, 2022 with daily frequency are used. The data used represent world prices of selected commodities – wheat, corn, feeder cattle, milk, and natural gas, which are expressed in the form of futures nearby contract. The world price of the commodity milk was obtained from Markets Insider (Markets Insider, 2022). The tools of econometric analysis will be used to determine the evolution of world commodity prices and to identify significant shocks to observations. According to Cipra (2008), one of the most widely used models of multidimensional time series is one-equation regression growth models. The models used are constructed uniformly for all types of observed commodity prices in the form of:

$$y_t = \gamma_0 + \gamma_1 x_t + \gamma_2 x_{01} + u_t \quad \textbf{(1)}$$

where:

t	…	number of observations $t = 1…T$,
y	…	endogenous variable,
x_t	…	time vector,
x_{01}	…	dummy variable representing the shock(s)
γ_0	…	constant,
γ_1	…	parameters of time vector,
γ_2	…	parameters of dummy variable,
u_t	…	random variable.

The estimated parameters will be verified from an economic and statistical point of view. Subsequently, the stability of the parameters and the significance of the structural break in the world price series in response to external conditions will be assessed using the Chow test. The Chow test works with H0: no structural break at observation and H1: structural break at observation. If the p-value is less than the chosen significance level $t_\alpha = 0.05$, H0 cannot be rejected.

3. Results and Discussion

Descriptive statistics were obtained for each time series and are presented in Table 1. The Coefficient of variance C. V., which expresses a statistical measure of the relative dispersion of data points in a data series around the mean, can be used to assess the volatility of the time series. In financial series, high volatility is associated with high risk when investing in a selected type of commodity. The table shows that the highest risk is in natural gas, followed by crop commodities such as wheat and corn. Conversely, the lowest risk is evident in animal commodities for feeder cattle and milk.

Table 1. Summary statistics of variables

	Mean	**Median**	**Minimum**	**Maximum**	**Std. dev.**	**C. V.**
WPWheat	667.83	640.63	474.00	1425.3	151.45	0.22678
WPCorn	505.96	534.50	302.75	815.75	138.69	0.27412
WPCattle	144.74	141.80	108.25	168.73	13.066	0.09027
WPMilk	18.119	17.438	11.300	24.540	2.8971	0.15989
WPGas	3.1920	2.8440	1.4820	7.8200	1.2952	0.40575

Source: CME, 2022 Own calculation

The selected time series were processed into a line graph from which outliers can be identified. In Figure 1, showing the evolution of the world price of wheat in units of US dollars per bushel, it is clear that a significant increase in prices occurred during the outbreak of the war in Ukraine.

Figure 1. World price of wheat in USD/Bushel

Source: CME, 2022 Own processing

Table 2 presents parameter estimates that represent the evolution over time and the presence of a significant outlier in the underlying data. This shows that there is a statistically significant increase in wheat prices over the days of observation, which is significantly affected by the war conflict. Using a Chow test with a p-value of 0.000, a significant break in the period of the beginning of the war in Ukraine and the instability of the parameters was demonstrated.

Table 2. Parameters Estimation of Wheat World price in USD/Bushel

	Coefficient	**Std. error**	**t-ratio**	**p-value**	
constant	483.569	9.984	48.43	<0.000	***
time	0.5435	0.0283	19.19	<0.000	***
WheatDummy	285.273	29.697	9.606	<0.000	***

R-squared	0.9047	Adjusted R-squared	0.9044
F(2, 597)	311.7195	P-value (F)	2.01e-93

Source: Own calculations using observations 2020:01-01:2022:04-22 (T = 600) and using HAC standard errors;
*Notes: * $t_\alpha = 0.1$, ** $t_\alpha = 0.05$, *** $t_\alpha = 0.01$*

From the next chart it is possible to assess the evolution of the world price of feed maize, which shows two irregular cycles from 30 April 2021 to 13 May 2021 and then at the end of the time series from the end of February 2022.

Figure 2. World price of corn in USD/Bushel

Source: CME, 2022 Own processing

As with wheat, both parameters of the explanatory variables are statistically significant, see Table 3. Again, an increasing trend in maize prices is evident, the presence of a deterministic trend is demonstrated and the breaks described by the dummy variable were also found to be statistically significant.

Table 3. Parameters Estimation of Corn World price in USD/Bushel

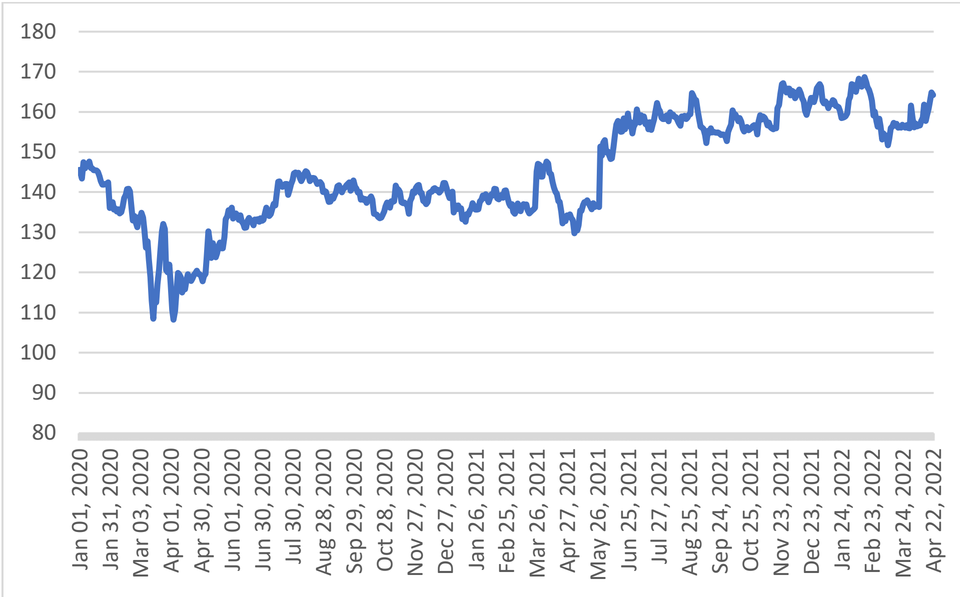
	Coefficient	**Std. error**	**t-ratio**	**p-value**	
constant	309.683	10.8326	28.59	<0.000	***
time	0.6494	0.03489	18.62	<0.000	***
CornDummy	119.066	23.7853	5.006	<0.000	***

R-squared	0.8085	Adjusted R-squared	0.8079
F(2, 597)	350.9586	P-value (F)	<0.000

Source: Own calculations using observations 2020:01-01:2022:04-22 (T = 600) and using HAC standard errors;
*Notes: * $t_\alpha = 0.1$, ** $t_\alpha = 0.05$, *** $t_\alpha = 0.01$*

Figure 3 shows that in the first monitored commodity of animal origin it is possible to observe an increasing trend over time as well as the significance of the structural break in the time series, which is subsequently confirmed in Table 4.

Figure 3. World price of Feeder Cattle in USD/100 Lbs



Source: CME, 2022 Own processing

In line with these parameter estimates, it can be concluded that the world price of feeder cattle in dollars per 100 Pounds shows a gradual increase, which is much more moderate compared to wheat and corn see parameter of time vector. The dummy variable to describe the shock due to the war reports a price decline, which is the opposite effect to that for crop commodities. World Feeder cattle prices are considered the most stable in terms of C.V.

Table 4. Parameters Estimation of Feeder Cattle World price in USD/100 Lbs

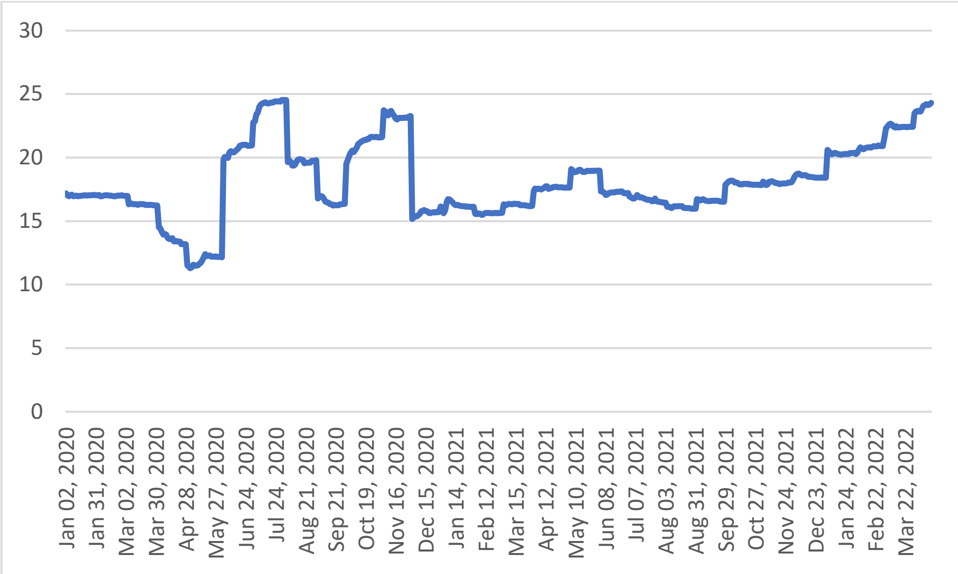
	Coefficient	**Std. error**	**t-ratio**	**p-value**	
constant	125.455	2.18	57.55	<0.000	***
time	0.0668	0.006	11.08	<0.000	***
CattleDummy	-6.2002	1.6665	-3.720	<0.000	***

R-squared	0.6797	Adjusted R-squared	0.6786
F(2, 597)	106.6536	P-value (F)	<0.000

Source: Own calculations using observations 2020:01-01:2022:04-22 (T = 600) and using HAC standard errors;
*Notes: * $t_\alpha = 0.1$, ** $t_\alpha = 0.05$, *** $t_\alpha = 0.01$*

Milk appears to be another relatively stable agricultural commodity in terms of C.V. According to the graph, it can be concluded that changes over time are the smallest. Significant shocks in the time series occur in the spring and autumn of 2020 and in the period of the war conflict, i.e. from 24.2.2022 onwards. A gradual, relatively stable increase in prices can be seen over the period under review.

Figure 4. World price of milk in USD/cwt.sh



Source: CME, 2022 Own processing

Table 5 shows from the parameter estimates that, as in the case of the previous commodities, there is a statistically significant deterministic trend in world milk prices, the parameter of which is the lowest of all the agricultural prices observed. Significant price shocks were found in the three periods 8 June 2020 - 1 September 2020, 30 September - 1 December 2020 and at the end of the time series observation from 24 February 2022.

Table 5. Parameters Estimation of Milk World price in USD/ cwt.sh

	Coefficient	**Std. error**	**t-ratio**	**p-value**	
constant	15.159	0.4232	35.81	<0.000	***
time	0.0582	0.00109	5.296	<0.000	***
MilkDummy	5.3742	0.3961	13.57	<0.000	***

R-squared	0.7045	Adjusted R-squared	0.7035
F(2, 597)	99.014	P-value (F)	<0.000

Source: Own calculations using observations 2020:01-01:2022:04-22 (T = 600) and using HAC standard errors;
*Notes: * $t_\alpha = 0.1$, ** $t_\alpha = 0.05$, *** $t_\alpha = 0.01$*

The last commodity monitored was natural gas, whose world price, as reflected in the chart and the C.V., shows the highest volatility of 40%.

Figure 5. World price of natural gas in USD/MMBTU

Source: CME, 2022 Own processing

According to the estimated parameters of the growth model in Table 6, it can be concluded that the world gas price expressed in dollars per Million Metric British Thermal Unit shows a statistically significant, positive deterministic trend and also responds with an increase to the war conflict in Ukraine, which leads to the imposition of sanctions against the Russian Federation. For all analyzed commodities, the dummy variables describing the time series shocks are found to be statistically significant based on the p-values of the Chow test.

Table 6. Parameters Estimation of Natural Gas price in USD/ MMBTU

	Coefficient	**Std. error**	**t-ratio**	**p-value**	
constant	1.279	0.0903	14.16	<0.000	***
time	0.0613	0.0003	16.37	<0.000	***
GasDummy	0.8058	0.3824	2.107	0.0355	**

R-squared	0.8096	Adjusted R-squared	0.8089
F(2, 597)	172.8315	P-value (F)	<0.000

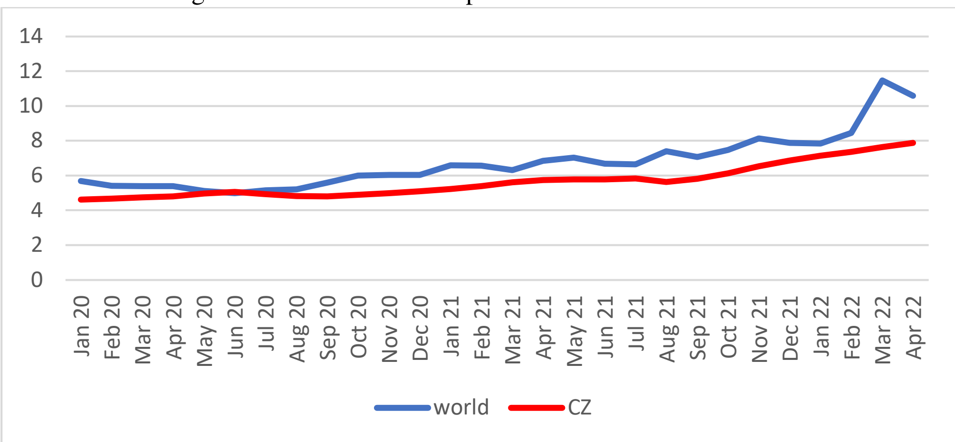
Source: Own calculations using observations 2020:01-01:2022:04-22 (T = 600) and using HAC standard errors;

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

In the following part of the paper, a comparison of the price development of world prices and prices on the domestic market of the Czech Republic was made with the aim of comparing the presence of price shocks in the analysed commodities and identifying any time lags. The source of data for domestic price developments was the Czech Statistical Office, and the data were monitored at a weekly frequency from the beginning of 2020 until mid-April 2022. Furthermore, to ensure easy comparison with world prices, Czech prices monitored in Czech crowns for an adequate natural unit were converted into units corresponding to world commodity trades. The Czech National Bank's mid-value fixed exchange rate method was used for currency conversion, and the conversion of metric units to the usual Anglo-Saxon exchange system was done through the Alberta conversion bridge (Alberta, 2022).

The first price development compared was for food wheat, see Figure 6. The above analysis of price shocks identified a statistically significant shock for this commodity, the beginning of which corresponds to the start of the Russian aggression in Ukraine, and which raised the world price level to a record high of just under USD 12 per bushel. At the same time, the overall evolution of world wheat prices shows a slight volatility, which may be due to standard cyclical and seasonal determinants. In comparison, however, the development of the Czech wheat price does not include either of these aspects. The development of the domestic price is free of major fluctuations and the only statistically significant change compared to the previous development is the higher growth dynamics from the second half of August 2021.

Figure 6. World and Czech price of Wheat in USD/Bushel

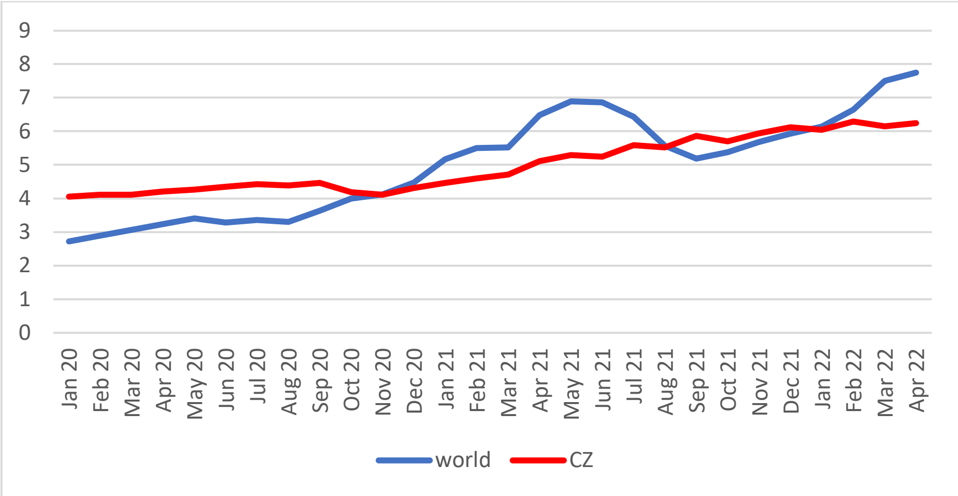


Source: CME, CSO CZ, 2022 Own processing

Overall, it can be stated that the basic trend of the world and Czech prices is very similar - stagnation followed by a slight increase can be observed from the edge of the monitored period. The main difference is therefore an explicit price shock in the world price of wheat, which has not yet been reflected in Czech prices.

The next commodity monitored is maize. A graphical comparison of price developments is made in Figure 7 (see Figure 7), which, unlike the previous wheat, provides relatively differentiated outputs. Two important structural shocks have been identified in the evolution of world prices by previous work. Firstly, a rapid price increase up to USD 7/Bushel in spring 2021, mainly attributed to adverse weather developments in the world's major production areas, but eliminated on the basis of world production results, i.e. prices subsequently fall to levels corresponding to those before the shock. Another statistically significant shock is again visible in the context of the start of the Ukrainian conflict, but, unlike world wheat prices, the increase in maize prices is not nearly as rapid and dramatic. The development of prices on the Czech market is again (as with wheat) much less volatile and generally free of shocks of a similar magnitude to the world price. When analyzing the overall trend, only a minor fluctuation can be identified after the 2020 harvest, which was relatively successful for maize growers, resulting in a slight decrease in the domestic farmgate price. In the following period, there is then an overall increase with very small decreases in weekly prices, but these were only short-lived and always accompanied by a further slight increase. Overall, therefore, it can be concluded that the development of maize farm-gate prices on the Czech market does not contain the structural shocks that are present in the world price, even in connection with the beginning of the Ukrainian crisis.

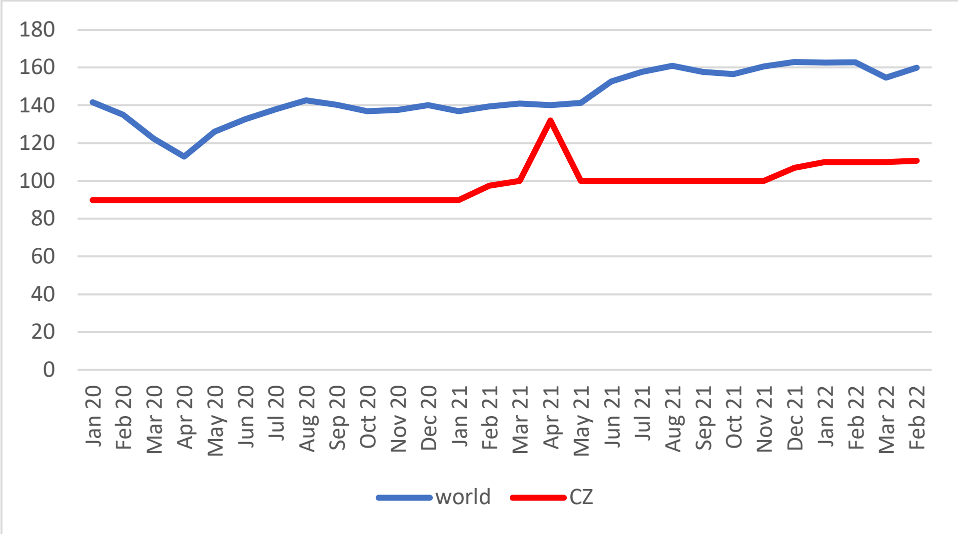
Figure 7. World and Czech price of Corn in USD/Bushel



Source: CME, CSO CZ, 2022 Own processing

In the next section, the evolution of cattle fattening prices has been analysed and compared, see Figure 8. The graph shows the basic differences in the evolution, which consist mainly in the different incidence of the shock, which at the same time are not correlated. In terms of the evolution of world fattening prices, an initial significant price drop in April 2020 is evident, which was first quickly levelled out and followed by stagnation at around USD 140/100lbs until May 2021. Thereafter, a sharp increase of around USD 20 occurred and the resulting level of around USD 160/100lbs has been maintained with slight fluctuations until the present. An interesting aspect is the slight decline at the end of the period under review, i.e. the beginning of the Russian aggression in Ukraine has not yet been reflected in world prices. The development of the Czech farmgate price of slaughter bulls shows an interesting extreme in an otherwise almost flat curve at the turn of March/April 2021, when a sharp, but short-term increase in the price compared to world prices occurred, which was subsequently eliminated and only reflected in a slight increase in the otherwise stagnant level. The cross-comparison therefore does not show any signs of a correlation between world and Czech beef cattle prices, with the exception of the overall (slightly rising) trend.

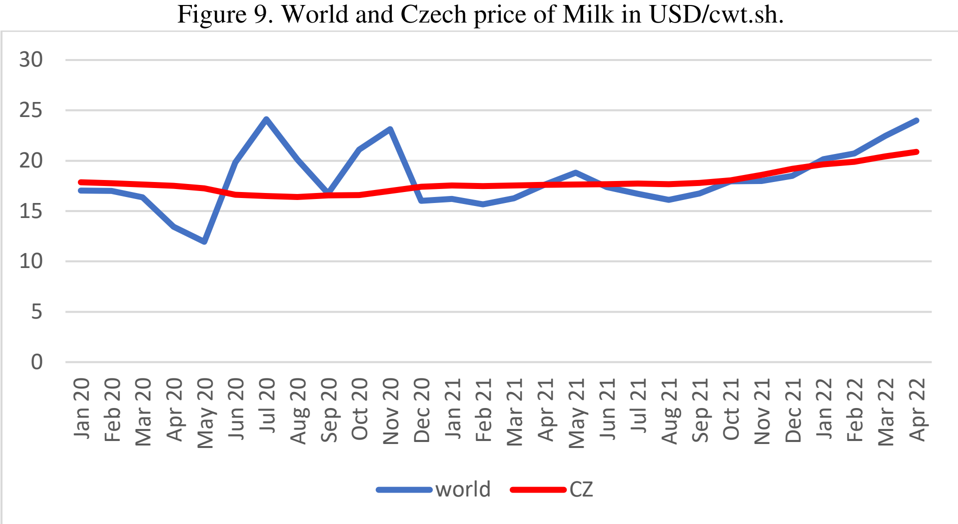
Figure 8. World and Czech price of Feeder Cattle in USD/100Lbs.



Source: CME, CSO CZ, 2022 Own processing

The last interesting comparison of the development of world and domestic prices is offered by the commodity milk, see Figure 9. From the presented functions it is quite obvious that the development of the Czech price is defacto an interleaving of the world price without the presence of identified shocks. Overall, it can therefore be concluded that the general price evolution is almost identical, with the main difference being the presence of significant shocks in the evolution of the world price between April 2020 and December 2020. These rather dramatic changes have caused fluctuations of an unprecedented magnitude of more than USD 10/sh and are probably due to developments on the international market, in particular the unexpectedly increased demand on the Asian market. In the following period, the changes were less pronounced, with a steeper increase towards the end of the period under review, with a further acceleration to around USD 24 per quintal at the very end.

Figure 9. World and Czech price of Milk in USD/cwt.sh.



Source: Source: CME, CSO CZ, 2022 Own processing

4. Conclusion

For the final evaluation, it is appropriate to link the partial outputs into a mutual context and derive adequate implications. In the first part of the article, price shocks on the international commodity market were analyzed. For the purposes of the agri-food market, two representatives of crop production and two representatives of animal production were elected. The analysis shows that crop commodities have experienced a statistically significant shock, which in terms of time responds to extreme changes in the energy market and is also in the direct context of market destruction caused by the Russia-Ukraine crisis. Both crop commodities, i.e. wheat and corn, are responding with a significant price increase, which reaches a historically record level of more than 800 USD / Bushel for wheat commodities. On the contrary, it can be deduced from the results of the analysis of livestock commodities that both commodities have not yet responded to the above-mentioned shocks, or only to a limited extent (especially in the case of the milk commodity). However, from the analysis of the development towards the end of the observed period, it is very probable that both mentioned commodities are also preparing for a new jump, as evidenced by selected leading indicators of the stock markets. In the next analysis, world prices were compared with the development of domestic prices on the Czech market. It is clear from the results that the development of domestic prices is not affected by price shocks on the world market, and it can be stated that the level and course of Czech purchase prices is largely subdued and lacks market shock indicators, which is certainly good news for both parties, demand and supply.

Overall, the characterized development can also be linked to the future of the Green Agreement on Europe, as the results of the price development of crop commodities (but also, with a delay, livestock commodities) are likely to correspond very intensively to the energy market shock. This shock is directly linked to the EU's Energy Policy strategy, the objectives of which were set with regard to compliance with the EU Green Deal. At the same time, however, the destruction of the energy market caused by the Russian aggression in Ukraine and the planned EU response in the form of the elimination of European energy dependence on Russian resources is having a very strong effect on the situation. If both aspects are combined, it is very likely that the prices of basic commodities of both crop and livestock production on world markets will reach absolutely extreme values, which could even lead to a market crash. It then necessarily follows that the EU will have to find an adequate strategy that will not allow such a course, which will necessarily lead to the modification of the original Green Agreement or at least to the redefinition of its objectives.

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TOTAL COST OF OWNERSHIP OF ELECTRIC VEHICLES

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Annotation: Electromobility is becoming a current trend in the automotive industry. At present, it has the greatest innovation potential for minimizing negative factors such as higher cost, short range and long charging times. The lack of subsidies for electromobility in 2021 in the Czech Republic is also problematic. This article deals with the opportunities that electromobility provides to the end customer. The purpose of this article is to identify the break-even point at which it is worthwhile for the end Czech customer to buy an electric car. The article compiles a TCO model - Total Cost of Ownership model, which includes the purchase price of the car, consumption, related fees, etc., based on which the effect of distance travelled on savings is calculated. According to the model parameter, the break-even point in the development of electric vehicle costs occurs according to the model parameter in the 7th year since purchase, the costs of purchasing an electric car intersect with the costs of a car with an internal combustion engine after 5.5 years. The benefit of this article is the creation of a model that can be used to calculate the benefits of purchasing an electric car.

Keywords: Total cost of ownership, Electric vehicle, Battery, Purchase price, Cost

JEL classification: Q54

1. Introduction

The number of fully electric cars on the road around the world is growing rapidly (Plewa and Strozik, 2019). The first electric cars were produced before the mass spread of internal combustion engines in the 19th century. This attempt was repeated several times, but always ended in failure. The penultimate electric car wave took place in the 1990s, when the California Environmental Protection Agency - Air Resources Board announced a Zero-Emissions Vehicle (ZEV) initiative to reduce automobile emissions. The result was the development of several electric vehicles by Chrysler, Ford, GM, Honda, Nissan and Toyota. The developed cars were later withdrawn from the market (Vlk, 2004; Wolfram and Wiedmann, 2017).

The latest wave of electric car development began in 2008 with the launch of the Tesla Roadster, which was developed by the Californian carmaker Tesla for four years. Further development of electric cars continues with mainstream brands such as Volkswagen (Skoda), Hyundai, Nissan. The European Commission and individual Member States are newly promoting the electric cars. In the Czech Republic, the Tesla Club, the Association for Electromobility of the Czech Republic and the Citizens' Association for Electromobility have even been established. Organisations are also organising EV rallies on an international level (Bahiraei et al., 2017; Markus, 2017).

The electric motor is quiet, does not pollute the air at its current position and is easy to start. The drive system of the electric car consists of the engine, transmission, drive shafts and differential. The central electric motor is most often used for the front or rear drive of the car. Tandem drive systems are also possible, where there are two electric motors or electric motors located directly in the wheels. Current options are synchronous motors with permanent magnets, serial DC motors, parallel DC motors with external excitation or asynchronous motors with transistor control. Standardization among electric cars has not yet taken place and large-scale production is still in its infancy. An important stage in the development of electric cars was not launched until 2008 by the California carmaker Tesla. The European Commission is also putting pressure on individual Member States to develop electric mobility under the Green Agreement for Europe (Andwari, 2017; Bahiraei and Nazri, 2017; Markus, 2017; Wolf, 2004; Wolfram and Wiedmann, 2017).

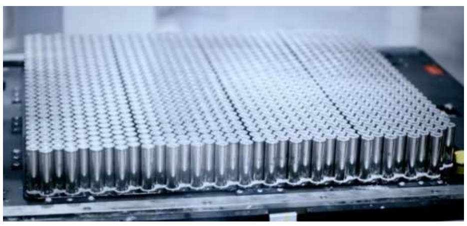
The purpose of a battery is to convert chemical energy into electrical energy. The battery consists of two electrodes of different materials, which are immersed in the electrolyte. The electrolyte is a dilute acid or a dissolved salt. Costs, longevity, specific power (Wh-kg-1), charging time (hours), specific energy (Wh-kg-1) and recycling options are crucial (Markus, 2017; Andwari et al., 2017).

More facts about electric cars:

1. Sports EVs achieve 0-60 km/h^{-1} in under 4 seconds, with the Tesla Model SP100D even getting to 2.28 seconds.
2. DC fast charging (ChaDeMo standard with up to 50 kW) can charge an electric car in less than an hour.
3. Charging is by AC current with an output of 22 kW (Mennekes standard).
4. Premature charging termination does not affect battery life.
5. The range of the most modern electric cars is over 500 km and increases as the ambient temperature rises.
6. Maximum performance can occur almost immediately.
7. Electric vehicles can be overloaded repeatedly and repeatedly.
8. The design is much simpler compared to conventional combustion-powered cars.
9. Traction battery life is now 3000-4000 charging cycles, extending battery life to 8-11 years.

(Andwari et al., 2017; E.ON Czech Republic, 2012; Li et. al., 2017)

Figure 4. Tesla Model S - Lithium-Ion Battery



Source: Horčík, 2021

Innovations in battery technology for improved performance are based on changes in the design elements:

Lead-acid batteries - the batteries are heavy and have an energy storage of 25Wh/kg. The lifetime is 4 years, or 700 cycles.

Nickel-metal-hybrid - the battery has higher power and energy density compared to a lead-acid battery, but cannot be discharged and charged frequently. Suffers from memory effect but does not harm the environment. End-of-life recycling is expensive.

Lithium-ion - the most commonly used technology in electric vehicles. The battery has a high energy and power density. The specific energy reaches 120–130 Wh-kg^{-1} and the lifetime is 1,000 cycles. They do not suffer from memory effect but are energy temperature dependent. The cost is also high (Fig. 1).

The sodium-sulphur battery has a large cell count and an operating temperature of 380 °C. Energy efficiency is 88 %. Lifetime is 1,000 cycles or 30,000 km. Thermal insulation of the battery is necessary.

Zinc-air - Energy density is up to 220 Wh/kg and is 30% lighter than a sodium-sulphur battery. Operation requires cooling and heating at low temperatures.

Lithium polymer - Power density is 200 W/kg, energy density is 150 Wh/kg. Operating temperature is in the range of 40-150 degrees Celsius. Efficiency is up to 90% at fast charging. The operating temperature makes this battery unusable for electric vehicles.

Lithium-metal-hybrid - energy density is the highest. Weight is the lowest compared to previous batteries. The battery is resistant to overcharging, short circuit, mechanical damage. The operating temperature has a very wide range (Vlk, 2004; Andwari et al., 2017; E.ON Czech Republic, 2012; Li et. al. 2017).

Electric cars are promoted as economical, environmentally friendly and safe. The economy is due to the low economy of operation. The cost per kilometer traveled is much lower than per kilometer traveled on fossil fuels. Maintenance is much easier due to their design (Fig. 2). Economy is also improved by energy recovery, which recharges the batteries during braking. The disadvantage is the high acquisition cost, which is due to their small production and the price of the batteries. The ecology of electric cars is due to zero local greenhouse gas production and lower noise. The production of greenhouse gases in the production of electricity must be taken into account. Safety means charging safety, when the car and the charging station communicate with each other and only then charges the electric car itself. The electric car is also safer in many design aspects. (Andwari et al. 2017; OECD, 2021; Vlk, 2004)

Figure 5. The BMW i3 electric car - simplicity in design

Source: Hořčík, 2021

The purpose of this article is to find out the break-even point and TCO - Total Cost of Ownership, which includes the purchase price of the car, consumption, related fees, etc., at which it is worthwhile for a Czech customer to buy an electric car.

2. Materials and Methods

This article compares 2 BMW cars to estimate the profitability of owning an electric car by a natural person who is not a non-entrepreneur (he is not entitled to subsidies). The hypothetical owner lives 30 km from the place of work, has his free funds deposited in a savings account with an interest rate of 1% p.a.

Car ownership is set for 8 years (BMW i3 battery warranty). The requirement is to use variable costs to pay for or become more profitable. The variables are determined by the input parameters of the computational model (Table 1).

Table 1. Model input parameters

Number of trips to work per week	5
Length of one trip to work (km)	30
Working day mileage (km)	60
Weekend mileage (km)	100
Annual mileage	20,800
Discount (Price of capital)	1.000 %
Electric car	
Price per kWh (EUR)	0.19
Price 1 kWh - charger (EUR)	0.28
Charge ratio on charger per year = 20%	20 %
Charge ratio at home per year = 80%	80 %
Consumption kWh/100 km (electric car)	13.10
Charge card price incl. VAT/month (EUR)	21.78
Rate of electricity discounting per year	3%
Rate of annual growth in the price of a charge card	10.00 %
Electric car price (BMW i3, 120 kW, automatic) (EUR)	39 572.00
Automobile	
Consumption l/100 (petrol) - maximum.	5.9
Annual growth rate of petrol prices	5.94 %
Annual rate of deterioration of car consumption (petrol)	3.00 %
Petrol price (average for April 2022) (EUR)	1.71
Car price (BMW 1, 135 kW, automatic) (EUR)	31547.36

Source: Czech Statistical Office, 2022; BMW i3, 2022; BMW 120i, 2022; Nissan Leaf 2022; OECD, 2021; Electromobility, 2022

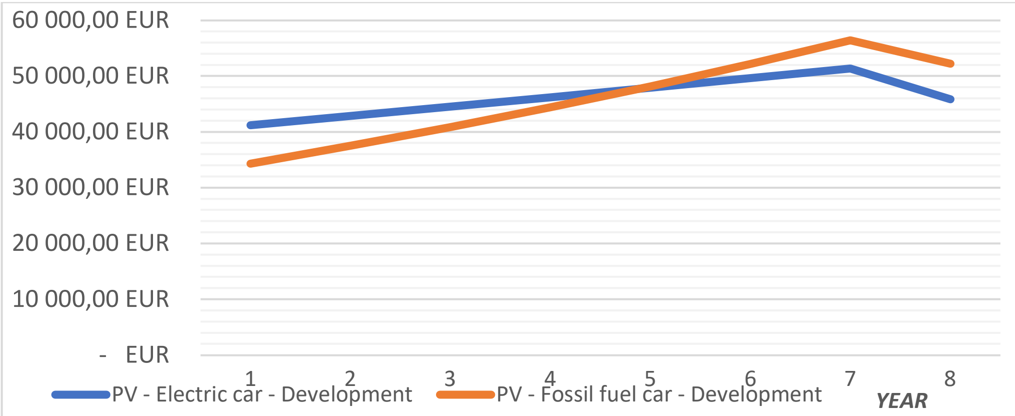
The battery capacity decreases over time, but due to the driving distance, it is not limiting. The disposal fee is not included, as it is not calculated for this type of machine (not even on batteries). Charges are included in the purchase price of the car. The owner is obliged to return the batteries to BMW (in the case of the BMW i3). BMW will continue to use them as backup sources for the electric car factory. Batteries are returned free of charge, they are not purchased (BMW i3, 2022; BMW 120i, 2022; Tesla Model S, 2022).

3. Results and Discussion

The available data and the calculation model show that cost recovery would occur when the cost of capital (e.g. interest on a savings account) is 1.8680 %, p.a. The consumer is then in a tie-breaker position. An increase in the capital cost would fundamentally disadvantage the ownership of an electric car.

Identifying the costs of electromobility is a decision-making tool for investment implementation (Mercik, 2022). As well as the publication Pietrzak and Pietrzak (2021) article fills the literature gap in the area of research on the impact of the energy mix of a given country on the issues raised in this article.

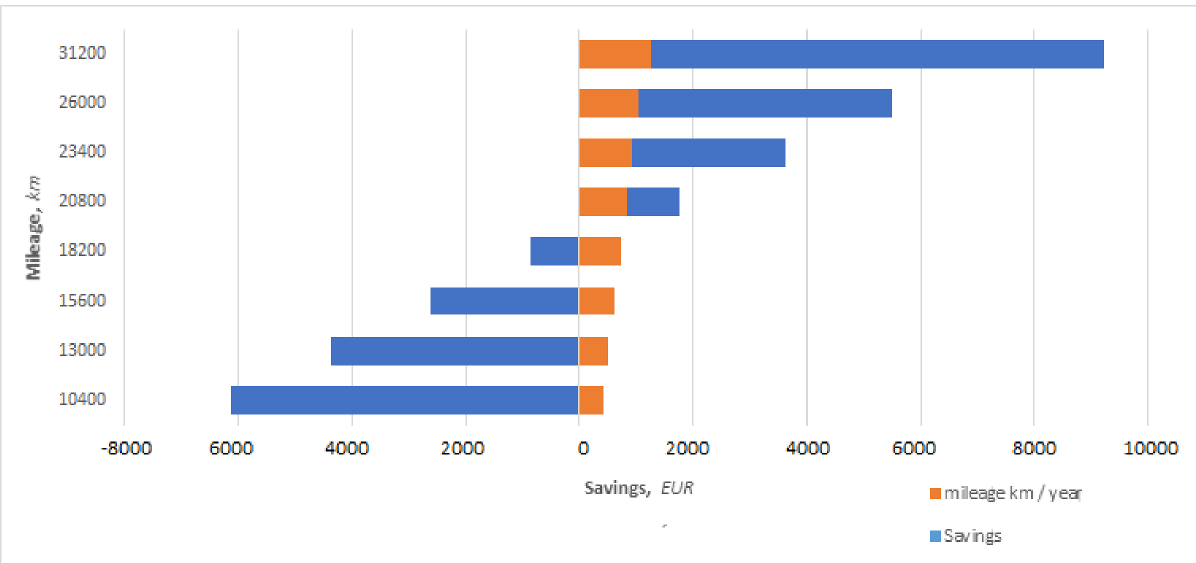
Figure 6. Cost turning point of the compared cars



Source: Own processing

Figure 3 shows the intersection of the cost evolution after about 5 years, the break-even point of electromobility occurs after the 7th year of ownership, the calculated savings on the ownership of the electric car 4,444.60, - EUR. The model also includes the consumer investing his free money. NPV (net present value) ownership of electric cars and cars is, of course, negative.

Figure 7. Effect of distance travelled on savings



Source: Own processing

Figure 4 shows that an electric car pays off more as the distance travelled increases. The result of the baseline model is consistent with the recommendation that an EV is more profitable for intercity transport (Wolfram and Wiedmann, 2017). An electric car for a family that travels 10,400 km a year will not pay off without subsidies. Therefore, Parry (2020) calculates the necessary infrastructure investment, arguing that higher prices for emissions in the EU emissions trading scheme would create the largest welfare gains and no country will benefit from this reform.

As confirmed by the study of Wappelhorst et al. (2014), there are two main barriers to buying an electric car from the user's perspective. Firstly, it costs more than a car with an internal combustion engine, and secondly, it generally has a limited range compared to a conventional vehicle.

Freitas et al. (2020) and Auvien et al. (2016) also emphasize that a critical variable in whether people are willing to invest in distributed energy systems is their user acceptability. Module-level reuse also offers exciting benefits, such as the ability to design more versatile and scalable solutions that, despite their initial disadvantages, could be more attractive to many second-life applications (Rallo et al., 2020).

According to Plewa and Strozik (2019), the declining costs of producing lithium-ion batteries, together with strong environmental marketing, could lead to one-third of the total number of passenger cars by 2040.

4. Conclusion

The article and the computational model show several important facts. For a calculation that includes only the annual mileage and the current consumption of the car, a rough estimate of the annual savings from the use of the electric car may suffice. The comparison of car variants requires a model that includes many variables with very high variability.

The article's calculation model shows that many factors influence the resulting benefits of owning an electric car and there is no single optimal solution. The optimum has to be set and calculated by the user according to their ability to change their lifestyle. In addition to such external conditions as fuel prices, electricity consumption, mileage, growth rates, input reductions, and finally subsidies, the EU's call for diversity requires an evaluation of the inherent free capital and intrinsic benefits that need to be included to reduce the mileage of EV repayment.

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COVID-19-RELATED STATE AID PROGRAMS FOR AGRICULTURE IN POLAND

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Annotation: Agriculture is a sector in which economic policy has an exceptionally significant influence. The paper aims to identify, discuss, and assess the actions taken by the Polish state (government) concerning agriculture in connection with the COVID-19 pandemic. We use data on state aid for agriculture in connection with the COVID-19 pandemic from the European Commission, the National Bank of Poland (NBP), and the Agency for Restructuring and Modernization of Agriculture (ARMA). The research period covers 2020-2021. Polish state has taken several measures concerning agriculture to limit the adverse effects of the COVID-19 pandemic. These anti-COVID-19 state measures covered: e.g. aid for farms at risk of losing liquidity, intervention purchases of agricultural products, subsidies to interest rates on banking loans, loans, guarantees and loan sureties, subsidies for the costs of employee salaries, allowances for rent or lease, subsidies or repayable assistance, exemption for farmers from paying social security contributions, children care benefits, sick benefits for the quarantine period. Public financial aid for agriculture with the highest value (2/3 of the aid for farmers) came from the RDP 2014-2020 program, i.e., EUR 270 million. Moreover, under state aid, ARMA implemented three programs with approximately a total value. EUR 135 million, i.e., financial aid for agricultural producers facing liquidity losses due to restrictions on the agricultural market, financial aid for the holders of chrysanthemums who have suffered losses due to market restrictions, and financial aid to pig producers. More than 90% of the submitted applications were approved as part of the national state aid. Such a large percentage of accepted applications, both from the RDP 2014-2020 and state programs, resulted from the willingness of the Polish state to help farmers quickly.

Keywords: Agriculture, COVID-19 pandemic, Agricultural policy, State financial support, Aid programs, Interventionism

JEL classification: H20, Q10, Q14

1. Introduction

Economies face many challenges nowadays. Economic literature devotes a lot of attention to relatively new research areas, including the impact of climate change on economic processes (Seddon et al., 2020; Sikora, 2021). A recent issue that should be considered in the modern paradigm of economics is the impact of the pandemic on economic processes, as the COVID-19 pandemic has substantially hit the world economy (Laing, 2020). The rapidly increasing numbers of infections and deaths caused by COVID-19 have forced national governments worldwide to introduce various types of restrictions and lockdowns to stop the spread of the novel coronavirus pandemic (De Vos, 2020; Koh, 2020). Various stringency policies have affected ca. 90% of the world's population (Bonaccorsi et al., 2020; Gössling et al., 2021). Consequently, these COVID-19 control measures resulted in massive disruptions in global and domestic supply chains (Guan et al., 2020; Mahajan and Tomar, 2021). Hobbs (2020) observes that during the first phase of the global pandemic, food supply chains had to adjust rapidly to demand-side shocks (e.g., panic buying and changes in food purchasing patterns) and prepare for any supply-side shocks (e.g., due to potential labor shortages and disturbances in transportation and supply networks).

One area of pandemic research is to assess its impact on agriculture. It is crucial as agriculture substantially contributes to every economy. Agriculture plays a key role in ensuring food security, is linked to the entire economy, is an important provider of public goods, and impacts food prices (Alston and Pardey, 2014; Beckman and Countryman, 2021; Dethier and Effenberger, 2012). Moreover, it represents an key driver of the rural areas development in the European Union (Bournaris et al., 2016). However, agriculture's role in contributing to the national economic growth is commonly underrated or neglected (Loizou et al., 2019).

Agriculture in Poland and the European Union has been affected by the COVID-19 pandemic. Negative phenomena occurred both on the demand and the supply side of farm activities. In agri-food sector, COVID-19 related supply and demand shocks transformed into three key types of effects, i.e., impacts on agricultural production, shifts in consumer demand, and disruptions to the food supply chain (Gruère and Brooks, 2021). In details, firstly, the closure of gastronomy led to a decrease in demand for food. Secondly, limiting food exports hit Polish producers and the economy. Thirdly, there were observed problems with workers' availability, particularly in labor-intensive sectors, e.g., horticulture. Moreover, sanitary restrictions caused the food industry to limit the demand for agricultural products.

Agriculture is a sector in which economic policy has an exceptionally significant influence. Therefore, in Poland, the state has taken a number of measures concerning agriculture to limit the adverse effects of the COVID-19 pandemic. The COVID-19 crisis has triggered reflexivity about the operation of agriculture, particularly the farming systems, in the context of their resilience to any potential adverse external shocks (Meuwissen et al., 2021).

Our contribution is the systematization of knowledge about Poland's forms, directions, principles, and level of public support for agriculture during the COVID-19 pandemic. Our research might be useful for decision-makers, farmers, and organizations related to agriculture on state support for agriculture.

The agenda of our paper is as follows. The next section presents the study's aim and describe the material and research methods used. The posterior section provides the empirical findings and discussion, and the final section offers our conclusions.

2. Materials and Methods

The article aims to identify, discuss, and assess the actions taken by the Polish state (government) concerning agriculture in connection with the COVID-19 pandemic. We use data on state aid for agriculture in connection with the COVID-19 pandemic from the European Commission, the National Bank of Poland (NBP), and the Agency for Restructuring and Modernization of Agriculture (ARMA). ARMA aims to support agriculture and rural development in Poland. Following Poland's decision to join the European Union, the Agency has been designated by the Polish government to perform the role of an accredited national paying agency. To discuss the activities undertaken by the Polish state, we use a critical literature review of the literature on the subject, legal documents, and reports of the above-mentioned institutions. Moreover, we apply selected descriptive and comparative methods in the analysis. The research period covers 2020-2021.

3. Results and Discussion

Characteristics of state aid programs for agriculture during COVID-19

Table 1 presents COVID-19 related Polish state aid programs for agriculture in 2020-2021 which the European Commission has notified. The below-presented list of Polish state measures has been approved under Articles 107(2)b, 107(3)b, and 107(3)c TFEU and under the State Aid Temporary Framework. The State aid Temporary Framework was adopted in March 2020 to enable the EU member states to use the complete flexibility foreseen under state aid rules to support the national economy in consequence of the coronavirus outbreak.

Table 1. List of aid programs notified by the European Commission for enterprises operating in the primary production sector of agricultural products or fishery and aquaculture who have suffered as a result of COVID 19

	No. of program	Program name	Aid support	Expenditures (EUR million)
1	SA.56876 (2020/N)	Polish anti-crisis measures - COVID-19 - guarantee scheme	Guarantee	1292.0323*
2	SA.56896 (2020/N)	COVID-19 - Anti-crisis measures in the form of loans and guarantees financed from EU funds	Guarantee; soft loans	28.271*
3	SA.56922 (2020/N)	Polish anti-crisis measures - COVID-19 virus - wage subsidies, tax and social contributions reliefs and other measures	Debt write-off Direct grant Reduction of social security contributions Reimbursable grant Repayable advances Tax advantage or tax exemption Tax deferment	29613.82*
4	SA.56996 (2020/N)	Repayable advance scheme for micro, small and medium-sized enterprises	Loan/ Repayable advances	54444.93*
5	SA.57015 (2020/N)	State aid in the form of grants or repayable assistance under operational programs for 2014 - 2020 to support the Polish economy in connection with the occurrence of the COVID-19 pandemic outbreak	Direct grant/ Interest rate subsidy Loan/ Repayable advances	1768.95*
6	SA.57054 (2020/N)	The Polish anti-crisis measures - COVID-19 – write off of loans	Debt write-off Soft loan	54.78*
7	SA.57055 (2020/N)	The Polish anti-crisis measures - COVID-19 – equity instruments	Other forms of equity intervention	0*
8	SA.57065 (2020/N)	COVID-19: anti-crisis measures in the form of loans and guarantees financed from the re-use of resources returned from 2007-2013 financial instruments	Guarantee Interest subsidy Soft loan	0*
9	SA.57191 (2020/N)	The Polish anti-crisis measures - COVID-19 - state aid in the simplified repayable from financial engineering instruments	-	6.83*

10	SA.57306 (2020/N)	COVID-19: Financial shield for large enterprises: Liquidity loans	Soft loan	93.2297*
11	SA.57452 (2020/N)	Guarantees on factoring	Guarantee	54.9983*
12	SA.57568 (2020/N)	Polish anti-crisis measures - COVID-19 - interest rates subsidies (for farmers)	Interest subsidy	0.1191
13	SA.57726 (2020/N)	State aid in the form of reduction of the annual fee for perpetual usufruct and relief in rent, lease and usufruct fees to support entrepreneurs affected by the COVID-19 pandemic outbreak	Tax advantage or tax exemption	5.4329*
14	SA.58105 (2020/N)	COVID-19: Aid scheme for agricultural producers who are at risk of liquidity loss as a result of agricultural market restrictions due to COVID-19	Direct grant	396.70
15	SA.58185 (2020/N)	COVID-19: Polish anti-crisis measures - State aid granted by the State Forests	Debt write-off	0
16	SA.59382 (2020/N)	Aid for producers of ornamental plants (chrysanthemums) threatened by a loss of liquidity due to restrictions on the agricultural market caused by the COVID-19 epidemic.	Direct grant	15.70
17	SA.60060 (2020/N)	Aid for pig producers who are threatened with a financial liquidity loss due to restrictions on the agricultural market caused by the COVID-19 outbreak.	Direct grant	0

* The total amount of expenditure for all eligible entities in Poland, not only related to agriculture

Source: Own elaboration based on data from the European Commission and Polish Ministry of Agriculture and Rural Development.

Related to COVID-19 Polish financial support for agriculture funded by ARMA was based on the programs listed below.

Measure M21 - Exceptional temporary support to farmers, micro, small and medium-sized enterprises particularly affected by the COVID-19 crisis (Aid to farmers particularly affected by the COVID-19 crisis).

The aid was addressed to farmers involved in the production of beef, milk, pigs (piglets), slaughter poultry (chickens, geese, and turkeys), breeding poultry in connection with the production of hatching eggs for slaughter hens, mutton/lamb, goats and ornamental plants under cover. The main objective of this support was to compensate for part of the losses suffered by farmers as a result of the COVID-19 crisis and to encourage them to continue production to minimize the risk of a decline in production levels in individual sectors. The support took the form of a one-off lump sum, and its amount depended on the type and scale of agricultural production. Aid for a single farmer could not exceed the PLN equivalent of EUR 7,000. As part of this program, the Agency for Development and Modernization of Agriculture conducted one call for applications from September 9 to October 7, 2020.

Financial aid for an agricultural producer who is threatened with a loss of financial liquidity due to restrictions on the agricultural market due to the COVID-19 epidemic.

In 2020, ARMA provided financial aid to an agricultural producer who was threatened with a loss of financial liquidity due to restrictions on the agricultural market due to the COVID-19 epidemic (notified by the European Commission). For this aid could apply an agricultural producer:

1. who has renounced the right to aid or who has not received aid under the applications submitted in 2019 for support for farms that have suffered damage to crops caused by drought, hurricane, hail, torrential rain, spring frost, or a flood in 2019;
2. who, together with this aid, under the provisions issued on the basis of the "Temporary Framework for State aid measures to support the economy in the current COVID-19 outbreak", received total aid for the activity of primary production of agricultural products for an amount not greater than EUR 100,000.

The maximum amount of aid for one farmer was set at EUR 15,000.

Aid for the holder of chrysanthemums at full maturity intended for sale who have suffered losses due to market restrictions caused by the COVID-19 epidemic.

In 2020, ARMA provided financial assistance to the holder of chrysanthemums in the phase of full maturity intended for sale, being a micro, small or medium-sized enterprise threatened with loss of financial liquidity due to market restrictions caused by the COVID-19 epidemic. The holder of chrysanthemums applying for aid could be an agricultural producer or run a non-agricultural business. The aid was granted to the holder at least:

1. 50 pot chrysanthemums in the stage of full maturity intended for sale as at the date of application or
2. 200 pieces of cut chrysanthemums at full maturity, intended for sale as of the date of submission of the application.

The aid rate was PLN 20 per piece in the case of pot chrysanthemum and PLN 3 per piece in the case of cut chrysanthemum. ARMA conducted one call for applications from November 2 to 6, 2020.

Financial aid to pig producers facing liquidity loss due to COVID-19 constraints

In 2020, ARMA provided aid to a pig producer, which is a micro, small and medium-sized enterprise threatened with a loss of liquidity due to restrictions caused by COVID-19. The support was directed to the pig producer:

1. who has not applied for aid to compensate for the amount of the reduced income obtained by a pig producer from the sale of pigs kept in an area subject to restrictions for the eradication of African swine fever for the period from the fourth quarter of 2019 to the third quarter of 2020,

2. which has not been granted a pig holding aid under the Exceptional temporary support measure for farmers, micro, small and medium-sized enterprises particularly affected by the COVID-19 crisis, or the decision to grant this aid has been revoked or reduced.

The rates of aid granted depend on the keeping on the holding of an average daily number of tagged pigs and are as follows:

1) PLN 4,500 - if at least 21 pigs and not more than 50 pigs are kept on average daily;
2) PLN 14,900 - for keeping an average of more than 50 pigs daily and no more than 200 pigs per day;
3) PLN 3,800 - if over 200 pigs are kept on average daily.

The amount of support granted, including the amount of aid granted to farmers particularly affected by the COVID-19 crisis under RDP 2014-2020 for reasons other than pig ownership, may not exceed EUR 7,000 (equivalent to PLN). ARMA conducted one call for applications from December 7 to 20, 2020.

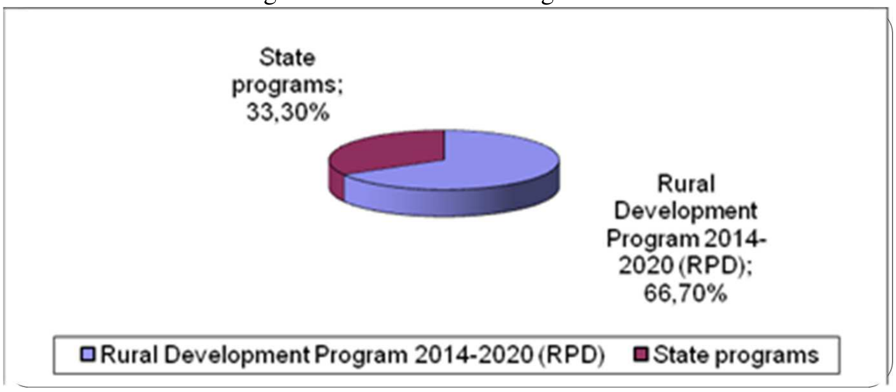
<u>The level and structure of state support for agriculture during COVID-19 in Poland</u>

In the Polish public support system for agriculture, the primary payment institution is the Agency for Restructuring and Modernization of Agriculture (ARMA). This institution has also financed the highest degree of agricultural support programs related to the COVID-19 pandemic. Public support to agricultural producers has been granted under the Rural Development Program (RDP) 2014-2020, financed by the EU and Polish funds as well as national programs.

Under the Rural Development Program 2014-2020, the Polish state could provide aid for farmers particularly affected by the COVID-19 crisis under Measure M.21, entitled "Exceptional temporary support to farmers, micro, small and medium-sized enterprises especially hit by the COVID-19 crisis".

In accordance with the Regulation of the European Parliament and of the Council (EU), such aid has been possible under the European Agricultural Fund for Rural Development (Regulation 2020). Under the national programs, state aid for agricultural producers affected by the COVID-19 crisis was provided under three programs, i.e., financial aid for an agricultural producer threatened with a loss of financial liquidity due to restrictions on the agricultural market due to the COVID-19 pandemic, the same aid, but only for pig producers, and financial aid for holders of chrysanthemums in full maturity intended for sale who have suffered losses due to market restrictions caused by the COVID-19 pandemic.

Figure 1. Structure of support for agricultural producers affected by the COVID-19 crisis paid by the Agency for Restructuring and Modernization of Agriculture in 2020-21



Source: own calculation and elaboration based on ARMA (2022) data.

In the years 2020-2021, Polish farmers received the biggest financial support from the ARMA related to the COVID-19 pandemic under the 2014-2020 RDP. This support amounted to EUR 270.1 million, i.e., two-thirds of the total COVID-19 related aid provided by ARMA (Figure 1). Almost all support from RDP 2014-2020 was paid to agricultural producers in 2020. It was the amount of EUR 269.3 million. This value consisted of funds from the European Agricultural Fund for Rural Development (EAFRD) in the amount of EUR 171.4 million (64%) and the Polish national budget of EUR 97.9 million (36%). In 2021, farmers received only less than

EUR 0.8 million. Moreover, in 2020-21, ARMA paid a total of EUR 134.8 million from national programs to agricultural producers affected by the COVID-19 pandemic. This accounted for 33% of all aid provided by the ARMA to the prevailing pandemic. The ARMA, supporting farmers in mitigating the effects of the pandemic, paid them 404.9 million euros in total under the RDP 2014-2020 and national programs. A key initial effect of the COVID-19 pandemic on farmers was the fall in the prices of agricultural products (Mroczek, 2020).

Table 2. Support for agricultural producers affected by the COVID-19 crisis from the Rural Development Program 2014-2020 in 2020-2021

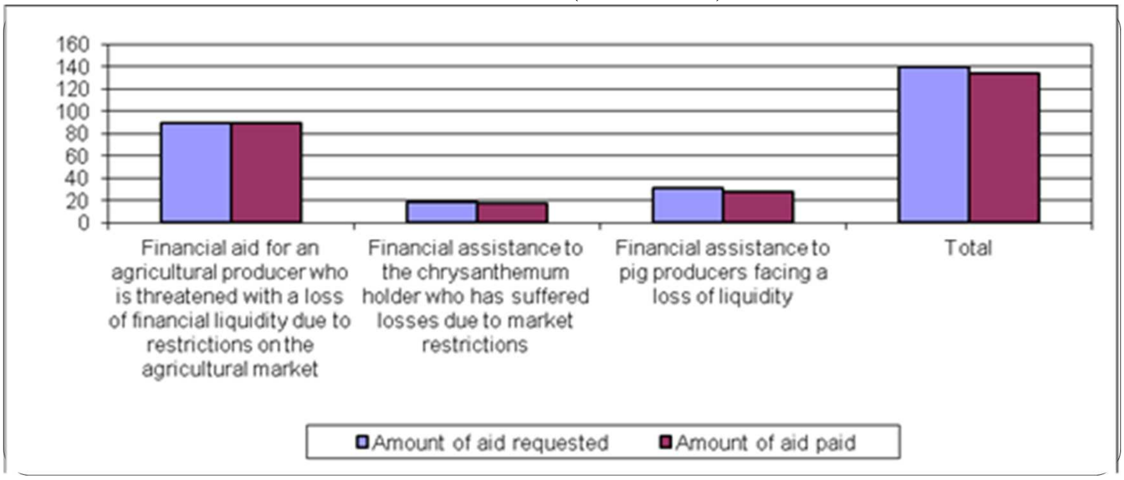
Voivodeship	**No. of submitted applications**	**No. of accepted applications**	**Rate of acceptance (%)**	**Amount of payments (EUR thousand)**
Lower-Silesian	2,749	2,482	90.3	3,708.6
Kuyavian-Pomeranian	16,786	15,578	92.8	31,410.6
Lublin	13,464	12,285	91.2	15,147.8
Lubusz	1,746	1,539	88.1	3,063.0
Lodz	17,908	16,499	92.1	23,760.0
Lesser Poland	10,117	9,299	91.9	8,624.8
Masovian	35,570	32,895	92.5	36,854.5
Opole	3,961	3,642	91.9	9,084.2
Subcarpathian	4,600	4,047	88.0	4,565.0
Podlaskie	23,936	22,623	94.5	23,526.3
Pomeranian	7,607	6,952	91.4	12,183.6
Silesian	4,984	4,653	93.4	7,826.2
Holly Cross	7,916	6,741	85.2	8,783.2
Warmian-Masurian	11,260	10,495	93.2	14,066.1
Greater Poland	30,853	28,699	93.0	64,506.6
West Pomeranian	2,168	1,879	86.7	2,955.2
Total	**195,625**	**180,308**	**92.2**	**270,065.6**

Source: own calculation based on ARMA (2022) and the National Bank of Poland (2022).

In the analyzed period, under the Rural Development Program 2014-2020, aid related to the COVID-19 pandemic was provided to over 180,000 agricultural producers. Almost all producers received aid in 2020. A total of over 195,000 applications were submitted (Table 2). ARMA has accepted about 180,000 applications across the country, constituting 92.2% of all submitted applications. Such a high level of acceptance of applications by ARMA resulted from the willingness to provide aid to farmers quickly and as widely as possible in connection with the increased uncertainty and the more challenging economic and financial situation of some agricultural producers related to the prolonged COVID-19 pandemic. In practice, submitted applications that met the formal requirements were accepted by ARMA. This public financial support was primarily focused on livestock production. Sowula-Skrzyńska et al. (2020) indicate that the COVID-19 pandemic has adversely impacted 58% of livestock-oriented farms.

The most farmers received the above-mentioned aid from RDP 2014-2020 in the following voivodeships: Masovian (32,901), Greater Poland (28,707), and Podlaskie (22,624). The first two voivodeships are the largest in terms of area, while Podlaskie is highly developed in terms of agriculture with quite fragmented agriculture. The largest number of applications was also submitted and approved (Table 1). ARMA accepted the biggest part of applications for implementation in the Podlaskie Voivodeship (94.5%) and the smallest in the Holly Cross Voivodeship (85.2%). As part of this support, the largest amount was paid to agricultural producers in the Greater Poland voivodeship (EUR 64.5 million). In this region, farms are among the largest in terms of production value and the best organized in Poland and very often with well-developed animal production. Farmers from Masovian voivodeship (EUR 36.9 million) and Kuyavian-Pomeranian voivodeship (EUR 31.4 million) also received high aid. The characteristics of the Kuyavian-Pomeranian Voivodeship are similar to that of the Greater Poland Voivodeship. Therefore, although fewer applications were submitted in the Kujavian-Pomeranian voivodeship, the obtained aid was of much greater value.

Figure 2. State aid from national programs for agricultural producers affected by the COVID-19 crisis in 2020-2021 in Poland (EUR million)



Source: own calculation and elaboration based on ARMA (2021, 2022) and NBP (2022).

COVID-19 related ARMA's assistance to farmers from national programs was more minor than from RDP 2014–2020, but also significant and vital, i.e., ARMA paid out EUR 134.8 million. It accounted for 96.6% of the requested aid. This percentage is even higher than with RDP 2014–2020. During the novel coronavirus pandemic, ARMA quickly simplified bureaucratic requirements to a minimum in providing support for agricultural producers. This scope of activity of the Polish state is assessed positively (Urban 2022, Żochowski, 2021).

Most funds under national programs were paid from the program: financial aid for an agricultural producer who is threatened with loss of financial liquidity due to restrictions on the agricultural market due to the COVID-19 pandemic (Figure 2). This program accounted for 66.3% of total aid from all national programs. As part of it, farmers submitted almost 60,000 applications for a total amount of EUR 89.6 million (Report, 2021). Funds were obtained by over 57,000 agricultural producers, who were paid EUR 89.3 million, i.e., almost the entire amount applied for. A very similar program, and second in terms of funds paid from national programs, was financial aid to pig producers threatened by a loss of financial liquidity due to restrictions caused by COVID-19. Aid to pig producers was earmarked because of their previous difficult situation with African swine fever. EUR 28.0 million was disbursed under this program, i.e., 89.6% of the amount requested. Producers submitted the applications in December 2020, and the payments were made in early 2021.

The most minor program in terms of amounts disbursed was financial assistance to holders of chrysanthemums in full maturity and intended for sale who have suffered losses due to market constraints caused by the COVID-19 pandemic. At the end of October 2020, due to the increasing COVID-19 incidence, the Polish government decided to ban access to cemeteries. As a result of this decision, chrysanthemum sellers found themselves in a difficult position, unable to sell them. In 2020, ARMA spent EUR 17.4 million on the purchase of chrysanthemums (Figure 2). In total, 5,211 sellers obtained assistance. The largest amount was paid in the Lesser Poland voivodeship (EUR 2.3 million), and the lowest was in the Lubusz and Podlaskie voivodeships (EUR 0.4 million each).

4. Conclusion

Agriculture is a sector in which economic policy has an exceptionally significant influence. Therefore, in Poland, the state has taken several measures concerning agriculture to limit the adverse effects of the COVID-19 pandemic. These anti-COVID-19 state measures covered: aid for farms at risk of losing liquidity, intervention purchases of agricultural products, subsidies to interest rates on banking loans, loans, guarantees and loan sureties, subsidies for the costs of employee salaries, allowances for rent or lease, subsidies or repayable assistance, exemption for farmers from paying social security contributions, children care benefits, sick benefits for the quarantine period.

Public financial aid for agriculture with the highest value (2/3 of the aid for farmers) came from the RDP 2014-2020 program, i.e., EUR 270 million. The vast majority of aid applications submitted by farmers were positively considered and financed by over 92%. Moreover, under state aid, ARMA implemented three programs with approximately a total value. EUR 135 million, i.e., financial aid for agricultural producers facing liquidity losses due to restrictions on the agricultural market, financial aid for the holders of chrysanthemums who have suffered losses due to market restrictions, and financial aid to pig producers. The largest amount of aid concerned the liquidity relief program. About 97% of the submitted applications were approved as part of the national state aid. Such a large percentage of accepted applications, both from the RDP 2014-2020 and state programs, resulted from the willingness of the Polish state to help farmers quickly. To sum up, the analyzed state aid support programs were aimed at maintaining the level of farm income during the COVID-19 pandemic.

An in-depth analysis and evaluation of COVID-19-related individual agricultural policy instruments and their effects on agricultural producers is a challenge for future research.

Acknowledgements

The publication is financed from the state budget under the project of the Ministry of Education and Science "Science for Society" No. NdS/532598/2021/2022. The total value of the project is PLN 290 950.00 (Poland).

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PRICE AND VOLATILITY TRANSMISSIONS BETWEEN OIL AND SELECTED AGRICULTURAL COMMODITIES

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Annotation: Prices for food products and energy resources are interrelated currently. Unfortunately global oil market players such as the Russian Federation, Saudi Arabia and Canada can manipulate prices for oil and consequently global prices for food products. The aim of this paper is to analyze impact of crude oil price on the main agricultural products. The authors made high level review meaningly in order to obtain global view of the problem. In this paper, monthly data for oil, wheat, soybeans and rice for almost 40 years was analyzed to find interrelationship between them. Data was taken from World bank in constant prices in UDS. It allows avoiding impact of inflation. Johansen cointegration test was chosen for VECM model with long-run cointegration. The model initiated impulse response analysis and short run prognosis. The results revealed that dependence of wheat and soybeans from oil price did really exist. However, the opposite dependence of oil from rice price exists too.

Keywords: World oil prices, Impulse response analysis, VECM, Johansen cointegration test

JEL classification: Q11, E3

1. Introduction

Agricultural commodities play a big role in our daily life. In many countries, especially in developing countries, the main item of expenditure is food. A sharp change in food prices can become a serious threat to the country's food security. Studying price transmission ways allows to analyze price changes and possible ways to predict them. A lot of scientific works are devoted to the topic of price transmission, topic is very popular among scientists around the world. Usually, agricultural products by types are analyzed. For example, Bakucs and Ferto (2009) studied the meat market, Maitah and Smutaka (2019) studied the sugar market price. Asche et.al (1999), Gizaw et.al 2021) investigated the Salmon market. Taking products, which required labor-intensive processing, gives a good picture of price transfer. Another research group is devoted to price transmission inside one selected country (Reziti, I., Panagopoulos, Y. 2008). Studying within one country only makes possible to delve into the topic with all the nuances, but on the other hand, not all the effects of world trade that affect price transmission can be taken into account.

The European Green Deal (2019) aims is to achieve 100% GHG reductions by 2050. EU Government invest money for alternative energy sources. However nowadays after Covid-19 EU policy focus moving from green priorities in the post-Covid-19 recovery programmers. Siddi, (2020) argued, that the EU commission also needs to ensure that the additional allocation of funds for the Green Deal is indeed supplementary to the pre-existing budget, rather than a reshuffling of commitments already made earlier. Moreover, Garcia and Jones C. (2020) suggested that reliance on private investment should be done carefully. Because some big corporations are investing huge amount of money in the fossil fuel industry and can play unfair to the Greed deal.

However, there is exists a problem of global players. The US, as the world's second largest emitter, is shying away from the Green deal. In addition China having ambivalent position about phasing out coal. Nevertheless, the European Union should to pursue the energy transition in cooperation with other major global players and polluters, such as Russia (Verhagen, et.al, 2020). Meinshausen M. (2009) declared that limiting cumulative CO2 emissions over 2000–50 to 1,000 Gt CO2 yields a 25% probability of warming exceeding 2 °C—and a limit of 1,440 Gt CO2 yields a 50% probability—given a representative estimate of the distribution of climate system properties. Hainsch et.al. (2022) suggested that achieving the decarbonization of the energy system will be driven by a combination of factors and synergies between technological development, policy exertion and societal attitudes. Each country of European Union could create a way of decarbonization. Tomaszewski (2020) proofed that Poland is able to effectively meet European climate targets, although the implementation of this challenge requires decisive action on the part of the government, as well as an adequate response from investors and society.

Russia as big player of fossils fuel influencing in o Greed Deal policy using price of Oil volatility. Actually, increasing oil price influenced negatively to EU economy on the one side, but on the other side it is stimulate moving use alternative energy sources.

Nowadays, there is a tendency for prices for food and non-food products to depend on the price of oil and gas (Shahbaz et al., 2021). Some researchers link oil prices to inflation and Monetary policy. And after, it affects to food prices. (Kartaev and Medvedev, 2020). The development of global agricultural trade, the change of major players and speculation in the oil and grain markets have a strong impact on prices (Svatos and Smutka, 2010).

In our paper, we focus at price transmission from a global perspective. It was taken the prices of three main food products - Wheat, Soybeans and Rice at average world prices and examined how they are affected by the cost of oil, as one of the main energy carriers. Esmaeili and Shokoohi (2011) have explored this topic already, and confirmed that oil prices affect the prices of agricultural products. Nazlioglu (2011) was demonstrated in research non -linear dependents between Crude Oil, Soybeans and corn.

<u>Research question</u> – How changing of fossil oil prices influence to the prices of Wheat, Rice and Soyabean.

<u>Data source</u> – World bank and Un Cometrade.

<u>Observations</u> – 520 monthly observation, from Jan 1979 till April 2022.

2. Materials and Methods

Many studies, devoted on the impact of oil prices on food, used a variety of methods. For example, Baffes (2007) used regression analysis with panel data in his work on the impact of oil prices on 35 agricultural commodities, and Xiaodong Du, Cindy and Hayes (2010) used Bayesian Markov Chain Monte Carlo methods.

In our research, 3 types Vector Error correction Model were used.

$$\Delta Oil_t = \sigma + \sum_{i=1}^{k-1} \beta_i \Delta Oil_{t-i} + \sum_{i=1}^{k-1} \varphi_i \Delta Wheat_{t-j} + \gamma_1 ECT_{t-1} + \mu_{1t} \quad \textbf{(1)}$$

$$\Delta Oil_t = \alpha + \sum_{i=1}^{k-1} \beta_i \Delta Oil_{t-i} + \sum_{i=1}^{k-1} \varphi_i \Delta Soybeans_{t-j} + \gamma_2 ECT_{t-1} + \mu_{2t} \quad \textbf{(2)}$$

$$\Delta Oil_t = \vartheta + \sum_{i=1}^{k-1} \beta_i \Delta Oil_{t-i} + \sum_{i=1}^{k-1} \varphi_i \Delta Rice_{t-j} + \gamma_3 ECT_{t-1} + \mu_{3t} \quad \textbf{(3)}$$

Where:

k-1 - the lag length is reduced by 1

β_i, φ_i – short-run dynamic coefficients of the model's adjustment long-run equilibrium

γ_j – speed of adjustment parameter with a negative sign

ECT_{t-1} – the error correction term is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressors.

μ_{jt} – residuals

A crucial requirement for using the model is testing variables for cointegration. VECM is used only if all data are co-integrated with each other (short-time and long-time model). For this reason, we will use the Johansen cointegration test (Johansen, S. 1988) and Engle-Granger cointegration test.

Engle-Granger cointegration test (Granger, 1969) was used residuals (errors) on the static regression. For checking Unit root tests it was used. Usually for Unit root test was used as Dickey-Fuller test. The null hypothesis is no cointegration exists, the alternative hypothesis is that it is some cointegration between two series.

Firstly, it was identified whether individual series are nonstationary by using the Augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1981).

For the variables that are cointegrated, there exists the Granger-cause type of relationship at least in one direction. The Granger causality tests identifies whether one time series is useful in forecasting another via seeking the direction of causality between prices. For this reason, it was estimated the following equation for testing Granger causality (presented for the two-variable case and only for one of the two variables).

$$P_{1t} = \alpha + \sum_{i=1}^{p} \beta_i P_{1t-i} + \sum_{i=1}^{p} \gamma_i P_{2t-j} + \varepsilon_t \quad \textbf{(4)}$$

Where P_{1t} depends on its own *p* lagged values as well as on the *p* lagged values of P_{2t} variable.

Johansen cointegration test was made to improved Engle-Granger cointegration test. But it general, it is recommended to use both tests. Some authors argued, that Engle-Granger cointegration test is more robust.

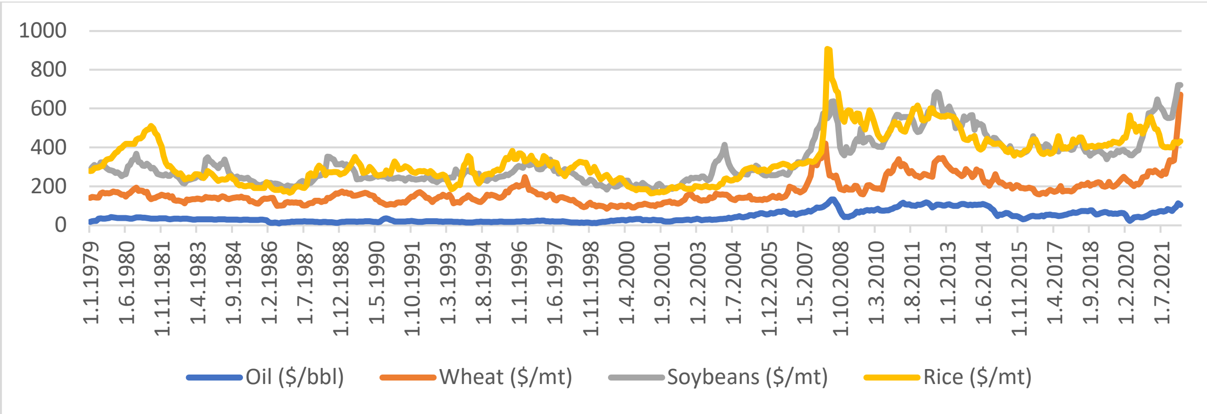
- Limitation - Data in nominal prices for avoiding inflation influences

- Variables (price in USD) - Crude oil, average ($/bbl), Wheat, US SRW ($/mt), Soybeans ($/mt), Rice, Thai 5% ($/mt).

3. Results and Discussion

Figure 1 illustrates price behavior over the past 40 years. A several price shocks in 1980, 2008 and 2021 are clearly visible. Figure supports our ideas, that correlation exists between oil price, wheat, rice and soybeans.

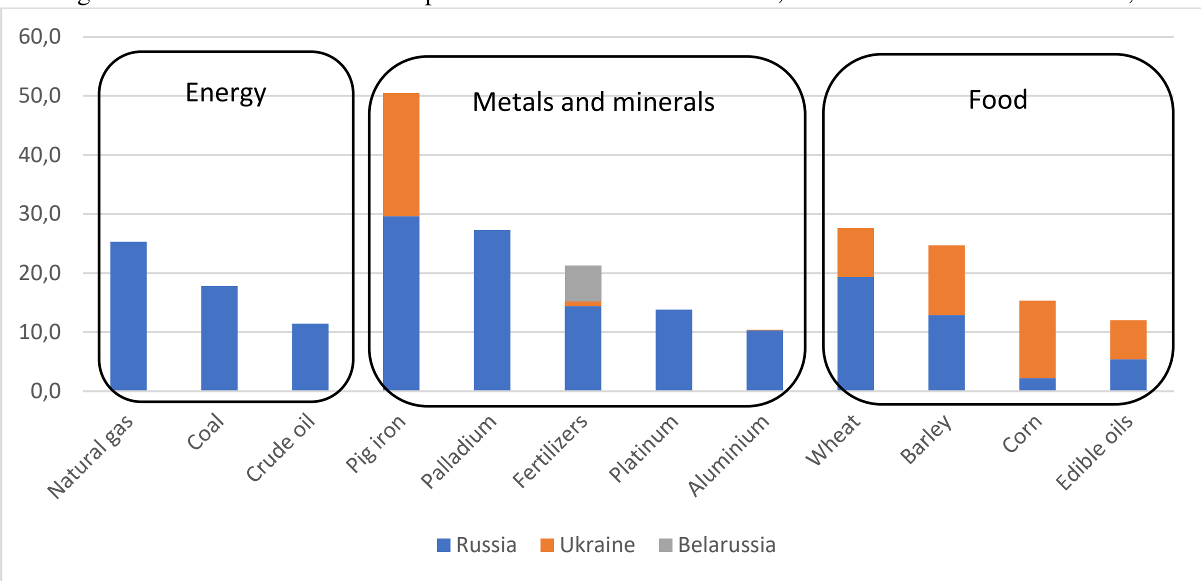
Figure 1. World prices for selected agricultural commodities and crude Oil in USD



Source: World bank, own calculation, 2022

The price of oil depends on many factors, and key players can influence this price. The largest oil exporters are Saudi Arabia and Russia and Canada. Figures 2 shows the role of Russia in world wide exports of Oil.

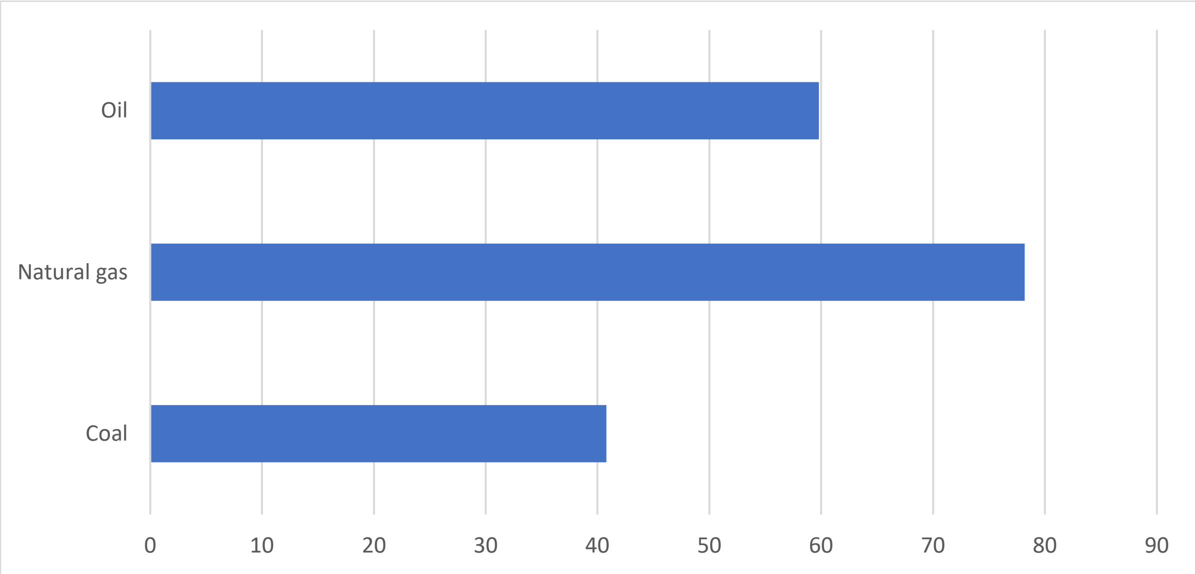
Figure 2. Selected commodities exported to worldwide from Russia, Ukraine and Belarussia in 2020,%



Source: World bank, own calculation, 2020

If we consider trade relations on energy resources between Russia and the European Union, then Russia is the main supplier and monopolist as shown in figure 3. This, unfortunately, gives the advantage to dictate prices to some extent and the transfer of these prices is reflected in food products. On the other hand, the increase in oil and gas prices stimulates the transition to biofuels and alternative energy sources. This shift weakens the relationship between agricultural output and the price of oil.

Figure 3. Share of Russia's energy exports to the EU in 2020,%



Source: Un Comtrade, own calculation, 2020

The descriptive statistics of the variables are summarized in table 1. According to table 2, the most volatility product is Rice. All price in UDS and covered period Jan 1979-April 2022.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Oil	520	43,099	28,890	9,617	132,825
Wheat	520	173,646	66,243	85,300	672,457
Soybeans	520	330,003	118,264	183,000	720,790
Rice	520	340,063	123,330	163,750	907,000

Source: Own calculations

The correlation matrix displayed in table 2. The correlation between commodities is quite high. Thus the shock from on commodity is immediately spread to others. However, we have to check relation between varibales using several specific tests.

Table 2. Correlation matrix

	Oil	Wheat	Soybeans	Rice
Oil	1,00000			
Wheat	0,78550	1,00000		
Soybeans	0,85940	0,89540	1,00000	
Rice	0,74440	0,69640	0,80850	1,00000

Source: Own calculations

The first for VECM creation is the checking up the series for stationarity. It was used unit root tests. The results of this test will be partly used later for the Engle-Granger cointegration test.

Table 3. Results for the unit root tests for Oil

	Augmented Dickey–Fuller test		**Phillips-Perron test**	
	Test statistic	5% Critical value	Test statistic	5% Critical value
Levels				
Intercept	-2,094	-2,860	-1,750	-2,860
With a trend	-3,149	-3,410	-2,736	-3,410
With a drift term	-2,094	-1,648	-	-
First-differences				
Intercept	-12,706	-2,860	-14,723	-2,860
With a trend	-12,703	-3,410	-14,713	-3,410
With a drift term	-12,706	-1,648	-	-

Source: Own calculations

The number of lags for ADF was selected manually, and for the PP test the number of lags was calculated automatically. Tables for Wheat, Soybeans and Rice were similarly made. They all showed that the series is not stationary in levels, but stationary in first differences. For ADF test and PP test, the vector is stationary if test statistics is lower that critical value. In addition, for all variable, it was significant drift term variable in ADF regression. The Engle-Granger cointegration test allows as to see the cointegration between variables. In table 4, we checked variables couples Oil-Wheat, Oil-Soybeans, Oil-Rice variable pairs.

Table 4. Engle-Granger cointegration test between Oil and selected commodities

Product	ADF levels		ADF first diff		Engle-Granger	
	Test statistic	5% Critical value	Test statistic	5% Critical value	Test statistic	5% Critical value
Oil	-2,094	-2,860	-12,706	-2,860	-	-
Wheat	2.702	-2.860	-14.055	-2,860	-1.996	-3.348
Soybeans	-0.432	-2.860	-18.487	-2,860	-3.695	-3.348
Rice	-2.202	-2.860	-15.911	-2,860	-3.112	-3.348

Source: Own calculations

Engle-Granger cointegration test included two steps. Firstly, it was checked by ADF test, series should be non-stationary in levels and should be stationary in first differences. These requirements are fulfilling in table 4 - test statistics is higher than critical value for levels and lower than critical value in first differences. Secondly, results of Engle-Granger test should be following – test statistics is higher that critical value. According table 4, for Wheat and Soybeans variables are no cointegration, but it is a cointegration for Rice. However, Engle-granger cointegration test is considered to be prone to robust errors and is therefore recommended to be performed in conjunction with the Johansen cointegration test. To conduct the Johansen cointegration test, it is necessary to know the number of lags for the model. It was determined optimal lag selection using Akaike criterium, optimal number of lags for VECM is 3.

Table 5. Johansen cointegration test

Maximum rank	Eigenvalue	Trace statistic	5% Critical value
0	-	104.9382	47.21
1	0.08237	60.4131	29.68
2	0.07284	21.2345	15.41
3	0.03942	0.4009*	3.76
4	0.00077	-	-

Source: Own calculations

As illustrated in table 5, the smallest weight for trace statistic column is for rank 3. It means that cointegrations exists in the model and thus long-run relationship exists too. Thus, the usage of the Vector Error Correction model is justified

In our research we created several price pair for VECM: Oil-Wheat, Oil-Soybeans, Oil-Rice.

Each model was tested for autocorrelation, heteroskedasticity, and normality tests was made.

The results of models are following - exists dependence of Wheat and Soybeans from Oil price. This result was expectable and suits of economic theory. However, dependence Oil from Rice was unexpectable. This result requires additional research focus.

Table 6. Vector error correction model results

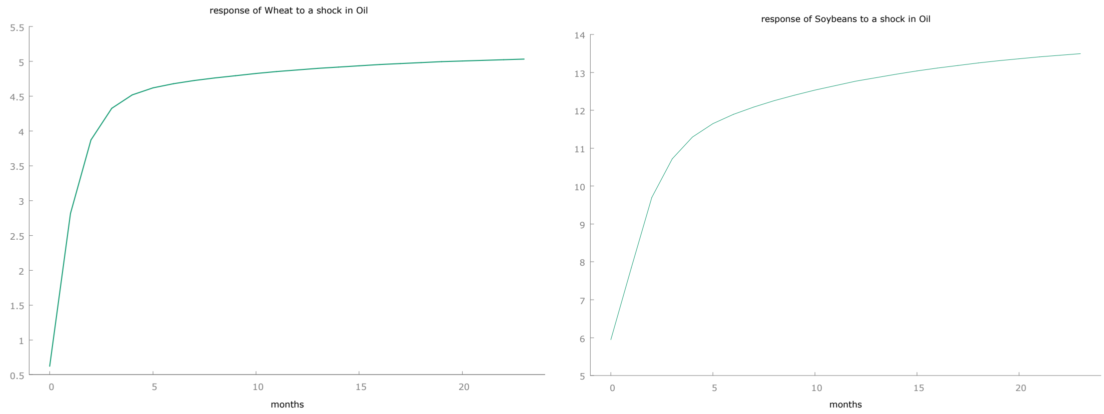
Model type	Dependence Agri products from Oil price	Dependence Oil from Agri products	Autocorrelation test (p-value)	Heteroskedasticity test (p-value)	Normality test (Dornik-Hansen test P-value)
Model Oil - Wheat	Confirmed P-value for EC1 less 0,05	Not confirmed P-value for EC1 more 0,05	0,0651	0,0000	0,0000
Model Oil- Soybean	Confirmed P-value for EC1 less 0,05	Not confirmed P-value for EC1 more 0,05	0,5257	0,0000	0,0000
Model Oil- Rice	Not confirmed P-value for EC1 more 0,05	Confirmed P-value for EC1 less 0,05	0,2963	0,0000	0,0000

Source: Own calculations

It was chosen third lag during model checking for autocorrelation, heteroskedasticity and normality test. For all three models autocorrelation is not confirmed, autocorrelation is confirmed, and there is no residual correlation.

Figures 4 and 5 demonstrates impulse response of Wheat, Soybeans and Rice to a shock in Oil using VECM model.

Figure 4. Impulse response of Wheat, Soybeans to a shock in Oil

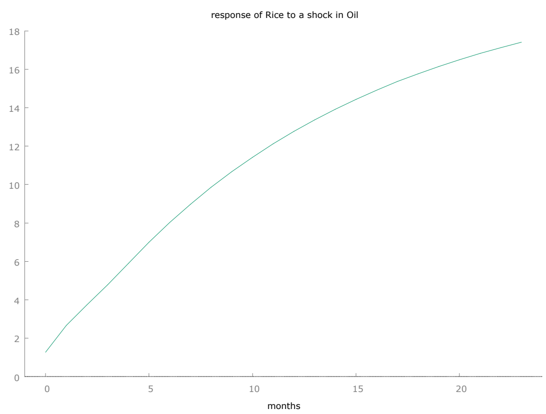


Source: own calculation

For Wheat and Rice time of response is in average 5 month. For Rice time of response is in average 20 month. So we can say that Wheat and Soybeans market are more sensitive for changing of Oil pricing. This result requires more detailed investigation. However, we can expect that differences in impulse response caused of country share in production amount. In our work we used average all world prices for wheat, rice and soyabeans. Countries, who produced main part of all word amount of soyabeans, wheat and rice differently reacted to oil price changes. For example America the main producer of soyabeans and China is the main produser of rice and economic reaction of oil price changing will be different for China and for America.

Moreover, in our work we did not focus on exchange rate, because we look only to world prices. Exchange rate plays a big role in establishing oil prices and agricultural commodity prices (Zhengwei, et.al. 2015).

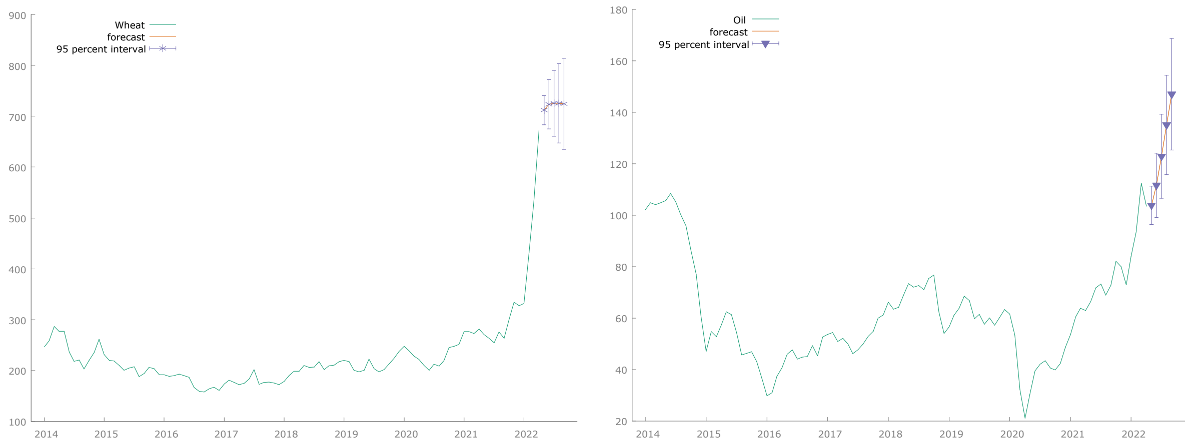
Figure 5. Impulse response of Rice to a shock in Oil



Source: own calculation

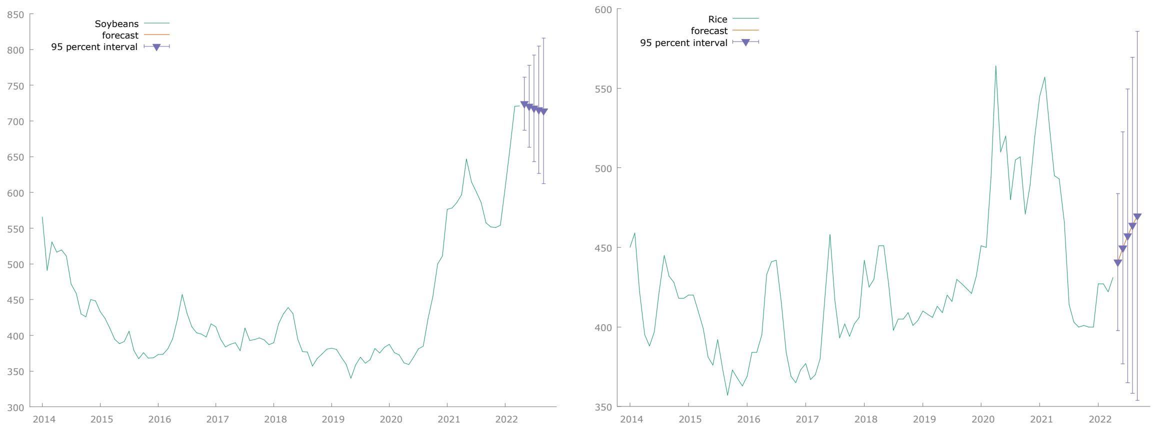
Figures 6 and Figure 7 illustrates prognoses for Wheat, Soybeans, Rice and Oil, using VECM model in to 2022 year.

Figure 6. VECM prognoses for 2022 year for Wheat and Oil



Source: own calculation

Figure 7. VECM prognoses for 2022 year for Soybeans and Rice



Source: own calculation

According prognosis in probability 95% interval, the price of wheat will be stable for all 2022 year. Price for soyabeans will be decreased. However price for rice and oil will be increased in 2022. However, limitation or our VECM will be political decision uncertainty. Local and global conflicts play important role in price creation and it is complicated involve it into the model.

4. Conclusion

European green deal is targeting to 0 GHG by 2050. It is ambitions plans, which can be reached by government, private cofounding, social and political decisions. However, it is necessary to pay attention to corporate investments, because some big companies are investing huge amount of money in the fossil fuel industry and can play unfair to the Greed deal. Russia one of the main exporter of natural gas and oil to European Union and can dictate price and conditions of trade. In this case this pressure make additional stimulation to changing into alternative source of energy and reducing GNG in the frame of 2050.

In this paper, monthly data for oil, wheat, soybeans and rice for almost 40 years was analyzed to find interrelationship between them. Johansen cointegration test was chosen for VECM with long-run cointegration. The model initiated impulse response analysis and short run prognosis. The results revealed that dependence of wheat and soybeans from oil price did really exist. However, the opposite dependence of oil from rice price exists too. Further investigation work is planned with rice prices.

Acknowledgements

The paper is a part of the internal research project 2021B0002 "The post-Soviet region in the context of international trade activities: opportunities and threats arising from mutual cooperation", solved at the Department of Economics, Faculty of Economics and Management, Czech University of Life Sciences in Prague.

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THE IMPACT OF THE COVID-19 PANDEMIC ON THE RISK OF BANKRUPTCY OF ENTERPRISES IN THE AGRI-FOOD SECTOR IN POLAND

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Annotation: The COVID-19 pandemic has become the cause of one of the greatest crises in the modern history of the global economy, including the agri-food sector. Business suspension and administrative restrictions on movement worsened business conditions and affected both the demand and supply of food products. On the other hand, state aid improved the financial liquidity of enterprises and limited the risk of their bankruptcy. In order to assess the impact of this situation, using the Altman Z-score index, changes in the level of bankruptcy risk in the 1000 largest enterprises in the agri-food sector in Poland in 2018-2020 were examined. The results indicated that during the period of the impact of the pandemic in 2020, the changes in bankruptcy risk were mild. Moreover, the directions of these changes varied depending on the section in which the enterprises operated. In 2020, out of the sixteen examined sections, the Z-score increased in nine and decreased in seven. The risk of bankruptcy decreased the most in the following sections: production of bread and bakery products and production of animal feed. It grew the most in the following sections: processing, preserving fruit and vegetables and refining fats and oils.

Keywords: Poland, COVID-19, Agri-food sector, Z-score.

JEL classification: E00, G33, Q13.

1. Introduction

The COVID-19 pandemic has become the cause of one of the greatest crises in the modern history of the global economy. Its effects and administrative restrictions slowed down the development of the financial and real sectors, including the agri-food industry. Estimates made by the International Monetary Fund (IMF) show that in 2020 the pandemic reduced the value of global GDP by 3.2%. The GDP dropped the most in developed economies (AE), i.e., by 4.6%, while in emerging market countries (EM) by 2.1%, including the countries of the Central and Eastern Europe by 2% (IMF, 2021). Larger losses were incurred by the hotel and tourist industry, retail trade and the commercial real estate market, whose global sales in the second quarter of 2020 decreased by 80%, 60% and 50% y/y, respectively (IMF, 2020). According to some central banks, these negative processes resulted in a significant deterioration of creditworthiness and bankruptcy of borrowers, mainly from the small and medium-sized enterprise (SME) sector (ECB, 2020; NBP, 2021; Alves et al., 2020).

The pandemic has introduced an enormous number of disturbances in the functioning of enterprises. Redundancies, fall in commercial real estate prices, decrease in liquidity and profitability of enterprises increased the probability of materialization of the bankruptcy risk (Chetty et al., 2020). The negative impact of COVID-19 on the functioning of enterprises was stronger in EM than in AE, which was often due to their weaker capitalization and maintaining smaller safety buffers necessary to absorb unexpected losses (Abbas et al., 2021). The sensitivity of EM enterprises was also increased by the persistence of a lower technological and infrastructural level in their economies, as well as a limited ability to diversify the revenue structure. As a result, while the pandemic contributed to a larger short-term decline in GDP in AE countries, the World Bank forecasts for 2021-2022 showed that GDP growth would return to positive there, while in lower income countries it would remain negative (World Bank, 2021).

However, the weakening of the impact of COVID-19 in the second half of 2020, as well as the improvement in economic activity did not eliminate the extraordinary risk to which enterprises, mainly from the SME sector, were exposed (ECB, 2021). Another sharp increase in the number of cases of illness recorded at the end of 2020 motivated the governments of many economically important countries, including Australia, Croatia, Greece, Spain, Japan and the UK to reintroduce stringent sanitary restrictions that are likely to reduce corporate profitability. It should also be noted that research by the Financial Stability Board (FSB) on the global pandemic in 2020 showed that in some countries the risk of business failure was due to the premature partial closure of state aid programs. For this reason, she suggested that the policy of withdrawing state aid should be flexible and adjusted to the current situation in a given country. The FSB noted that a smooth return to normal operations could also be harmed by the fact that for some companies the pandemic disrupted their long-term strategy and forced them to start major restructuring due to uncertainty about the prospects for the development of the sectors of the economy in which they had operated so far. These activities, even supported from public funds, generate additional credit risk in the long term, as the aid funds must be fully or partially repaid in the future (FSB, 2021).

In Poland, the negative effects of the pandemic have been largely neutralized thanks to public aid. Its individual programs, referred to as anti-crisis shields, made it possible to protect employment, reduce burdens and maintain a stable level of financial liquidity of enterprises. Public aid consisted, inter alia, the temporary exemption of micro-enterprises (up to 9 employees) and cooperatives from the obligation to pay social security contributions, paying employees of small enterprises (10-49 employees) and self-employed workers, as well as subsidizing the salaries of employees of enterprises in a bad financial situation. The estimated total value of the planned public aid amounted to approx. PLN 300 billion, i.e., approx. 15% of GDP, and was directed mainly to micro and small enterprises (Ministry of Development and Technology, 2022).

The state aid prepared by the government was unfortunately of a temporary nature and did not liberate the enterprise from the risk resulting from the dynamically changing labor market, breaking the existing supply chains, and losing some of the existing contractors and clients. Moreover, the uncertainty as to the further changes to the state aid regulations, the necessity to end credit holidays and the further development of the pandemic contribute to the continuing difficulties in running the business of enterprises and the prospects for their further development. The agri-food industry has been affected by the negative effects of COVID-19 in a similar way as the entire economy. Despite the limitation of the destructive impact of the pandemic, enterprises in this sector were exposed to the total loss and periodic absenteeism of employees, limitation of distribution channels, especially direct sales, loss of the existing domestic and foreign sales markets (Szczepaniak, Ambroziak and Drożdż, 2020).

These problems lead to a question about the strength of the impact of the COVID-19 pandemic on the risk of bankruptcy of companies in the agri-food sector. Additionally, when assessing the measures of the resilience of enterprises in this sector to the risk of bankruptcy, it is important to examine whether COVID-19 had an equal impact on all sections of this sector. The study was conducted on the basis of financial data from the EMIS database and covers about 1000 agri-food companies operating in Poland in 2018-2020. The level of risk of bankruptcy of enterprises was measured using the Z-score index developed by Altman (1968) for non-financial enterprises. The choice of research topic was dictated by the fact that so far only a small number of studies on the impact of the COVID-19 pandemic on the activities of the agri-food sector have been published. The research to date covers the financial sector to a greater extent.

The results of the study provide new insight into the assessment of the resilience to pandemic risk for the entire agri-food sector as well as its sections. The discussed subject may be particularly important in the face of the growing increased risk related to the aggression of the Russian Federation against Ukraine and its strong negative effects on the world economy, especially Poland. This article is part of an ongoing study focused on assessing the consequences of the COVID-19 pandemic in the agri-food sector. The research results are important for analysts of the agri-food sector, governmental and local government institutions, as well as for economists and analysts of the food market. They fill the gap in the literature on the subject and shed new light on the problem of assessing the stability of the agri-food sector on the devastation that took place during the crisis.

Much research to date has focused on assessing the impact of the COVID-19 pandemic on the macroeconomic situation of regions (Fernandez, 2021), the production volume of enterprises (Fernandez et al., 2021) as well as the level of employment and the situation of micro-enterprises (Abbas et al., 2021; World Bank, 2021; ECB, 2021). Fernandez (2021), while studying the impact of COVID-19 on a group of 4,000 companies in Spain, noted that factors deteriorating their financial situation were, among others, restrictions in the movement of people, employment of workers on temporary contracts. In turn, Blanco et al. (2020) examining 8,000 Spanish companies, found that the COVID-19 pandemic significantly reduced the stability of business operations and, as a result, decreased financial liquidity and profitability, which contributed to the largest decline in economic activity in Spain since 2002. The decrease in corporate revenues and the need to maintain current financial liquidity resulted in an increase in indebtedness of enterprises, especially in the SME sector.

Analyzing individual sectors of the economy, Blanco et al. (2020) stated that the largest declines in revenues (measured by gross value added) were recorded in: hotel and leisure (-24.3%), transport and warehousing (-24.1%), and arts, entertainment and other services (-24%). In turn, the smallest losses were suffered by e.g., sectors where it is possible to work remotely i.e., financial services (+ 2.9%) and public administration (+ 1.4%). Fernandez et al. (2021) also confirmed the existence of an uneven impact of COVID-19 on the financial performance of enterprises in various sectors of the economy (FSB, 2021). They noted that the largest declines in revenues and employment were experienced by enterprises with up to 50 employees, as well as enterprises with a short market presence, low efficiency and located in urban areas. Moreover, Jurgensen et al. concluded that COVID-19 has a mixed impact on the SME sector. Smaller enterprises did not have the possibility to use the economies of scale in their operations and relatively quickly lost financial liquidity and, as a consequence, went bankrupt. For this reason, the prospects for the development of the SME sector after the end of state aid may be diversified and strongly dependent on the trends emerging in the economy (Juergensen, Guimón and Narula, 2020).

The pandemic also highlighted the problem of the existence of inequalities in access to public aid. The research of OECD found that micro and small enterprises, while being the most sensitive to COVID impact, were often not fully protected by state aid schemes. The review of the regulations governing state aid to combat the effects of COVID-19 in OECD member countries showed that the SME sector was not treated on an equal footing with other economic entities and households throughout the period (OECD, 2021). The risk of receiving insufficient public aid appeared most often in the case of the smallest and the shortest-operating entities, incl. start-ups, self-employed people, and enterprises run by women and ethnic minorities. In these cases, the decision to obtain government assistance was subject to a number of additional conditions. The sensitivity of micro and small enterprises to COVID-19 was also confirmed by the research by Cajner et al. (2020), which showed that in the US in the first quarters of the pandemic, most jobs were lost in small and micro-enterprises that were running or employed low-income workers and performing simple tasks, especially in the hotel industry, gastronomy and tourism.

While state aid programs improved the financial health of enterprises and their employees, they addressed the pandemic's significant loss of economic and profit-generating capacity. The losses incurred have become a source of increased risk of bankruptcy. Fernandez et al. (2021) indicated that the absenteeism of sick employees and the obligation to remain in quarantine limited human capital resources, especially in the production sectors of the economy. As a result, the financial liquidity of enterprises and their ability to meet obligations towards banks and contractors have significantly worsened. State aid from governments and central banks was both direct, in the form of subsidies, and indirect, in the form of loan moratoria and loan guarantees for enterprises taking out new loans. Statutory and non-statutory credit moratoria have allowed companies to defer their loan installments while paying only interest on existing loans, and the newly granted loans, due to being backed by a treasury guarantee, ensured a lower credit margin (interest) (ECB, 2020).

The issue of the impact of the COVID pandemic on the financial situation of enterprises has not been discussed too often by academics. When studying the changes caused by the COVID pandemic in public transportation companies in Poland in 2020, Wielechowski, Czech and Grzęda (2020) found that the introduction of administrative restrictions in interpersonal contacts, the need to maintain social distance and the reorganization of the economy in the direction of remote work significantly limited the mobility of society. This was reflected in the reduced demand for local and regional public transportation and the deterioration of the situation of transport companies.

The impact of COVID on the functioning of the economy, including the enterprise sector in Poland, was taken by Czech et al. (2020) and showed that the uncertainty as to the further development of the pandemic and numerous administrative restrictions may significantly deteriorate the stability of the functioning of enterprises and their financial results. Similar conclusions were brought by a study by Czech and others (2020) of companies listed on the stock exchanges of the Visegrad Group countries. They found that the negative effects of the COVID-19 pandemic significantly increased the risk of depreciation of the Czech koruna (CZK), Hungarian forint (HUF) and Polish zloty (PLN). Moreover, the severity of the disease is negatively correlated with changes in stock exchange indices and indicates that listed companies have periodically lost their ability to generate profits.

In turn, Szczepaniak, Ambroziak and Drożdż (2020) examined the effects of the COVID-19 pandemic among food companies in the first months of its presence in Poland. They stated that state aid programs as well as the growing domestic and foreign demand for Polish food products and the continued price competitiveness of Polish food exports mean that the effects of the pandemic may be mild. Only a temporary slowdown in the development of food sector enterprises may turn out to be negative effects of the pandemic, mainly due to fluctuations in the dynamics of export growth. The research did not reveal any risk of a wave of bankruptcies in this sector.

Based on this literature, the following research questions were formulated:

• Question 1: Has the COVID-19 pandemic affected the risk of bankruptcy of agri-food companies in Poland in 2020?

• Question 2: Was the level of bankruptcy risk different depending on the section of the agri-food sector?

2. Materials and Methods

The research sample included the 1000 largest enterprises, in terms of assets, from the agri-food sector from the following sections:

1. Processing and preserving of fruit and vegetables – 138 enterprises;
2. Processing and preserving meat and production of meat products - 103;
3. Slaughter of animals (except poultry) – 94;
4. Cheese production – 85;
5. Poultry processing – 69;
6. Production of bread and bakery products – 66;
7. Production of food for animals – 63;
8. Manufacture of other food products – 58;
9. Processing and preserving of fish and crustaceans – 55;
10. Manufacture of grain mill products, starch and vegetable oils – 53;
11. Dairy production – 42;
12. Manufacture of chocolate and cocoa confectionery – 35;
13. Production of cookies and crackers – 25;
14. Refining of fats and oils – 20;
15. Production of mayonnaise, sauces and other ready-made sauces – 18;
16. Other food sections – 76.

The total value of assets of the analyzed enterprises amounted to PLN 135.6 billion, PLN 143.9 billion and PLN 143.5 billion at the end of 2018, 2019 and 2020, respectively. The Z-score indicators were determined two years before the outbreak of the COVID-19 pandemic i.e., 2018 and 2019, and for 2020. The financial data of the companies were taken from the EMIS database of companies.

The Z-score indicator was used to assess the probability of bankruptcy of enterprises (Altman, 1968). This index was first proposed by Edward Altman in 1968. It is the sum of the coefficients representing various areas of the company's financial situation, scaled to the value of assets. At that time, this model made it possible to predict the bankruptcy of a company within two years with an accuracy of 94%. It was intended mainly for the evaluation of production companies. In the following years, based on the observation of the situation on the financial markets, it was slightly amended and adjusted to the assessment of companies not listed on the stock exchange.

The current updated version of this indicator takes the form (Altman et al., 2016):

$$Z = 0.717 \cdot \mathrm{X}_1 + 0.847 \cdot X_2 + 3.107 \cdot X_3 + 0.420 \cdot X_4 + 0.998 \cdot X_5 \quad \mathbf{(1)}$$

where: X_1 – working capital / total assets, X_2 – retained earnings / total assets, X_3 – operating earnings / total assets, X_4 – book value of equity / book value of debt, X_5 – sales / total assets.

The criteria for assessing the company's financial situation depending on the value of the Z-score model are presented in Table 1.

Table 1. Financial situation criterion based on the Z-score model

Z-score range	**Financial situation**
Z > 2.9	Safe zone – Stable financial situation and financial difficulties are not expected even in the future
1.21 < Z < 2.89	Grey zone – unstable financial status and ambivalent results
Z < 1.2	Distress zone – high bankruptcy probability

Source: own deliberations based on Altman et al. (2016).

3. Results and Discussion

The values of the Z-scores were calculated individually for each enterprise on the basis of formula 1. Then, the asset-weighted averages of the Z-score values for the sections of the agri-food sector mentioned in the previous chapter were calculated. The values of the indicators are presented in Table 2.

Table 2. Number of companies by the level of Z-score

	2018			2019			2020		
Sections of sector	**Safe**	**Grey**	**Distress**	**Safe**	**Grey**	**Distress**	**Safe**	**Grey**	**Distress**
A	38	85	15	35	88	15	36	88	14
B	50	51	2	51	50	2	53	48	2
C	71	16	7	62	24	8	68	22	4
D	48	34	3	51	31	3	54	29	2
E	42	25	2	43	24	2	37	30	2
F	28	35	3	29	34	3	32	32	2
G	25	33	5	29	31	3	27	34	2
H	16	40	2	18	38	2	21	35	2
I	18	35	2	17	36	2	20	34	1
J	15	35	3	18	33	2	18	35	0
K	13	29	0	14	28	0	13	29	0
L	10	24	1	9	22	4	8	25	2
M	7	15	2	5	18	2	5	19	1
N	10	8	2	11	7	2	12	6	2
O	11	7	0	11	7	0	9	9	0
P	28	42	7	29	43	4	27	44	5

Note: descriptions of sections of the agri-food sector in accordance with the list in the Materials and Methods

Source: own study based on EMIS data.

The values of the Z-score indicator reveal that in 2020, in most sections of the agri-food sector in Poland, the number of enterprises that are in real danger of bankruptcy has decreased (Table 2). The number of safe zones not endangered by the risk of bankruptcy in the near future has also increased. These results allow to answer the first research question and show that the COVID-19 pandemic did not noticeably worsen the financial situation of agri-food companies and their resistance to the risk of bankruptcy. Additionally, they are consistent with the forecasts presented by Szczepaniak et al. (2020), who pointed out that the persistence of high demand, both domestic and foreign, for Polish food, as well as price competitiveness of exported Polish food products will allow the good financial standing of food producers in Poland. Such a favorable situation will not contribute to the emergence of an increased number of bankruptcies in the agri-food sector during the COVID-19 pandemic. An additional factor that allows to maintain good financial liquidity in the period of the pandemic is probably state aid provided especially to the SME sector, referred to as anti-crisis shields.

Table 3 presents the average value of the Z-score indicator (weighted by the assets of enterprises) for individual sections of the agri-food sector.

Table 3. Average values of the Z-score indicator for the section of the agri-food sector in Poland in 2018-2020

Sections of sector	2018	2019	2020	Change 2020/2019 (%)
A	3.08	2.91	2.66	-8.59
B	3.21	3.24	3.02	-6.79
C	3.77	3.54	3.66	3.39
D	3.22	3.11	3.17	1.96
E	3.37	3.19	3.02	-5.33
F	2.33	2.54	2.88	13.39
G	2.71	2.22	2.45	10.36
H	2.87	3.24	3.38	4.32
I	2.72	2.66	2.91	9.40
J	2.45	2.75	2.91	5.82
K	3.17	3.22	3.42	6.21
L	2.46	2.58	2.45	-5.04
M	4.39	4.14	4.45	7.49
N	3.86	4.02	3.57	-11.19
O	3.12	3.42	3.26	-4.68
P	2.75	2.81	2.61	-7.12

Note: descriptions of sections of the agri-food sector in accordance with the list in the Materials and Methods

Source: own study based on EMIS data.

The average Z-scores show that the best financial situation and the lowest risk of bankruptcy are characteristic for enterprises in the following sections: production of biscuits and crackers, animal slaughter, cheese production, production of mayonnaise, sauces and other ready-made sauces. Enterprises in the following sectors: processing, preserving fruit and vegetables, production of animal feed and production of chocolate and cocoa confectionery are characterized by the highest risk of bankruptcy.

Moreover, the mean values of the Z-score (Table 3) indicate that the COVID-19 pandemic had a different impact on the bankruptcy probability level. In nine of the 16 analyzed sections, the Z-score index increased from 2% to 13%. On the other hand, in seven sections the ratio fell from 5% to 11%. The greatest improvement compared to 2019 was recorded in sections with a Z-score lower or close to 2.9 i.e., in the sections: production of bread and bakery products, production of animal feed and processing and preserving of fish and crustaceans. In 2020, the Z-score in the refining of fats and oils decreased the most (by about 11%), although it still remained at a relatively high level and amounted to 3.57. Such directions of changes in the Z-score allow to respond to the second research question and indicate that the COVID-19 pandemic had a different impact on the risk of bankruptcy in enterprises in various sections of the agri-food sector.

4. Conclusion

The COVID-19 pandemic has become the cause of one of the greatest crises in the modern history of the global economy, including the agri-food sector. Business suspension and administrative restrictions on movement worsened business conditions and affected both the demand and supply of food products. On the other hand, state aid improved the financial liquidity of enterprises and limited the risk of their bankruptcy.

In order to assess the impact of this situation, using the Altman Z-score index, changes in the level of bankruptcy risk in the 1000 largest enterprises in the agri-food sector in Poland in 2018-2020 were examined.

The results indicated that during the period of the impact of the pandemic in 2020, the changes in bankruptcy risk were mild. Moreover, the directions of these changes varied depending on the section in which the enterprises operated. In 2020, out of the sixteen examined sections, the Z-score increased in nine and decreased in seven. The risk of bankruptcy decreased the most in the following sections: production of bread and bakery products and production of animal feed. It grew the most in the following sections: processing, preserving fruit and vegetables and refining fats and oils.

Acknowledgements
The publication is financed from the state budget under the project of the Ministry of Education and Science ”Science for Society” No. NdS/532598/2021/2022. The total value of the project is PLN 290 950.00 (Poland).

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THE IMPACT OF EURO FUNDS ON SELECTED EU COUNTRY INDICATORS

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Annotation: The impact of the implementation of the European Structural and Investment Funds on the economic indicators of the EU Member States is a key topic in the process of their economic convergence and economic growth. The objective of the paper is to examine the relationship between the support received by the EU Member States from the European Structural and Investment Funds and the development of their economic indicators. In the paper we explain the main concepts related to economic growth and theories of economic growth, as well as the role of economic policy and development aid in the form of the European Structural and Investment Funds in the process of economic growth. We provide an analysis of support for the EU Member States from the European Structural and Investment Funds (with emphasis on the Slovak Republic) and the relationship between the volume of funds obtained and selected economic indicators, which are gross domestic product, unemployment and expenditure on research and development. For the most EU Member States, the results of the analyses carried out did not show a demonstrable correlation between the country's support obtained from the EU Structural and Investment Funds and its economic indicators. The data used for the performed analyses come from the databases of the European Commission and Eurostat.

Keywords: Economic development, Economic growth, European Structural and Investment Funds, Correlation analysis, Granger causality

JEL classification: F02, F15, O19, O38, O43, O57

1. Introduction

A transfer of financial resources and other resources between two countries or groups of countries without the expected full return of these resources can be defined as development aid (Gebregergis, 2018). This a type of aid is designed to help a country's or region's long-term, sustainable economic growth (Yiew, Lau, 2018). Within the European Union, EU funds are just this type of aid that is applied in the EU under its cohesion policy. Access to EU funds is considered to be one of the main benefits of joining the European Union (Surubaru, 2020).

The European Union (EU) provides funding to the Member States through a variety of instruments and policies to meet its priorities. The most well-known tools include the so-called European Structural and Investment Funds, but funds in the Union are also redistributed through a number of different programs, grants and the like, e.g. Horizon 2020, the LIFE Program, the EU Health Program, the Structural Reform Support Program (SRSP) and others. (European Commission, 2020).

The European Structural and Investment Funds (ESIF) are the main sources of investment in job creation and a sustainable economy and environment. More than a half of European funds are redistributed through the ESIF (Murauskiene, Karanikolos, 2017). ESIF, on the one hand, generate investment and, on the other hand, provide an incentive tool for additional investment in both the public and private sectors (Panfiluk, 2016).

There are currently five Structural and Investment Funds within the EU (European Commission, 2020):

1. European Regional Development Fund (ERDF) - given the budget and the scope of the thematic priorities, the ERDF is the most important of the Structural Funds. It contributes to the economic convergence of EU Member States and regions through regional operational programs. (Spilanis, Kizos, 2016).
2. European Social Fund (ESF) - this fund focuses primarily on investment in human capital, to address the problem of high unemployment. The ESF pays special attention to young people, who were among the most vulnerable groups in terms of unemployment during the last crisis of 2007/2008. (Bussi et al., 2019).
3. Cohesion Fund (CF) - focuses only on countries whose gross national income per capita is less than 90% of the average of the Member States of the Union. It mainly provides funds to support transport and environmental projects. The following countries have access to the fund: Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia.
4. European Agricultural Fund for Rural Development (EAFRD) - the priority objective of this fund is to support sustainable rural development and address the challenges faced by the rural environment. (Stanciu, 2017).
5. European Maritime and Fisheries Fund (ENFR) - as stated by the European Commission (2020), this fund aims to help fishermen in the process of transition to sustainable fishing, support coastal communities in diversifying their economies, it helps creating new jobs in coastal areas and developing sustainable aquaculture. (European Commission, 2020).

<u>Regional disparities and cohesion policy</u>

ESIF represent the main tool of the so-called cohesion policy of the EU. Cohesion policy aims to contribute to the development of the Member States of the Union, in particular by reducing regional disparities, creating new jobs and increasing GDP per capita (Paul, 2019). It is realized through a set of various multiannual programs. Melecky (2018) states that the main goal of cohesion policy is to increase the competitiveness of EU Member States and regions by reducing regional as well as social disparities between the states and regions of the Union. Durova (2017) adds that cohesion policy is a redistributive tool for redistributing wealth between richer and poorer Member States of the Union.

Michalek and Podolak (2014) define the concept of regional disparities as inequalities, differences between the monitored regional units. They represent differences in the performance of individual regions, differences in the manifestations of economic phenomena, differences in living standards and the well-being of the inhabitants of the regions. Nizamuddin (2014) adds that regional disparities are the result of unbalanced regional development and vary considerably across countries. Regional disparities depend mainly on the socio-cultural, demographic, economic and environmental characteristics of regions and can lead to many economic, social, cultural and environmental impacts. The OECD (2016) states in an empirical study that the Slovak Republic and Ireland are among the countries with the largest regional disparities within OECD member countries. The OECD also states that economic disparities between countries are not as significant as regional disparities within countries. Regional disparities represent a significant barrier to economic growth and can slow down the overall growth of the national economy (Novkovska, 2017). Obradovic et al. (2016) state that there is a statistically significant relationship between economic growth and regional disparities, and thus economic growth causes an increase in regional disparities.

Azwar et al. (2013) list the following reasons for the emergence of regional disparities:

- Differences in the quality and quantity of the factors of production
- Accumulation of factors deepening the so-called "the vicious circle of poverty", Garcia and Sanchez (2017) define this term as a group of interacting factors that exacerbate poverty, e.g. level of education, qualification of the workforce, etc.
- The influence of the so-called spread and backwash effect (spread effect - positive impact on economic activity of the region; backwash effect - predominance of negative effects dampening economic activity).
- Market deformities such as pricing policy, disadvantages resulting from the specialization of the region, low labor mobility, etc.
- Concentration of economic activity.
- Allocation of public and private investment in the regions.

Reasons for the existence of regional disparities within the European Union have been summarized and specified by Marchis (2016):

- Economies of scale – concentration of production in key regions and geographical centers of the EU.
- Localization and agglomeration effects – developed European regions, especially the regions around the capitals, are an attraction for new economic activities, but excessive concentration of economic activities in these regions only deepens regional disparities.
- Intra-industry trade and market dominance – the positive effects of trade liberalization are most visible in prosperous regions, where most multinational corporations are concentrated, but their desire for expansion and market dominance deepens regional disparities and pushes smaller companies from less developed regions out of the market.
- Insufficient competitiveness in peripheral regions – disadvantaged location, poorly developed infrastructure, low level of education and skills of the workforce, local taxes, insufficient support are factors that further deepen regional disparities.
- Selective labor migration – center-periphery migration model, labor migration from peripheral regions to centers of the EU is intensifying, but the migration process involves mainly young, qualified people, which negatively affects the qualification distribution of the workforce in the regions.
- Loss of the impact on macroeconomic decisions – as a result of joining the Eurozone the Member States lost the influence on the conduct of monetary policy, fiscal policy restrictions conditioned by public debt requirements.

<u>Regional disparities and economic development</u>

The aim of cohesion policy is to reduce regional disparities and to contribute to economic growth. Sabayova (2016) defines economic growth as an increase of the real output of an economy over time. Most popular theories of economic growth (like the Schumpeter theory, the Lewis theory, Rostow's 5 phases of economic growth or the Harrod-Domar model of economic growth) study factors effecting economic growth. Quantitative change together with qualitative development of all sectors, industries and areas in the national economy are then denoted economic development. Development is a prerequisite for future growth, which is not possible without innovation and qualitative structural change in the long run (Hudec et al., 2009).

There are several empirical studies that address the relationship between regional disparities and economic growth. Most studies claim that there is a link between regional disparities and economic growth. There is a link between the level of economic development and regional disparities, such that interregional disparities also increase in the initial stages of development, but when a certain level of development is reached, these disparities begin to decrease. However, it is clear that regional disparities have a significant impact, which is reflected in particular in high levels of social exclusion, high unemployment, income inequality, both in regional GDP per capita and inequality of disposable income. (Gurgul, Lach, 2011).

Studies that evaluate the impact of European funds on economic growth or economic development mostly agree that there is a positive correlation between economic growth and EU funds. However, there are also studies that have not shown a statistically significant relationship between development aid and economic growth. Dapkus and Streimikiene (2014) examined the impact of EU funds on the example of Lithuania. The authors state that EU funds are an excellent tool for the new Member States, which is an attraction for new foreign investment. However, they say that the contribution of EU funds is still not enough for these funds to have a significant impact on the country’s sustainable development.

The authors of Hrůza et al. (2019) examined the impact of ESI Funds on economic growth in the Czech Republic. The results of the analysis showed a statistically significant relationship between the inflow of ESI Funds and economic growth in the Czech Republic.

Radvansky et al. (2016) examined the impact of EU cohesion policy on economic growth in the case of the Slovak Republic. The results of the study show that in the monitored period 2007-2015, cohesion policy funds had a significant positive impact on the Slovak economy. The importance of cohesion policy resources has been reflected in particular in managing the effects of the global economic and financial crisis. The impact of the crisis on the Slovak economy would be much worse without the use of EU funds, especially the impact of the crisis on the labor market and economic growth itself. The authors estimate that in the absence of funds from the EU sources, the GDP of the Slovak Republic would be 5% lower in 2013, almost 6% in 2014 and up to 8.4% in 2015.

A positive impact of EU funds on economic growth has also been shown in a study by Surubaru (2020) for Romania and Bulgaria, especially in the previous decade. At present, according to the author, the impact of funds on economic growth and development is uncertain and requires further research.

Startiene et al. (2015) examined the relationship between the ESIF and the economic indicators for the EU as a whole for 2000-2013 and concluded that the statistical correlation could not be confirmed.

In general, we can say that the impact of any development aid depends on the development level of the country. Gebregergis (2018) examined the impact of development aid in Ethiopia.

The result of this study is that in the short term there is no significant relationship between the country's economic growth and development aid, but in the long term, development aid is an important factor for the country's economic growth.

According to the European Commission (2021), each EU region can benefit from the Structural and Investment Funds. EU funds are a source for investments, and investments are a prerequisite for economic growth and economic development. The objective of this study is to identify and to analyze the correlation and causal relationship between the amount of support obtained from the European Structural and Investment Funds and selected economic indicators of EU Member States with focus on the Slovak Republic.

2. Materials and Methods

The relationship between ESIF support received by EU countries and the country's economic growth represented by GDP has been analyzed. Moreover, the relationship between ESIF and unemployment and the relationship between ESIF and research and development expenditures have been studied to capture possible effects of ESIF aid on economic development. The two additional indicators have been chosen because EISF cover the area of business support and job creation and research and innovation investments. The analysis has been divided into two partial steps.

The first step is correlation analysis between ESIF and each of the selected indicators (GDP, unemployment, research and development expenditures, respectively). Due to non-stationarity of the original time series, a correlation analysis for data in first differences has been performed. Pearson correlation coefficient has been used (Schober et al., 2018):

$$r = \frac{\sum_{i=1}^{n}(x_i - \acute{x})(y_i - \acute{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \acute{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \acute{y})^2} \qquad \textbf{(1)}$$

where r is Pearson correlation coefficient, x and y are analyzed variables, $\acute{x}$ and $\acute{y}$ are average values of analyzed variables, n is the number of observations with i denoting the order of an observation.

To assess statistical significance of the correlation coefficient, the Student's t-test has been used (H_0: the correlation coefficient is zero). For the calculated t-test value the corresponding p-value has been found. If the p-value is lower than the significance level α ($\alpha = 0.05$ in our case), we consider the Pearson correlation coefficient to be significant (H_0 rejected) and we conclude that there is a correlation between the examined pair of variables.

The second step is meant to identify causal relationship between the examined variables in terms of Granger causality, this is whether prior values of a time series can be used to predict future values of another time series, whereas also lagged past values of a time series could be used for the prediction (Song, Taamouti, 2019). The tested pairs of variables have been ESIF and GDP, ESIF and unemployment, ESIF and research and development expenditures (differentiated data have been used for the test). The Granger test may lead to one of the following results:

- x Granger causes y ($x \rightarrow y$)
- y Granger causes x ($y \rightarrow x$)
- x Granger causes y and y Granger causes x ($x \leftrightarrow y$)

- there is no Granger causality between x and y $(x - y)$

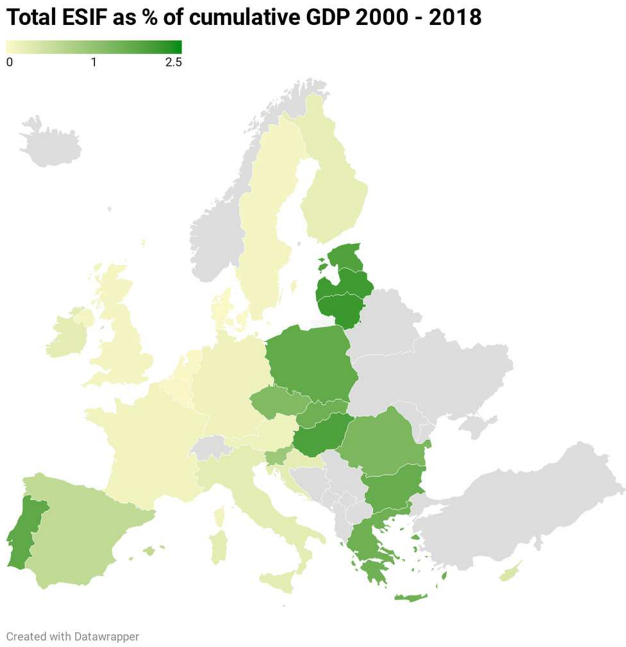
To evaluate the results, we compare the calculated values of the Granger test (it tests the hypothesis H_0: variable x does not influence variable y in terms of Granger causality) with the significance level α ($\alpha = 0.05$ in our case).

This study provides an analysis for 28 EU countries for the period 2000-2018. For countries that accessed the EU later the staring year has been adjusted accordingly. Data related to the financial implementation of ESIF (in bil. EUR) come from the official website of the European Commission. Data related to economic indicators of the countries come from the Eurostat database and represent GDP at current prices (in bil. EUR), unemployment rate of the population aged 20 to 64 (in percent), total expenditures on research and development (in bil. EUR).

3. Results and Discussion

Thanks to European cohesion policy, less developed countries and regions of the EU have received more European funding from the ESIF. The inflow of funds from the ESIF into the economies of European countries is represented in Figure 1. It shows the cumulative share of ESIF received as a percentage of the cumulative GDP of individual European countries in 2000-2018. For countries of Central Europe, South-Eastern Europe, the Baltic States and Portugal the development aid from ESIF is an important source of financing, the share of ESIF in their cumulative GDP is between 2% and 2.5%. In other EU countries this share is lower.

Figure 1. Total ESIF as percentage of cumulative GDP (2000-2018)



Data source: European Commission

In general, the development trend of aid from the ESIF and the development trend of the EU-28 GDP over the period from 2000 to 2018 both are positive. There was only a slight drop in the GDP development in 2009, which was caused by the global economic crisis of 2008/2009. The inflow of ESIF increases over the entire period but with some volatility. A drop in the implementation of ESIF occurred after 2013 (until 2016). This decrease was caused by several factors, especially the introduction of new regulations to operational programs managing ESIF aid and the start of a new programming period 2014-2020.

The correlation between ESIF and GDP of individual EU-28 countries has been analyzed and results are shown in Table 1. The table presents correlation coefficients (and p-values) for the original data of ESIF and GDP time series and also for data is first differences that have been used due to the need for stationary time series. At the significance level 0.05, we can state that, with the exception of Ireland, there is no correlation between the inflow of implemented ESI-Funds and the countries' GDP. This finding is consistent with the results of a study by Startiene et al. (2015), who were not able to confirm the correlation between ESIF and GDP for the EU as a whole.

Correlation between ESIF and unemployment in EU economies was not confirmed in our study, correlation between ESIF and research and development expenditures was confirmed only for three countries. Table 1 presents correlation coefficients calculated for data before and after differentiation (and the corresponding p-values; compared to significance level of 0.05). No correlation between ESIF and the unemployment of population aged 20 to 64 was found. However, results for the correlation between ESIF and research and development expenditures differ for individual EU countries. We can conclude that a correlation between ESIF and R&D expenditures exists in Cyprus, Slovakia and Bulgaria; for other countries we cannot confirm any correlation.

Table 1. Correlation analysis: ESIF and selected indicators

Country	**ESIF and GDP**				**ESIF and unemployment**				**ESIF and R&D expenditures**			
	Correlation with original data		**Correlation with differen-tiated data**		**Correlation with original data**		**Correlation with differen-tiated data**		**Correlation with original data**		**Correlation with differen-tiated data**	
	r	**p-value**	**r**	**p-value**	**r**	**p-value**	**r**	**p-value**	**r**	**p-value**	**r**	**p-value**
BE	0.188	0.440	0.168	0.506	0.077	0.753	0.101	0.689	0.060	0.809	0.028	0.911
DK	0.711	**0.001**	0.318	0.198	0.293	0.223	0.215	0.392	0.698	**0.001**	0.190	0.449
DE	0.206	0.398	0.085	0.736	0.270	0.263	0.118	0.642	0.222	0.361	0.289	0.244
IE	0.453	0.052	0.476	**0.046**	0.561	**0.013**	0.170	0.500	0.665	**0.002**	0.124	0.624
EL	0.553	**0.014**	0.198	0.431	0.017	0.946	0.099	0.697	0.008	0.975	0.151	0.549
ES	0.477	**0.039**	0.001	0.997	0.290	0.229	0.026	0.920	0.436	0.062	0.038	0.881
FR	0.579	**0.009**	0.341	0.166	0.006	0.981	0.190	0.449	0.509	**0.026**	0.063	0.804
IT	0.304	0.206	0.046	0.858	0.189	0.438	0.064	0.801	0.261	0.280	0.033	0.899
LU	0.426	0.069	0.194	0.440	0.504	**0.028**	0.193	0.442	0.528	**0.020**	0.074	0.771
NL	0.180	0.460	0.436	0.070	0.276	0.254	0.063	0.805	0.001	0.996	0.420	0.083
AT	0.719	**0.001**	0.062	0.806	0.359	0.131	0.074	0.771	0.700	**0.001**	0.141	0.578
PT	0.099	0.687	0.171	0.498	0.505	**0.027**	0.350	0.154	0.216	0.374	0.047	0.852
FI	0.723	**0.000**	0.350	0.155	0.473	**0.041**	0.150	0.553	0.706	**0.001**	0.066	0.795
SE	0.403	0.087	0.220	0.381	0.436	0.062	0.105	0.679	0.269	0.266	0.324	0.190
UK	0.117	0.633	0.401	0.100	0.010	0.968	0.256	0.304	0.021	0.934	0.353	0.151
CZ	0.652	**0.008**	0.021	0.942	0.316	0.252	0.162	0.580	0.767	**0.001**	0.354	0.215
EE	0.356	0.193	0.206	0.479	0.435	0.105	0.421	0.134	0.635	**0.011**	0.218	0.454
CY	0.662	**0.007**	0.066	0.822	0.526	**0.044**	0.018	0.951	0.789	**0.000**	0.587	**0.027**
LV	0.524	**0.045**	0.274	0.343	0.403	0.136	0.021	0.943	0.728	**0.002**	0.511	0.062
LT	0.435	0.105	0.099	0.738	0.506	0.054	0.256	0.377	0.423	0.116	0.126	0.667
HU	0.527	**0.044**	0.074	0.801	0.176	0.530	0.183	0.531	0.757	**0.001**	0.492	0.074
MT	0.483	0.068	0.324	0.259	0.155	0.582	0.102	0.728	0.650	**0.009**	0.276	0.339
PL	0.683	**0.005**	0.218	0.454	0.560	**0.030**	0.001	0.998	0.614	**0.015**	0.466	0.093
SI	0.443	0.098	0.103	0.726	0.580	**0.023**	0.034	0.908	0.807	**0.000**	0.460	0.098
SK	0.705	**0.003**	0.302	0.293	0.295	0.286	0.038	0.897	0.783	**0.001**	0.719	**0.004**
BG	0.429	0.164	0.243	0.472	0.555	0.061	0.284	0.397	0.688	**0.013**	0.659	**0.027**
RO	0.487	0.109	0.052	0.879	0.047	0.885	0.225	0.506	0.120	0.710	0.397	0.227
HR	0.932	**0.007**	0.073	0.907	0.952	**0.003**	0.204	0.742	0.885	**0.019**	0.330	0.588

Source: own calculations

Note: BE – Belgium, DK – Denmark, DE – Germany, IE – Ireland, EL – Greece, ES – Spain, FR – France, IT – Italy, LU – Luxembourg, NL – Netherlands, AT – Austria, PT – Portugal, FI – Finland, SE – Sweden, UK – United Kingdom, CZ – Czechia, EE – Estonia, CY – Cyprus, LV – Latvia, LT – Lithuania, HU – Hungary, MT – Malta, PL – Poland, SI – Slovenia, SK – Slovakia, BG – Bulgaria, RO – Romania, HR – Croatia

The Granger causality test for ESIF and GDP in EU countries shows that there is no clear causal relationship between the two variables. The Granger causality test for ESIF and unemployment of the population aged 20 to 64 reveals that there is no statistically significant impact of ESIF on unemployment development. On the contrary, the opposite causality, that is that unemployment affects the development of ESIF, can be observed in Portugal. According to the last test, for ESIF and research and development expenditures, we can confirm Granger causality in the direction that ESIF contribute to the prediction of research and development expenditures in the following countries: Belgium, Poland, Estonia. Vice versa, Granger causality that research and development expenditures affect the development of ESIF, is observed in the Czech Republic and Croatia. All results are summarized in Table 2 and have been evaluated for the significance level 0.05.

Table 2. Granger causality: ESIF and selected indicators

	ESIF and GDP		ESIF and unemployment		ESIF and R&D expenditures	
Country	**ESIF do not influence GDP**	**GDP does not influence ESIF**	**ESIF do not influence unempl.**	**Unempl. does not influence ESIF**	**ESIF do not influence R&D**	**R&D does not influence ESIF**
	p-value	**p-value**	**p-value**	**p-value**	**p-value**	**p-value**
BE	0.723	0.594	0.300	0.757	**0.001**	0.217
DK	0.378	0.356	0.717	0.464	0.668	0.389
DE	0.222	0.678	0.724	0.698	0.257	0.869
IE	0.080	0.337	0.535	0.644	0.332	0.356
EL	0.878	0.805	0.974	0.743	0.164	0.775
ES	0.067	0.694	0.244	0.789	0.444	0.709
FR	0.520	0.123	0.263	0.669	0.578	0.708
IT	0.820	0.979	0.797	0.903	0.463	0.690
LU	0.287	0.872	0.258	0.971	0.667	0.761
NL	0.100	0.863	0.615	0.357	0.223	0.865
AT	0.361	0.462	0.876	0.430	0.577	0.965
PT	0.839	0.364	0.997	**0.047**	0.805	0.153
FI	0.493	0.855	0.077	0.211	0.449	0.466
SE	0.365	0.631	0.110	0.396	0.649	0.667
UK	0.652	0.734	0.370	0.937	0.716	0.400
CZ	0.698	0.856	0.891	0.470	0.241	**0.039**
EE	0.509	0.287	0.888	0.583	**0.026**	0.076
CY	0.873	0.095	0.766	0.111	0.317	0.448
LV	0.485	0.984	0.495	0.778	0.795	0.670
LT	0.610	0.940	0.780	0.990	0.722	0.987
HU	0.538	0.793	0.826	0.358	0.061	0.684
MT	0.372	0.077	0.805	0.653	0.270	0.404
PL	0.331	0.941	0.707	0.592	**0.003**	0.886
SI	0.493	0.696	0.351	0.416	0.774	0.153
SK	0.873	0.714	0.789	0.922	0.148	0.430
BG	0.781	0.787	0.837	0.561	0.196	0.438
RO	0.549	0.949	0.703	0.829	0.812	0.908
HR	0.646	0.277	0.286	0.102	0.948	**0.037**

Source: own calculations (lag = 3, for Croatia lag is one period because of shorter time series)

Note: BE – Belgium, DK – Denmark, DE – Germany, IE – Ireland, EL – Greece, ES – Spain, FR – France, IT – Italy, LU – Luxembourg, NL – Netherlands, AT – Austria, PT – Portugal, FI – Finland, SE – Sweden, UK – United Kingdom, CZ – Czechia, EE – Estonia, CY – Cyprus, LV – Latvia, LT – Lithuania, HU – Hungary, MT – Malta, PL – Poland, SI – Slovenia, SK – Slovakia, BG – Bulgaria, RO – Romania, HR – Croatia

Generally, EU countries face a problem of efficient spending of available sources from the ESIF. The Slovak Republic and Spain are the two countries with the worst ability to use funds from ESIF (European Commission, 2021). The Slovak Republic does not achieve satisfactory results in spending funds in any of the areas supported by ESIF, it was able to make the most efficient use of funds for investments in network infrastructure in transport and energy, but it lags behind in the use of funds for research and development, information and communication technologies, and education and training (based on Eurostat data, 2021).

In agreements between the European Commission and the Slovak Republic the following priorities have been set for the ESIF in the 2014-2020 programming period (European Commission, 2020):

1. Promoting innovation and business competitiveness and fostering cooperation between research organizations, education and the business sector,
2. Support for small and medium-sized enterprises, agricultural and fisheries enterprises and so increasing productivity and added value in the business sector,
3. Promoting the sustainability of fisheries and aquaculture,
4. Funding initiatives to support education and training at all levels to ensure that pupils acquire the necessary knowledge and skills,
5. Promoting employment and social inclusion of people in need and poverty, by promoting employment opportunities for marginalized groups as well as providing opportunities for integration into society, further supporting local governments with the largest share of the Roma minority,
6. Investing in the efficiency of public administration and the judiciary in order to reduce regulatory and administrative burdens,
7. Investing in a low-carbon economy, increasing energy efficiency of public buildings, residential buildings and businesses,
8. Investment in information and communication technologies to expand broadband coverage as well as support of next generation networks,
9. Contribute to the completion of the TEN-T transport networks, increase transport accessibility, modernize public transport as well as improve conditions for inland waterway transport, including the modernization of the port of Bratislava,
10. Support for the construction of environmental infrastructure, environmental protection and the promotion of energy efficiency.

Hullova et al. (2020, 2021) state that problems of project implementation and ESIF spending in the programming period 2014-2020 include:
high administrative complexity,
low level of adaptations of simplifications during the implementation process,
prolonged and inefficient public procurement jeopardizing the absorption of European funds,
lengthy payment control processes,
failure of the managing authorities (public authority responsible for the implementation of a specific operational program) / intermediate bodies (delegated authority responsible for the implementation of a specific part of an operational program) in checking and approving applications for payment,
many levels of control and no guarantee of unchanged decisions,
low degree of flexibility and low possibility to modify projects during implementation,

- extremely demanding approach to verification of funds resulting in additional administrative and capacity costs,
- introduction of unnecessary limitations and restrictions beyond the original Structural Funds management system,
- lack of capacity for comprehensive approach by managing authorities / intermediate bodies,
- limitations of the electronic system used by financing authorities and beneficiaries to monitor projects supported from ESIF.

4. Conclusion

The purpose of ESIF is to support the development of the economy in EU Member States. However, no significant correlation and Granger causality was confirmed between the ESIF and economic indicators as the GDP, unemployment rate and research and development expenditures (with several exceptions for some EU countries, see the Results section). We consider the biggest problem of ESIF to be the problem with the efficiency of resource allocation and the associated problem of corruption (as also suggested by the 2019 OECD report). The European Commission regularly evaluates the factors that influence the ESIF implementation process in individual Member States. In the 2014-2020 programming period, the Commission's report (2018) lists the following key factors influencing the implementation of the funds:

- economic factors / impact of the global crisis of 2008/2009 – individual Member States had to cope with structurally changing demand. The decline in public spending in certain areas has led to a decline in co-funding opportunities in ESIF projects.
- quality of managing authorities – in some Member States, there is considerable spatial differentiation in the quality of management within regions (e.g. the Czech Republic or Bulgaria).
- implementation capacity of the ESIF and experience with implementation – it seems necessary to provide the additional technical assistance from the EC accompanying the implementation of financed projects.
- institutional infrastructure of individual Member States – ongoing institutional reforms in individual Member States have the potential to affect the effectiveness of ESIF implementation.
- legislative context and relevant regulations – sector-specific rules as well as the general legislative framework have a significant impact on the implementation of the funds.

The biggest challenge for Slovakia remains the ability to effectively spend aid from the ESIF, efficient implementation of individual operational programs and projects financed through the programs. Measures that can support the usage of ESIF in Slovakia include improvements in public procurement, elimination of corruption, faster verification and control of projects and others (KMPG, 2016).

Although past evidence shows that Slovakia experienced shortcomings in implementing ESIF, we are convinced that the country has potential to improve its ability in terms of using funds and that the new multiannual programming and financing period for 2021-2027 represents a good opportunity to make major investments and reforms that can help to restart the convergence of the economic growth and development of Slovakia to the levels of other EU countries.

Acknowledgements
The paper was created with the support of scientific projects APVV-18-0512, APVV-19-0544, VEGA 1/0768/20 and VEGA 1/0729/21.

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AGRICULTURAL LAND PRICES IN POLAND DURING THE COVID-19 PANDEMIC

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Annotation: The article aims to estimate the dynamics of agricultural land prices in nominal and real terms and to assess their differentiation due to land localisation and land quality in the period of the COVID-19 pandemic compared to the period preceding the pandemic in Poland. The results of the analysis, showed that during the five years before the pandemic the rate of growth of the arable land prices was high. In the first year of the pandemic, the prices were stable, but in the second one, the prices soared. The rate of growth was higher than the rates in the previous years. One of the reasons for the excessively high increase was inflation. The appearance of urban households on the land market was another reason. The restrictions imposed on society due to COVID-19, combined with the development of remote work opportunities, resulted in a rise in the interest in purchasing residential real estates in rural areas and increased demand for agricultural land. This phenomenon will have long term multidimensional effects for rural areas. Moreover, the quick growth of land prices, despite the existing legal barriers to trade, means that land is regarded more and more as an regular investment good. The rapid growth of agricultural land prices increases the attractiveness of agricultural land as a speculative good. In such circumstances, it is not surprising that during the pandemic, the relation of the prices of fertile land to prices of lower quality land decreased. Probably this phenomenon will be an important barrier to the improvement in the area structure of the Polish agriculture.

Keywords: Agricultural land prices, COVID-19, Agricultural land turnover

JEL classification: E39, Q10, Q15

1. Introduction

The COVID-19 pandemic has significantly affected various aspects of economic and social life. This impact was mainly due to the use of lockdown as the fundamental countermeasure to the pandemic. The significant reduction in economic activity was an effect of this strategy, mainly in 2020. In 2020 the pandemic caused a decline in real GDP worldwide, estimated at –3.4% in the world, -1.7% in emerging markets and developing economies, -4.6% in advanced economies, -6.4% in Euro Area and -2.5% in Poland. But in 2021, the output rebounded and for the world is estimated at 5.5% (World Bank, 2022). It should be emphasized that sectors of the economy have been affected by the pandemic unevenly. Sectors of the economy have been affected by the pandemic unevenly. Restrictions hit industries such as retail, entertainment and event, tourism, hotels, restaurants, hairdressing and beauty. Many other industries suffered from the break of the supply chains. The pandemic worsened the moods of the economic agents and expectations about the future, at least in the short term. It also forced an accelerated change in the organization of work. Remote work spread in many areas of the economy. The fact that work can be provided from any place of a worker's stay will impact urban-rural migrations for a long time (Ramachandran and Vidya, 2021), (Whitaker, 2021), (DeWaard, 2021) and, consequently, on the directions of land use and the demand for it.

Due to the specificity of agricultural production, agriculture could not be fully locked down. However, it also suffered the consequences of the pandemic. As Dudek and Spiewak (2022) note, pandemics affected the food system directly and indirectly. The factors influencing agriculture directly include the limitation of seasonal travel temporary workers (Kalantaryan et al., 2020), (Cortignaniet et al., 2020), a reduction in processing activity and restrictions in foreign trade, and an overall increase in uncertainty (Čechura et al., 2021). Schmidhuber et al. (2020) indicate the supply and demand channels of the impact of the COVID-19 pandemic on the food system. The supply channels were connected to the primary supply, to processing, to trade national and international logistics systems, as well as to factor markets, namely labour and capital, and intermediate inputs of production. The demand channels act by macroeconomic factors, like exchange rates, instability in energy and credit markets, and, most importantly, the expected surge in unemployment and the contractions in overall economic activity.

In the EU, in 2020, compared with 2019, the total agricultural output and the gross value added generated by agriculture declined by 1.1% and 1.3%, respectively. However, the situation varied between countries. Agricultural production fell in 11 EU member countries and increased in 16 (Eurostat 2021). Since the land is the main factor in agriculture, it can be expected that changes in the size and the structure of the demand for agricultural products combined with the other factors related to the pandemic have affected the price and demand for agricultural land. This is confirmed by the dynamics of the arable land prices in selected European Union countries. The data in Table 1 show that during several years before the pandemic, arable land prices rose systematically from year to year, although at an uneven pace. The year-on-year drop in prices was sporadic. In 2020, a decline in land prices was recorded in 6 out of 18 surveyed countries. The highest fall amounted to 8.4%, occurred in Ireland. In a few countries: Luxembourg, Slovenia and Latvia, prices increased significantly although, in the previous years, the growth rate was much lower. However, in a few countries, the growth rate remained at the same level as in the past years. Generally, the average growth rate for the analysed countries decreased.

Table 1. Rates of growth of arable land prices[1] in the EU member countries[2] (%)

Country	2016/2015	2017/2016	2018/2017	2019/2018	2020/2019
Bulgaria	6.2	11.9	8.4	7.4	-1.0
Czechia	13.4	14.9	14.8	12.7	14.1
Denmark	-6.4	-1.5	2.5	-0.6	-0.7
Estonia	6.5	5.7	9.8	9.0	9.0
Ireland	-23.1	9.7	38.0	2.2	-8.4
Greece	-2.9	-0.1	1.0	1.8	0.0
Spain	-0.4	2.4	1.5	-0.7	-0.2
France	1.2	-0.7	-0.2	-0.3	1.3
Croatia	2.9	5.0	8.6	3.4	3.0
Italy	-17.3	-4.4	-3.7	18.8	-2.4
Latvia	9.9	2.0	29.6	1.7	6.6
Lithuania	13.8	1.6	8.9	1.8	4.2
Luxembourg	-6.2	36.7	-1.3	6.2	24.7
Hungary	25.2	3.7	10.1	6.4	8.7
Poland	2.7	4.2	7.5	6.4	0.8
Slovenia	6.6	-1.5	9.4	1.6	14.4
Finland	2.3	4.7	-3.9	3.7	-1.9
Sweden	3.4	11.9	8.1	5.7	10.4

Source: Author's calculation based on Eurostat data

[1] *market prices in national currency*

[2] *in Eurostat the data are available for 22 EU member countries. Slovakia and Romania were excluded from the analysis due to break in time series and Netherlands because of the lack of data for 2020*

The article aims to estimate the dynamics of agricultural land prices in nominal and real terms and to assess their differentiation due to land localisation and land quality in the period of the COVID-19 pandemic compared to the period preceding the pandemic in Poland.

As mentioned, agricultural land is the fundamental factor of agricultural production. For the valuation of the assets, the net present value model is used. According to it, the asset price equals its discounted stream of future net returns (Lloyd et al., 1991), (de Fontnouvelle and Lence, 2002), (Edwards, 2017). Thus, at a given interest rate in the economy (discount rate), determinants of net returns may be treated as determinants of land prices. These include factors such as land taxation, the profitability of production as well as the possibility of obtaining nonagricultural earnings (different kinds of fees charged for hunting rights, rent earned from a dwelling or other buildings, and government subsidies). Marks-Bielska (2013) indicates that the price of land is influenced by many factors of different nature. She divides the determinants of land prices into two groups. The first includes a number of economic factors such as the demand and supply of land, profitability of alternative applications, and production profitability. The second group refers to historical factors like attitudes toward land and its cultural and symbolic value.

The agricultural land market has its own specificity to the markets of other factors of production. The specificity is due to such features the land has as: indestructibility, inflexible amount (supply), especially in the short term, and immobility (physical non-transferability). In addition, rural tradition, culture and sometimes farmers' emotional attitudes to agricultural land are important factors for its demand and supply. Nowadays, agricultural land attracts attention due to its close relationship with environmental public goods. It plays a fundamental role in their provision. Because of these complex reasons, some authors postulate the need for state intervention in the agricultural land market (Wilkin, 2018).

2. Materials and Methods

In this paper, we use data on the prices of the agricultural land in EU member countries published by Eurostat. The data are available for 22 out of 27 EU current member countries. Data for detailed analyses of the examined phenomena in Poland were obtained from Local Data Bank - Poland's largest economic database carried out by Statistics Poland. Because of the lack of data on the prices of agricultural land in Poland, the price of arable land was chosen as a good proxy for the price of agricultural land. The share of arable land in agricultural land area in Poland amounted at 74% justifies such choice.

The analysis period covers the years 2015-2021, so it includes 5 years before pandemic and 2 years with pandemic.

The statistical analysis was concerned with the dynamics and spatial differentiation of agricultural land prices. The analysis of the price dynamics was carried out in nominal and real terms. Prices in nominal terms were expressed in the Polish currency units (PLN). They represent average market prices in the country paid for 1 ha of land. Thus, their dynamics reflect not only the change in the value of the land area unit, but also the increase in prices as a result of the inflation. To eliminate the inflation influence and to illustrate the change in land affordability for the farmers we applied the real prices of land. They were expressed in decitons of wheat and in kilograms of pork livestock per one hectare of arable land. These products are typical for the Polish agriculture. Although the Polish statistics uses the prices of rye for the real prices, we decided to use the wheat prices as the wheat is much more popular than rye, which has become marginal cereal.

The nominal prices were used to examine the differentiation of the land prices between 16 voivodships - administrative units in Poland, and due to land quality and suitability for agricultural production. The fertile arable land obtains the land of class I, II, IIIa, whereas barren land – class V and VI. The analysis did not include medium productive land.

The dynamics of land prices and the dynamics of prices of means of agricultural production were compared to evaluate the relationship between agricultural production conditions and land prices.

3. Results and Discussion

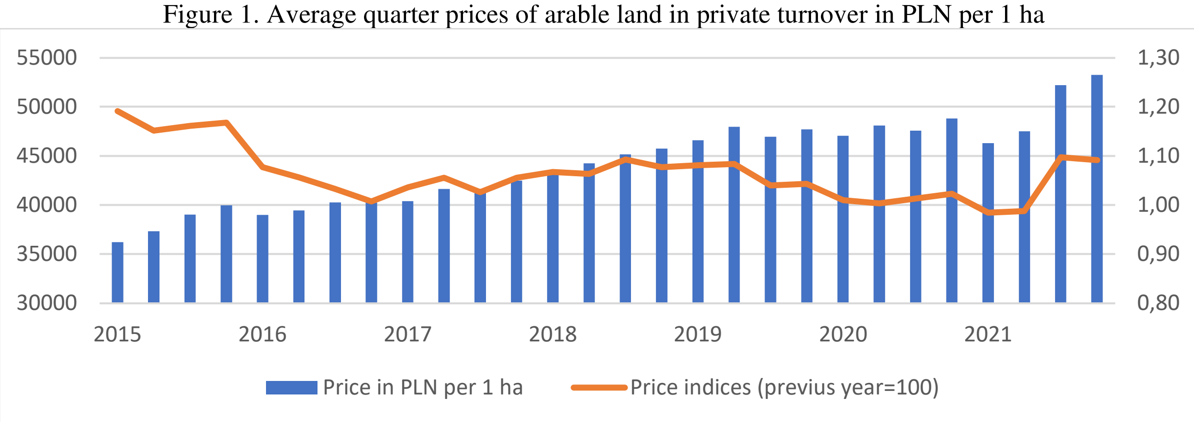
3.1 Characteristics of the agricultural land market in Poland

In 2015, the agricultural area covered approximately 18,600 thousand hectares of land, 74 of which were arable land, and 21% were meadows and pastures. The vast majority of agricultural land, about 92%, belongs to private owners. In 2015, the number of farms with at least 1 ha of agricultural land was 1,400,000. The average area of a private farm is relatively small. In 2015 it was 10.3 ha of agricultural land. Most land owners received it from their parents (parents-in-law) by inheritance or donation (Marks-Bielska, 2013). The state-owned approximately 1,500,000 hectares, which accounted for about 8% of the agricultural land area. The state's ownership rights to agricultural land are exercised by the state agency KOWR. The agency leases land to private entrepreneurs and farmers. The state intervenes in the agricultural land market, both in the form of legal regulations concerning its turnover, selling state-owned land and supporting the purchase of land with preferential loans to improve the area structure of farms (Chadrzyński et al., 2020, Marks-Bielska, 2020).

3.2 COVID-19 and dynamics of the of the arable land prices

Figure 1. presents the average quarter private market prices of arable land in Poland. The prices showed an upward trend in the analysed years 2015-2021. The price of 1 ha of arable land increased from PLN 36,203 in the 1st quarter of 2015 to PLN 53,254 in the 4th quarter of 2021 - an increase of 47%. However, the dynamics of price growth were diversified and depended on macroeconomic conditions, and economic and political factors relating to the agricultural sector.

Figure 1. Average quarter prices of arable land in private turnover in PLN per 1 ha



Source: GUS, 2015-2021

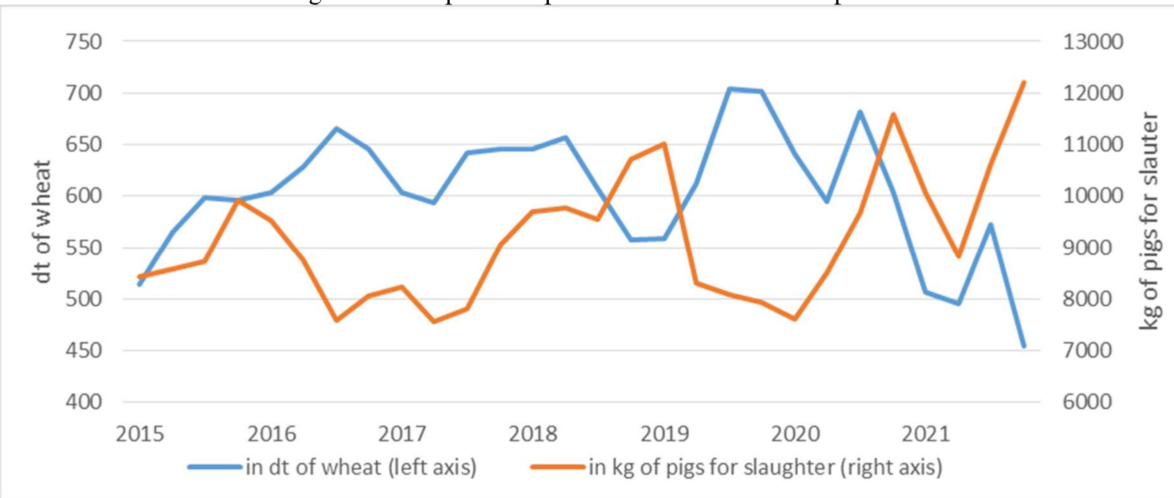
In the pre-COVID-19 pandemic years, the rate of increase in prices was 1-19% per year. 2015 was exceptional in this respect when land prices increased by an average of 17% compared to the previous year. In 2016-2017, the price growth rate was weaker (4%). The weakening of price dynamics was undoubtedly influenced by the introduction of new, restrictive regulations governing the sale of agricultural land. On May 1, 2016, the protection period ended, and the farm land market became accessible to citizens of the European Economic Area and the Swiss Confederation. But very soon, the regulations against foreigners' speculation and land acquisition and facilitating land access for individual farmers were introduced. Amendments to the Act of April 11, 2003, on the shaping of the agricultural system, presented by the Act of April 14, 2016, on suspending the sale of real estate owned by the State Treasury Agricultural Property Stock (2016), were very restrictive. According to the new regulations from April 30, 2016, agricultural land with an area of 0.3 hectares and more has been allowed to be purchased only by individual farmers. Other buyers have had to obtain special consent (from 2019, non-farmers can buy agricultural land with an area of 0.3 to 1 ha without permission). A significant reduction in the number of people entitled to acquire agricultural real estate was the effect of these regulations. As a result, the demand for agricultural land was significantly reduced. The years 2018 and 2019 were marked by slightly higher price dynamics. The prices increased on average by 6-8% during the year.

In 2020, COVID-19 pandemic influenced the functioning of the land market. The disturbing information coming from abroad and the threat of a pandemic spreading to Poland resulted in the blockade of the further increase in land prices in the first quarter already. In the entire year 2020, the increase in arable land price was only 1% per annum, and in the first two quarters of 2021, there was even a decrease in price of 1-2% compared to the same quarter last year. The situation in the agricultural land market in this period should be associated with the condition of the entire economy. Economic growth in the first quarter of 2020 remained at the level of 2.6% per annum, but already in the second quarter, GDP decreased by 7.9%. The decline in GDP at the level of 0.5-2% annually continued until the first quarter of 2021. Throughout this period of economic downturn, inflation, as measured by the consumer price index, amounted to 2.7-3.2% annually (GUS, 2015-2021). The macroeconomic situation changed in the second quarter of 2021. The economic growth rate rocketed to a high of 11.3%, and in the following quarters of this year, it remained at a lower but still high level of 5.5-7.6%. At the same time, the inflation rate increased to 4.5% and continued to rise in the two following quarters to 5.4% and 7.7%, respectively[1]. The arable land prices in the 1st and 2nd quarters of 2021 were still stable, but in the 3rd and 4th quarters rose noticeably. Finally, the annual growth rate of land price in this period was 9-10%.

Real prices, expressed in decitons of wheat and kilograms of live pigs, can be used to compare the market value of land over time (Figure 2). The analysis of these data does not give unequivocal results as to the changes in the real value of agricultural land. The price of land expressed in wheat decitons increased in 2015-2019. In the 1st quarter of 2015, 1 ha of arable land was equivalent to 514 dt of wheat. In the following four years, it rose gradually, and in the 4th quarter of 2019, it reached over 700 dt. From the first quarter of 2020, this trend collapsed, and the price of arable land began to decline. In the 4th quarter of 2021, the price of 1 ha of land was only 454 dt of wheat. It stems from two phenomena: the stabilization of nominal land price in the first period of the COVID-19 pandemic and, above all, the rapid growth of the wheat price. It increased from PLN 68/dt in the 4th quarter of 2019 to PLN 117/dt in the 4th quarter of 2021 (GUS, 2015-2021). The situation on the wheat market in 2020-2021 was strongly influenced by the pandemic, including, in particular, restrictions in foreign trade in agricultural products and rapidly rising food prices.

[1] CPI $_{\text{December 2021 to December 2020}}$ = 108,6

Figure 2. Real prices of private arable land in PLN per 1 ha



Source: Authors own calculations based on data GUS, 2015-2021

In the analyzed period, the price of land per kg of live pigs was constantly increasing. This increase was from 6,330 kg in the first quarter of 2015 to 12,214 kg at the end of 2021. The pandemic period was specific in this respect: the real land price increased on average by 9% in 2020 and by 13% in 2021. The rising real price of land, especially in the first period of the pandemic, was mainly influenced by rapidly falling pork prices. According to data from the Central Statistical Office (2015-2019), in the first quarter of 2020, the purchase price of live pigs was PLN 6.17/kg, and in the fourth quarter of 2021, it was only PLN 4.36/kg. Additionally, in the 3rd and 4th quarters of 2021, there was a rapid increase in nominal land prices (9-10% annually).

3.3 COVID-19 and spatial differentiation of the arable land prices

Arable land prices in Poland show large spatial differentiation (table 2).

The comparisons of the average prices of arable land between voivodships show that at the end of 2021, prices ranged from PLN 32,336 per 1 ha to PLN 71,869 per 1 ha. In three voivodships, i.e. Wielkopolskie, Kujawsko-Pomorskie and Podlaskie, arable land prices were the highest. They were 35%, 15% and 10% higher than the average ones in Poland, respectively. In turn, the lowest land prices were recorded in the voivodeships: Podkarpackie, Zachodniopomorskie, and Lubuskie. In these regions, arable land prices were 35-39% lower than the average prices in the country. It stems from the high development of agriculture in the three voivodships with the highest prices.

The high growth rate of agricultural land prices took place in Podlaskie, Lubelskie and Malopolskie voivodships. In 2015-2021, prices of arable land in these voivodships increased by 64-88%. For comparison, the country's average land prices increased by 47%. At that time, in the Opolskie, Kujawsko-Pomorskie, and Dolnoslaskie voivodships much smaller increase in prices took place, i.e. in the range of 13-27%. During the COVID-19 pandemic (from Q4 2019 to Q4 2021), land prices rose by an average of 12% in the country. As in the period of 2015-2021, the most noticeably increase in prices was recorded in the Podlaskie, Lubelskie and Małopolskie voivodships (an increase of 22-28%). The most stable land prices were realized in the Kujawsko-Pomorskie, Łodzkie and Sląskie provinces, where the price of land increased by 9-12%.

Table 2. Average prices of arable land in private turnover in voivodships in Poland (PLN per 1 ha)

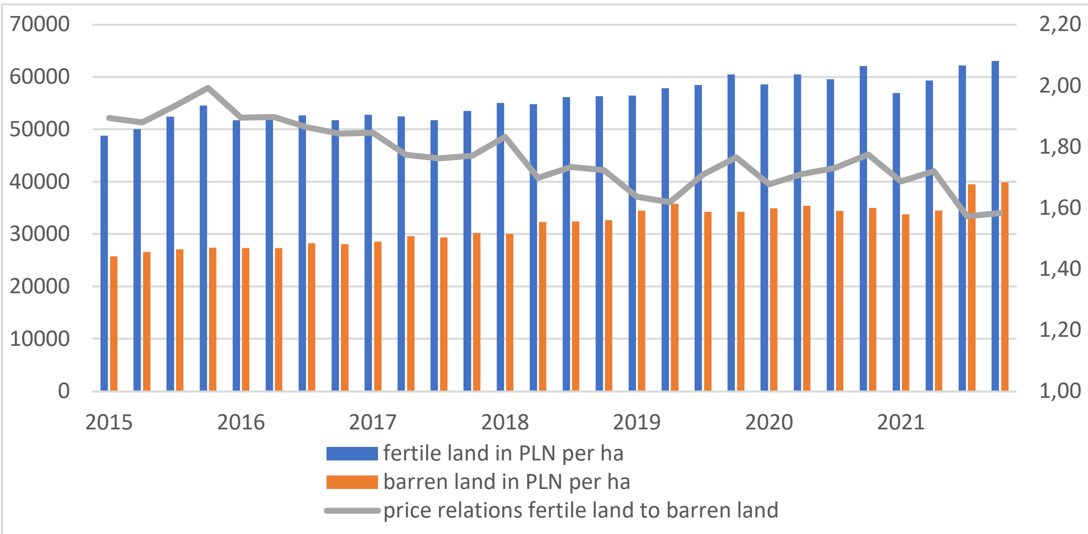
Specification	1Q 2015	4Q 2019	4Q 2021			
	in PLN	in PLN	in PLN	(Poland=100)	(1Q 2015=100)	(4Q 2019=100)
Poland	36 203	47 706	53 254	100	147	112
Dolnośląskie	33 876	36591	42 875	81	127	117
Kujawsko-pomorskie	49 618	56274	61 224	115	123	109
Lubelskie	25632	34738	42 518	80	166	122
Lubuskie	24525	30515	34 429	65	140	113
Łódzkie	32474	41832	46 159	87	142	110
Małopolskie	27042	34584	44 233	83	164	128
Mazowieckie	32581	40905	49 358	93	151	121
Opolskie	48105	47788	54 418	102	113	114
Podkarpackie	20850	28781	32 336	61	155	112
Podlaskie	31948	47528	58769	110	184	124
Pomorskie	35494	41564	48685	91	137	117
Śląskie	31767	39217	43868	82	138	112
Świętokrzyskie	24352	31530	35653	67	146	113
Warmińsko-mazurskie	35921	43841	52316	98	146	119
Wielkopolskie	47937	63348	71869	135	150	113
Zachodniopomorskie	24248	29423	33000	62	136	112

Source: GUS, 2015-2021

Arable land prices also show huge differentiation resulting from their quality and suitability for agricultural production (Figure 3). In 2015, the average price of good quality arable land was PLN 48,770 per 1 ha, whereas poor quality arable land costs PLN 25,756 per 1 ha. It means that good quality land was 89% more expensive than poor quality land. In the following years, the prices of poor quality land increased more quickly than good quality land. Average annual price growth rates for good quality land were 1-6%, while for poor quality land of 1-9%. The largest increases in the prices of lower quality land (8-9%) occurred in 2018-2019. At the same time, the prices of the land of good quality increased by only 5-6%. The relative increase in the prices of poor quality land was also clearly visible in 2021. In the first two quarters of this year, land prices remained stable, but in the next two quarters, they soared (15% and 14%, respectively, in relation to the corresponding quarter of the previous year). In this period, the increase in the price of good quality land was only 4% and 2%, respectively. As a result, the ratio of good to poor quality land prices decreased from 1,89 in 2015 to 1,58 in 2021.

The relatively more expensive agricultural land of poor quality is an element of a broader process characterizing the land markets in developed countries. It stems from the exclusion of land from agricultural production. Poor quality land, and thus of low suitability for agricultural production, can be much easier to reclassify for land for investment purposes, including housing. It causes an increase in demand from buyers who see the investment potential of this type of land. It can be assumed that this process will intensify in the current situation when the restrictions in the functioning of the economy during the COVID-19 pandemic accelerated the process of digitization of the economy and the aforementioned importance of remote work. It became an additional impulse for the housing development in rural areas, especially in the vicinity of large urban agglomerations. The demand for agricultural land for investment purposes was supported additionally by the macroeconomic situation in the form of negative real interest rates.

Figure 3. Prices of arable land due to land quality (PLN per 1 ha)



Source: Authors own calculations based on data GUS, 2015-2021

Land is one of the main factors of production in agriculture. That is why the changes in land prices ought to be considered together with the prices of other factors of production and agricultural products. Relations between product prices and prices of production factors create farming conditions and affect the income of agricultural producers. Annual data, including price indices of sold agricultural products and production factors purchased by farms, were used to analyze the relation of prices in agriculture (table 3).

Table 3. Price indices of sold agricultural products and goods and services purchased by private farms in agriculture

Specification	2015	2018	2019	2020	
	previous year=100				2015=100
Sold agricultural products	96.7	97.2	115.7	97.7	120.4
Purchased					
-current agricultural production goods and services	97.3	103.3	103.3	99.8	106.8
-investment goods and services	100.7	103.8	104.5	104.0	115.9
-arable land	119.4	115.0	106.4	100.8	123.4
Index of price relations („price gap") sold agricultural products to					
-current agricultural production goods and services	0.99	0.94	1.12	0.98	1.13
-investment goods and services	0.96	0.94	1.11	0.94	1.04
-arable land	0.81	0.84	1.09	0.97	0.98

Source: GUS, 2021

The data analyses indicate that in the entire period of 2015-2020, prices of agricultural products growth rate were higher compared to goods and services purchased for investment and the needs of current agricultural production. The prices of products increased by over 20%, whereas the prices of the current means of production by 6.8%, and the prices of capital goods by almost 16%. So the increase in land prices amounted to over 23% was higher than the increase in the prices of agricultural products and means of production.

The price gap index evaluates the changes in farming conditions and profitability of agricultural production. Between 2015 and 2018, the profitability of agriculture production deteriorated. Price relation indices ranged from 0.81 to 0.99, which indicates that sold products were occurring cheaper than purchased goods and services, including agricultural land. In 2019, the prices of agriculture products increased noticeably, in relative terms, much more than purchased goods and services. As a result, the price relation indices ranged from 1.09-to 1.12. In 2020, the first year of the pandemic, indexes of price relations slipped back to a little below 1.00, which led to the fall in the profitability of agricultural production. Ultimately, in the entire analyzed period (2015-2020), the ratio of agricultural product prices to prices of purchased goods and services was positive, which contributed to an increase in the profitability of agricultural production. However, this does not apply to agricultural land. The ratio of agricultural product prices to land prices was 0.98. It follows that agricultural land has become relatively more expensive for agriculture products and other factors of production.

4. Conclusions

The analysis showed that during the five years before the COVID-19 pandemic, the agricultural land prices increased noticeably in Poland. The rate of growth was high, albeit uneven. The annual growth rate fluctuated from 0% to 20%. In the first year of the pandemic, land prices were quite stable (in 2020 they slightly increased and in the first half of 2021 even slightly fell). However, in the second half of 2021, the high growth took place. As a result, at the end of 2021, they were higher than the prices before the pandemic (2019) by 15%. One of the reasons for the excessively high land price increase in 2021 was inflation. An appearance of a new group of buyers on the agricultural land market, namely urban households, was the second reason. The restrictions imposed on society due to COVID-19, combined with the development of remote work opportunities, resulted in an increased interest in purchasing residential real estates in rural areas and increased demand for agricultural land. It can be assumed that this phenomenon will persist at least in the medium term and will have multidimensional effects for rural areas.

The dynamic growth of arable land prices, despite the existing legal barriers to trade, indicates that agricultural land is increasingly seen as an attractive investment good. Inflation which began in 2020, increased the attractiveness of agricultural land as a speculative good. This phenomenon probably will be a barrier to the improvement of the area structure of agriculture and its modernisation. It will have an impact on the directions of agricultural land use as well. The phenomenon deserves to be monitored and examined in the future. The conclusions and recommendations should be considered by agricultural policy.

Due to the significant fluctuations of wheat and pig livestock prices, the prices of arable land in real terms fluctuated noticeably. The rapid growth of wheat price in 2021 caused the decrease in the real price of arable land expressed in dictions of wheat to the lowest level in the analysed period. As the price of pigs for slaughter plummeted this year, a reverse effect on the real land prices expressed in kilograms of pigs took place. It indicates that the arable land become more affordable for plant producers and less affordable for animal producers.

Agricultural land prices in Poland show significant spatial differentiation. In three voivodships where highly efficient agriculture exists, there were the highest prices. However, during the pandemic, only in one of them - Podlaskie Voivodeship - prices rose more than average. Their very high growth took place in the Mazowieckie and Małopolskie voivodships, which capitals are large urban centres: Warsaw and Krakow. It corresponds with the pressure on the land market from the housing market in these regions and explains the decline in the distance between the prices of fertile and prices of barren arable land.

Acknowledgements
The publication was financed from the state budget under the project of the Ministry of Education and Science "Science for Society" No. NdS/532598/2021/2022. The total value of the project is PLN 290,950.00 (Poland).

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OPINIONS AND ATTITUDES OF GENERATION Z IN THE CONTEXT OF WASTE SORTING

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Annotation: In recent years, a lot of attention has been paid to the issue of waste. Their production and subsequent disposal are extremely economically and energy intensive activities that are discussed in terms of sustainability and the renewability of natural resources. Households are significant producers of waste and their approach to waste separation can therefore have a significant impact on society as a whole. In this context, issues related to the use of packaging materials and packaging in general cannot be overlooked. The drive to reduce the use of packaging is one of the trends in consumer purchasing behaviour. Young people develop their personal identity in relation to current events in the world and have a strong sense of environmental issues and the overall state of the planet. Their opinions and behaviour influence society and determine its future direction. The aim of this paper is to evaluate the views and attitudes of members of Generation Z in terms of waste segregation and to make an identification of their food shopping behaviour on the issue of waste production from food packaging. Primary data was obtained through the implementation of quantitative research using the questionnaire survey method, which was conducted in the autumn months of 2021 through electronic and face-to-face interviews. A total of 253 respondents participated in the actual survey. All respondents belonged to the age category generation Z - 16-26 years. The results show that almost 90% of the households of Generation Z respondents are practicing waste segregation. In terms of materials, plastics, glass and paper are the most commonly sorted. Overwhelmingly, this is a systematic and regular activity. Approximately half of the respondents said that they are concerned about packaging issues when buying food. Approximately 57% of the participants try to avoid plastic.

Keywords: Environment, Generation Z, Material, Packaging, Sustainability, Waste, Waste sorting

JEL classification: Q00, Q53, 56Q

1. Introduction

The number of people inhabiting our planet is constantly increasing, leading to a growing consumption of global resources. In this context, issues related to the environmental impacts of human activity and other related social and economic issues come to the fore (Lakatos et al., 2018). Global environmental degradation and pollution and the gradual depletion of natural resources are largely due to overindustrialisation, accompanied by overconsumption (Bogusz et al., 2021, Wiefek and Heinitz, 2021). This is confirmed by Khaw-ngern et al. (2021), who consider overconsumption as one of the causes that exacerbates the current waste situation. Wiefek and Heinitz (2021) unanimously see in the current lifestyle, which is driven by consumption and the associated production of waste, an element that threatens the sustainability of the entire world. Pietzsch et al. (2017) emphasize that, historically, waste management has been set up to meet the needs of a linear economy. However, for the sustainable future of the planets, it is necessary to look for new directions in the development of economic systems in the context of sustainability. This raises the need to transform the traditional model of production, consumption and waste disposal Tantau et al. (2018).

Purposeful waste management, based on social, economic and environmental aspects, is one of the main factors influencing the harmonious development of the whole society and the quality of life Butkus et al. (2018). Efficient and effective waste management appears to be a factor for future social development, which requires not only innovation but also the involvement of all stakeholders (Ma and Hipel, 2016). Demands for responsible consumption, production and waste prevention are thus becoming increasingly important on a global scale (Lakatos et al., 2018).

Packaging has become an integral part of today's manufacturing and business processes. They have a variety of functions, both in terms of transport and communication with the consumer. The modern concept of packaging is a rather complex and comprehensive issue (Vorobeva, 2017). Packaging sustainability concepts have evolved with the increasing integration of sustainability principles at different levels within industry and organisational platforms (Boz et al., 2020). The topic of plastic waste, which is a widely discussed problem worldwide, is at the forefront of the interest of the professional and general public. Plastic packaging currently accounts for almost half of all plastic waste worldwide, and much of it becomes waste almost as soon as it is used. However, it is this type of packaging that places a disproportionate burden on the environment, as the need for disposal is extremely high and the half-life is long (UNEP, 2018).

The term "generation" is used very widely in today's world (Pilcher, 1994). The year of birth of an individual is considered to be the determining factor for the population breakdown in generational terms. However, account must also be taken of the social, political and economic events that framed the times in which the generation grew up and the experiences that shaped its general character (Cogin, 2012; Dencker et al., 2007). Seemiller and Grace (2016) identify Generation Z as responsible, innovative and motivated to make a difference in the world. Matusiková (2015) considers young people of Generation Z to be much more socially responsible than previous generations because they are acutely aware of current world problems thanks to the large amount of information generally available. Djafarova and Foots (2022) considers young people of Generation Z to be much more socially responsible than previous generations because they are acutely aware of current world problems thanks to the large amount of information generally available. Osgerby (2020) notes, members of this age group grew up in a time of peace and have been closely connected to technology throughout their lives, thus living in parallel real and virtual worlds (Seemiller and Grace, 2016). This fact is also confirmed by Priporas et al. (2017), who based on their research confirm the strong innovation orientation of Generation Z consumers and point out that this population group expects smart technologies to enable them to make informed purchasing decisions and contribute to their autonomy, and speed of transactions.

Diet and nutrition have an individual and societal dimension, as they play a fundamental role in the daily life of each individual and influence the quality of life and thus the health of the population as a whole (Wahl et al., 2018). In recent years, there has been a growing interest in healthy lifestyles in society, which has been accompanied by changes in the way we eat (Chhabra et al., 2021). Kymäläinen et al. (2021) in the context of young people's eating habits and requirements for sustainable food consumption, highlight the important role of digital technologies and their impact on members of Generation Z. Based on their research, the authors conclude that respondents in the age group studied consider the availability of diverse, clear and interesting information to share within their community as an important motivation to promote economic consumption through the use of sharing economy practices.

The aim of this paper is to evaluate the views and attitudes of members of Generation Z in terms of waste segregation and to make an identification of their food shopping behaviour on the issue of waste production from food packaging.

2. Materials and Methods

The theoretical framework of the paper was developed by analysing secondary sources drawn from scholarly articles and professional literature, using a document examination method based on the criteria of Hendl (2015). Additional information was obtained from up-to-date relevant internet sources. The basic parameters of the research were set with respect to the definition of this generation, which varies among authors and in some cases overlaps (see Table 1.).

Table 1. Summary of the definition of Generation Z according to different authors

Period of birth	Authors
1993 - 2005	Turner, 2015
1995 - 2020	Matusiková, 2015
1995 - 2003	Deloitte, 2021
born after 1995	Seemiller and Grace, 2018; Cilliers, 2017
born 1996 and after	Bejtkovský 2016

Source: Own elaboration, 2022

Primary research on Generation Z was carried out by means of a questioning technique, the actual method used was a questionnaire survey, which was carried out in the autumn months of 2021. The creation of the questionnaire was inspired by the survey Public Opinion Research Center of the Academy of Sciences of the Czech Republic (CSSDA, 2021) "Food 2020", which was focused on the general population 15+ in the Czech Republic. After completing the questionnaire, in accordance with the recommendations of Ikart (2019), 26 people were piloted to determine the comprehensibility and continuity of individual questions. The actual data collection was carried out via the Internet within the LimeSurvey platform. The target group was selected in accordance with the definition of Generation Z according to Deloitte (2021) as young people who belonged to the age category 16-26 in the given year. The total number of respondents was 253 (79 males and 174 females). Only those persons who at least sometimes buy food (n=249) were examined in detail. Four men responded that they never buy food.

In terms of gender, 31.2% (79) of men and 68.8% (174) of women participated in the survey. The age of the respondents, as mentioned earlier, ranged between 16 and 26 years, with 33.6% (85) of the respondents being under 19 years of age and 64.8% (164) between 20 and 26 years of age. By the age of 19, the vast majority of young people in the Czech Republic are completing their secondary education and heading either into tertiary education or into work experience. Between the ages of 20 and 26, all members of the younger generation complete their educational cycle and enter working life. More than three-quarters (76.7%, 194) of the respondents reported being students, 18.6% (47) were employed and 2.8% (7) were in private business. A low percentage of women stated that they were on maternity leave (2.0%, 5) and no respondents were unemployed.

Settlement size parameters are not subject to detailed definition, although this information was collected as part of the questionnaire survey conducted, Generation Z, which is considered to be the first globally connected generation because it has been using the internet and other digital technologies since childhood (NEW& Deloitte, 2022).

Statistical Means for Analysis

The contingency table is used to clearly display the relationships between two statistical variables. The type of contingency table is determined by the number of rows r and the number of columns s, that is, r × s (Hindls et al., 2007). χ^2 is a measurement of the overall dissimilarity of n_{ij} and m_{ij}. The greater the difference between the observed and expected values, the higher the test statistic χ^2.

$$m_{ij} = \frac{n_i . n_j}{n} \tag{1}$$

$$\chi^2 = \sum_{i=1}^{k} \frac{(frequency\ observed_i - frequency\ expected_i)^2}{frequency\ expected_i} \tag{2}$$

$$\chi^2 = \sum_{i=1}^{r} \sum_{j=1}^{s} \left(n_{ij} - m_{ij}\right)^2 / m_{ij} \tag{3}$$

i and *j* are row and column indices, 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. The χ^2 value is compared to the critical value χ^2 with a chi-square distribution of *(r-1)(s-1)* degrees of freedom at selected level of significance. The hypothesis is rejected if χ^2 value is greater 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 asymptotically valid and therefore can only be used when a sufficient number of observations are available. All expected values should be greater than one (Hendl, 2015), while the table should not contain more than 20% of the theoretical frequencies of occurrence (frequencies) less than 5. If null values occur in any of the fields, we proceed to analyze the 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 variables (Blaikie, 2003).

The method was used to identify statistically significant differences between the observed residues. The calculation of residues is based on the following calculation relationship

$$ar_{ij} = (n_{ij} - m_{ij}) / \sqrt{\left(1 - \frac{n_i}{n}\right) * \left(1 - \frac{n_j}{n}\right) * m_{ij}} \tag{4}$$

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 2.).

Table 2. Summary of established hypotheses

No. of Hypothesis	**Text of Hypothesis**
H01	The respondent's interest in the issue of packaging in which food is purchased does not depend on their gender.
H02	Whether a respondent buys food without packaging does not depend on their gender.
H03	Whether a respondent separates waste in the household in which respondent lives does not depend on gender.
H04	Whether a respondent separates waste does not depend on their interest in food packaging issues.

Source: Own research, 2021

The following abbreviations have been used in the article: CSSDA = Czech Social Data Archive, NEW = Network of Executive Women, OECD = Organization for Economic Co-operation and Development, UNEP = United Nations Environment Programme.

3. Results and Discussion

Respondents were asked about their share of food purchases for the household in which they live. Of the total number of people who participated (n = 253), just under a third (31.2%, 79) reported that the proportion was balanced in their household. More than a quarter (26.1%, 66) declared that they also buy food, but most of it is procured by other household members. Approximately the same number of respondents (24.1%, 61) chose the answer „I do most of the shopping, but other members of my household also shop". Furthermore, 16.2% (41) of the participants stated that all food shopping is done by them alone. Less than two percent (1.6%, 2) of the respondents indicated that they do not shop for food and two individuals could not estimate the proportion (0.8%).

It was also investigated whether young people from Generation Z show interest in the issue of packaging of the food they buy. Of the total number of people answering this question (n = 249), approximately half declared their interest in this issue (49.8%, 124), 5.6% (14) chose the answer "very interested" and 44.2% (110) chose the answer "rather interested". 41.4% (103) and 7.6% (19) of the respondents indicated rather uninterested and completely uninterested respectively. Only 1.2% (3) of the participants could not form a strong opinion (answer "don't know"). Further, the individual responses were combined for statistical testing purposes. The results of hypothesis H01 are presented in the following table (Table 3).

Table 3. Interest in the issue of packaging in which food is purchased in relation to the gender of respondents

Answers	**I'm interested**	**I'm not interested**	**Total**
Male	29	46	75
Female	95	79	174
Total	124	125	249
Percentage			
Male	37.7%	61.3%	100.0%
Female	54.6%	45.4%	100.0%
Total	49.8%	50.2%	100.0%

Source: Own research, 2021

The $\chi 2$ statistic value of 5.32 is higher than the critical value of 3.84 by 1 degree of freedom at the 0.95 significance level. The null hypothesis can be rejected. Whether a respondent is interested in the issue of the packaging of the food they buy depends on their gender. The relationship, as measured by Cramer's V, is weak ($V = 0.15$). Through the calculation of adjusted residuals, it was found that women are more interested in the issue.

All food shoppers (n = 249) responded to the question about whether the respondent tries to avoid any of the packaging materials. The results are summarised in the following table (Table 4). The values show that one third of the respondents (33.3%, 83) do not avoid any packaging material. The most frequently rejected packaging material is plastic, indicated by more than half (56.2%, 140) of the respondents.

Table 4. Avoidance of individual packaging materials

Waste type	Absolutely	Relatively
Plastics	140	56.2%
Aluminium	34	13.7%
Sheet	33	13.3%
Paper	21	8.4%
Glass	18	7.2%
Composite packaging	3	1.2%
I don't avoid any packaging material	83	33.3%

Source: Own research, 2021

Respondents were also asked to indicate on a scale the importance they attached to each of the factors listed above when purchasing food, which were price, market availability, packaging material, origin, composition, breadth of range, pack size and how the food or its ingredients were farmed/grown. The results revealed that less than 40.0% of the respondents considered packaging material somewhat important when buying food, 5.2% (13) of the respondents indicated that it was very important to them, while 34.1% (85) chose the response "rather important". Approximately half (47.8%, 119) of survey participants considered this factor to be somewhat unimportant and one-tenth (10.4%, 26) considered it to be not at all important. Kymäläinen et al. (2021), based on research conducted among Finnish members of Generation Z, they conclude that this age cohort considers Encouraging sustainable food consumption, (i) organic food, (ii) products supporting animal welfare standards, (iii) promoting local or home-grown food, and (iv) minimizing plastic in food packaging.

1.2% (3) and 10.8% (27) of survey participants always or often buy food without packaging, i.e. in their own bags. Approximately one-fifth (19.7%, 49) of respondents reported occasional frequency. The answer "rarely" was chosen by 28.9% (72). Almost 40.0% (39.4%, 98) of people never buy food without packaging. Next, the null hypothesis H02 was tested by merging the "always" and "often" responses for this purpose due to the low number of responses (see Table 5).

Table 5. Purchase of food without packaging in relation to the gender of the respondent

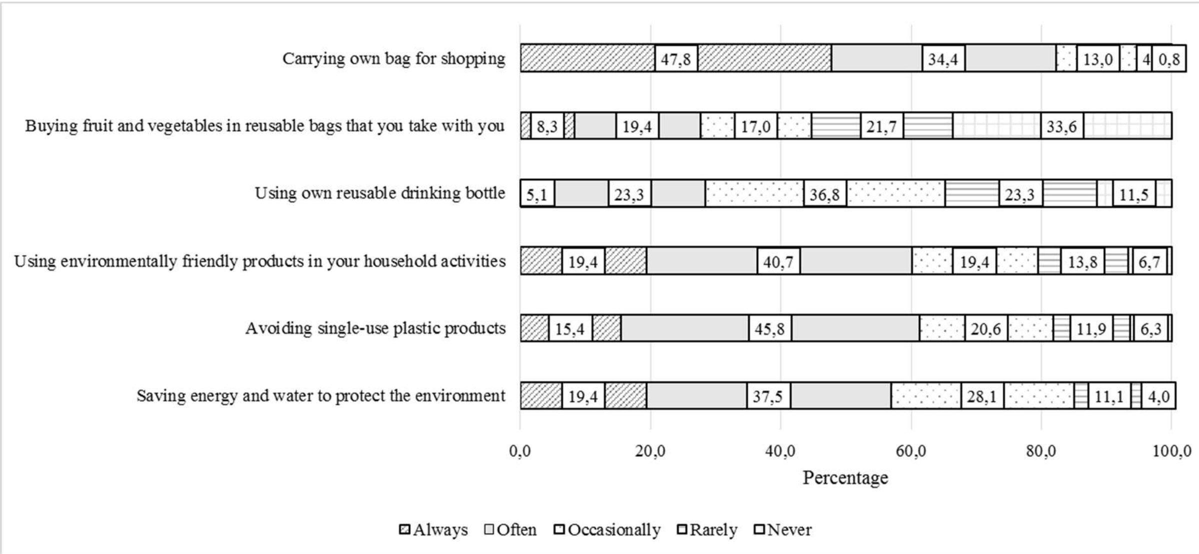
Gender/Answers	Always, often	Occasionally	Rarely	Never	Total
Male	7	9	25	34	75
Female	23	40	47	64	174
Total	30	49	72	98	249
Percentage					
Male	9.3%	12.0%	33.3%	45.3%	100.0%
Female	13.2%	23.0%	27.0%	36.8%	100.0%
Total	12.0%	19.7%	28.9%	39.4%	100.0%
Adjusted residuals					
Male	-0,86	-2,00	1,01	1,27	
Female	0,86	2,00	-1,01	-1,27	
Sign scheme					
Male		-			
Female		+			

Source: Own research, 2021

The $\chi 2$ statistic value of 7.81 is higher than the critical value of 5.57 by 3 degrees of freedom at the 0.95 significance level. The null hypothesis can be rejected. Whether a respondent buys food without packaging depends on his/her gender. The relationship, as measured by Cramér's *V*, is weak (*V* = 0.15). The data show that women are more likely to purchase food without packaging. Through the calculation of adjusted residuals, it was found that there was a statistically significant difference between men and women in the response "occasionally".

In the context of Generation Z's behaviour, the extent to which they engage in activities in their daily lives that can have a positive impact on the environment was also examined. Respondents always chose one of the possible answers on the scale provided. The results are clearly illustrated in the following figure (Figure 1.). The results show that Generation Z shows in most cases, compared to the general population (Hanzlová, 2021) higher levels of pro-environmental behaviour.

Figure 1. Activities of Generation Z respondents in relation to the environment



Source: Own research, 2021

Municipal waste is largely made up of conventional household waste. The overall waste management situation is therefore very important for how each individual approaches the issue. It was investigated whether waste is segregated in Generation Z households. Almost 90.0% (89.6%, 223) of the respondents answered positively to this question. Similar results are also found by Hanzlová (2021) in a questionnaire survey conducted among the general population in the Czech Republic.

Within this question, the null hypothesis H03 was tested. The results are presented in the following table (Table 6).

Table 6. Waste sorting in Generation Z households in relation to the gender of the respondent

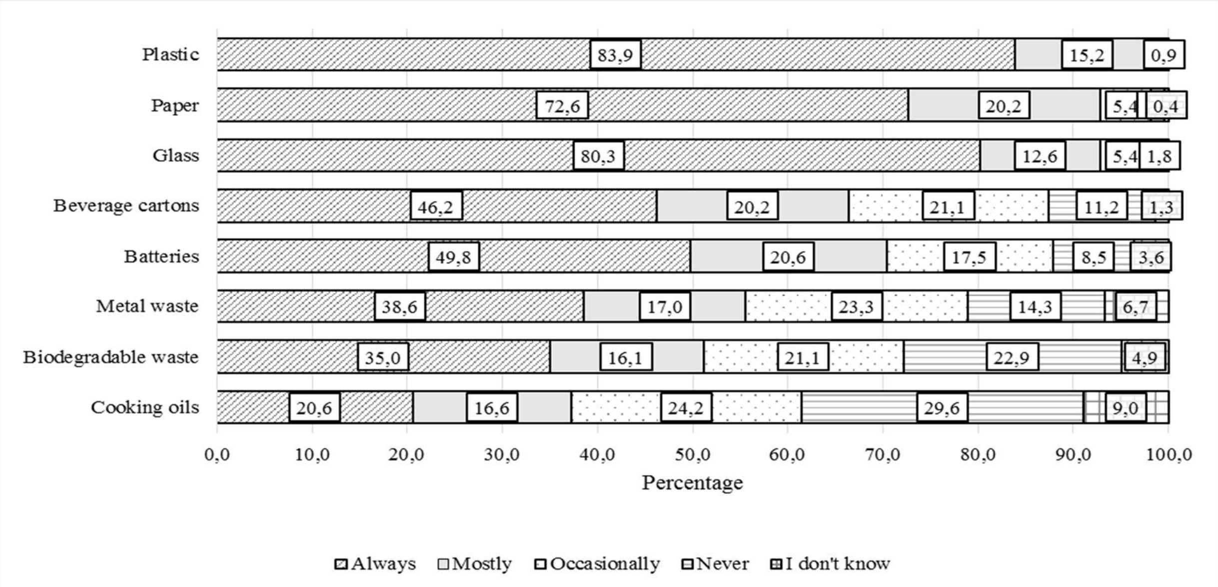
Gender/Answers	**Yes**	**No, I don't know**	**Total**
Male	69	6	75
Female	154	20	174
Total	223	26	249

Source: Own research, 2021

The calculated value of the $\chi 2$ statistic of 0.68 is less than the critical value of the $\chi 2$ distribution (3.84) by 1 degree of freedom at the 0.95 significance level. Therefore, the null hypothesis cannot be rejected. We could not demonstrate a relationship between the gender of the respondent and whether they separate waste in their household. Rybová (2019) considers, among others, the sex ratio in a municipality as one of the factors that influence the generation of recyclables or recyclable generation. The author also considers other important variables to be the proportion of people with higher education, purchasing power per capita and, in the Czech Republic, regional specificities

More detailed attention was also paid to which specific types of municipal waste, and to what extent, are sorted in the households of young people from Generation Z (n= 223). The results are clearly presented in the following figure (Figure 2.).

Figure 2. Waste sorting of different types of waste in households of Generation Z respondents



Source: Own research, 2021

As can be seen in Figure 2, in Generation Z households, plastic, glass and paper are often the types of waste sorted. Of the total number of respondents (n=223) who answered this question, all of them indicated that they sort plastic, albeit with varying frequency (responses - 83.9% (183) always, 15.2% (34) mostly and 0.9% (2) occasionally). The results also show that Generation Z households pay a lot of attention to sorting glass and paper, which are sorted regularly by 80.3% (179) and 72.6% (162) of respondents respectively. The sorting of bio-waste and oils is less frequently used. This may be due to the fact that bins for these types of waste are generally less accessible (Slavík et al., 2019).

According to the authors, links between interest in packaging and waste sorting behaviour can be assumed. For this reason, the following related issues were investigated and their interrelationship was further explored through the null hypothesis H04 (see Table 7.).

Table 7. The relationship between the respondent's interest in packaging issues and their waste sorting behaviour

Answers	Yes	No, I don't know	Total
I'm interested	117	7	124
I'm not interested	106	19	125
Total	223	26	249
Percentage			
I'm interested	94.4%	5,6%	100.0%
I'm not interested	84.8%	15.2%	100.0%
Total	89.6%	10.4%	100.0%

Source: Own research, 2021

The $\chi 2$ statistic value of 6.08 is higher than the critical value of 3.86 by 1 degree of freedom at the 0.95 significance level. The null hypothesis can be rejected. Whether a respondent separates waste depends on his/her interest in food packaging issues. The relationship, as measured by Cramér's V, is weak ($V = 0.16$). The results show that those who sort waste are more likely to be interested in the packaging of the food they buy. Also, the investigations of Esmailpour a Rajabi (2016) show that consumers' green attitude has a positive and significant effect on their sensitivity to the recyclability of product packaging.

Based on the primary research conducted among young people aged 16-26 in the Czech Republic, it can be noted that there are differences in attitudes between males and females. The same conclusions were also reached by Bulut et al. (2017) in their study of the relationship between sustainable consumption behaviour and gender and generation. The authors conclude that women exhibited higher levels of sustainable consumption behaviour. Also, OECD (2020) notes that women can be key drivers in shifting consumption towards sustainable behaviours and therefore a gender perspective needs to be taken when examining the consumer. Diversity is very important for Generation Z. Its perception of a person is therefore not limited to gender or race, but also needs to take into account their personal identity and orientation. For Gen Z, it is more likely that some individuals will identify as third gender (NEW& Deloitte (2022).

The results of an international study by Simon-Kucher & Partners (2021), which compared the purchasing behaviour of different generations in the context of sustainability over the last five years, indicate a generally positive shift in this direction, across all age categories. However, the results also show that younger people choose a sustainable product alternative when it is available more often than older people. However, the majority of respondents in the research conducted were not willing to pay more for sustainable products, with only 34.0% of the sample generally agreeing. Within this group of respondents, this view was clearly led by younger cohorts i.e. members of Generation Z and Generation Y versus Generation X and baby boomers (39.0% and 42.0% versus 31.0% and 26.0% respectively). Members of Generation Z showed a willingness to pay a higher amount for sustainable products and services than older respondents (Simon-Kucher & Partners, 2021). Similar results are confirmed by Forbes (2020). Kamenidou et al. 2019 , in their research on sustainable food consumption among university students aged 18-23 in Greece, note their deep interest in this issue. Similarly, Djafarova a Foots (2022) note a strong awareness of ethical and environmental issues among Generation Z.

As part of the general consumer education process, emphasis should be placed on the individual acquiring the skills to deal responsibly with themselves and others in terms of nutrition and consumption (Wahl et al., 2018). Changes in consumer behaviour in the context of their attitudes towards the environment can be achieved by raising public awareness. This is a process based on a long-term and continuous influence on individuals from a very young age through an educational process (OECD, 2020). These facts, according to the authors, open up a wide range of possibilities for discussing the sustainability and responsibility of each individual in the field of consumption within the didactic practice in all educational institutions.

As members of Generation Z enter or will enter adulthood and the workforce in the coming years, their views, attitudes and behaviours will shape the future shape of today's world. Djafarova a Foots (2022) carried out qualitative research among Generation Z respondents in the UK and concluded that young people of the relevant age are aware of ethical issues in contemporary society and, although limited by financial resources, express a desire to purchase ethical products in the future. The wide range of possibilities for implementing sustainability principles in the perception of Generation Z leads retail operators to use recommerce models (Forbes, 2020). This makes it necessary for manufacturing and trading companies to act according to the principles of sustainability and follow new trends in this area if they want to continue to make profits and attract new customers in the future (Simon-Kucher & Partners, 2021). Shen et al. (2014) emphasise the role of sustainable marketing as a means of understanding consumers and highlighting the value of sustainability in general. Research of Deloitte (2021) considers the creation of sustainable values and a meaningful response to change as a tool to protect resources as a key factor in a company's attractiveness to young Generation Z employees.

4. Conclusion

The aim of this paper is to evaluate the views and attitudes of members of Generation Z in terms of waste segregation and to make an identification of their food shopping behaviour on the issue of waste production from food packaging. The results show approximately 57.0% of respondents who shop for food try to avoid plastic. Less than 40.0% of the respondents consider packaging material to be somewhat important when buying food. Almost half of the respondents regularly carry their own bag for shopping. Waste sorting in households was declared by 90.0% of respondents. The most frequently sorted materials are plastic, glass and paper. Differences in the attitude of males and females were noted, with female respondents showing a higher rate of positive responses. The results show a correlation between interest in the issue of packaging materials when purchasing food and waste sorting in households. It can be concluded that young people of Generation Z show signs of positive environmental behaviour and are aware of the importance of the current issues of the day.

The theoretical contribution of the paper is the elaboration of an overview of the issues addressed. The practical contribution of the article is the presentation of the results of the attitudes of a specific group of the population - young people aged 16-26, members of the so-called Generation Z. In terms of other research directions, the possibility of comparison with other age cohorts (e.g. Generation Y or X) is offered. The authors also consider the possibility of comparing Generation Z in an international context to be very inspiring.

Acknowledgement
This work was funded by the Faculty of Economics and Management, Czech University of Life Sciences in Prague under Grant number 2022B0004".

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DIFFERENCES IN PRODUCTIVITY IN MILK INDUSTRY IN THE EU

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Annotation: Dairy production plays an important role in EU economy and its transition has a role in achieving the Farm to Fork Strategy´s goals. Green Deal is aimed to more sustainable food systems, contributing to better climate change keeping the high standard of livestock sector. Productivity in this sector can be expected to be one of the key benchmarks. The aim of this paper is to find the factors that influence productivity in the dairy industry. In particular, labour productivity and productivity per cow are evaluated with respect to differences between small and large EU countries, old and new EU countries or enterprises with a large and small market share of dairy production in the total food industry production or in relation to the abolition of milk quotas. Results show significant differences in productivity between old and new member states and with respect to milk quotas abolition. As factor not affecting the productivity can be stated the size of country or the share of milk production on total food industry production.

Keywords: Milk industry, EU, Productivity, Labour productivity

JEL classification: Q13, Q18

1. Introduction

The EU Green Agreement announced in 2019 will focus on agriculture to move towards a low-carbon sustainable model of growth, food and energy security, biodiversity and natural resource management (Ronzon, Iost, Philippidis, 2022) as well as to develop environmentally friendly forms. For this purpose, the various instruments of the common agricultural policy are set out (Rudnicki, Wiśniewski, Biczkowski, 2021).

Achieving carbon peaks and carbon neutrality is a far-reaching and profound systematic change in economic and social development. EU farming systems have become more vulnerable and less sustainable due to over-reliance on herbicides and a huge increase in herbicide-resistant levels. The EU Green Agreement aims to reduce the use and risk of chemical pesticides by 50% by 2030 (Tataridas, Kanatas, Chatzigeorgiou et al. 2022).

With the development of modern agriculture and support for the modernization of agriculture, agriculture and the rural area have shown great potential in reducing greenhouse gas (GHG) emissions (Xie, Yang, Zhao et al., 2022).

The adverse environmental impacts of agriculture and livestock production are well known and need to be mitigated in order to achieve sustainable production in the food chain (Andrade, Bonmati, Esteller, 2022). Together with legislation and new restrictions imposed at EU and national level, they require control and reduction of emissions in the primary sector.

Cervelli et al. (2021) They point out that it would be appropriate to promote good agricultural practices which can protect the environmental system and, in addition, become an additional economic resource. The results show that, on the one hand, suitable areas for livestock manure treatment plants have been identified; on the other hand, suitable manure spreading areas were also identified and evaluated. The framework makes it possible to approach the issue of manure management from the point of view of sustainability and mitigation of environmental impacts, not only on the basis of production, but also with regard to socio-economic and environmental criteria.

The focus of this article is on the productivity of individual EU countries in the dairy industry, which contributes to the production of CO2 equivalent emissions. European Union food and drink industry belong to the largest manufacturing sector in the EU in terms of turnover (15.2% share) and gross value added (12.2% share). It is also the leading employer in the EU, with 4.82 million employed in 291,000 companies. Competitiveness is one of the most critical factors for the sustainability and viability of the dairy business (Michaličková et al., 2014). It is influenced by many determinants, in agriculture also by economic parameters and biological specifics of production (Bohušová et al., 2012; Látečková et al., 2009). One of the critical factors to improve the competitiveness of nations in the global market is productivity, including labour productivity (Auzina-Emsina, 2014).

2. Materials and Methods

The article uses aggregated data of food industry enterprises operating in the dairy sector (C10.5 Manufacture of dairy products) primarily from Eurostat (years 2008-2018). Indicators as total labour productivity and productivity per cow were calculated. Total labour productivity was defined as total production per hour worked by an employee. Productivity per cow was defined as total production per milking cow.

Research questions are divided into four parts dealing with differences between new and old member states (Q1-Q2); large and small EU countries (Q3-Q4); between countries with a large share of milk production on total food industry production (Q5-Q6) and the impact of milk quota abolition (Q7-Q10).

The new Member States include Bulgaria, the Czech Republic, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia. The old Member States are Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom. Small countries were defined countries with less than 15 mil. inhabitant. A country with a large share of dairy production in total food production is considered to have a share of more than 16.1% (average of dairy production on food production – 2018, all countries).

Following research questions were formulated:

Q1 Is there a statistically significant difference in labour productivity between old and new (post-2004 accession) EU countries in 2008 and 2018?

Q2 Is there a statistically significant difference in productivity per cow between old and new EU countries in 2008 and 2018?

Q3 Is there a statistically significant difference in labour productivity between large and small EU countries between 2008 and 2018?

Q4 Is there a statistically significant difference in productivity per cow between large and small EU countries between 2008 and 2018?

Q5 Is there a statistically significant difference in labour productivity between EU countries that have a large share of milk production in total food industry production in 2008 and 2018?

Q6 Is there a statistically significant difference in productivity per cow between EU countries that have a large share of milk production in total food industry production in 2008 and 2018

Q7 Has the abolition of milk quotas had an impact on labour productivity?

Q8 Has the abolition of milk quotas had an impact on labour productivity in old and new countries?

Q9 Has the abolition of milk quotas had an impact on labour productivity in small and large countries?

Q10 Has the abolition of milk quotas had an impact on labour productivity in countries with a large market share of the dairy sector in the food industry?

The basic procedure of statistical induction in the form of statistical hypothesis testing was used to determine the answers to the research questions. The sample sets are random and independent with unknown variances. To assess the level of the random variable under study, tests for equality of means in a normal distribution were applied using a two-sample t-test where we consider the following hypotheses:

H0: $\mu_1 = \mu_2$ nebo $\mu_1 - \mu_2 = 0$ for unknown variances.

H1: $\mu_1 < \mu_2, \mu_1 > \mu_2, \mu_1 \neq \mu_2$.

The test criterion is calculated:

$$T = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad \textbf{(1)}$$

in case the variances are different or:

$$T = \frac{\bar{X}_1 - \bar{X}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad \textbf{(2)}$$

if the variances are equal. The choice of the test can be decided by consideration when comparing their magnitudes and can be estimated using the statistic:

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \quad \textbf{(3)}$$

Another test to determine equality of means is the paired t-test, which is applied when we examine samples before and after the change under consideration. In this case, the hypotheses are stated as in the two-sample t-test, but the test criterion is of the form:

$$T = \frac{\sqrt{n}\bar{D}}{S_D} \quad \textbf{(4)}$$

The agreement of variances in two samples from a normal distribution can also be tested using an F-test with the hypotheses set:

$$\text{H0: } \sigma_1^2 = \sigma_2^2 \text{ or } \frac{\sigma_1^2}{\sigma_2^2} = 1 \quad \textbf{(5)}$$

$$H1: \sigma_1^2 < \sigma_2^2, \sigma_1^2 > \sigma_2^2 \neq \sigma_1^2 \neq \sigma_2^2 \quad \textbf{(6)}$$

The test can be based on the test criterion:

$$F = \frac{s_1^2}{s_2^2} \quad \textbf{(7)}$$

The evaluation of the above tests can be done using a critical region or an alternative way that uses a p-value assessment. In this thesis, a significance level of α=0.05 will be chosen against which the estimated p-value will be compared. If the p-value < α then H0 is rejected.

Subsequently, clustering maps are created for the sectors under study based on the values of the indicators assessing the productivity of milk production - these are milk production per cow and gross value added per employee. Subsequently, map clusters are created for the sectors under study based on the values of per capita emissions from each sector. The breakdown of the EU28 countries itself was based on K-means clusters, which is a non-hierarchical method. In this case, the number of clusters was set to 5 and determined with respect to previous studies such as Tutak and Brodny (2017) and Brodny and Tutak (2019). Clustering of K-means was performed using Statistica multivariate analysis software. The goal of the k-means algorithm is to detect the optimal "partition" to divide the number of objects into k clusters. This procedure shifts objects from one cluster to another with the goal of minimizing within-cluster variance and maximizing between-cluster variance. The algorithm of the k-means method usually requires that all variables analyzed are quantitative.

3. Results and Discussion

Differences between old and new EU member states

First two research questions (Q1-Q2) stated in the Materials and Methods section analysed the differences between old and new EU member states concerning labour productivity per employee (total productivity) and per cow. According to Golebiewski, (2018) when new member states joined the EU, there was an increase in food trade that can influence the competitiveness of states.

According to the results of the statistical hypothesis testing of Table 1, it can be concluded in the case of question Q1 that there is a significant difference in the total labour productivity of the dairy sector between the old and the newly admitted countries to the EU in both years.

Table 1. Two-sample t-test with inequality of variances – labour productivity per employee (old and new member states)

2008	Old members	New members	2018	Old members	New members
Mean value	262.368	66.830	Mean value	277.882	82.039
Variance	15518.522	725.348	Variance	16470.730	697.803
Observation	11	10	Observation	12	11
Hyp. Difference of mean values	0		Hyp. Difference of mean values	0	
Differential	11		Differential	12	
t Stat	5.077		t Stat	5.168	
P(T<=t) (1)	0.000		P(T<=t) (1)	0.000	
t crit (1)	1.796		t krit (1)	1.782	
P(T<=t) (2)	0.000		P(T<=t) (2)	0.000	
t crit (2)	2.201		t krit (2)	2.179	

Source: own data processing

Testing the statistical hypothesis related to question Q2, whether productivity per cow differs in old and new EU countries is presented in Table 2. It leads to the conclusion that it differs statistically significantly in both 2008 and 2018.

Table 2. Two-sample t-test with inequality of variances – productivity per cow (old and new member states)

2008	Old members	New members	2018	Old members	New members
Mean value	7 168.96	3 166.08	Mean value	8 766.80	4 252.73
Variance	13 498 434.51	4 479 332.71	Variance	23 264 863.03	7 862 374.45
Observation	12	12	Observation	13	12
Hyp. Difference of mean values	0		Hyp. Difference of mean values	0	
Differential	18		Differential	20	
t Stat	3.270		t Stat	2.887	
P(T<=t) (1)	0.002		P(T<=t) (1)	0.005	
t krit (1)	1.734		t krit (1)	1.725	
P(T<=t) (2)	0.004		P(T<=t) (2)	0.009	
t krit (2)	2.101		t krit (2)	2.086	

Source: own data processing

The first set of the analysis showed significant differences between new and old member states in both indicators. There are significant differences in labour productivity (per hour). On average, labour productivity in 2018 in new member states was around 79.1 Euro; in old states, 277.7 Euro. The highest labour productivity is in Netherlands, Germany and Belgium (374 Euro and higher), lowest in Greece and Portugal (range from 112-127 Euro). The highest labour productivity in new old member states is in the Czech Republic and Poland. These countries almost reached values as less labour productive old states (111-118 Euro in 2018). More dynamic changes in indicator between 2008 and 2018 showed new member states (increase of 18%), while in old member states, there was an increase only by 6%.

The same results were found in the case of productivity per cow. Very high productivity was identified in old member states. The highest is in Greece, Spain, and Italy. Productivity in Cyprus (new member states) also reach very high values compared to older states. The average growth rate between 2008 and 2018 showed new member states, then older states.

Differences between old and new member states were also found in agriculture (Wicki, 2012). Another study by Kijek et al. (2019) also found differences with respect to total factor productivity. The growth of older member states concerning productivity is faster in old member states. However, some new member states are catching up older (for example, Poland and Lithuania) (Jansik and Irz, 2014).

Differences between small and large EU member states

Research question Q3-Q4 evaluated differences between small and large EU states. As large states are considered countries with more than 15 mil. inhabitants. According to Table 3, the following question Q3 could be evaluated with the conclusion that there are no differences in total labour productivity between small and large countries in the surveyed years.

Table 3. Two-sample t-test with inequality of variances – labour productivity per employee (small and large countries)

2008	**Large countries**	**Small countries**	**2018**	**Large countries**	**Small countries**
Mean value	264.2073921	131.2736206	Mean value	250.9878338	155.0061791
Variance	30498.86274	9554.471989	Variance	30816.97074	11900.93097
Observation	6	15	Observation	7	16
Hyp. Difference of mean values	0		Common variance	17305.51376	
Differential	6		Hyp. Difference of mean values	0	
t Stat	1.757653202		Differential	21	
P(T<=t) (1)	0.064657186		t Stat	1.610056356	
t krit (1)	1.943180281		P(T<=t) (1)	0.061157895	
P(T<=t) (2)	0.129314372		t krit (1)	1.720742903	
t krit (2)	2.446911851		P(T<=t) (2)	0.12231579	
			t krit (2)	2.079613845	

Source: own data processing

Question Q4 also communicates that there are no significant differences in productivity per cow between large and small EU countries in both years, see Table 4.

Table 4. Two-sample t-test with inequality of variances – labour productivity per cow (small and large countries)

2008	Large countries	Small countries	2018	Large countries	Small countries
Mean value	5700.207	4901.17	Mean value	7078.864	6374.721
Variance	11733009	13890504	Variance	13751694	24616063
Observation	8	16	Observation	8	17
Common variance	13204029		Common variance	21309516	
Hyp. Difference of mean values	0		Hyp. Difference of mean values	0	
Differential	22		Differential	23	
t Stat	0.507824		t Stat	0.355773	
P(T<=t) (1)	0.308315		P(T<=t) (1)	0.362626	
t krit (1)	1.717144		t krit (1)	1.713872	
P(T<=t) (2)	0.616631		P(T<=t) (2)	0.725253	
t krit (2)	2.073873		t krit (2)	2.068658	

Source: own data processing

In the case of monitoring productivity per cow in EU countries, an outlying observation was found in both years with a value of 16 343.5 EURO/head in 2008 and 22 645.3 EURO/head in 2018 belonging to Greece.

It was confirmed that there are no significant differences between small and large EU countries concerning their productivity. The size of the country is not a significant factor influencing productivity indicators.

Differences between countries with a high and low share of milk production

Research question Q5-Q6 analysed if significant differences between countries with a high share of milk production a low share of milk production exist. Bórawski et al. (2020) identified the biggest and the smallest milk producers of EU and stated that the milk production is very different. The biggest producers are self-sufficient in production. According to this statement, it is expected that significant differences between countries with a higher share of milk production and a low share of milk production exist.

Regarding question Q5, which assesses differences in total labour productivity, it can be stated that statistically significant differences were not found between enterprises with a large and small market share of dairy production in the food industry in the surveyed years, see Table 5.

Table 5. Two-sample t-test with inequality of variances – labour productivity per employee (share of milk production)

2008	High share	Low share	2018	High share	Low share
Mean value	171.678	166.023	Mean value	197.793	166.571
Variance	22909.391	13727.958	Variance	23094.079	13959.768
Observation	12	9	Observation	13	10
Common variance	19043.525		Common variance	19179.374	
Hyp. Difference of mean values	0		Hyp. Difference of mean values	0	
Differential	19		Differential	21	
t Stat	0.093		t Stat	0.536	
P(T<=t) (1)	0.463		P(T<=t) (1)	0.299	
t krit (1)	1.729		t krit (1)	1.721	
P(T<=t) (2)	0.927		P(T<=t) (2)	0.598	
t krit (2)	2.093		t krit (2)	2.080	

Source: own data processing

Similar results were obtained for questions Q6 on productivity differences per cow, see Table 6.

Table 6. Two-sample t-test with inequality of variances – labour productivity per cow (share of milk production)

2008	High share	Low share	2018	High share	Low share
Mean value	5760.64	4337.142	Mean value	7734.044	4899.052
Variance	14496695	10401817	Variance	25612575	9557443
Observation	14	10	Observation	15	10
Common variance	12821518		Common variance	19330132	
Hyp. Difference of mean values	0		Hyp. Difference of mean values	0	
Differential	22		Differential	23	
t Stat	0.960164		t Stat	1.579465	
P(T<=t) (1)	0.173704		P(T<=t) (1)	0.063943	
t krit (1)	1.717144		t krit (1)	1.713872	
P(T<=t) (2)	0.347407		P(T<=t) (2)	0.127885	
t krit (2)	2.073873		t krit (2)	2.068658	

Source: own data processing

Results did not significantly differ in productivity indicators between countries with a low or high share of milk production on total food production. This cannot be stated as a criterion driving productivity.

Differences in productivity with respect to milk quotas abolition

EU milk market after removal of quotas is adjusting very fast, concerning increase milk production (Bórawski et al., 2020). After 2015, the EU quotas were phased out, and the restrictions on the import of milk products from outside the EU were relaxed (Parzonko and Bórawski, 2020), as it was pointed out that the quotas can affect the dynamics of the industry, competitiveness, and productivity (Jorgenson and Timmer, 2011). On the EU market, the milk quota had a negative effect on productivity (Gillespie et al., 2015). After milk quota elimination, EU milk production was on growth.

Research question Q7-Q10 analysed if there are any significant differences in production indicators before and after milk quotas removal. According to the results presented in Table 7, it can be concluded that there was an increase in total labour productivity after the abolition of milk quotas. Question Q7 is answered positively.

Table 7. Two-sample t-test with inequality of variances – labour productivity with respect to milk quotas abolition

	2008	**2018**
Mean value	169.2546981	183.1058197
Variance	18099.57199	19686.27556
Observation	21	21
Pears. correlation	0.985186032	
Hyp. Difference of mean values	0	
Differential	20	
t Stat	-2.607450474	
P(T<=t) (1)	0.008426519	
t krit (1)	1.724718243	
P(T<=t) (2)	0.016853037	
t krit (2)	2.085963447	

Source: own data processing

When examining the changes for old and new EU countries (Q8) after the abolition of milk quotas, it was found that there was a statistically significant increase in total productivity only for the new countries. For the old countries, this change did not increase productivity.

Table 8. Two-sample t-test with inequality of variances – labour productivity with respect to milk quotas abolition (new and old countries)

	New members		**Old members**	
	2008	**2018**	**2008**	**2018**
Mean value	131.2736206	146.6524347	264.2073921	274.2392823
Variance	9554.471989	11554.68239	30498.86274	32439.07409
Observation	15	15	6	6
Pears. correlation	0.9848658		0.981567962	
Hyp. Difference of mean values	0		0	
Differential	14		5	
t Stat	-2.930806627		-0.7125049	
P(T<=t) (1)	0.005477056		0.254005682	
t krit (1)	1.761310136		2.015048373	
P(T<=t) (2)	0.010954112		0.508011364	
t krit (2)	2.144786688		2.570581836	

Source: own data processing

Question Q9 was also answered positively in the case of large countries, where higher labour productivity in the dairy sector was recorded in the period following the abolition of milk quotas. Small EU countries did not see a significant change, see Table 9.

Table 9. Two-sample t-test with inequality of variances – labour productivity with respect to milk quotas abolition (small and large countries)

	Small countries		**Large countries**	
	2008	2018	2008	2018
Mean value	262.3677876	277.6608885	66.83029972	79.09524409
Variance	15518.52155	18117.15893	725.3476379	669.4057809
Observation	11	11	10	10
Pears. correlation	0.972090925		0.886064416	
Hyp. Difference of mean values	0		0	
Differential	10		9	
t Stat	-1.575483526		-3.067132369	
P(T<=t) (1)	0.073111288		0.006708016	
t krit (1)	1.812461123		1.833112933	
P(T<=t) (2)	0.146222577		0.013416032	
t krit (2)	2.228138852		2.262157163	

Source: own data processing

The last scientific question was whether there are differences between countries with a high and low share of the dairy sector in total food production after the abolition of milk quotas. Again, the high share countries experienced significant increases in total labour productivity. In contrast to the low share countries where the change was statistically insignificant Table 10.

Table 10. Two-sample t-test with inequality of variances – labour productivity with respect to milk quotas abolition (share of milk production)

	High share		**Low share**	
	2008	**2018**	**2008**	**2018**
Mean value	171.6783043	190.9159828	166.0232232	172.6922689
Variance	22909.39128	24522.90755	13727.95843	15283.19575
Observation	12	12	9	9
Pears. correlation	0.983311545		0.992658203	
Hyp. Difference of mean values	0		0	
Differential	11		8	
t Stat	-2.329252759		-1.254361007	
P(T<=t) (1)	0.019960809		0.122559271	
t krit (1)	1.795884819		1.859548038	
P(T<=t) (2)	0.039921618		0.245118543	
t krit (2)	2.20098516		2.306004135	

Source: own data processing

4. Conclusion

According to the results, significant differences in labour productivity in the dairy sector were found between the old and the newly admitted countries to the EU. It can be concluded that there was an increase in overall labour productivity after the abolition of milk quotas. When examining the changes for the old and new EU countries after the abolition of milk quotas, it was found that there was a statistically significant increase in total productivity only in the case of the new countries. In the case of the small countries, higher labour productivity in the dairy sector was observed in the period after the abolition of milk quotas. Also, in this case, countries with large shares recorded significant increases in total labour productivity. There are no differences in total labour productivity between small and large countries in the years studied. Statistically significant differences were also not found between enterprises with large and small market shares of dairy production in the food industry.

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THE AGRARIAN POTENTIAL OF UZBEKISTAN IN THE POST-SOVIET COUNTRIES: THE COMPARATIVE ADVANTAGES OF VARIOUS TRADE GROUPS

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Annotation: The agricultural sector is one of the leading and largest sectors of the Uzbek economy. The agricultural sector accounts for about 28% of the GDP and the share of employees in the agricultural sector is 27% of the population. The foreign trade coverage ratio of Uzbekistan in 1995 amounted to 15%, and in 2018 this figure reached 65%. During the years 1995 - 2018, the value of agrarian trade turnover increased from cc 388 million USD to 2.8 billion USD. This paper examines Uzbek foreign trade in agricultural products from the following perspectives: trade balance of Uzbekistan and international competitiveness. The intention of the paper is to determine changes in the character of agricultural trade. Changes in the product structure are identified, and individual changes are explained. The comparative advantages are analyzed according to different groups of countries (CIS without Asian countries, Asian countries without CIS countries, EU28 without other European countries, other European countries without EU and CIS countries, and developing countries). Agrarian trade competitiveness and territorial and commodity structure changes are analyzed for the period 1995 - 2018. The commodity structure of agricultural trade is analyzed on the basis of the standard Harmonized System. The source of information in the article is UN COMTRADE. The analysis is based on the following method and indexes: Herfindahl-Hirschman index, Lafay index, the "product mapping approach" method and the trade balance 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 and Asian countries and limited when compared with other territories.

Keywords: Agrarian trade, Uzbekistan, Comparative advantages, 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 of Uzbekistan. 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.

In the second decade of the 21st century, the world economy is undergoing significant changes in its overall picture, the continuation of the global pandemic and the appearance of new geopolitical situations, which we were accustomed to seeing during the period of so-called hyper-globalization. It is the result of fundamental changes in the economic and geopolitical framework of global development and the transformation process that globalization processes have brought about as a result of profound structural changes.

The essential factors that have emerged in international relations include the slowing down of globalization processes, or even in certain areas, the opposite process of de-globalization, both at the global and regional level.

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. ("Veebel & Markus, 2018", "Benešová, Novotná, Šánová, & Laputková, 2016a").

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 ("Hartwell, 2013", "Connolly, 2015").

Uzbek agrarian foreign trade experienced significant changes in the period of 1995 to 2018 was significantly changed. Only in the period from 1995 through 2018 its export value decreased from 48 million USD to 1.1 bil. USD. The growth of imports even exceeded the growth of exports (from 339 million USD up to 1.6 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 1995 to 2018 was heavily focused on Asian and CIS countries. Only in 1995, the share of CIS members in agricultural exports and imports reached 31% and 18%, respectively. In the same year - the share of other Asian countries in agri-food exports and imports reached cc 39.2% respectively 23.8%. Later on (in 2018), 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 66.2% respectively 69.6%, the share of other Asian countries decreased up to 31.7%, respectively 14.1%. 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 paper analyzes the agrarian potential of Uzbekistan in the Post-Soviet countries and includes the international market of agricultural products for the last two decades (1995 - 2018). 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: European countries (without CIS and EU28), CIS countries (without Asian countries), other European countries (without EU28) and Asian countries (without the CIS). 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 paper analyzes the allocation of comparative advantages in relation to the post-Soviet countries' (CIS members) market, as well as to the rest of the world (Asian countries, other European countries (without EU28), the European Union (EU28), and developing countries). The following methods are used to achieve the above-mentioned results: Lafay index, trade balance index, Herfindahl-Hirschman index and product mapping. The LFI and TBI indices only provide limited knowledge of trade competitiveness development. The Herfindahl-Hirschman index uses a common measure for market concentration and the determination of market competitiveness. 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 "Svatoš, et al., 2010", "Bielik, et al., 2013", "Řezbová, et al., 2014", "Maitah, et al., 2016", "Jambor, et al., 2017", "Fertö, 2017, 2018", "Borák, et al., 2018", "Wajda-Lichy & Kawa, 2018", "Bilan, et al., 2018", "Kozlovskyi, et al., 2018", "Braha, et al., 2019"). The use of the Herfindahl-Hirschman index is a common indicator of market concentration and is used to determine market competitiveness. The Lafay index ("Lafay, 1992") analysis is used to help provide information on bilateral trade relations between countries and regions.

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.

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.

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:
Comparative Advantage
Net-importer
(LFI > 0 and TBI < 0)</td><td>Group A:
Comparative Advantage
Net-exporter
(LFI > 0 and TBI > 0)</td></tr>
<tr><td>Group D:
Comparative disadvantage
Net-importer
(LFI < 0 and TBI < 0)</td><td>Group C:
Comparative
disadvantage Net-
exporter
(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 (2022)

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:

$$\text{TBIij} = (\text{xij}-\text{mij})/(\text{xij}+\text{mij}) \qquad \textbf{(2)}$$

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 ("Dalum, Laursen and Villumsen, 1998", "Bielik, Smutka and Svatoš, 2013", "Řezbová, Smutka and Purkrabek, 2014", "Maitah, Řezbová and Smutka, 2016", "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) **(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) **(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 ("Svatoš 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 Benešová, 2019", "Ortikov and Smutka, 2021").

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 increased from about 48.8 mil. USD to about 1.1 bil. USD. The value of imports recorded growth from 339,7 mil. USD up to 1.7 bil. USD. The total value of the negative agri-food trade balance increased from 284.6 mil. USD up to about 582.9 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	**1995**		**2018**	
	Market share	**HHI index**	**Market share**	**HHI index**
Asia	23.8%	566.4	14.1%	198.8
Africa	0.2%	0.04	0.3%	0.09
EU 28	53.3%	2840.9	11.3%	127.7
Other European countries	2.7%	7.3	0.5%	0.3
CIS	18.3%	334.9	69.6%	4844.2
North America	0.3%	0.09	0.3%	0.09
Latin America	1.5%	2.3	3.9%	15.2
Australia and Oceania	0.0%	0.0	0.0%	0.0
World	100.0%	3751.9	100.0%	5186.3

Source: own processing, 2022

During the analyzed time period export/import coverage ratio significantly increased from 15% to 65%.

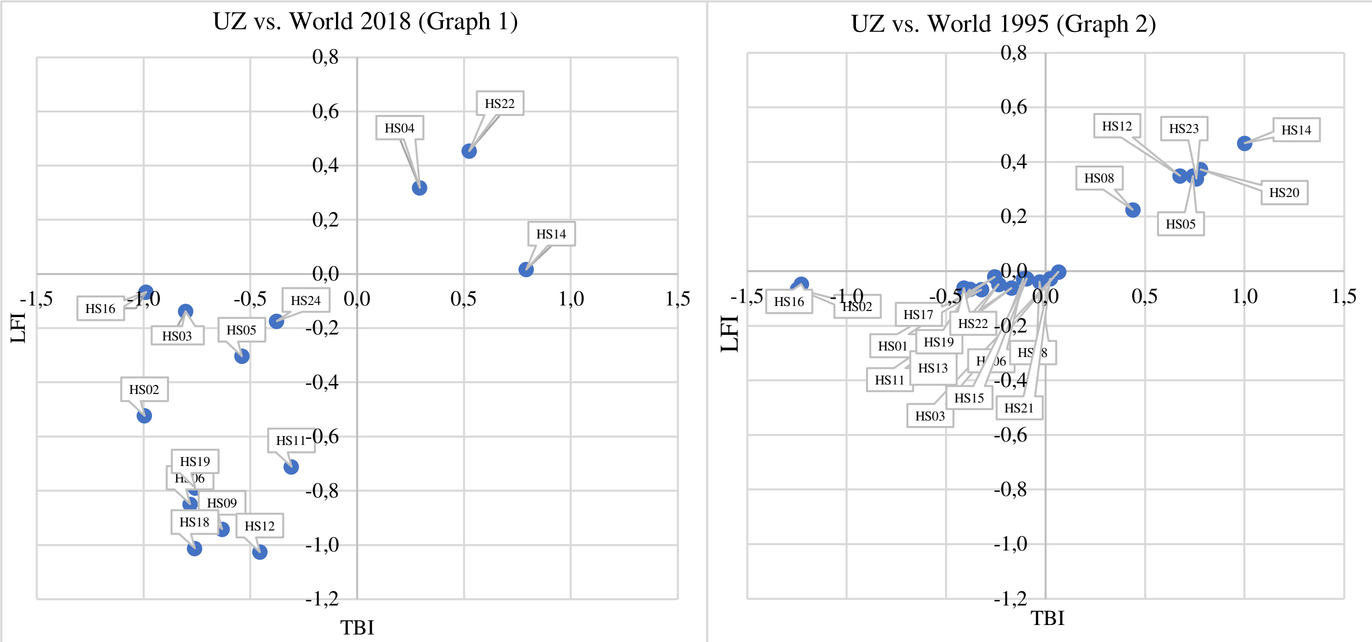
In 1995, the Asian share in Uzbek agricultural exports and imports reached about 39.2% and 31.7%, respectively. In the same year - the share of EU28 in agricultural exports and imports reached about 29.2% and 1.8%, respectively and the share of CIS members in agricultural exports and imports reached 31% and 66.2%, respectively.

Table 2. Uzbek agrarian foreign trade value development between 1995 and 2018 in USD

1995	**Asia**	**Africa**	**EU 28**	**Other European countries**	**CIS**	**North America**	**Latin America**	**Australia and Oceania**	**World total**
Export	19,125,435	67,379	14,275,793	2,641	15,139,841	204,740			48,815,829
Import	80,859,051	636,358	180,904,505	9,072,518	62,152,922	851,335	5,227,238		339,703,927
Balance	-61,733,616	-568,979	-166,628,712	-9,069,877	-47,013,081	-646,595			-285,660,860
Balance/Export	-322.78%	-844.45%	-1167.21%	-343425.86%	-310.53%	-315.81%			-585.18%
2018	**Asia**	**Africa**	**EU 28**	**Other European countries**	**CIS**	**North America**	**Latin America**	**Australia and Oceania**	**World total**
Export	350,697,619	356,832	19,612,179	281,193	731,889,267	2,821,751	35,221		1,105,694,062
Import	237,673,958	5,131,002	190,393,528	7,901,691	1,174,946,324	5,291,454	66,130,720	1,180,138	1,688,648,815
Balance	113,023,661	-4,774,170	-170,781,349	-7,620,498	-443,057,057	-2,469,703	-66,095,499	-1,180,138	-582,954,753
Balance/Export	32.23%	-1337.93%	-870.79%	-2710.06%	-60.54%	-87.52%	-187659.35%	-3350.67%	-52.72%
Export Basic index 2018/1995	18.34	5.30	1.37	106.47	48.34	13.78			22.65
Import Basic index 2018/1995	2.94	8.06	1.05	0.87	18.90	6.22	12.65		4.97

Source: COMTRADE database, 2022 and own calculations.

Graphs 1 - 2. Uzbek agrarian exports' comparative advantages distribution – traditional and modified "Product mapping approach"



Source: own processing, 2022

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 97 % of export value and 83.7 % 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 1995 (traditional product mapping approach) in USD

All trade transactions worldwide 1995									
B-1995	**Export**	**Share in export**	**Import**	**Share in import**	**A-1995**	**Export**	**Share in export**	**Import**	**Share in import**
HS03	55,710	0.11%	403,256	0.12%	HS05	1,255,960	2.57%	364,572	0.11%
HS21	673,537	1.38%	8,406,785	2.47%	HS08	497,930	1.02%	415,735	0.12%
					HS12	1,606,879	3.29%	462,849	0.14%
					HS14	23,976,234	49.12%	16,570	0.00%
					HS20	7,902,184	16.19%	1,726,779	0.51%
					HS23	7,543,119	15.45%	2,418,849	0.71%
Total	729,247	1.49%	8,810,041	2.59%	Total	42,782,306	87.64%	5,405,354	1.59%
D-1995	**Export**	**Share in export**	**Import**	**Share in import**	**C-1995**	**Export**	**Share in export**	**Import**	**Share in import**
HS01	91,919	0.19%	951,082	0.28%	HS07	831,324	1.70%	3,886,531	1.14%
HS02	115,600	0.24%	28,926,790	8.52%					
HS04	78,534	0.16%	3,670,671	1.08%					
HS06	29,000	0.06%	351,980	0.10%					
HS09	67,399	0.14%	5,592,275	1.65%					
HS10	313,914	0.64%	108,039,941	31.80%					
HS11	15,199	0.03%	1,332,290	0.39%					
HS13	10,500	0.02%	281,100	0.08%					
HS15	1,209,296	2.48%	14,766,631	4.35%					
HS16	61,499	0.13%	1,540,656	0.45%					
HS17			52,689,536	15.51%					
HS18	1,339,799	2.74%	23,448,339	6.90%					
HS19	112,998	0.23%	39,048,226	11.49%					
HS22	427,496	0.88%	36,536,961	10.76%					
HS24	599,799	1.23%	4,425,523	1.30%					
Total	4,472,952	9.16%	321,602,001	94.67%	Total	831,324	1.70%	3,886,531	1.14%

Source: own processing, 2022

Table 4. Uzbek agrarian trade commodity structure by CIS countries in 1995 (traditional product mapping approach) in USD

Trade transactions by CIS countries 1995									
B-1995	**Export**	**Share in export**	**Import**	**Share in import**	**A-1995**	**Export**	**Share in export**	**Import**	**Share in import**
					HS05	2,699	0.02%	2,500	0.00%
					HS08	301,169	1.99%	12,400	0.02%
					HS12	1,066,543	7.04%	145,497	0.23%
					HS13	10,500	0.07%	4,600	0.01%
					HS14	6,012,298	39.71%	15,300	0.02%
					HS15	606,296	4.00%	76,599	0.12%
					HS18	1,339,799	8.85%	12,672	0.02%
					HS20	2,809,695	18.56%	171,399	0.28%
					HS21	487,897	3.22%	41,399	0.07%
					HS24	597,768	3.95%	384,289	0.62%
					Total	13,234,664	87.42%	866,655	1.39%
D-1995	**Export**	**Share in export**	**Import**	**Share in import**	**C-1995**	**Export**	**Share in export**	**Import**	**Share in import**
HS01	45,600	0.30%	769,196	1.24%	HS07	606,192	4.0%	1,405,799	2.26%
HS02	115,600	0.76%	2,117,098	3.41%	HS09	67,399	0.4%	101,497	0.16%
HS03		0.00%	91,799	0.15%	HS19	112,998	0.7%	213,597	0.34%
HS04	54,299	0.36%	262,899	0.42%					
HS10	277,498	1.83%	36,286,397	58.38%					
HS11	15,199	0.10%	1,148,696	1.85%					
HS16		0.00%	66,800	0.11%					
HS17	57,999	0.38%	14,639,305	23.55%					
HS22	414,496	2.74%	2,744,684	4.42%					
HS23	137,897	0.91%	1,438,500	2.31%					
Total	1,118,588	7.39%	59,565,374	95.84%	Total	786,589	5.2%	1,720,893	2.77%

Source: own processing, 2022

Table 5. Uzbek agrarian trade commodity structure in 2018 (traditional product mapping approach) in USD

All trade transactions worldwide 2018									
B-2018	**Export**	**Share in export**	**Import**	**Share in import**	**A-2018**	**Export**	**Share in export**	**Import**	**Share in import**
					HS04	11,519,642	1.04%	6,306,013	0.37%
					HS07	307,714,084	27.69%	46,876,707	2.76%
					HS08	543,935,423	48.95%	25,303,500	1.49%
					HS13	23,681,603	2.13%	2,297,119	0.14%
					HS14	432,113	0.04%	50,530	0.00%
					HS20	30,727,553	2.77%	14,786,471	0.87%
					HS22	13,253,219	1.19%	4,135,961	0.24%
					Total	931,263,637	83.80%	99,756,301	5.87%
D-2018	**Export**	**Share in export**	**Import**	**Share in import**	**C-2018**	**Export**	**Share in export**	**Import**	**Share in import**
HS01	2,603,732	0.23%	75,001,264	4.41%					
HS02	40,035	0.00%	18,641,325	1.10%					
HS03	638,303	0.06%	5,850,531	0.34%					
HS05	5,921,220	0.53%	19,823,595	1.17%					
HS06	4,520,133	0.41%	37,106,855	2.18%					
HS09	11,483,346	1.03%	51,046,497	3.00%					
HS10	20,569,994	1.85%	305,594,848	17.98%					
HS11	70,111,379	6.31%	132,548,155	7.80%					
HS12	31,814,015	2.86%	85,136,376	5.01%					
HS15	1,918,960	0.17%	238,216,058	14.01%					
HS16	13,480	0.00%	2,376,474	0.14%					
HS17	4,794,369	0.43%	347,426,508	20.44%					
HS18	6,182,092	0.56%	45,450,239	2.67%					
HS19	4,877,633	0.44%	35,507,175	2.09%					
HS21	764,354	0.07%	48,021,765	2.82%					
HS23	4,705,420	0.42%	132,538,363	7.80%					
HS24	9,047,084	0.81%	20,008,873	1.18%					
Total	180,005,549	16.20%	1,600,294,901	94.13%					

Source: own processing, 2022

Table 6. Uzbek agrarian trade commodity structure by CIS countries in 2018

Trade transactions by CIS countries 2018									
B-2018	**Export**	**Share in export**	**Import**	**Share in import**	**A-2018**	**Export**	**Share in export**	**Import**	**Share in import**
					HS05	967,509	0.13%	298,730	0.03%
					HS06	4,399,916	0.60%	181,054	0.02%
					HS07	159,678,854	21.82%	25,368,716	2.16%
					HS08	487,262,332	66.58%	1,054,224	0.09%
					HS09	5,837,989	0.80%	1,805,370	0.15%
					HS14	313,027	0.04%	2,529	0.00%
					HS20	20,893,587	2.85%	10,499,936	0.89%
					HS22	12,722,868	1.74%	1,336,916	0.11%
					HS24	4,815,777	0.66%	3,051,523	0.26%
					Total	696,891,859	95.22%	43,598,998	3.71%
D-2018	**Export**	**Share in export**	**Import**	**Share in import**	**C-2018**	**Export**	**Share in export**	**Import**	**Share in import**
HS01	995,059	0.14%	28,643,144	2.44%					
HS02			10,559,437	0.90%					
HS03	1,820		1,065,803	0.09%					
HS04	1,610,161	0.22%	12,027,581	1.02%					
HS10	420,697	0.06%	301,620,277	25.67%					
HS11	67,855	0.01%	128,502,892	10.94%					
HS12	13,967,112	1.91%	64,648,547	5.50%					
HS13			301,657	0.03%					
HS15	1,910,610	0.26%	192,952,729	16.42%					
HS16	10,556		1,262,824	0.11%					
HS17	4,196,115	0.57%	248,918,994	21.19%					
HS18	5,391,381	0.74%	27,232,210	2.32%					
HS19	4,011,230	0.55%	32,368,597	2.75%					
HS21	561,902	0.08%	33,261,013	2.83%					
HS23	1,852,910	0.25%	47,981,621	4.08%					
Total	34,997,408	4.78%	1,131,347,326	96.29%					

Source: own processing, 2022

As already mentioned, Uzbek agrarian trade is focused on the Asia, CIS and Europe. In the analyzed time period (1995 - 2018), 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 (EU28, CIS, Other European countries, North America, Latin America). 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 - 5). 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 1995 to 2018 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 (2018)

Value 2018 (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	229,802		89,163	122,136			37,867	5,007,847	356,832	5,129,983
EU 28	13,558,000	2,820,796			5,413,156	20,442,610	641,023	167,130,122	19,612,179	190,393,528
Other European countries	281,193			5,854		7,895,837			281,193	7,901,691
CIS	696,891,859	43,598,998					34,997,408	1,131,347,326	731,889,267	1,174,946,324
North America	2,641,564	262,718	179,209	326,247			978	4,702,489	2,821,751	5,291,454
Latin America			35,221	1,621,011				64,509,709	35,221	66,130,720
Australia and Oceania										
World	1,050,401,101	81,677,082	303,593	2,075,248	8,225,971	30,654,412	46,763,397	1,573,060,916	1,105,694,062	1,687,467,658

Source: own processing, 2022

Table 9. Uzbek agrarian trade value commodity structure – modified product mapping approach (1995)

Value 1995 (in USD)	**A**		**B**		**C**		**D**		**Total**	
	Export	**Import**	**Export**	**Import**	**Export**	**Import**	**Export**	**Import**	**Export**	**Import**
Asia	19,052,546	359,342					72,889	80,499,709	19,125,435	80,859,051
Africa										
EU 28	13,165,948	1,853,929			288,932	2,632,276	820,913	176,418,300	14,275,793	180,904,505
Other European countries										
CIS	13234664	866,655			786,589	1,720,893	1,118,588	59,565,374	15,139,841	62,152,922
North America										
Latin America										
Australia and Oceania										
World	45,453,158	3,079,926	0	0	1,075,521	4,353,169	2,012,390	316,483,383	48,541,069	323,916,478

Source: own processing, 2022

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 (93% to 95%). The share of the A group in total imports changed from 0.95% to 4.8%. The share of exports and imports realized under group C decreased from 2.2% to 1% and import increased from 1.3% to 2%, respectively. Exports and imports realized under group D recorded the following changes: The share of exports in total agrarian exports increased from 4.15% to 4.3% and the share of realized imports decreased from 97.7% to 93.2%. 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 97.9% respectively 83.7%. In 1995, their cumulative share in total exports and imports reached only 70.2%, respectively 42.1%.

4. Conclusion

An analysis of the past twenty-three 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 3.2 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.

Acknowledgement

The paper is a part of the internal research project 2021B0002 "The post-Soviet region in the context of international trade activities: opportunities and threats arising from mutual cooperation", solved at the Faculty of Economics and Management, Czech University of Life Sciences in Prague.

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SITUATION IN THE BEER MARKET AND CONSUMER ATTITUDES TOWARDS CRAFT BEER CONSUMPTION

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Annotation: Recently, the food industry has been facing new challenges related to sustainable principles and environmental protection, and the brewing industry, which has a long tradition in Slovakia, is no exception. Therefore, it is necessary to address sustainable development issues in beer production and consumption as well. Craft brewing seems to be a viable alternative to industrial beer production and meets the principles of sustainable production. The aim of the paper is to evaluate and compare the current situation in the brewing industries of the Visegrad Group countries and also to evaluate Slovak consumers' behavior on the beer market with the emphasis on craft beer. The data on beer production and consumption were compiled using statistical reports of the European association The Brewers of Europe. They are complemented by the data obtained from a questionnaire survey conducted in the Slovak Republic in which 527 respondents participated. The results show the beer production and consumption per capita in the countries of the Visegrad Group declined in 2020 compared to 2019. Despite the lower consumption, the number of craft breweries in Slovakia has increased, which might be a sign of high potential of craft beer consumption among Slovak consumers. This preference was also confirmed by the consumer survey. The results further show that beer produced by craft breweries is currently acknowledged by more than 75% of Slovak consumers and 65% of consumers drink it. The most popular beer types among Slovak consumers are India Pale Ale, American Pale Ale, Light Lager, special beers and these beer types are also the most frequently consumed. To further support the sustainability of Slovak brewing industry, it is important to focus on the production of quality beers produced in smaller quantities, since the craft brewing has a huge potential in Slovakia.

Keywords: Beer market, Craft beer, Consumption, Consumer preferences

JEL classification: Q13, M31, M39

1. Introduction

Nowadays, the emphasis is on sustainability, environmental impact, and other aspects, which are included in the European Green Deal. The European Green Deal aims to transform the European Union's economy into a competitive, modern, and resource-efficient economy (European Commission, 2019). Of course, meeting the objectives of the European Green Deal also applies to the brewing sector. The European Union is one of the largest producers of beer and beer is one of the most popular alcoholic beverages, it is essential to focus on European brewing sector in this context as well.

Beer is one of the oldest drinks and most widely consumed alcoholic beverage in the world (Caon et al., 2021; Gómez-Corona et al., 2016; Kawa-Rygielska et al., 2019; Salanță et al., 2020). Moderate consumption of beer can bring health benefits for consumers such as cardiovascular protection, protects against the development of atherosclerosis, reduces platelet aggregation (Olšovská, 2014), can help prevent osteoporosis, stimulate the immune system, and reduce the risk of dementia (Sohrabvandi et al., 2012). Beer also contains trace amounts of minerals such as iron, zinc, calcium, magnesium, sodium, manganese, fluoride and others (Quesada-Molina et al. 2019).

Raw materials are mainly used in the beer production. Beer is composed of water, malt, hops and yeast (Mascia et al., 2014; Quesada-Molina et al., 2019). Various types of raw materials are used in the production, such as wheat, rye, oats, maize, rice, unmalted barley, sorghum, millet, and cassava (Salanță et al., 2020). Crop production is affected by climate change (El Afandi, 2017) and for this reason the issue included in the European Green Deal also affects the brewing industry. One of the main ingredients used in brewing process is water. More than 90% of the beer content is water and a large amount of water is used in beer industry (Olajire, 2012; Olšovská, 2014). The protection of water resources is therefore essential. For this reason, it is important for breweries to focus on regulating water consumption, it is also important to invest in new technologies and to emphasize the waste management of the beer industry (Fillaudeau et al., 2005). The Secretary General of The Brewers of Europe argues that beer production can have a positive effect on the planet by saving water, reducing emissions, protecting biodiversity, and moving to a circular economy (Bergeron, 2020).

In the brewing sector, sustainability practices affect incoming (main ingredients, packaging energy) and outgoing resources such as air emissions and different types of waste (Patterson et al. 2016). Today, many industrial breweries have environmental initiatives, and their activities are geared towards sustainability. Beer producers are increasingly investing in environmental sustainability equipment, which helps to reduce inputs and have a positive impact on the environment (Staples et al., 2020). Craft breweries can also contribute to the sustainability of the sector in a variety of ways. If craft brewers pay attention to operational changes in their supply chains, they can improve their sustainability performance by reducing waste or conserving natural resources (Bahl et al. 2021). Sustainable practices are part of the craft brewing culture (Kline et al., 2017). For example, Brooklyn Brewery focuses on the use of wind energy, New Belgium Brewery supports the restoration of local waterways and Yards Brewing Co. send its spent grain to farmers to use as livestock feed (Mazzoni, 2014).

According to the European Economic and Social Committee (2013), the emergence of new small and micro-breweries is a testament to the sector's innovation potential and its contribution to sustainability. The trend of establishing craft breweries and changing consumer preferences has been a popular topic not only abroad but also in Slovakia in recent years. In recent years, their expansion has been recorded in several European countries and also in Slovakia. The statistics of the establishment of new microbreweries according to The Brewers of Europe also confirm of the development of craft beer sector in European countries, ie also in the V4 countries. Compared to industrial beer, craft beer is produced in small quantities by independent breweries that focus on taste and style (Jacobs et al., 2010). The craft brewery is usually characterized as a small, independent and traditional brewery (Villacreces et al., 2022), which brews beer in smaller quantities with a focus on high quality, brewing method and also wide selection of ingredients (Wojtyra and Grudzień, 2017). Craft beer is often defined as unfiltered and unpasteurized beer, and in its production the brewery focuses on the local market with an emphasis on taste and techniques used (Villacreces et al. 2022). The trend of craft beer consumption has changed as this product has become known among consumers and brewers are adding new flavors and ingredients to beer (Lazzari et al., 2021).

2. Materials and Methods

The aim of the paper is to evaluate the development of beer consumption in the V4 countries and to identify consumer preferences in beer consumption in the Slovak Republic with an emphasis on craft beer. Data on beer consumption in the V4 countries were obtained from the statistical reports of The Brewers of Europe, which became the basis for examining the trend in beer consumption. The regression analysis was applied in order to express the trend of average annual beer consumption per capita in the V4 countries in the period 2003-2020 and its forecast until 2023. The trend of beer consumption development was described using the following regression functions:

Linear function is expressed by the formula:

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \qquad i=1,2,...,n \tag{1}$$

Quadratic function is expressed by the formula:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \varepsilon_i \qquad i=1,2,...,n \tag{2}$$

where: y_i - i-th observed value of the explained variable; β_0, β_1, β_2 - unknown parameters of the regression model; x_1 - i-th value of the explanatory variable; ε_i - number of observations.

Mathematical methods and calculation of the coefficient k¯ were used in the analysis of secondary data. The formula for calculating the coefficient is as follows:

$$k = \sqrt[n-1]{k_2 * k_3 * .... k_n} \tag{3}$$

We identified consumer behavior in the beer market based on a questionnaire survey conducted on a sample of 527 respondents online and personally in the 2019 and 2020. The data collection was carried out using the snowball technique. Characteristics of respondents is shown in the Table 1.

Table 3. Characteristics of respondents

Demographic characteristics	Options	All respondents	Craft-beer consumers	Demographic characteristics	Options	All respondents	Craft-beer consumers
age	18 – 25 years	48%	24%	gross monthly income	up to 600 euros	19%	11%
	26 – 41 years	36%	60%		600 – 900 euros	20%	18%
	more than 41 years	16%	16%		900 – 1200 euros	20%	23%
gender	men	69%	77%		1200 – 1500 euros	15%	17%
	women	31%	23%		more than 1500 euros	26%	31%
education	primary	1%	1%	place of residence	city with more than 20.000 inhabitants	49%	60%
	secondary	49%	44%		city up to 20.000 inhabitants	12%	13%
	higher	50%	55%		countryside	39%	27%
marital status	single	67%	65%	parenthood	yes	32%	35%
	married	29%	32%		no	68%	65%
	divorced	4%	3%	preferred place of consumption	at home	37%	36%
economic status	employed	71%	69%		at bar/pub	50%	54%
	self-employed	20%	25%		in the household of friends/family	8%	5%
	un-employed	9%	6%		at restaurant	3%	3%
type of work	mental	67%	71%		other	2%	2%
	physical	33%	29%				

Source: own processing

For fulfillment of aims of the paper, the following hypotheses were formulated:

There are differences in consumers' preferences when beer type evaluated (domestic craft beer, foreign craft beer, domestic industrial beer, foreign industrial beer).

The consumers' preferences of beer types (domestic craft beer, foreign craft beer, domestic industrial beer, foreign industrial beer) are influenced by selected demographic factors (age, gender, frequency of consumption, gross monthly income, type of work, parenthood).

There are differences in consumers' preferences when beer style evaluated (Light Lager, Dark Lager, IPA, APA, Porter, Stout, Light Weizen, Beer Specialties, Non-alcoholic beer).

The consumers' preferences of beer styles (Light Lager, Dark Lager, IPA, APA, Porter, Stout, Light Weizen, Beer Specialties, Non-alcoholic beer) are influenced by selected demographic factors (age, gender, frequency of consumption, gross monthly income, type of work, parenthood).

Microsoft Excel XLstat and IBM SPSS for calculations were used. The non-parametric Kruskal-Wallis H and Mann-Whitney U tests, the Friedman test and the Nemenyi's method were used to test the established hypotheses. The significance level was set to 0.05.

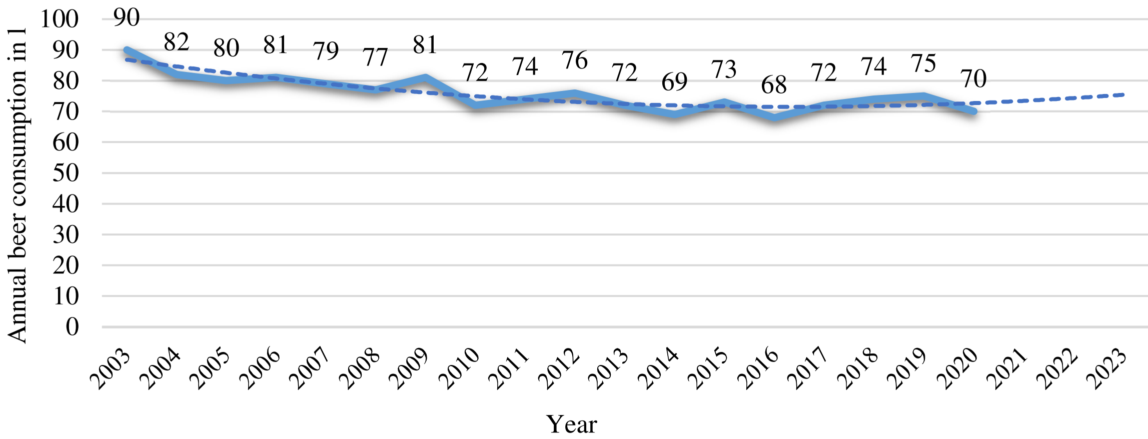
3. Results and Discussion

Beer is one of the most preferred alcoholic beverages of Slovak consumers in terms of consumption. It is the most sought-after alcoholic beverage, as its annual consumption per capita is currently on the level of 69 liters, while wine is consumed at 16 liters and spirits at 10 liters per year (SO SR, 2020). In the past, beer was consumed in Slovakia to a greater extent, and in 1990 consumption was recorded at the level of almost 100 liters annually per capita. In recent years, beer consumption has been declining, and the Figure 1. shows a more detailed development of beer consumption in Slovakia since 2003. Based on data from The Brewers of Europe, it can be stated that in the observed period 2003-2020, beer consumption was declining with an average annual decrease of up to 1.5% (k´ = 0.985326). From 2003 to 2009, beer consumption showed a gradually decreasing trend. In 2010, there was a rapid decrease in beer consumption, up to 9 liters year-on-year. This could have been caused by the financial and economic crisis, which also negatively affected the Slovak beer market in terms of production and also consumption. Beer consumption was determined by the reduced purchasing power of the Slovak population, as well as gradually rising beer prices. Over the next three years, the level of beer consumption was stable, but since 2012 there has been another gradual decrease, which was interrupted in 2015, when beer consumption increased by more than 6% year-on-year. In 2016, beer consumption fell again to the level of 68 liters per capita, which is the lowest level in the observed period. From 2011 to 2017, the price of beer in the HORECA sector grew at a faster pace compared to retail trade. Due to downward pressure on beer prices in retail and relatively faster growth in beer prices in the HORECA sector (as well as relatively higher beer prices in this channel) beer consumption has gradually shifted from the HORECA sector to households. While in 2011 the HORECA sector consumed almost 40% of the volume of beer, in 2017 this distribution channel accounted for less than 29% of total consumption (EY, 2018). However, from 2017 to 2019, beer consumption had a growing trend. In 2020, due to the pandemic situation, beer consumption was reduced to the level of 70 liters. To support beer consumption, beer sales in the pandemic period also moved into the e-commerce environment, and beer producers, especially the smaller ones, began to be more active on social networks. To increase the attractiveness of beer consumption, support activities were created, such as online tastings and webinars. In general, it is important to emphasize that Slovak consumption is characterized by a relatively high proportion of beers produced abroad, especially in the Czech Republic. Beer consumed by Slovak consumers is from four largest Slovak breweries - Heineken Slovakia, Plzeňský Prazdroj Slovakia, Steiger Brewery and Banskobystrický Brewery, which represent 99% of the production of the Slovak beer market (EY, 2018). In the context of the above, it is important to point out the support of the consumption of Slovak beer produced by craft breweries, which are characterized by higher quality and processing technology in relation to a sustainable approach. At first, Slovak consumers were looking for yeast beer, but nowadays they are also beer specialties, IPA, APA, Stout, or Porter. These beer styles may support the beer consumption in Slovakia. In the observed period 2003-2020, we described the trend of annual beer consumption in Slovakia using a quadratic function, which acquires the following parameters:

$$q_t = 89.248 - 2.4836 * t + 0.0869 * t^2 \qquad R^2 = 0.7925 \tag{4}$$

Based on the regression model, it can be stated that in the long term, beer consumption has a declining trend and with a view to the future, beer consumption may increase only slightly. Beer consumption can be determined primarily by the level and development of alcoholic beverage prices, while the intensity of consumer reaction to price changes depends on price elasticity of Slovak consumer demand, wine price, which is based on cross-elasticity analysis, substitution product (EY, 2018). In connection with current issues of sustainability, beers from craft breweries are required, which in the following years, due to their quality and taste, may support the consumption of Slovak beer.

Figure 8. Annual beer consumption in the Slovak Republic per capita (in l)



Source: own processing according to The Brewers of Europe

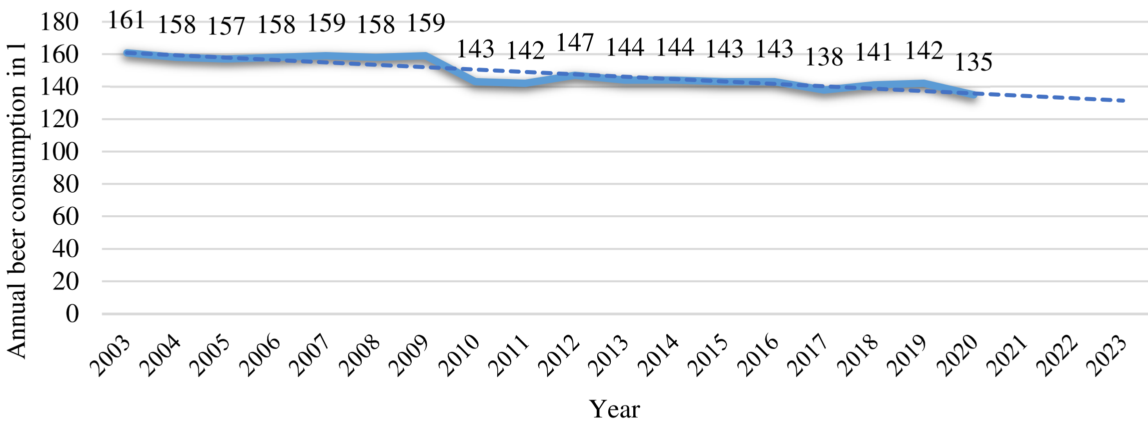
At present, Slovakia is ranked within the European countries as a country with an adequate level of beer consumption. However, the Czech Republic has the highest beer consumption per capita in Europe by consuming almost 140 liters per year, followed by Austria by consuming more than 100 liters per capita. For comparison, beer consumption in France is only about 30 liters. Within the V4 countries, Slovak consumers together with Hungarian consumers consume a relatively small amount of beer, as the current consumption of beer in these countries is below the level of 70 liters annually. Polish consumers consume more than 90 liters of beer annually, which places them in a relatively high manner of beer consumption. As the Czech Republic is the most important beer consumer in Europe, Czech consumers also show the highest beer consumption within the V4. In connection with the above, we present the development of beer consumption in the V4 countries in the period 2003-2020.

The Czech Republic has long been one of the countries with the highest beer consumption in the world. However, a gradual decrease in beer consumption was recorded in the observed period of years (Figure 2.) and the average decrease coefficient reached the level of 0.992182, which represents an average year-on-year decrease in consumption of 0.78%. In 2003, annual beer consumption per capita was recorded at a level of up to 161 liters. A relatively stable development was recorded until 2009. In 2010, beer consumption fell by more than 10% year-on-year, due to the economic and financial crisis, which negatively affected the global brewing market. The downward trend in consumption continued in 2011, but in 2012 the situation improved, and beer consumption increased to 147 liters. In 2020, the brewing industry and beer consumption were significantly determined by the COVID-19 pandemic. Epidemiological measures complicated the beer sales and consumption of beer, which was reflected in a year-on-year decrease of 9.5%. The decline in beer consumption was influenced by the cancellation of events, festivals, and the absence of tourism. Beer consumption reached the level of only 135 liters, which is at least since 1960 (The Associated Press, 2021). We have described the trend of beer consumption per capita in the Czech Republic using a linear function that acquires the following parameters:

$$q_t = 162.42 - 1.4716 * t \qquad R^2 = 0.8156 \qquad (5)$$

Based on the above regression model, it is possible to state a gradually declining trend in the observed period, which should continue in the next three years. In 2021 and 2022, the pandemic situation of COVID-19 persists, which may affect the level of beer consumption. As the Czech Republic is a country in which beer and brewing have a long tradition, the Czech brewing industry is going through a very difficult period. Consumption in the future may be significantly affected by rising input costs, shortages of raw materials and rising inflation, which will negatively affect the amount of beer produced in the Czech Republic, as well as consumer prices. Based on the above, a favorable situation in beer consumption is not expected for the following years. Craft breweries established in the Czech Republic, which produce beer from raw materials and in the traditional way, can support beer consumption.

Figure 9. Annual beer consumption in the Czech Republic per capita (in l)



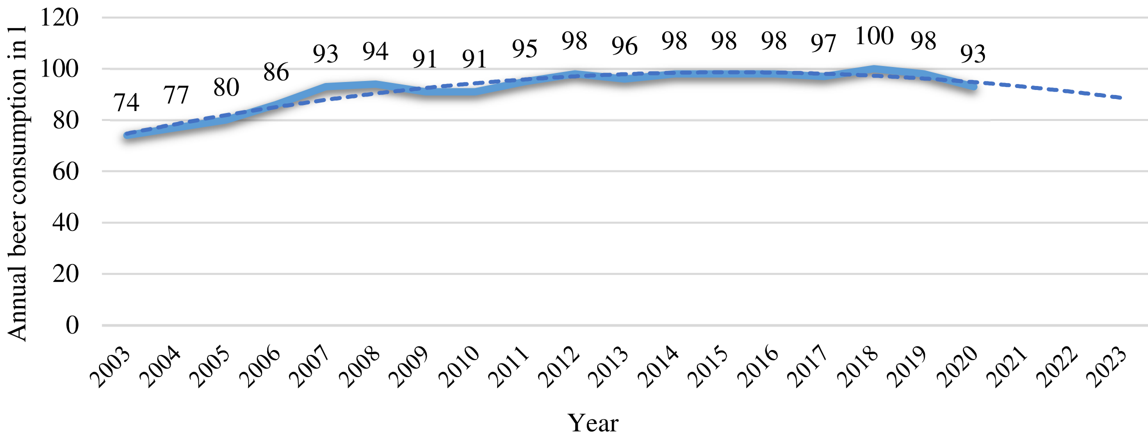
Source: own processing according to The Brewers of Europe

Compared to the Slovak Republic, Poland currently has a higher beer consumption and ranks among the countries with a relatively high beer consumption. In the past, Poland achieved a lower level of beer consumption compared to Slovakia, but the situation has changed in recent years. Based on data from The Brewers of Europe, we present the development of beer consumption in the years 2003-2020 (Figure 3.). Poland, as the only V4 country in the long run, shows a growing trend in beer consumption, and since 2003 there has been an average annual growth rate of up to 1.35% (k´ = 1.013534). In the first monitored year 2003, the annual beer consumption in Poland was recorded at a level of only 74 liters per capita. Since then, beer consumption has gradually increased, but in 2009 and 2010 a slight decline was recorded due to the economic and financial crisis. Subsequently, from 2012 to 2019, beer consumption among Polish consumers was at a stable level ranging from 95 to 100 liters per capita. The largest decline was recorded in 2020, when the COVID-19 pandemic hit the world. As in the other V4 countries, as well as in Poland, epidemiological measures and the limited consumption of beer in gastronomic establishments have caused beer consumption to fall to 93 liters per capita. We described the trend of beer consumption development in Poland using the quadratic function with the following parameters:

$$q_t = 70.532 + 4.2711 * t - 0.1626 * t^2 \qquad R^2 = 0.9213 \qquad \textbf{(6)}$$

Based on the regression model, we state a slightly growing trend in beer consumption, which should slow down in the next years and beer consumption should have a declining trend. This follows from the current pandemic situation, which negatively determines the production and consumption of beer. The production quantities of beer are also affected by the rise in energy prices and raw materials. However, it is also necessary to emphasize that a higher tax on alcoholic beverages in Poland may also be an important factor for beer consumption. On the other hand, the tax applies to alcohol up to 300 milliliters (KPMG, 2020), so it is possible that alcohol consumption, including beer, will increase and at least partially reduce the negative effects of the COVID-19 pandemic.

Figure 10. Annual beer consumption in the Poland per capita (in l)



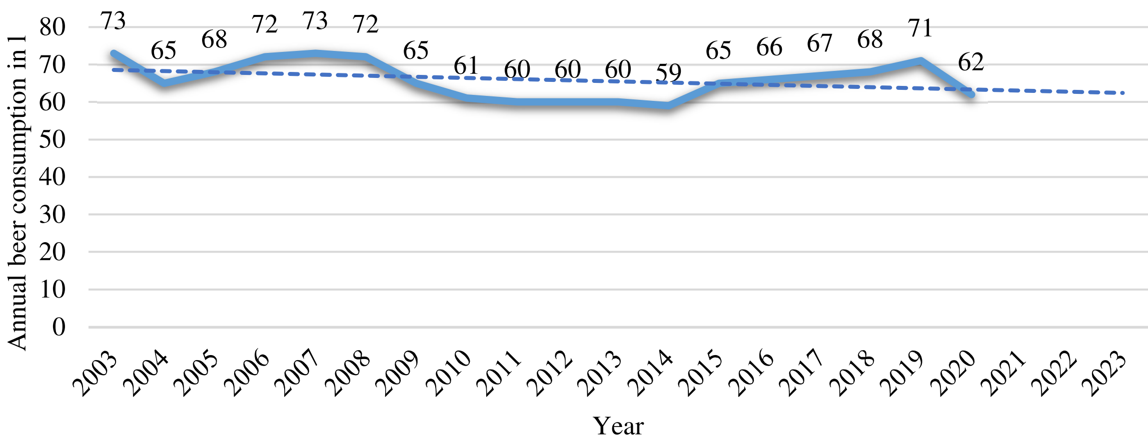
Source: own processing according to The Brewers of Europe

The last country within the V4 is Hungary, where beer consumption per capita is at the lowest level compared to Slovakia, the Czech Republic and Poland. This may be justified by a higher preference for wine. In the observed period of 2003-2020, the fluctuating development of beer consumption was recorded (Figure 4.), and the average annual decrease reached the level of up to 1.5% (k´ = 0.985326). A significant year-on-year decline of more than 10% was recorded in 2004, which may have been due to Hungary's accession to the European Union and the Hungarian beer market had to face new challenges. From the point of view of beer consumption, the adaptation to the existing trend was mainly a matter of maintaining a healthy lifestyle, and the need to consume beer with a lower alcohol content was emphasized. This may have been key to the decline in beer consumption, but no significant changes were expected (Major and Nótari, 2004). Since 2005, beer consumption has been gradually increasing and as light decline in beer consumption has been recorded during the economic and financial crisis, but the change has not been as significant as in the other V4 countries. In the years 2010 to 2014, beer consumption was relatively stable, approximately 60 liters per capita. From 2015 to 2019, a gradually increasing trend in beer consumption was recorded again, which was caused by an increased consumer preference for beer consumption over wine. However, the development situation changed in 2020 due to the ongoing pandemic situation. COVID-19 and epidemiological measures reduced beer consumption in Hungary by almost 13% year-on-year. To express the development trend of beer consumption in Hungary, the linear function was used with the following parameters:

$$q_t = 68.856 - 0.3065 * t \qquad R^2 = 0.1124 \tag{7}$$

Based on this regression function, beer consumption achieved a declining trend. Due to the low reliability of the model, it is not possible to accurately predict the development of beer consumption in Hungary. Beer consumption by Hungarian consumers can be determined primarily by consumer preferences. Another factor may be the price of beer, which is expected to grow given the rising raw material and energy prices. The Hungarian beer market can be positively affected by small breweries. The beer revolution hit Hungary as early as 2010 and new types of beers (IPA, APA, Stout, Wild ale, Session, Gose) began to be brewed, which are innovative beer products and thus pose a threat to existing brewing companies (Jantyik et al., 2021). Based on the above, it can be assumed that the new types of beers will become more consumed among Hungarian consumers and thus meet consumer expectations and taste requirements.

Figure 11. Annual beer consumption in the Hungary per capita (in l)



Source: own processing according to The Brewers of Europe

In terms of consumption, beer is considered the most consumed alcoholic beverage among Slovak consumers, which is confirmed by previous findings. For this reason, we focused on identifying beer consumers behavior using a questionnaire survey.

Beer is a popular drink among consumers and is one of the most widely consumed alcoholic beverages (Caon et al., 2021; Gómez-Corona et al., 2016; Kawa-Rygielska et al., 2019; Salanță et al., 2020). In our research, we dealt with the frequency of consumption. We concluded that up to 44% of consumers drink alcoholic beverages several times a week and 33% of consumers stated that they consume alcoholic beverages at least once a week. The results of the consumer survey further show that up to 71% of consumers consider beer to be their favorite alcoholic beverage, as evidenced by the amount of beer consumed by respondents, which is at the level of 2-3 dcl per day. We were also interested in the preference for the place of beer consumption. We found that 50% of Slovak consumers prefer beer consumption in a pub, bar. The research conducted by Lerro et al. (2020) reports a similar preference regarding the place of beer consumption. The second most preferred is drinking at home. 37% of respondents prefer drinking beer at home and only 3% of respondents prefer drinking beer in a restaurant.

We evaluated consumer preferences of beer consumers regarding types of beer (domestic craft beer, foreign craft beer, domestic industrial beer, foreign industrial beer). Consumers have expressed their preferences through the Likert scale (1-least preferred, 5-most preferred). Based on the results of the research, it can be stated that the most preferred among consumers is domestic craft beer. There are statistically significance differences in consumers' preferences when beer type evaluated and these results are confirmed by the Friedman test (p-value is less than the chosen significant level).

Using Nemenyi's method, we pointed out the differences in consumer preferences for the consumption of beer types (domestic craft, foreign craft, domestic industrial, foreign industrial). Based on the results shown in Table 2. we can state that domestic craft beer is the most preferred among consumers in our research sample (group C). Foreign craft beer is less preferred by consumers (group B) and domestic and foreign industrial beer are least preferred (group A).

Table 2. Multiple pairwise comparisons using Nemenyi's procedure

Preferences of beer types	**Sum of ranks**	**Mean of ranks**	**Groups**		
Foreign industrial beer	1127.000	2.139	A		
Domestic industrial beer	1175.000	2.230	A		
Foreign craft beer	1416.000	2.687		B	
Domestic craft beer	1552.000	2.945			C

Source: own processing

Using non-parametric tests, we determined the statistically significant differences consumers' preferences of beer types according to selected demographic characteristics. By evaluating the results of the consumer survey, we identified statistically significant differences in consumer preferences according to all selected demographic characteristics (Table 3.). We have found that men prefer domestic and foreign craft beer more than women. Such findings have been identified in several studies (Gómez-Corona et al. 2016, Graefe, D.A. & Graefe, A.R. 2021). However, according to Watson (2014), the consumption of craft beer is growing among young women. Another finding was, that respondents who perform mental work have a greater preference for consuming craft beer than respondents who perform physical work. Parenthood has statistically significant impact on the consumer preferences related to beer consumption. Childless respondents prefer industrial beer more than those who have children. This may be due to the lifestyle which usually change after parenthood. The research found that consumer preferences are influenced by age. Industrial beer is most preferred by young consumers under 25 years, as they usually have lower incomes and therefore prefer beer from a lower price range. This may also be due to the fact that they have not yet gained enough experience and have not developed a preference for consuming craft beer, which is specific in its taste or aroma. The highest preference for domestic and foreign craft beer was recorded among respondents from 26 to 40 years old. The reason may be that this group of respondents follows trends in the beer market, travels abroad, where they taste various types of craft beer and also look for them in Slovakia. Statistical differences in the frequency of beer consumption were found for all types of beer. Consumers who consume beer more often may be able to better assess the quality and taste of beer and therefore show a greater preference for craft beer, which is more diverse in taste and aroma than industrial beer. We found that consumer preferences are also influenced by income. Consumers with lower income prefer to consume domestic industrial beer. This may be because the price of industrial beer is lower compared to the price of craft beer. This is also confirmed by findings, which point to the fact that consumers with higher incomes tend to drink craft beer.

Table 3. Results of Kruskal-Wallis and Mann-Whitney tests to test the differences between consumer preferences and demographic characteristics

Type of non-parametric test	Demographic characteristics	p-value			
		Domestic industrial beer	**Foreign industrial beer**	**Domestic craft beer**	**Foreign craft beer**
Kruskal-Wallis H	Age	**0.011**	**0.014**	**<0.001**	**<0.001**
	Frequency of consumption	**0.002**	**0.050**	**<0.001**	**<0.001**
	Gross monthly income	**0.002**	**0.047**	**<0.001**	**<0.001**
Mann-Whitney U	Gender	0.199	0.310	**<0.001**	**<0.001**
	Type of work	0.206	0.166	**<0.001**	**<0.001**
	Parenthood	**0.035**	**0.005**	0.202	0.733

Source: own processing

Based on the previous findings, it can be stated that craft beer is the most preferred by Slovak consumers, and for this reason we have focused our research on the preferences of craft beer consumers.

The results showed that craft beer is consumed by more than 65% of Slovak consumers who participated in the consumer survey and its popularity is gradually growing. However, the fact that craft beer is preferred by consumers in our sample does not mean that consumers no longer consume other types of beer. Because more than 90% of consumers stated, that taste is the most important factor when purchasing beer, we focused on identifying the preferences of beer styles.

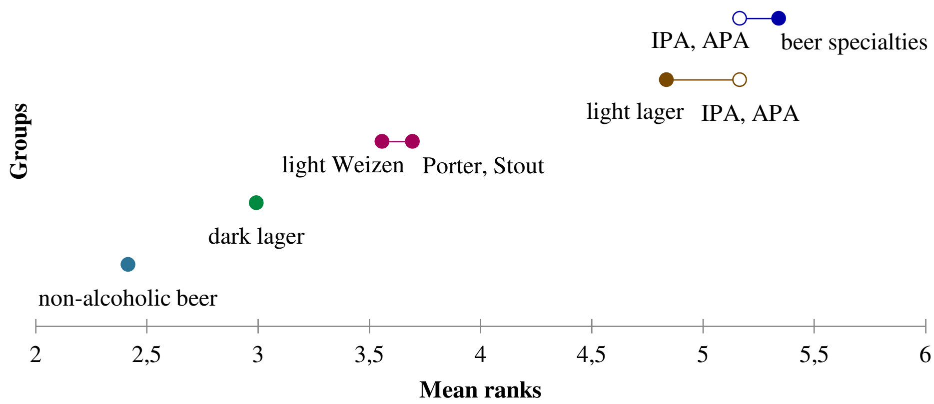
Craft beer consumers expressed their preferences for consuming various beer styles (Light Lager, Dark Lager, IPA, APA, Porter, Stout, Light Weizen, Beer Specialties, Non-alcoholic beer) through the Likert scale (1-least preferred, 5-most preferred). Research has shown that IPA, APA, beer specialties and Light Lager are the most preferred among craft beer consumers. We also confirmed this with the non-parametric Friedman test, on the basis of which we identified statistically significance differences in consumer preferences between beer styles (p-value is less than the chosen significant level). Subsequently, using the Nemenyi's method, we pointed out the specification of differences in the preference for consumption of beer styles. Based on the results shown in Table 4. we can state that beer specialties, IPA, APA and Light Lager are the most preferred from beer styles (groups D, E). Compared to groups D and E, group C, which includes Light Weizen, Porter, Stout, is less preferred. The least preferred beer are non-alcoholic beers and Dark Lager (groups A, B). The consumer preferences are also shown by the Demsar plot (Figure 5).

Table 4. Multiple pairwise comparisons using Nemenyi's procedure

Preferences of beer styles	Sum of ranks	Mean of ranks	Groups				
Non-alcoholic beer	814.000	2.415	A				
Dark Lager	100.500	2.993		B			
Light Weizen	1199.000	3.558			C		
Porter, Stout	1245.000	3.694			C		
Light Lager	1629.500	4.835				D	
India Pale Ale, American Pale Ale	1740.500	5.165				D	E
Beer specialties	1799.500	5.340					E

Source: own processing

Figure 12. Demsar plot



Source: own processing

In the research, we further examine the existence of statistically significant differences in the preferences of craft beer consumers, focusing on beer styles such as Light and Dark Lager, India Pale Ale and American Pale Ale, Porter, Stout, Light Weizen, beer specialties and non-alcoholic beer. Using appropriate statistical methods, we found that in our sample there are no statistically significant differences in the preferences of beer styles among craft beer consumers according to age, income, type of work. However, we found statistically significant differences in issues regarding gender, parenthood, and frequency of consumption (Table 5.).

Table 5. Results of Kruskal-Wallis and Mann-Whitney tests to test the differences between craft consumer preferences and demographic characteristics

Type of non-parametric test	Demographic characteristics	p-value						
		Light Lager	Dark Lager	IPA, APA	Porter, Stout	Light Weizen	Beer Specialties	Non-alcoholic beer
Kruskal-Wallis H	Age	0.418	0.101	0.148	0.396	0.943	0.377	0.218
	Frequency of consumption	0.967	0.558	**0.003**	**0.017**	0.677	0.161	0.430
	Gross monthly income	0.765	0.734	0.481	0.800	0.667	0.420	0.899
Mann-Whitney U	Gender	**0.008**	0.933	0.578	0.076	0.555	**0.010**	0.594
	Type of work	0.167	0.121	0.110	0.213	0.396	0.393	0.511
	Parenthood	0.800	0.186	0.174	0.892	0.263	**0.049**	**0.028**

Source: own processing

4. Conclusion

Recently, there is an increasing emphasis on environmental aspects and sustainability in several economic areas, and brewing sector is no exception. It is necessary to support the consumption of craft beer, which is becoming increasingly popular among consumers and can also contribute to the sustainability of the sector. The aim of the paper was to evaluate the development of beer consumption in the V4 countries for the period 2003-2020 and to identify consumer preferences in beer consumption in the Slovak Republic with an emphasis on craft beer. Based on the results, we can state that beer consumption per capita in the countries of the Visegrád Group had a declining trend in 2020 compared to 2019. Decrease of beer consumption may have been caused by a COVID-19 pandemic. The ongoing pandemic may affect the beer market in the future. Despite the negative factors affecting the brewing sector, beer is the most consumed beverage among Slovak consumers. In the recent years, the beer industry has been influenced by changes in consumer preferences related to exploring new tastes. We can confirm this statement with the results of our research, in which we found that domestic craft beer is the most preferred type of beer, which differs from industrial beer in taste, ingredients used, but also brewing methods and production volume. Taste was considered the most important factor affecting purchasing of beer and the most preferred beer styles are beer specialties, India Pale Ale, American Pale Ale, and Light Lager. Based on the results, breweries should reflect the requirements of the market and should focus on brewing the above-mentioned beer styles regarding the taste preferences of consumers. The limitation of the research is the fact that the questionnaire survey was carried out only on the territory of the Slovak Republic. In the future research, it would be appropriate to extend the scope of research to the V4 countries and compare consumer behavior in the beer market. It is also important to focus on consumer attitudes towards sustainability in the brewing sector, which is a current topic.

Acknowledgements

This publication was supported by the Operational Program Integrated Infrastructure within the project: Demand-driven Research for the Sustainable and Innovative Food, Drive4SIFood 313011V336, cofinanced by the European Regional Development Fund.

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INSTAGRAM ANALYSIS OF GREEN DEAL COMMUNICATION

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Annotation: This paper aims to identify the main topics of communication related to the Green Deal based on a social media analysis on the Instagram social network. Based on the imported data, from 23 316 posts of 9 284 unique users, 6,014 unique hashtags were identified, which are connected via 82,679 connections. We have identified 7 most important hashtags on the grounds of the values of frequency and eigenvector centrality: 1) #sustainability 2) #climatechange 3) #environment 4) #innovation 5) #circulareconomy 6) #renewableenergy, 7) #greenwashing. Using community analysis, it is possible to recognize 3 main cluters 1) Environment sustainability 2) Renewable energy and 3) Agriculture. This research describe the key areas that are communicated on the social media (Instagram), which is a key factor in understanding people's and organization interests in the context of the various elements of the EU Green Deal and on the other hand offers the comprehension of the topics that are communicated which affects public perception of the Green Deal.

Keywords: Green Deal, Social media analysis, Sustainability, Environment, Renewable energy, Agriculture

JEL classification: Q13, Q15, O13

1. Introduction

The European Green deal is tailored to deal with problems encountered in the environment (Commision, 2019). The aim of the European Green Deal is not only to secure climate protection, but also the climate-neutral transition (Aszódi *et al.*, 2021). It is a program that was launched and is run by a body based in Europe, with the primary goal being to ensure that the European Union will be climate neutral by 2050 (Johnson *et al.*, 2021). The program is driven by a need to protect the environment from any harmful production and to suggest better ways of doing things to save our surroundings in every industry as well as agriculture (Keenor *et al.*, 2021; Fayet *et al.*, 2022). Several studies have been conducted to bring out the available feedback regarding the Green deal and green transitions within Europe (Knodt and Ringel, 2019; Aszódi *et al.*, 2021; Fayet *et al.*, 2022).

The European Commission introduced the program in 2019, and all its mechanisms are channeled into making the environment better (Commision, 2019). Its operations are based on Europe's journey regarding the harmful products released to the environment and towards changes within global economies (Buckley *et al.*, 2021). The program plans to reduce the greenhouse gas emission to the surroundings by fifty percent and seeks to improve it to even higher percentages (Wolf *et al.*, 2021). All the existing policies are to be reviewed to verify whether they have a benefit to the climate or not. Generally, through the Green Deal, Europe might achieve greater heights in its climatic conditions standards and value for the environment (Aszódi *et al.*, 2021).

The European Green Deal is focused on making Europe an example to other nations around the globe as a global leader in climate and environmental measures, social protection and workers' rights (Commision, 2019). One of the initial plans is to cooperate with other nations that rely on fuels from fossils in phasing out fossil fuel subsidies by virtue of an agreed methodology and as well monitoring and reporting its progress (European Commission, 2022). All countries need a transition to renewable energy sources to protect the climate and achieving such goals will represent economic, social and industrial changes of a fundamental nature, which have not yet taken place in recent history (Schuelke-Leech, 2021). Among the areas that the deal has looked into are farming, building renovations, and biodiversity (Bonfante, Basile & Bouma, 2020). The green value is an appropriate move that Europe has taken to achieve its climate and environmental goals as the green values are already in the research concerns (White, Habib and Hardisty, 2019; Tan *et al.*, 2022). It is rooted in the belief that economies can still grow without increasing the usage of resources by producing and consuming less within the transition to sustainability (Robbins, 2020). However, this is disputed by critical studies claiming that the Green Deals worldwide have narrow focus on technologies by which humans can benefit but with lack of concerns to socio-ecological costs of these technologies (Dunlap & Larrate, 2022).

Toward the end of 2020, the Green deal planning committee released its plan for a clean energy and green surroundings in the years to come (Krämer, 2020). With its strategic approach intended for power scheme incorporation serving as a basis, the EU hopes to attain a more rounded energy scheme while increasing direct electrification and the development of clean fuels such as hydrogen (Fleming and Mauger, 2021). However, the success of the scheme depends, among other things, on financial security, where, according to some authors, should be a noticeable shift in the redistribution of public funds to renewables and energy efficiency from hydrocarbons (Siddi, 2020). The program is therefore well structured to ensure that Europe grows to a higher level in its climatic standards (Fleming and Mauger, 2021). As mentioned in the previous studies (Siddi, 2020), the European Green Deal has a potential to make a significant difference to the European Union's economy as a whole, and the long-term perspective must be taken into account, especially in terms of climate, and could change the direction of financial measures and the use of funds (Sikora, 2021).

The integrated resource industrial policy initiation has already been a part of the EU's environmental objectives since 2010 (European Commission, 2010). In March 2020 European Commision unveiled its industrial strategy to sanction people, revive areas, and develop the most advanced knowledge that are based on the environmental objectives' backgrounds. The modernization of industries and the discovery and formation of "climate neutral" sustainable industrial friendly products markets, which means the transition to green and digital economy, that will enable EU industry to be globally more competitive (European Commission, 2021). Decarbonization, modernization within the agriculture are also parts of this effort (Fayet *et al.*, 2022). The political ecology that the European Green Deal is, in essence, should help to overcome the socio-environmental problems of the current global environment with high energy consumption and at the same time a small workforce in agriculture towards a better future in this area (Robbins, 2020) It as a response to the current needs of farmers within European Union, moreover it fosters a sustainable agricultural sector which might be competitive while contributing significantly to the European Green Deal (Rep, 2021).

In addition, there is also an emerging autonomous product policy focused on waste reduction (European Commission, 2020a). By supporting such a policy, the reusability of products and the efficiency of recycling efforts can be raised as well as the integrated reporting system that will help waste registries within the EU countries (Sileryte *et al.*, 2022). Many materials are being evaluated at length to ensure that all the intended plans are all met; textiles, buildings, automobiles, batteries, and computer electronics, to list a few, are some of the primary materials that the policy looks into (European Commission, 2020b). As a result, the European Union will re-examine its policies regarding waste shipping and illegal exports. The EU is aware of a fact, that that it must cease outsourcing its unused materials (European Commission, 2020b).

The study of Ringel, Bruch & Knodt (2021) introduced the concerns of stakeholders in terms of clean energy as a part of the European Green Deal. In particular, this study highlights the fact that stakeholders are cautious about a soft governance in the clean energy package and prefer a more binding governance (Ringel, Bruch and Knodt, 2021).

Social media analysis

Social media has become a common part of many people's lives (Pilař, Stanislavská, *et al.*, 2021). Currently, on social media is 4.65 billion people, of which 4.15 billion use a mobile phone to access a particular social media platform (Statista Research Department, 2022). In comparison with a total population of the planet (7.95 billion people), about 50% of the population has access to social media from all places where there is access to the Internet. Social media is therefore used during most of the residents' daily activities, such as hygiene, travel, work/school, shopping, food consumption and leisure activities. Based on this behavior on social media, users of this platform create a huge active and passive digital footprint. This digital footprint creates the potential for researchers to identify the views, attitudes, and experiences that individual users of social networks leave on these platforms.

2. Materials and Methods

The data analysis was based on the Knowledge Discovery in Databases process and was modified to the requirements of social media data analysis with a focus on hashtags research. For this purposes, SMAHR Framework was used (Pilař, Kvasničková Stanislavská, *et al.*, 2021). Hashtag analysis has already been used successfully in the areas of healthy food (Pilař, Kvasničková Stanislavská and Kvasnička, 2021; Pilař, Stanislavská, *et al.*, 2021), Covid communication (Sabou *et al.*, 2021), Farmers' Markets (Pilař *et al.*, 2017). The data analysis process consisted of five main steps:

1) Data collection - the Instagram Scraper was used to obtain posts from communications on the Instagram social network (Gorichanaz, 2021). The software captured posts that used the hashtag #greendeal. A hashtag is a specific part of the message text that begins with a "#" character. In social media, a hashtag has two primary functions; firstly, to filter posts, where social media algorithms display an archive of messages related to this hashtag (topic) according to a selected hashtag. The second function of hashtags is a tool to express experience, attitudes, opinions, and values via social media in areas that a user wants to highlight on social media. For example, to highlight that the strawberries which users put on social media are organic through the hashtag #organic. 23 316 posts from 9 284 unique users were captured. This dataset contains all messages that contained the hashtag #greendeal, which users sent to the Instagram social network. It is 70.1% of all Instagram social network posts that contain this hashtag.

2) Content filtration: all words that were not preceded by the hashtag symbol ("#") were removed as our analysis only focused on hashtags. This led to a dataset that consisted purely of hashtags (i.e., words beginning with the symbol #).

3) Content transformation: text was transformed based on the SNAFR framework (transformed into lower-case letters, hashtag reducing based on degree value) etc.

4) Data mining - the following methods were used to describe the network:

(1) Degree centrality - the number of links incident upon a node (hashtag).

(2) Eigenvector centrality – this is an extension of degree centrality, which measures the influence of hashtags in a network. Eigenvector centrality is calculated based on the premise that connections to hashtags with high values of degree centrality values have a more significant influence than links with hashtags of similar or lower values of degree centrality values.

Eigenvector centrality was calculated as follows:

$$x_v = \frac{1}{\lambda}\sum_{t\in M(v)} \quad x_t = \frac{1}{\lambda}\sum_{t\in G} \quad a_{v,t}x_t, \tag{1}$$

where $M(v)$ denotes a set of adjacent nodes and λ is the largest eigenvalue. Eigenvector x can be expressed by Equation (2):

$$Ax = \lambda x. \tag{2}$$

(3) Modularity and community analysis - modularity represents an index that identifies the cohesion of communities within a given network (Newman and Girvan, 2004). The purpose is to identify hashtags communities that are mutually interconnected to a greater degree than other hashtags. Networks with a high modularity show strong links between hashtags inside the community and weaker links between hashtags in other communities (Knoke and Yang, 2008).

5) Knowledge representation - a procedure that uses visualization tools to represent the results of data mining. Knowledge representation is based on the synthesis of individual values and outputs from the data evaluation phase.

3. Results and discussion

Based on the imported data, 6,014 unique hashtags were identified, which are connected via 82,679 connections. According to the eigenvector centrality, the 7 most important hashtags were identified: 1)#sustainability 2)#climatechange 3)#environment 4)#innovation 5) #circulareconomy 6) #renewableenergy, 7) #greenwashing see table 1.

Table 1.

No.	Hashstag	EVC	Degree	No.	Hashstag	EVC	Degree
1	#greendeal	1	6013	11	#europe	0,098553	405
2	#sustainability	0,242371	1072	12	#innovation	0,094408	372
3	#eu	0,178655	813	13	#circulareconomy	0,093361	366
4	#climatechange	0,177785	756	14	#renewableenergy	0,087612	332

5	#green	0,150282	630	15	#ecofriendly	0,086122	317
6	#eugreendeal	0,145199	604	16	#sostenibilit	0,085245	335
7	#environment	0,12468	463	17	#greenwashing	0,085148	316
8	#europa	0,115123	506	18	#climatecrisis	0,083357	300
9	#sustainable	0,111765	439	19	#nachhaltigkeit	0,076072	326
10	#ambiente	0,098804	409	20	#climateaction	0,07142	230

Source: Own processing based on Instagram data

The #sustainability hashtag comes first in terms of eigenvector centrality values. According to the subsequent analysis of connection values through Weight value, it is possible to identify two main areas that relate to #sustainability hashtag. Sustainability in the context of the environment through climate and sustainability of fashion. Environmental sustainability is one of the main themes of Green Deal (Cordella and Sala, 2022) and the field of fashion is typical of the social network Instagram, where sustainable fashion is one of the main topic (Lee and Weder, 2021).

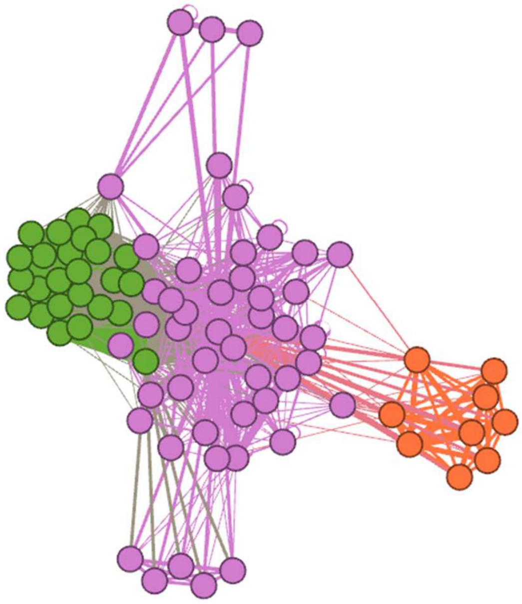
The second and third areas are highly related. This is an area of climate change and environment. It is mainly the impact of climate change on the environment through the activities of both people and companies (Barry and Hoyne, 2021). This is followed by the hashtag #innovation, through which information about innovations is disseminated on the Instagram social network. Based on the weight value, it is possible to identify that the most important is the communication of innovations in the connection of climate change and energy areas. This means innovations in the field of energy that affect the climate change.

The fifth area is identified by the hashtag #circulareconomy, which according to weight values, is most connected with the area of biodiversity, architecture, and agriculture. In the area of biodiversity and agriculture, it mainly concerns protecting soil biodiversity (Köninger *et al.*, 2022) and in the field of architecture about reducing global greenhouse gas emissions (GHC), where construction and real estate are responsible for 40% of GHC worldwide (Larsen *et al.*, 2022). The sixth area is renewable energy, which is the central point of policy action that supports both renewable energy and energy efficiency. The settlement area is green washing, which is an area that can be defined as "making sustainability claims to cover a questionable environmental record" (Watson, 2016). This space is most closely associated with climate change on the Instagram social network, where the authors of the articles try to convince others of the controversial impact of the Green Deal on Climate change.

Based on community analysis, it is possible to identify three main areas: 1) environment sustainability 2) renewable energy and 3) agriculture.

No.	Color (figure 1)	Community	Selected hashtags
1	Purple	Environment sustainability	#sustainability, #environment, #climatechange
2	Green	Renewable energy	#renewableenergy, #greenenergy, #energytransition, #energy
3	Orange	Agriculture	#agriculture, #agricultureandfarming, #agriculturetechnology

Figure 1. Community polarization



Source: Own calculating

4. Conclusion

Based on the imported data, 6,014 unique hashtags were identified, which are connected via 82,679 connections. Based on the values of frequency and eigenvector centrality, the 7 most important hashtags were identified: 1) #sustainability 2) #climatechange 3) #environment 4) #innovation 5) #circulareconomy 6) #renewableenergy, 7) #greenwashing. Based on community analysis, it is possible to identify 1) environment sustainability 2) renewable energy and 3) agriculture.

This results are important in area of understanding people's interests in the context of the various elements of the EU Green Deal.

Acknowledgements

This study was supported by the Internal Grant Agency (IGA) of FEM CULS in Prague, registration no. 2020B0004—Use of artificial intelligence to predict communication on social networks.

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THE FUTURE OF MEAT CONSUMPTION AND CONSUMER PERCEPTION OF MEAT SUBSTITUTES

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Annotation: The paper is based on the issues currently discussed in the food market regarding sustainable development from the perspective of climate change as well as changing eating habits of consumers toward sustainable consumption. One of the most discussed topics is meat consumption and its impact on the environment. The aim of the paper is to evaluate the current trends in meat consumption, as well as to point out possible dietary alternatives in order to reduce meat consumption in the future. The aim of the paper was achieved by using and processing secondary and primary data. Secondary data were obtained by statistical offices of Slovakia and the Czech Republic, and they became the basis for examining the development of the consumption trend. The consumption trend was described by regression functions and forecasted until 2023. Primary data were obtained by questionnaire survey conducted using snowball sampling method in Slovakia (n = 733 respondents). The following statistical methods were used to evaluate the data: Chi-square test for independence, Kruskal-Wallis H test, Mann-Whitney U test, Friedman test, as well as categorical principal component analysis. The results show that the trend of future meat consumption will have an increasing tendency in Slovakia and the Czech Republic which follows from the fact that in recent years meat consumption is constantly growing and currently in both countries is at the level of more than 70 kg per capita and year. Meat consumption is highly excessive, and it is desirable to eliminate it due to the negative impact of meat production and consumption to the environment. Following the above, the results of the questionnaire survey show that future meat consumption can be affected by food scandals, meat adulteration, animal welfare, animal diseases, as well as lifestyle changes and meat substitutes consumption. The results show that plant substitutes (soy and tofu) are well known and the most consumed by consumers. Edible insects are also known among Slovak consumers, but their consumption is not preferred. On the other hand, meat substitutes such as seitan, robi, klaso and tempeh are not widely known among Slovak consumers. Moreover, consumers' eating habits have the most significant impact on meat substitutes consumption in the future. In connection with current trends in meat market, it is desirable to appeal to the experts and researchers in the field of public health as well as to food companies and deal with the issues of future meat consumption. We also propose for Slovak consumers to begin to develop eating habits toward meat substitutes regarding sustainability and environmental protection.

Keywords: Consumer, Future consumption, Meat, Meat substitutes

JEL classification: M31, M39, Q13

1. Introduction

The agro-sector consumes a significant amount of natural resources, such as land, water or energy. The population is expected to grow by almost 30% by 2050 and agriculture will be under enormous pressure due to growing food demand by up to 60%. (FAO, 2021; Acosta-Alba et al., 2019; Akhigbe et al., 2021). In the context of sustainability, the environment and reducing the negative impacts of greenhouse gases, a European Green Deal has been set up and its aim is to make Europe the first climate-neutral continent by 2050. This deal emphasizes a sustainable and inclusive growth strategy to revitalize the economy as well as improve people's health and quality of life (European Commission, 2019). One of the currently most discussed food groups is meat. Higher demand for meat consumption is expected and its production and consumption can have a significant negative impact on sustainable development in terms of climate change (Godfray et al., 2018). In accordance with the aim of the European Green Deal, there is emphasized the need to reduce meat consumption (Stubbs et al., 2018), mainly due to greenhouse gas emissions from livestock (Barthelmie, 2022).

Despite the need to reduce meat consumption in the future, it is important to emphasize that meat is considered one of the staple foods in human nutrition. Moreover, meat is highly nutritious, and it is a source of nutrients that is almost impossible to obtain in the right amount from other food groups (Geiker et al., 2021). This is justified by the fact that meat contains vitamins and minerals, as well as all the essential amino acids, making it an excellent source of protein. Consumption of meat protein has a positive effect on body composition and muscle strength. The most important minerals are iron, zinc, selenium, or phosphorus. Meat, especially red, is a rich source of easily absorbed iron and has a positive effect on hemoglobin production. Foods of animal origin, including meat, are the only non-fermented foods that naturally provide vitamin B12. Meat consumption has positive effects on consumer health, e.g. improving the overall health of the consumer, protecting the consumer from infections, supporting the immune system, supporting cognitive and psychomotor processes, supporting the central nervous system, supporting mental health and many other benefits (Geiker et al., 2021; Wyness, 2011; Tieland et al., 2012; Hathwar et al, 2012; Valenzuela et al., 2019).

Globally increasing meat consumption is influenced by population growth and increasing average individual incomes, and it is necessary to reduce meat consumption (Godfray et al., 2018). Excessive meat consumption can have a negative impact on the health of consumers. It is necessary to emphasize that long-term excessive meat consumption, especially red and processed meat, together with other factors such as age, race, BMI, anamnesis, smoking, blood pressure, lipids, physical activity, and several nutritional parameters are included in the multivariate analysis. This combination of factors can cause consumer health problems (Battaglia Richi et al., 2015) However, excessive meat consumption may increase the risk of chronic diseases, cardiovascular disease, colon cancer, metabolic syndrome, obesity, diabetes, high blood pressure or stroke (Salter et al., 2018; McNeil and Van Elswyk, 2012; Wolk, 2017; Biesalski, 2005). Health risks are also caused by the consumption of processed meat and processing techniques include salting, curing, cooking, fermentation, or smoking to improve color, flavor, and shelf-life (Sych et al., 2019; Händel et al., 2021). Future demand for meat can also be significantly affected by meat adulteration. In recent years, meat adulteration has become a problem (Rahmati et al., 2016). Meat adulteration, especially for economic purposes, is widespread and leads to serious risks to public health, such as exposure to toxins, pathogens, or allergens in these products (Čapla et al., 2020). Adulteration relates to the meat origin, the replacement of the meat by other ingredients, non-compliance with the declared quantities, the type of processing and the addition of unmixed ingredients such as water, flour, salt (Dooley et al., 2004; Ballin, 2010). Recently, the negative effects of meat production and consumption on the environment have been increasingly discussed, which may significantly affect meat consumption in the future. The livestock production, meat production and transport produce a relatively large amount of greenhouse gas emissions and meat sector belongs to the largest producers of greenhouse gases (Malý et al., 2017; Šrédl et al., 2021). Steinfeld (2006) further emphasizes that livestock production is responsible for the destruction of forests that are burned in order to obtain pastures, as well as for soil degradation. Greenhouse gas emissions are also due to animal waste and crop production, which later serves as livestock feed (Weidema and Wesnaes, 2008). Meat production has a high influence on climate change with an emphasis on global warming. Livestock production has a very high level of water consumption, which is confirmed by the fact that water footprints are estimated at the level of 15,000 liters per kg of beef, approximately 6,000 liters per kg of pork and 4,300 liters per kg of poultry (FAO, 2020).

Based on the above and key objectives of the Europe Green Deal, it is necessary to reduce meat consumption and at least partially replace it with other alternative foods. Vegetarian and vegan meat substitutes can significantly affect the meat market. It is probable and desirable that the consumption of meat and meat products be partially replaced, e.g. soy protein-based products, such as tempeh, tofu, soy meat, or plant-based substitutes, legume substitutes. These foods are characterized by lower fat content, the absence of cholesterol and the content of unsaturated fatty acids (Hoek et al., 2011). Another alternative to meat is the consumption of edible insects or products containing insect flour. The use of insects as food seems to be a good opportunity, as it exerts less pressure on natural resources and contributes to lower emissions of greenhouse gases (de Carvalho, 2019). In addition, insects contain large amounts of high-quality and highly digestible proteins and unsaturated fats, as well as vitamins, minerals and other bioactive compounds (Tang et al., 2019). In the context of the above, it can be stated that consumer insects meet the quality requirements for nutrition. Despite this fact, consumer acceptability is still low. The reason is mainly psychological barriers, entomophobia or emotional factors (Abdullahi et al., 2021; Pascucci and Magistris, 2013). Another dietary alternative is cultured meat (also called in vitro, or laboratory-grown meat). This alternative is suitable for consumers who want to be more responsible but do not want to change their eating habits (Chriki and Hocquette, 2020). Meat grown from animal cells has the potential to solve many of the moral, environmental, and public health problems associated with conventional meat production (Bryant, 2020). Consumer acceptance of cultivated meat is expected to be influenced by various factors, e.g. processing technology, product expectations, media influence to promote consumption, or trust in science, politics, and society (Verbeke et al al, 2015).

Following the current situation on the meat market and the objectives of the European Green Deal, it is necessary to reduce meat consumption in the future and to focus on meat substitutes consumption. The aim of the paper is to point out the development of meat consumption in the Slovak and Czech Republic, identify key factors determining future meat consumption and explore the consumer perception of meat substitutes with emphasis on their possible consumption. Therefore, research paper tries to answer the following research questions:
RQ 1. Which factors are key ones for elimination of future meat consumption?
RQ 2. What are the attitudes of consumers towards meat substitutes with an emphasis on consumer awareness and consumption?

2. Materials and Methods

The aim of the paper was achieved by using and processing secondary data, which were obtained by statistical offices of the Slovak Republic and the Czech Republic. The purpose was to point out the development of meat consumption in the Slovak Republic and the Czech Republic. For processing data mathematical methods and calculation of the coefficient $\overline{k}$ were also used.

$$k = \sqrt[n-1]{k_2 * k_3 * \ldots . k_n} \quad (1)$$

These data also became the basis for examining the development of the consumption trend. The consumption trend was described by following regression functions and forecasted until 2022:

Quadratic function is expressed by formula:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i{}^2 + \varepsilon_i \qquad i=1,2,\ldots,n \quad (2)$$

Cubic function is expressed by formula:

$$y_i = \beta_0 + \beta_1 x_i + \beta_2 x_i{}^2 + \beta_3 x_i{}^3 + \varepsilon_i \qquad i=1,2,\ldots,n \quad (3)$$

where y_i – i-th observed value of the explained variable; β_0, β_1 – unknown parameters of the regression model, x_1 – i-th value of the explanatory variable, ε_i – number of observations.

The paper also focused on identifying factors that may affect the reduction of meat consumption with a view to the future. The ambition of the paper was to identify consumer perceptions of meat analogues, which may play an important role in consumer nutrition in the future. The above was examined based on a questionnaire survey and the obtained primary data contributed to the fulfillment of the aim of the paper. The questionnaire survey was conducted in the Slovak Republic in 2021 in an electronic version and the survey was conducted by the snowball sampling method and was attended by 733 respondents. Respondents involved in the questionnaire survey were divided into eight categories (Table 1).

Table 1. Distribution of respondents in terms of demographic characteristics

Gender			**Residence**		
Man	260	35.5%	City	348	47.5%
Woman	473	64.5%	Rural area	385	52.5%
Age			**Education**		
18-25 years	353	48.2%	Elementary	28	3.8%
26-45 years	230	31.4%	Secondary	317	43.2%
More than 45 years	150	20.5%	Higher education	388	52.9%
Number of members in household			**Economic activity**		
1	25	3.4%	Employed	312	42.6%
2	154	21.0%	Student	303	41.3%
3	205	28.0%	Self-employed	47	6.4%
4	257	35.1%	Unemployed	14	1.9%
5	65	8.9%	Retired	23	3.1%
6	21	2.9%	Maternity leave	23	3.1%
More than 6	6	0.8%	Other	11	1.5%
Monthly income of respondent			**Monthly income of household**		
Up to 500 €	313	42.7%	Up to 1,000 €	83	11.3%
501-1,000 €	242	33.0%	1,001-2,000 €	366	49.9%
1,001-1,500 €	133	18.1%	2,001-3,000 €	194	26.5%
1,501-2,000 €	30	4.1%	3,001-4,000 €	58	7.9%
More than 2001€	15	2.0%	More than 4001€	32	4.4%

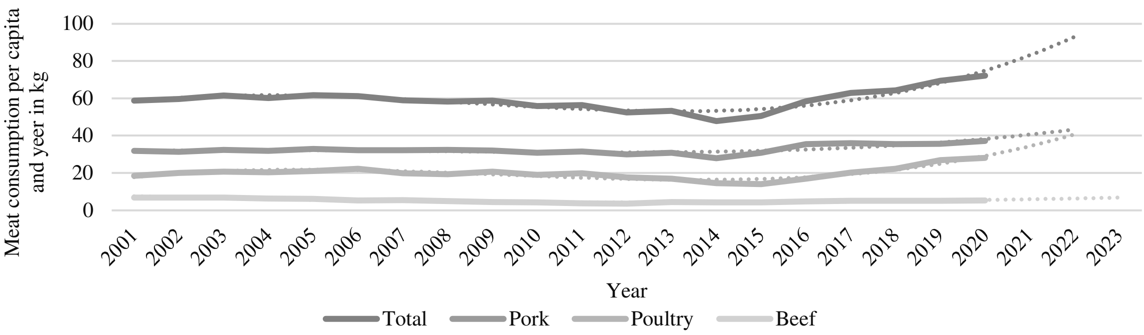
Source: questionnaire survey, 2021

The collected data were processed by using Microsoft Excel and evaluated in the statistical programs IBM SPSS and XLStat. Consumer survey was oriented on the factors related to the elimination of meat consumption. The factor analysis was based on a 11-item factors, which were evaluated by consumers at the scale from 1 to 5, where 1 represents the most important factor and 5 represents the least important factor. The following factors were evaluated: practices in traditional meat production, food scandals, composition (antibiotics, emulsifiers, water content, salt content), meat adulteration, poor animal welfare, animal diseases, insufficient meat supply, claims that meat is harmful to the human body, consumers will be more environmentally friendly, consumers believe that eating less or no meat is healthier, the price of meat will be too high. These factors were divided into latent components by using categorical principal component analysis (CATPCA). For further examining differences between factors affecting future meat consumption was also applied Friedman test and multiple pairwise comparisons using Nemenyi's method. Our study also includes consumer attitudes of meat substitutes. Chi-square test of independence, Kruskal-Wallis test and Mann-Whitney test tested the association between consumer perception toward meat substitutes and selected demographic criteria and it was based on the evaluation of eating habits related to meat consumption, consumer awareness of meat analogues and future consumption of meat analogues. For statistical testing, the significance level was set to 0.05.

3. Results and Discussion

Meat consumption per capita in the Slovak Republic in the observed period 2001 - 2020 (Figure 1) was at a relatively stable level with an average annual growth of only 1.10% (k´ = 1.0110). The development in consumption was accompanied by a slightly growing trend and the Slovak consumer consumed an average of 59.1 kg of meat per year. A gradual increase in consumption was recorded from the first year of the observed period and consumption was at the level of 58.7 kg per capita, while in 2020 consumption was at the level of up to 72.2 kg per capita and year. Based on the data of the Statistical Office of the Slovak Republic, it can be stated that during the monitored period, except for the years 2010-2015, meat consumption was at a sufficient level and exceeded the recommended consumption (57.3 kg). The lowest meat consumption was recorded in 2014, when the average Slovak consumed 47.9 kg and consumption lagged behind the interval of recommended doses by almost 17%. Lower meat consumption may have been caused by food scandals, mainly related to poultry and beef, as well as rising prices. Since 2015, there has been a relatively fast growth rate of meat consumption because of the increased consumption by 24 kg per person per year over the last six years. The current average meat consumption is at the level of 72.2 kg per capita and is excessive and covers approximately 126% of the recommended amount. Pork (51.5%) and poultry (38.9%) have the highest share in total meat consumption. On the other hand, beef has a share of only 7.3% in total meat consumption. Pork consumption had a slightly increasing trend in the observed period with an average growth of 0.83% (k´ = 1.0083). During this period, the average annual pork consumption was recorded at 32.5 kg per capita in the Slovak Republic. In the years 2004-2018, a more significant decrease in the pork meat consumption was recorded, and in 2014 the annual consumption was at the level of 28 kg, which was mainly due to lower prices of poultry meat. Since that year, there has been an increase in pork consumption of almost 10 kg. Poultry meat consumption in 2001-2020 was accompanied by slight fluctuations. During the analyzed period, the average growth coefficient k´ reached the value of 1.0222, which results in a slight growing development of poultry meat consumption. The average annual poultry meat consumption per capita in the analyzed period was 20 kg. In 2014 and 2015, the consumption of poultry meat did not reach the level of the recommended consumption and lagged behind by approximately 5%. However, since 2016, a growing trend in poultry meat consumption has been recorded again, and in 2020 it reached the level of 28.1 kg. The last analyzed type of meat is beef, the consumption of which in the observed period 2001 - 2020 had a decreasing tendency with the average growth rate k´ at the level of 0.9855. Beef consumption in the analyzed period did not reach the level of recommended consumption, and currently consumption is at the level of only 5.3 kg per capita per year.

Figure 1. Annual meat consumption in the Slovak Republic in the years 2001-2020



Source: own processing according to the data of the Statistical Office of the Slovak Republic, 2022

The trend of the development of meat consumption in the observed period of 20 years can be expressed by the following functions listed in Table 2.

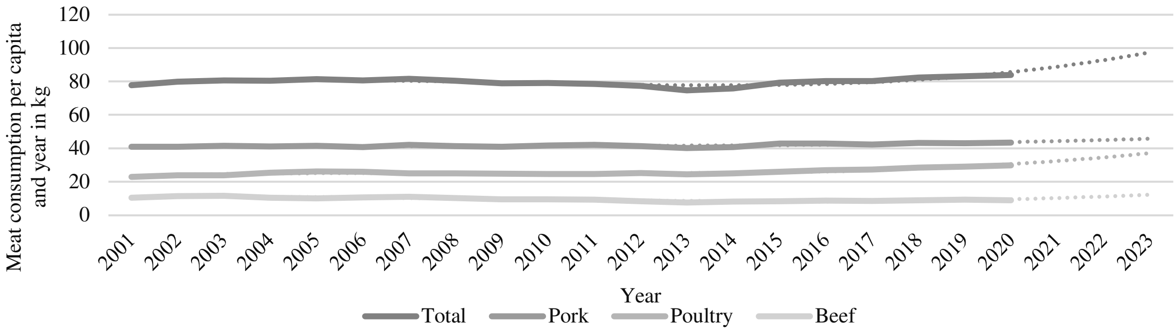
Table 2. Development trend of meat consumption in the Slovak Republic

Development trend of meat consumption	***Regression functions***	R^2
Total meat consumption	$q_t = 55.139 + 3.5857*t - 0.5819*t^2 + 0.0226*t^3$	0.8643
Pork meat consumption	$q_t = 30.939 + 0.762*t - 0.1271*t^2 + 0.0054*t^3$	0.678
Poultry meat consumption	$q_t = 15.073 + 3.1653*t – 0.4442*t^2 + 0.0161*t^3$	0.8562
Beef meat consumption	$q_t = 8.1413 – 0.6111*t + 0.0241*t^2$	0.8837

Source: own processing

For comparison, meat consumption in the Czech Republic in the period 2001-2020 was at a higher level (Figure 2). The average annual meat consumption reached 79.8 kg per capita. The development of meat consumption was accompanied by a slightly increasing rate and the average growth rate reached the level of 1.0040. The lowest meat consumption was recorded in 2013 and the average Czech consumer consumed 74.8 kg of meat. Meat consumption in the Czech Republic is excessive and exceeds the recommended doses by more than 40%. The Czech Republic is considered a major consumer of pork, and pork consumption has 51.7% share in total meat consumption. Poultry meat has a third share in total consumption and beef meat consumption has share of 10.6% of total consumption, so the Czech Republic is one of the largest consumers of beef among the V4 countries. Pork consumption had a slightly increasing trend in the observed period with an average consumption growth of 0.31% (k´ = 1.0031). During the years 2001-2020, the average annual pork consumption was recorded at 41.7 kg per capita. In the analyzed period, no significant decreases in consumption were recorded and annual consumption reached a level of more than 40 kg per capita, so the consumption is significantly exceeding the recommendations. Poultry meat consumption in the observed period was accompanied by slight fluctuations and the average growth coefficient k´ reached the value of 1.0140, which results in a slight growing development of poultry meat consumption. The average annual consumption of poultry meat per capita in the analyzed period was 25.7 kg. Since 2014, there has been a relatively fast-growing trend in poultry meat consumption, and in 2020 it reached a level of almost 30 kg. The Czech Republic also records a higher consumption of beef compared to Slovakia. However, beef consumption in the observed period 2001 - 2020 had a declining trend and the average annual growth k´ was at the level of 0.9918. The average annual consumption of beef meat was recorded at the level of 9.5 kg. Beef consumption in the analyzed period did not reach the recommended consumption and current annual consumption is at the level of 8.9 kg per capita.

Figure 2. Annual meat consumption in the Czech Republic in the years 2001-2020



Source: own processing according to the data of Czech Statistical Office, 2020

The development trend of meat consumption in the Czech Republic in the observed period of 20 years can be expressed by the following functions listed in Table 3.

Table 3. Development trend of meat consumption in the Czech Republic

Development trend of meat consumption	***Regression functions***	R^2
Total meat consumption	$q_t = 76.696 + 1.9579*t - 0.2733*t^2 + 0.0099*t^3$	0.7492
Pork meat consumption	$q_t = 40.815 + 0.1774*t - 0.0231*t^2 + 0.0011*t^3$	0.6269
Poultry meat consumption	$q_t = 22.168 + 1.1175*t - 0.1318*t^2 + 0.0048*t^3$	0.9125
Beef meat consumption	$q_t = 10.497 - 0.3534*t + 0.0751*t^3 + 0.0027*t^3$	0.8482

Source: own processing

Based on the quadratic and cubic functions, it is possible to assume trends in the consumption of individual types of meat with a perspective in the future, which should have a growing trend and in 2023 the total meat consumption in the Slovak Republic and the Czech Republic should be more than 90 kg per capita and year. In the case of individual types of meat, the largest increase in consumption should be recorded in the case of poultry meat. In connection with the above-mentioned forecast, we state that with growing meat consumption in both countries, the meat industry is unsustainable and highly excessive meat consumption has negative effects on human health. From the point of view of the environment, excessive consumption is undesirable and it is necessary to appeal to consumers and motivate them to lower meat consumption.

Following the analyzed development trends in meat consumption a significant change toward a reduction in consumption is not likely. For this reason, we conducted a survey in the Slovak Republic with the ambition of finding consumer eating habits with the possibility of reducing meat consumption and consumer perception toward meat substitutes. The results of the survey showed that more than 85% of respondents consume meat and do not include meat substitutes in their diet, especially plant-based food, which are most widespread on the Slovak market as meat substitutes. Approximately 7% of Slovak consumers consume meat as well as meat substitutes and 6.6% consume plant-based meat substitutes and exclude meat from their diet. Higher preference for meat consumption compared to meat substitutes consumption was also confirmed by other research, the results of which showed that consumers mostly consume meat and only tried meat substitutes due to the consumer skepticism toward alternative foods (Verbeke et al., 2015; Weinrich, 2018). Due to a deeper analysis of eating habits related to meat consumption in the Slovak Republic, we also identified differences between the individual demographic characteristics of respondents. Based on the applied Mann-Whitney test and Kruskal-Wallis test (Table 4), we identified differences between consumers' eating habits and following demographic characteristics: gender, age and household income. We note that men consume more meat compared to women. This may be influenced by the fact that women are more inclined to a healthy lifestyle and are also aware of the negative consequences of excessive meat consumption, so they include meat substitutes in their diet. We also identified differences in eating habits between the younger and older generations of consumers. Older consumers tend to consume mainly meat, while younger consumers are becoming more aware of the negative effects of livestock production and are also focusing on consuming meat substitutes. We also identified that consumers from lower-income households consume less meat. This may be influenced by the fact that meat prices are constantly rising, as well as by the fact that lower-income households are mainly younger consumers. In the case of other demographic characteristics - residence, education or respondent's monthly income, dependencies were not identified, which means that the eating habits of consumers are not affected by these variables.

Table 4. Eating habits in relation to meat consumption

Demographic characteristics	***Kruskal-Wallis test***	***Mann-Whitney test***	***p-value***
Gender	-	53559.500	**0.002**
Age	10.209	-	**0.006**
Residence	-	65177.500	0.489
Education	4.637	-	0.462
Income of respondent	4.799	-	0.309
Income of household	12.784	-	**0.012**

Source: own processing

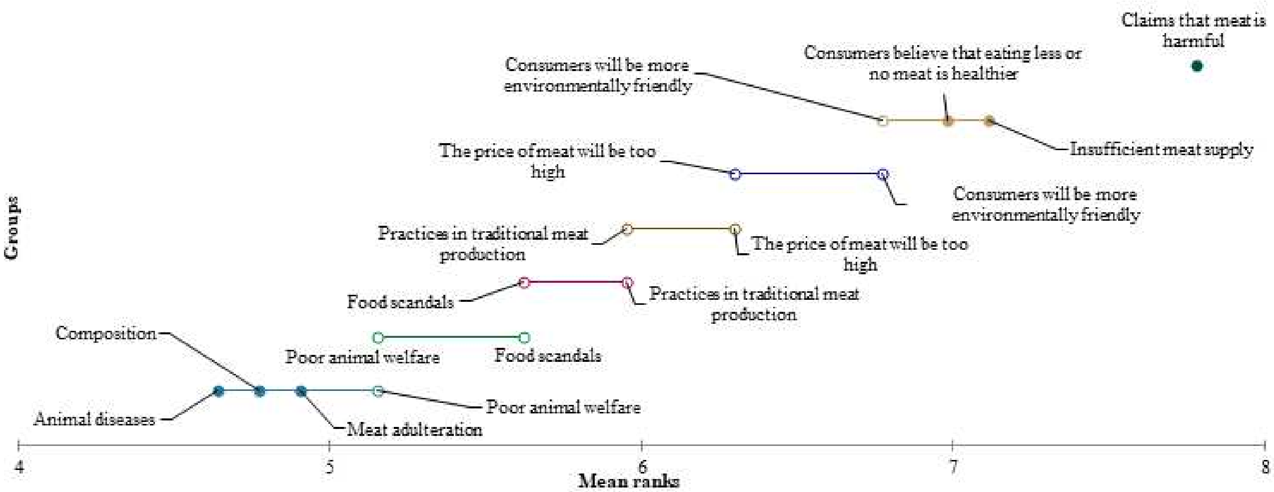
Consumer research has also focused on key factors that may determine reducing meat consumption in the future. The results showed that Slovak consumers consider animal diseases, meat composition and meat adulteration to be the main factors that may lead to a reduction in meat consumption. On the other hand, claims relating to negative effects on consumer health have the least impact on the elimination of meat consumption. These are also confirmed by the results of the Friedman test (p-value =<0.0001), which can indicate differences in the evaluation of factors determining the future meat consumption. By applying Nemenyi's method, we identified differences in evaluation between specific factors. No differences were identified between the factors that belong to one group. However, differences were identified between factors from different groups. The specification of the differences in evaluation is given in the following table (Table 5) and graphically represented by the Demsar graph (Figure 3).

Table 5. Differences in consumer evaluation of factors determining the elimination of meat consumption

Sample	*Mean of ranks*	*Groups*
Animal diseases	4.643	A
Composition	4.774	A
Meat adulteration	4.906	A
Poor animal welfare	5.153	A B
Food scandals	5.621	B C
Practices in traditional meat production	5.952	C D
The price of meat will be too high	6.297	D E
Consumers will be more environmentally friendly	6.774	E F
Consumers believe that eating less or no meat is healthier	6.983	F
Insufficient meat supply	7.115	F
Claims that meat is harmful to the human body	7.782	G

Source: own processing

Figure 3. Demsar plot - Differences in the evaluation of factors determining the elimination of meat consumption



Source: own processing

For a deeper analysis of the factors related to the elimination of meat consumption in the future, we also identified hidden relationships between the factors. Based on the results of categorical principal component analysis (CATPCA), two latent components were created (Table 6). The first latent component consists of factors: composition (antibiotics, emulsifiers, water content, salt content), meat adulteration, animal diseases, poor animal welfare, food scandals, and practices in traditional meat production. These factors relate mainly to meat quality, which is affected by livestock farming, meat production process and the addition of various ingredients to meat products. The lower meat quality can significantly affect the future meat consumption, and therefore the factor has been called a "factor influencing the quality of meat". The second latent component consists of the following factors: consumers believe that eating less or no meat is healthier, claims that meat is harmful to the human body, consumers will be more environmentally friendly, insufficient meat supply and the price of meat will be too high. This factor is related to the current trends in the meat market resulting from the change in consumers' eating habits and the reduction of consumption due to the negative effects of environment and health, so the component was named as a "factor decreasing the demand for meat".

Table 6. Factor loadings from CATPCA - Factors determining the elimination of meat consumption

Factors	***Dimensions***	
	1.	**2.**
Composition (antibiotics, emulsifiers, water content, salt content)	**0.845**	0.011
Meat adulteration	**0.841**	-0.025
Animal diseases	**0.830**	0.072
Poor animal welfare	**0.746**	0.166
Food scandals	**0.678**	0.096
Practices in traditional meat production	**0.555**	0.250
Consumers believe that eating less or no meat is healthier	0.007	**0.850**
Claims that meat is harmful to the human body	-0.011	**0.841**
Consumers will be more environmentally friendly	0.027	**0.804**
Insufficient meat supply	0.188	**0.505**
The price of meat will be too high	0.277	**0.388**

Source: own processing

The relevance of the achieved results is also confirmed by the research carried out by Verbeke et al. (2015), which emphasizes that consumers will reduce meat consumption because they do not agree with traditional meat production and their ambition is to behave environmentally. On the other hand, it emphasizes that the rising price of meat may have a negative effect on meat consumption, but this factor has been evaluated by consumers as the least significant.

The consumer survey was also focused on the consumer perception of meat substitutes. The results showed that plant-based meat substitutes such as soy and tofu are known among 80% of consumers. 74.5% of Slovak consumers stated that they had heard about edible insects and 5.2% consumers also consumed it. Cultivated meat is known to more than 50% of consumers, but only 22.8% of consumers really know how this meat is produced. An interesting finding was the fact that meat substitutes such as seitan, robi, klaso or tempeh are less known and consumed among Slovak consumers, although these foods are already commonly available in groceries. We also examined differences in consumer awareness of individual meat substitutes between the individual demographic characteristics of respondents. Based on the applied Chi square test of independence (Table 7), we identified the following differences. Gender differences have been identified in consumer awareness of soy, tempeh, tofu and edible insects. We found that women are more aware of the meat analogues consumption and most of them have already tried to consume plant-based meat substitutes, such as soy, tempeh or tofu. The age also affects the consumer awareness of meat substitutes. The results showed that younger consumers are following trends in the food industry and know novel foods including meat substitutes, such as soy, tempeh, tofu, quorn, or robi. The impact of residence on consumer awareness was identified only in the case of seitan and it can be stated that urban consumers are better aware of the consumption. Education and income have an impact on consumer awareness of soy consumption, and consumers with higher education are more informed about soy. Further finding was that the economic status has impact on the consumer awareness of seitan and employed consumers are more aware of seitan, which may be justified by eating out in restaurants. The results further showed that the respondent's monthly income has an impact on the consumer awareness of cultivated meat, klaso, robi and edible insects. We note that consumers with a higher monthly income are more aware of these foods than consumers with a lower income and may have consumed them during their holidays in exotic countries or in luxury restaurants. The monthly household income has an impact on the consumer awareness of edible insects. Edible insects are better known by consumers from higher-income households compared to consumers from low-income household. We also identified differences between the consumer awareness of meat analogies and eating habits of consumers. Based on the applied Kruskal-Wallis test (Table 7), it can be stated that consumers' eating habits had an impact on consumer awareness of all meat substitutes, except cultured meat. Consumers who prefer to reduce meat consumption are flexitarians or vegetarians, have more information and are better aware of the individual substitutes compared to consumers who prefer to consume meat at a relatively high level. However, eating habits do not affect the awareness and acceptability of cultivated meat, and it may be justified by the fact that, cultured meat is food of animal origin although the production of cultivated meat does not have a negative impact on the environment.

Table 7. Consumer awareness of meat substitutes

Demographic characteristics	***Cultured meat***	***Soy***	***Tempeh***	***Tofu***	***Quorn***	***Klaso***	***Robi***	***Seitan***	***Edible insects***
Gender	0.937	**0.044**	**<0.001**	**0.001**	0.923	0.699	0.673	0.156	**<0.001**
Age	0.321	**0.049**	**0.010**	**0.027**	**0.046**	0.115	**0.037**	0.078	0.069
Residence	0.081	0.342	0.704	0.069	0.310	0.065	0.167	**0.012**	0.112
Education	0.617	**0.020**	0.599	0.036	0.171	0.673	0.028	0.106	0.113
Economic status	0.066	0.164	0.298	0.206	0.372	0.108	**0.002**	0.586	0.124
Income of respondent	**0.031**	0.545	0.659	0.862	0.137	**0.050**	**0.025**	0.178	**<0.001**
Income of household	0.426	0.328	0.057	0.132	0.960	0.756	0.199	0.602	**0.010**
Eating habits	0.093	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.015**

Source: own processing

As we assumed that most consumers would not know meat substitutes, we provided a brief explanation of this food and consumers should indicate whether they could imagine meat substitutes consumption in the future. Today, almost 30% of consumers already consume plant-based meat substitutes. The results also showed that 40.2% of consumers would try plant substitutes, 5.2% would consume them regularly, but 26.1% of consumers would not consume these meat substitutes at all. 47.9% of respondents would try cultured meat, 5.6% would consume it regularly and 46.5% of Slovak consumers would refuse to consume it. Consumption of edible insects is unimaginable for up to 70.1% of Slovak consumers, 25.1% of consumers would try food containing edible insects and 4.8% of respondents can imagine consuming edible insects regularly. Based on the applied Chi square test of independence (Table 8), we also identified the following differences in the future consumption of meat substitutes between the individual demographic characteristics of the respondents. The first demographic variable was gender, and based on the results, we state that women would be more willing to consume plant-based meat substitutes and edible insects than men. We further found that age has an impact on future consumption of laboratory meat and plant-based meat substitutes, younger consumers are appearing to be more adaptable and willing to consume meat analogies. Economic status has an impact on the future consumption of plant-based meat substitutes. Employed consumers tend to consume these foods more in the future than other consumer groups. This also follows from the current consumer awareness and the consumption of plant-based meat substitutes. The future consumption of plant-based meat substitutes and edible insects is also influenced by the monthly income of the respondents. Higher-income consumers are willing to consume these foods more compared to lower-income consumers. The monthly household income may also affect the future consumption of edible insects. Higher edible insect consumption is expected for higher-income household consumers than for lower-income household consumers. This may be justified by the fact that currently foods containing edible insects are more expensive compared to traditional foods. An interesting finding was the fact that education does not affect the future consumption of meat substitutes. In addition to the impact of demographic variables, we also identified differences in future consumption depending on the eating habits. We note that differences were identified for all meat substitutes and consumers who eat less meat nowadays, will tend to consume meat substitutes in the future. Results of survey also showed the most important barriers for meat substitutes consumption is strong preferences toward meat, taste of meat substitutes, distrust of alternative diets, as well as poor consumer awareness of meat substitutes.

Table 8. Future consumption of meat substitutes

Demographic characteristics	***Cultured meat***	***Plant-based meat substitutes***	***Edible insects***
Gender	0.067	**<0.001**	**<0.001**
Age	**0.003**	**0.018**	0.102
Residence	0.175	0.418	**0.030**
Education	0.106	0.890	0.313
Economic status	0.238	**<0.001**	0.588
Income of respondent	0.124	**0.046**	**<0.001**
Income of household	0.155	0.115	**0.001**
Eating habits	**<0.001**	**<0.001**	**<0.001**

Source: own processing

The results regarding the consumer perception of meat substitutes were confronted with the results of other studies and it can be stated that despite reasons for the elimination of meat consumption, the consumption of meat substitutes is still low (Weinrich, 2018). A suitable nutritional strategy would be a partially vegetarian diet, e.g. one or two meatless meals a week, in order to eliminate the negative effects on the environment, but also to promote the sustainability and health aspects of consumption (Helms, 2004). However, perception of taste and appearance are the most important factors that can determine meat substitutes consumption. The availability of novel foods in groceries can be the basis for their successful establishment in the food market (Weinrich, 2019). Although neophobia and disgust are very strong factors, they may be alleviated (Mancini et al., 2019). The fear from consumption can be eliminated by raising consumer awareness of nutritional aspects of meat substitutes. In the future, meat substitutes may be an alternative to ensuring the nutrition of the population. At present, vegetarian and vegan substitutes are commonly available and their assortment is constantly expanding. Insect consumption is actively dealt with by the European Union, and it continuously regulates insect consumption in the member countries. The popularity of edible insect production is constantly growing, and in the Czech Republic and the Slovak Republic, startups are established with business activities focused on edible insect production, and sale of insect foods. The market of cultured meat in our condition has also potential. In the Czech Republic there is established company which cooperates with Slovak experts and focuses on research and development of technology for cultured meat production. In this context, it can be stated that food enterprises reflect on market requirements and appeal to consumers to consume novel foods.

4. Conclusion

The meat market is currently affected by objectives of the European Green Deal, regarding to reducing the negative environmental impact of meat production. The aim of the paper was to point out the meat consumption in the Slovak Republic and the Czech Republic with a view to the future, as well as to identify factors determining future meat consumption and to point out the consumer perception of meat substitutes. Based on the results, it is possible to assume a growing trend in meat consumption in both countries, which should reach a level of almost 90 kg per capita and year in 2023. By conducting a consumer survey in the Slovak Republic, we identified two factors that may eliminate meat consumption: factor influencing the quality of meat and factor decreasing the demand for meat. We also found that women, urban consumers, and higher-income consumers are better aware of meat substitutes and may tend to consume them in the future. Currently, only plant-based meat substitutes are widespread, but the market for edible insects and cultivated meat is expected to grow in the future. However, most Slovak consumers cannot imagine consuming these meat substitutes, and key barriers are the fear, the taste of meat substitutes, the habits of meat and the poor consumer awareness. Based on the results, it is necessary to appeal to consumers and motivate them to consume less meat. It is also necessary to eliminate consumers' barriers to meat substitutes consumption and to inform and educate consumers about alternative diets. On the other hand, it is necessary to ensure the supply of novel foods, and in this context, it is desirable to appeal to food enterprises and initiate them to develop and produce meat substitutes. Despite the contribution of the paper to science, research and application in practice, the paper also has limitations. The key limitation is conduction of the consumer survey only in Slovakia. In future research it is desirable to conduct comparative studies focused on meat substitutes in several countries of the European Union.

Acknowledgements

This publication was supported by the Operational Programme Integrated Infrastructure within the project: Demand-driven research for the sustainable and innovative food, Drive4SIFood 313011V336, co-financed by the European Regional Development Fund.

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ECONOMIC ADVANTAGES OF USING AGRICULTURAL ROBOTS IN PRECISION FARMING

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Annotation: The paper proposes to use special robots that specialize in seeding crops, applying fertilizers, water, herbicides. The main purpose is to substantiate the economic benefits of the introduction of robots in precision agriculture on the example of a private farm in Kyzylzhar village, Irtysh district, Pavlodar region (Kazakhstan). Scientific novelty consists in the use of robots to help in the practical implementation of precision agriculture. Robots according to pre-defined program algorithm carry out seeding of seeds, fertilizer application. According to the results of our experience in the field with the traditional technology, the average yield of winter wheat was 29.8 c/ha, and this figure was in the range of 25-30 c/ha in the dominant part of the field. The control field is characterized by a high level of heterogeneity in the values of the actual yield. The field where we followed precision farming principles showed an average yield of 35.7 c/ha, with a much lower degree of heterogeneity in yield levels in the field. Only fragmentary plots in the left and right extremes of the field had the lowest yields (20-25 c/ha and less than 20 c/ha). Due to precision farming, it was possible to achieve not only more stable and more even distribution of winter wheat yields in the experimental field, but also a higher yield of 19.8%.

Keywords: Robot, Precision farming, Yield, Winter wheat, Fertilizer

JEL classification: Q15, Q16, Q55

1. Introduction

The authors developed, designed, and programmed a robot for planting seeds and taking care of them [4]. Robotic solutions in crop production are of interest to agronomists, ameliorators, specialists in precision agriculture.

The tasks put forward are:

1) to disclose the methodology and information base for preparing the farm to engage in precision farming;

2) to determine the economic and environmental benefits of using our robots in a private farm;

3) to compare production and economic results on the example of traditional and "smart" technologies of winter wheat growing.

The survey solves two scientific questions: if our robots are used in combination with precision farming, it is possible:

1) to achieve a 10% reduction in total seed consumption, compared to the traditional technology, 15% decline in fertilizers, 17% lessening in fuel and 10% reduction in plant protection products (per 1 ha of winter wheat);

2) to get a yield of winter wheat, 30% higher than the traditional technology.

The research was conducted on the farm in the Irtysh natural-economic microzone [2]. Experiments on precision farming were conducted on winter wheat "Princess Olga" (with high protein – 16.9% and gluten – 34.2%).

The farm has been using precision farming technology on the fields of winter wheat and barley since 2017, while traditional farming technologies continue to be used on the remaining fields.

To assess the degree of burial of mineral salts and the level of fertility, one soil section with layer-by-layer soil sampling (5 cm) was laid on each plot before and after plowing.

Immediately after plowing, and 2 years after plowing, soil samples of 5 cm to a depth of 15 cm were taken for physicochemical studies (mechanical composition and humus content). In order to assess the possible removal of mineral salts from the soil by plants, one mixed sample of above-ground plant parts was taken on each plot for chemical analysis before plowing, 1 year, 2 years and 3 years after plowing.

Despite the chernozem type of soils, the prevailing proportion of soils in the field is not very high in humus content (about 3.6-4.0%). This is explained by the long-time of using the soils for agricultural purposes, with the resulting agro-industrial depletion.

The average perennial yield of winter wheat is on average in the range of 25-30 c/ha. Fields prior to the introduction of precision farming stood out for distinct heterogeneity in terms of yields at different locations in the fields. The higher the yield in an area, the higher the dose of fertilizer it receives.

Soil condition maps prepared during the preparatory stage of the transition to precision farming served as a basis for determining differentiated rates of mineral fertilizer consumption.

The content of mobile phosphorus varies considerably in different parts of the fields (151-250 mg/kg of soil). We took this fact into account during the analysis of the balance of inflow and outflow of phosphorus required for the successful development of crops in the field.

Herbicides "Herbitox", "Tornado 540" are used to control weeds in the farm. From the insecticides "Borey", "Kaizo" are used. The list of fungicides includes "Titan", "Menara", "Avial". Among the protectants, "Oplot" (8 l/t seed) is preferred.

2. Materials and Methods

In our experiment, we conducted a comparative analysis of two types of agricultural technologies of winter wheat cultivation – traditional technology (implementation of modern large-sized agricultural machinery, with the observance of generally accepted norms, in terms of cultivation, seeding, harvesting) and precision agriculture technology (based on the results of agrochemical soil survey and data from space monitoring of crops, with adjusted parameters of robotic application of seeds, fertilizers, plant protection products). The venue was a private farm in Kyzylzhar village, Irtysh district (Pavlodar region, Kazakhstan). The duration of our experiment was 3 seasons. The beginning of the experience – from September 18, 2018, when the seeds of winter wheat variety "Princess Olga" were sown. The experience ended in June 2020.

The selected area was divided into 2 plots of 90 hectares each, according to the selected technologies (by traditional and precision farming).

Based on soil characteristics and data on the distribution of mineral salts in the soil profile of the study area, the method of plowing with minimal impact on the soil was determined. Considering meteorological characteristics of the field area, where wind gust speed can reach

14 m/sec, the increasing deflation of the soil cover after plowing is predictable. Therefore, to assess the impact of different tillage methods on the rate of deflationary processes, the soil was plowed using two tillage technologies: with classical sowing of winter wheat seeds and with robotic sowing of wheat seeds. A robot, the description of which is available in the patent [4], was used for seed sowing and tillage.

Rates of working liquid for herbicides were determined in accordance with NDVI values in crops (thus, for NDVI = 0.30-0.35 – rate of "Herbitox" 0.8 l/kg, for NDVI = 0.35-0.40 – 0.9 l/kg, for NDVI = 0.40-0.45 – 1.0 l/kg, for NDVI = 0.45-0.50 – 1.1 l/kg, for NDVI = 0.50-0.55 – 1.2 l/kg).

With regard to fertilizers, the method of differentiated application was also used. For this purpose, in the phases of the flag leaf, earing, flowering, and ripening of winter wheat the robot determined NDVI index of the plants using N-Sensor ALS, in proportion to which fertilizer doses were set using the calibration table. In high-yielding areas of the field, the plants responded positively to increased fertilizer rates.

3. Results and Discussion

The agricultural robot for tending winter wheat crops is shown in Figures 1-7. It is equipped with a tank, a hose, and nozzles for spraying fertilizer on the plants.

Figure 1. General view of the robot (isometric)

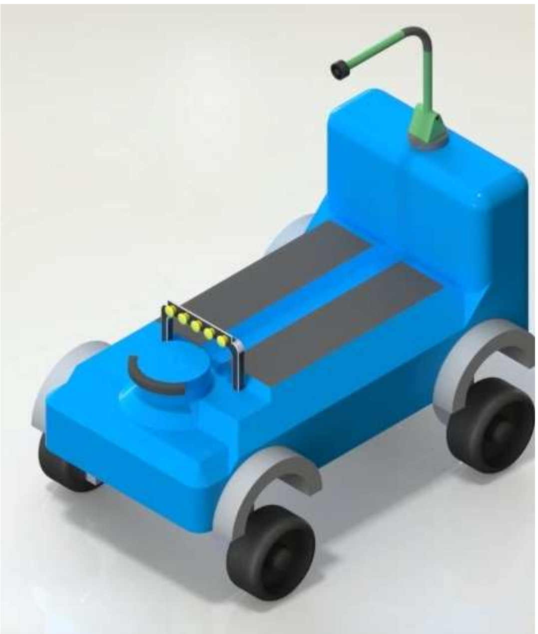


Figure 2. General view of the robot (isometric)

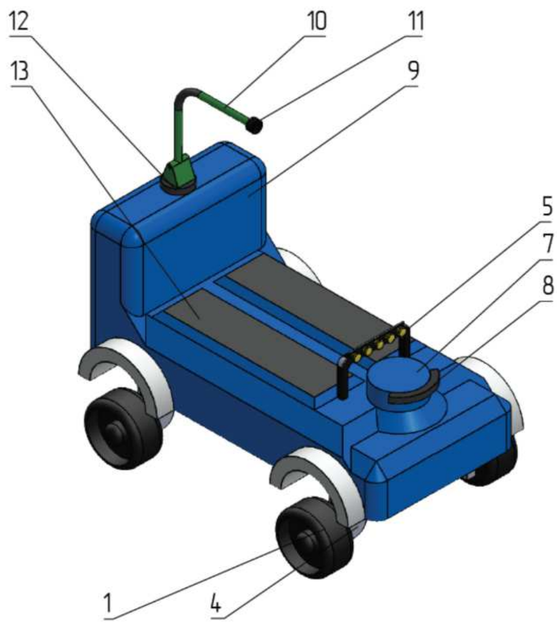


Figure 4. Side view of the robot from the right

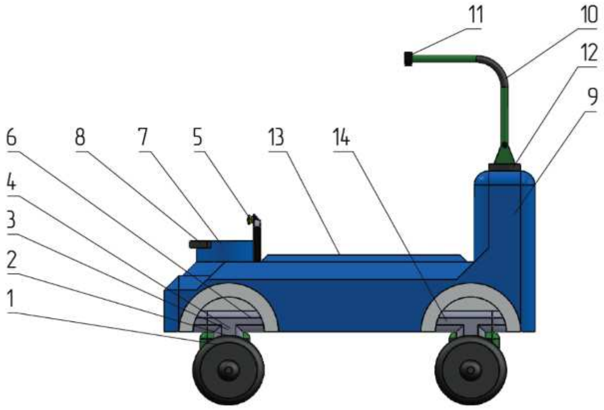


Figure 3. Front view of the robot

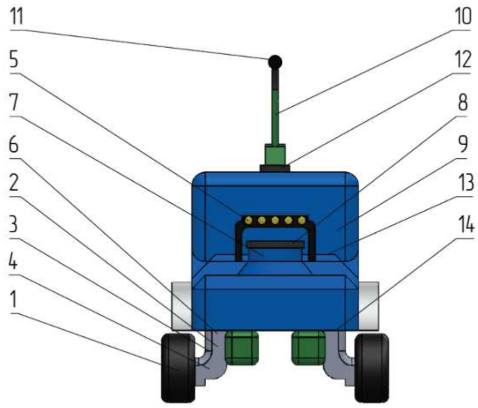


Figure 5. View of the robot from above

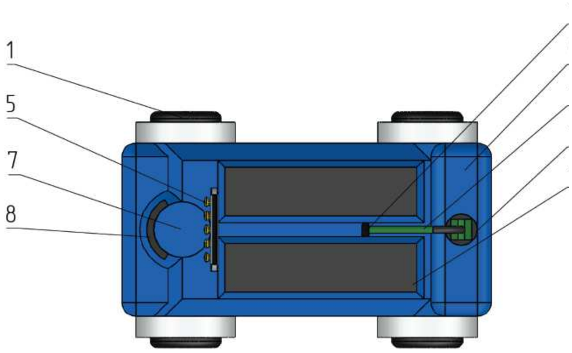


Figure 6. General view of the robot with internal components

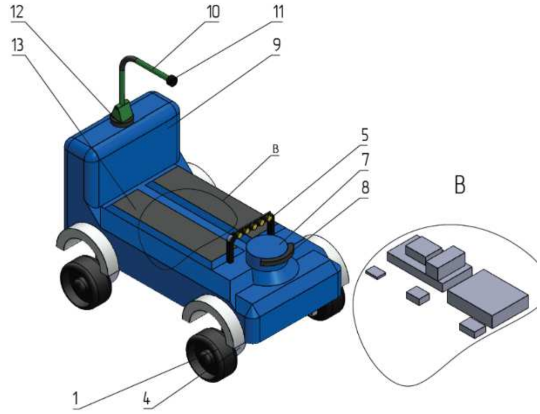
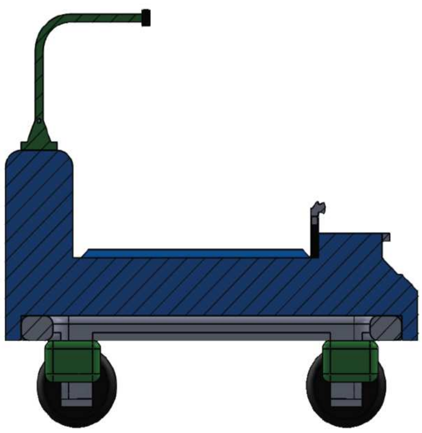


Figure 7. Side view of the robot from the left



Source: compiled by the authors.

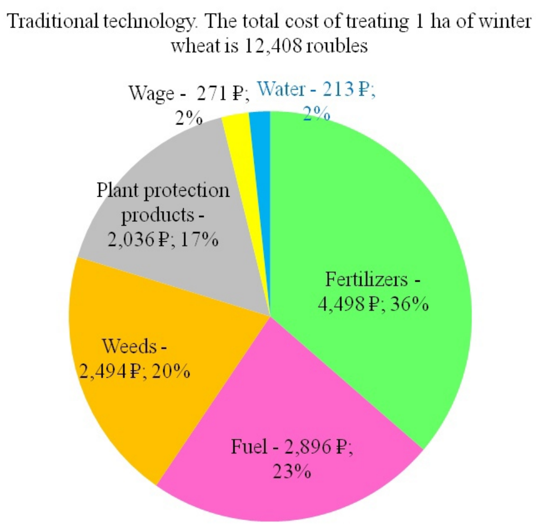
Note: The elements of the agricultural robot (for Fig. 1–7): 1 – Motor wheel; 2 – Rotary desk; 3 – Rotary table; 4 – Rotary element; 5 – LED lights; 6 – Suspension; 7 – GPS navigation device; 8 – HD-camera for terrain analysis; 9 – Fertilizer storage tank; 10 – Hose for the delivery of fertilizer; 11 – Nozzle for spraying fertilizer; 12 – Rotary table for the hose; 13 – Solar panel; 14 – Housing.

According to ground monitoring of crops, we can observe good condition of winter wheat in the fields, with no signs of dangerous diseases. Under the influence of precision farming, it was possible to achieve a more uniform and sustainable development of plants within the field.

Thanks to robots, successful germination and development of wheat seeds can be ensured. Robots can free up some labour from the work of sowing the seeds. Robots also contribute to a significant increase in labour productivity during planting and tending.

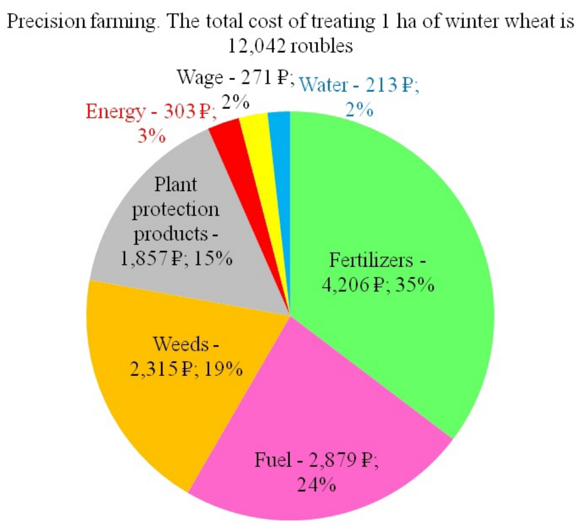
In the farm's cost structure for cultivation of 1 ha of winter wheat with traditional technology, fertilizers take the largest share (36%), fuel and lubricants are in the second place (23%), and seeds account for 1/5 of the cost structure (Figure 8). In the case of precision farming, the cost structure for cultivation of 1 ha of winter wheat does not undergo significant changes, except that the cost of power supply for robots is added (3%) (Figure 9). Compared to the traditional technology, the total costs decreased by 2.9%, amounting to 12,042 roubles (Figure 9). One robot costs 1,8 million roubles, and it's comparable with small power tractor.

Figure 8. Cost structure for treatment of 1 hectare of winter wheat in the farm using conventional technology, without the robots



Source: compiled by the authors.

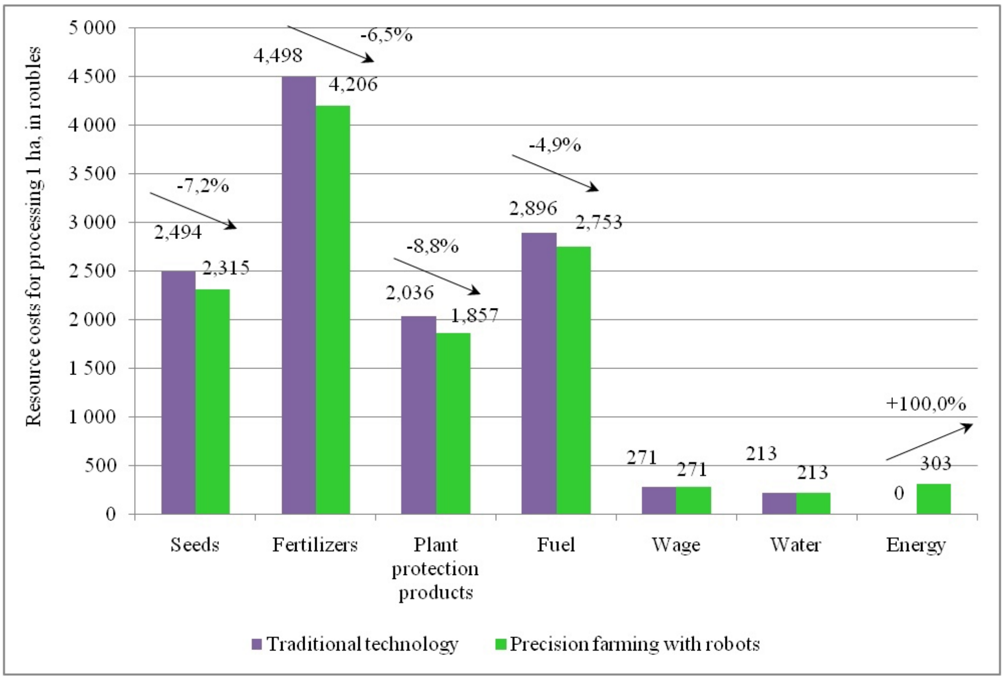
Figure 9. Cost structure for treatment of 1 hectare of winter wheat in the farm under the precision farming system, with the robots



Source: compiled by the authors.

The precision farming system reduces the cost of seeds and fertilizers by 7%, plant protection products by 9%, and fuel and lubricants by 5% (Figure 10). At the same time, precision farming requires energy costs to charge the robots' batteries.

Figure 10. Cost structure for cultivation of 1 hectare of winter wheat using: a) conventional technology without the robots; b) precision farming system with the robots (in roubles)



Source: compiled by the authors.

Table 1 summarizes the differences in the results of cultivation of 1 hectare of winter wheat using conventional technology and precision farming system. There are lower rates of overconsumption of seeds (lower by 60%), fertilizers (lower by 55%), plant protection products (lower by 39%), fuels and lubricants (lower by 42%) – in the field where the system of precision agriculture with robots (compared with conventional technology) was implemented. It should be added that the area of seed reseeding when following the principles of precision farming is 57% less than the traditional technology (Table 1).

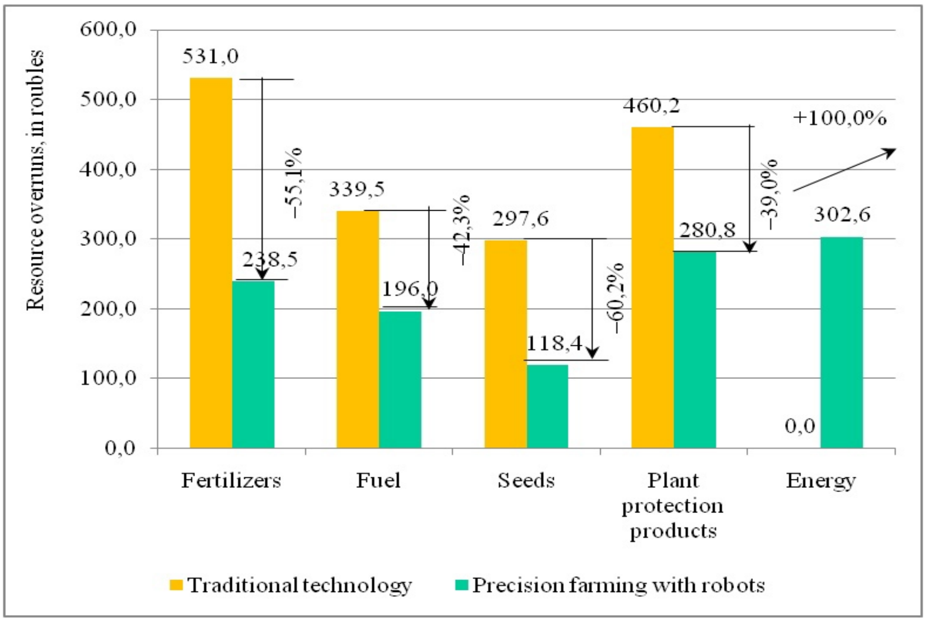
Table 1. Comparative analysis of resource overconsumption in winter wheat cultivation by two methods: a) traditional; b) based on precision farming and robots

Indicator	**Traditional technology**		**Precision farming with robots**		**Absolute difference**		**Relative difference**
	Per 1 hectare	**On 90 hectares**	**Per 1 hectare**	**On 90 hectares**	**Per 1 hectare**	**On 90 hectares**	
Area of seed sowing	0.082 ha	7.380 ha	0.035 ha	3.150 ha	-0.047 ha	-4.230 ha	-57.3%
Seed overruns	18.6 kg	1674.0 kg	7.4 kg	666.0 kg	-11.2 kg	-1008.0 kg	-60.2%
Fertilizer overruns	11.8 kg	1062.0 kg	5.3 kg	477.0 kg	-6.5 kg	-585.0 kg	-55.1%
Overconsumption of plant protection products	5.9 kg	531.0 kg	3.6 kg	324.0 kg	-2.3 kg	-207.0 kg	-39.0%
Overconsumption of fuel and lubricants	9.7 litres	873.0 litres	5.6 litres	504.0 litres	-4.1 litres	-369.0 litres	-42.3%
Energy consumption to power the robots	0.0 kWt·h	0.0 kWt·h	116.4 kWt·h	10476.0 kWt·h	116.4 kWt·h	10476.0 kWt·h	+100.0%

Source: Calculated by the authors.

Figure 11 contains information on the difference between overconsumption of resources in absolute and relative terms under the systems of traditional and precision farming. Total saving of resources for cultivation of 1 ha of winter wheat during one sowing season amounts to 366 roubles, and in recalculation for 90 ha – almost 33 thousand roubles. The greatest difference in overspending can be traced on the example of seeds when there is a fall in their overspending by 60% (Figure 11).

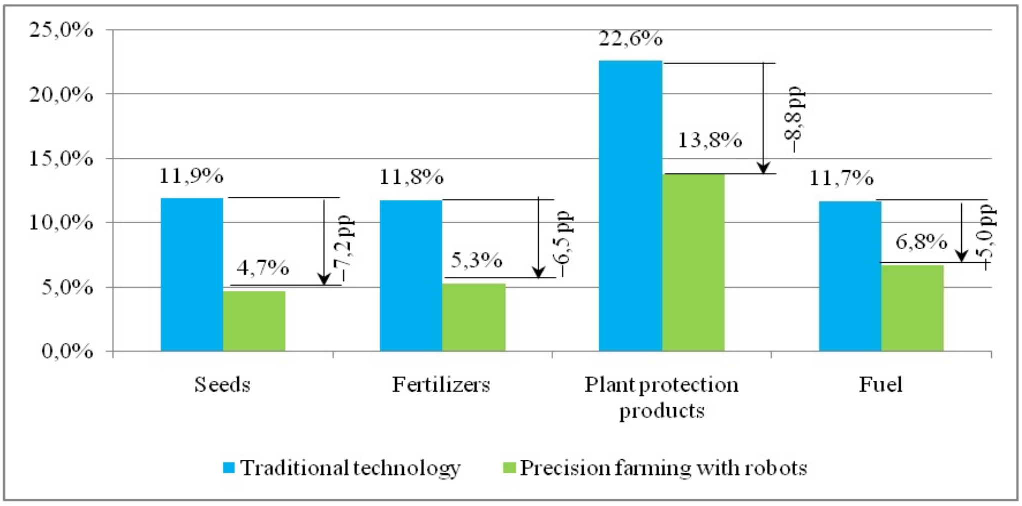
Figure 11. Volume of overconsumption of resources when cultivating 1 hectare of winter wheat by traditional and precision farming (arrows show the relative difference in overconsumption of resources), in roubles



Source: compiled by the authors.

If we refer to the structure of resource consumption by the criterion of "overconsumption/optimal consumption", we can see that in the traditional technology about 12% of seeds and fertilizers are overconsumed, while for plant protection products the share of overconsumption is almost 2 times higher – 23% (Figure 12).

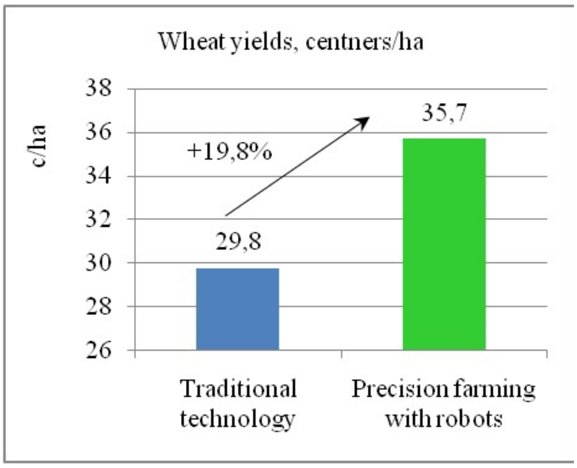
Figure 12. Share of the overconsumed resource in the total costs of the corresponding resource in traditional and precision farming



Source: compiled by the authors.

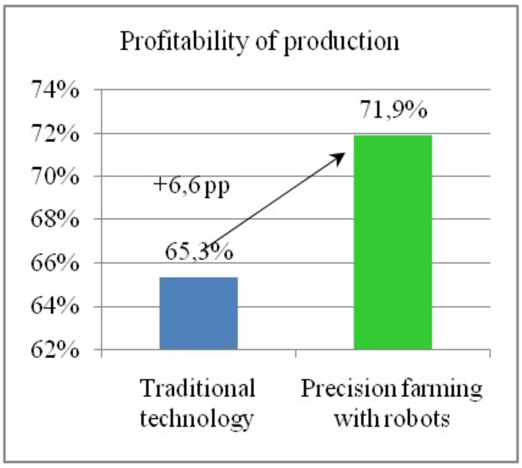
Aggregated analysis of the ratio of income and costs of grain production revealed that, when using the technology of precision farming, the positive difference of conditional profit is 7,446 roubles in terms of 1 ha – relative to the classical technology. Profitability of production with precision farming increases by 6.6 pp (Figure 14).

Figure 13. Comparative analysis of yields when growing winter wheat using two methods – without and with precision agriculture and robots – on 90 hectares of harvested area



Source: compiled by the authors.

Figure 14. Comparative analysis of the profitability of production at cultivation of winter wheat using two methods – without and with precision agriculture and robots – on 90 hectares of harvested area



Source: compiled by the authors.

The reason for the growth of profit in the first year after the introduction of precision farming technology is the fact that costs have decreased (due to significant savings in resources) and income has increased (due to increased yields). In 4 seasons, after the introduction of precision farming technology will come the payback of costs for the purchase of special agricultural equipment designed for precision farming (robots). Transition to precision farming technology has led to a decrease in fuel costs – due to the replacement of part of the fleet with robots, powered by batteries from an electricity source, instead of diesel fuel, as in conventional tractors.

Thanks to precision farming, the fields have seen an improvement in soil structure and yields have increased by an average of 19.8% (Figure 13). The low yield is due to the varietal qualities of the winter wheat "Princess Olga". This variety is aimed primarily at high protein content in the grain, rather than providing large yields. Low fertilizer consumption and low rainfall in the region from September 2018 to February 2019 (150-160 mm) also become causes of low wheat yields.

Summarizing the identified economic effects, we note that the increase in the conditional profit of the farm by 7,446 roubles per 1 ha was due to an increase in the yield of winter wheat by 5.9 c/ha, due to the reduction of overspending resources, among which the largest share falls on fertilizers; for example, overspending of the latter decreased by 55.1%. In addition, the cost of the company decreased by 7% for seeds, by 9% for the means of protection, by 5% for fuel. All of the above effects prove the economic feasibility of precision farming and robots.

We chose the "higher yield – higher fertilizer rate" strategy, especially since experts and agronomists recognize ineffective strategies to equalize yields by increasing fertilizer application rates in low-yielding parts of the field. Such inefficiencies tend not to increase average yields across the field. Crop yields in "bad" areas do not increase with increasing the rate of fertilizer application because it is not the content of nutrients in the soil that is the limiting factor for plants, but some other factor, the role of which must be separately clarified (e.g., uneven field topography, low soil acidity, low moisture in the soil, etc.). In this situation, the application of increased fertilizer rates results in nothing more than an inefficient waste of resources.

The rate of plant biomass formation depends on the chosen technology for sowing wheat seeds. The robot uses two methods to determine materials and resources according to the precision farming system:

a) offline mode based on a digitized map of the last year's field yield – to calculate differentiated seed rates (due to the fact that there are no objects in the fields before seed sowing to calculate the NDVI index);

b) online mode based on the N-Sensor ALS – to determine differential rates of fertilizers, herbicides.

The robot is equipped with the N-Sensor ALS, which detects the NDVI index using its own radiation source. Reflected photons are directed to the sensor's photodiodes, which measure the amount of light received. The robot's control unit calculates the NDVI index based on the values received by the N-Sensor ALS. The control unit then compares the actual NDVI index values to the preliminarily set NDVI values. Depending on how much the NDVI index deviates from the set value, the robot receives commands for application of the appropriate amount of fertilizers, herbicides. N-Sensor ALS in real time sends signals to the robot control unit about the differentiated application rates. The considered method provides the technology of differentiated application of resources necessary for the full development of crops. This method accelerates the payback period of the robots and provides an opportunity to monitor the status of plants in the field in real time. With this knowledge, the robot applies exactly as much material as required according to an algorithm to each area of the field.

However, one disadvantage of the N-Sensor ALS is that it is not able to recognize the NDVI index in the early phases of plant development before the plants have reached a height of 60 cm. Therefore, we have to resort to offline mode for the period of sprouting, tillering – in the case of wheat – that is, to rely on satellite image data on the state of the fields.

In the control field, where we followed the traditional agrotechnology, the rate of seed, crop protection products and fertilizers was the same in all parts of the field.

In the field where precision farming principles were followed, a higher rate of plant protection products was set in the areas with the highest NDVI values. While, in areas with a relatively lower NDVI index, the application rates were lower. It means that we followed the principle of direct proportionality in composing the rate of application of protective agents depending on the NDVI index, as recommended in the work of I.A. Smelkova [5]. This allowed us to obtain higher yields from the field areas demonstrating high NDVI index. Precision farming helps to reduce the use of chemicals by 25-30% compared to traditional methods of fertilizer and pesticide application [1]. Rykov et al. [3] on the example of winter wheat indicate an increase in the proportion of plant protection agents (up to 11% per 1 t) – in the case of transition to the technology of zero tillage. With traditional methods of tillage, their share is 3%.

4. Conclusion

As a result of using our robots in combination with precision farming, the following effects were obtained:

1) With respect to the structure of total resource consumption for tillage, we achieved a 7.2% reduction in seed consumption, compared with the traditional technology, and a 6.5% reduction in fertilizer, 4.9% reduction in fuel and 8.8% reduction in plant protection products;

2) Compared to the traditional technology, we achieved a 60.2% decrease in overspending of seeds, 55.1% reduction in overspending of fertilizers, 42.3% lessening in overspending of fuel and 39.0% reduction in overspending of plant protection products;

3) We obtained the yield of winter wheat 19.8% higher than with the traditional technology;

4) The profitability of precision farming was 31.9% higher than under the traditional technology, while the level of profitability of production increased by 6.6 pp.

Thus, the scientific questions put forward at the beginning of the study were not fully confirmed, because we expected to obtain larger harvesting effects as a result of the introduction of robots and precision farming. Such results can be explained by the lack of moisture in the season and the lack of experience with new technologies in crop production, but we are confident that in the near future it will be possible to achieve greater benefits from precision farming. The company has plans to increase nitrogen fertilizer application rates to increase the yield of 3rd class winter wheat, without compromising the high protein and gluten content of the grain.

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THE EUROPEAN GREEN DEAL AND THE US RESOLUTION TO CREATE A GREEN NEW DEAL – A COMPARATIVE DOCTRINAL ANALYSIS

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Annotation: This paper presents a comparative doctrinal analysis of the European Green Deal, *i.e.* the Communication from the Commission to the European Parliament, the European Council, the European Economic and Social Committee and the Committee of the Regions (COM/2019/640 final), and the United States' resolution to create a Green New Deal, i.e. the resolution of the Federal House of Representatives No 109, recognizing the duty of the Federal Government to create a Green New Deal (H.Res.109 — 116th Congress, 2019-2020, 1st Session, introduced in House on the 7th of February, 2019). The purpose is to compare the discursive strategies employed in both legislative documents and to elucidate the respective linguistic forms as embodiments of comparative context-dependent discursive practices. The discursive strategies herein examined include nomination - naming actors linguistically, predication – attributing them specific qualities, and argumentation - constructing condensed arguments which lead to certain conclusion rules (Reisigl and Wodak 2001: 31-90). The results include the identification of similarities between the two central legal documents as well as differences in the used linguistic practices. The identified nominative and predicative discursive strategies include those which are seemingly neutral such as "environmental-related challenges" (EU Green Deal) as well as those with positive connotations such as "growth strategy" (*ibid.*) or negative ones, *e.g*., "extreme weather events that threaten human life" (US Green New Deal). Some examples of the argumentation schemes include for example the *topoi* of "transforming the society into a fair and prosperous one" (EU Green Deal) or "mass migration caused by climate change" (US Green New Deal). The similarities and differences between the two documents are based in the in the respective legal cultures as well as in the cultural contexts of accepting responsibility for environmental issues.

Keywords: Comparative doctrinal analysis, Critical discourse analysis, Discursive strategies, Doctrinal legal analysis, European Green Deal, Green New Deal, Legal discourse

JEL classification: F55, F64, K10, K32, N50

1. Introduction

This paper presents a comparative doctrinal analysis of the European Green Deal, *i.e.* the Communication from the Commission to the European Parliament, the European Council, the European Economic and Social Committee and the Committee of the Regions (COM/2019/640 final) – 'EGD' hereinafter, and the United States' resolution to create a Green New Deal, *i.e.* the resolution of the Federal House of Representatives No 109, recognizing the duty of the Federal Government to create a Green New Deal (H.Res.109 — 116th Congress, 2019-2020, 1st Session, introduced in House on the 7th of February, 2019) – 'USGND' hereinafter. The purpose is to compare the discursive strategies employed in both legislative documents and to elucidate the respective linguistic forms as embodiments of comparative context-dependent discursive practices.

The recent and ongoing crises have made the key international actors such as the EU and the US aware of the necessity to adopt fitting legal measures to promote environmental protection internationally. According to Pogge and Mehta (2022), such crises are an opportunity to achieve more protection-wise than what could be achieved in ‘ordinary times’ (497). On the other hand, as Jessup (2020) points out, any new legislative measures will necessarily face ‘controversies’ (140) regarding the ‘legal process’ (*ibid.*) and ‘appropriateness’ (*ibid.*) of the newly adopted legal measures. Marquardt and Naghmeh (2021) suggest that ‘climate mitigation’ can only result from the change of our paradigm and ‘is bound to our fundamental ideas of social and political order’ (2).

2. Materials and Methods

We conduct a discursive analysis of the two legal texts. The importance of discourse in achieving environmental goals, environmental justice, and ‘inter-generational equity’ (Lawrence 2012: 23) is undisputable. Jessup (2012) states that ‘[a]lthough the political climate and political priorities’ are changing, ‘the environmental justice argument still resonates’ (47). Participation in shaping the public discourse and in environmental decision making and law-making is presently vital in achieving environmental justice (Jessup 2012: 47-48).

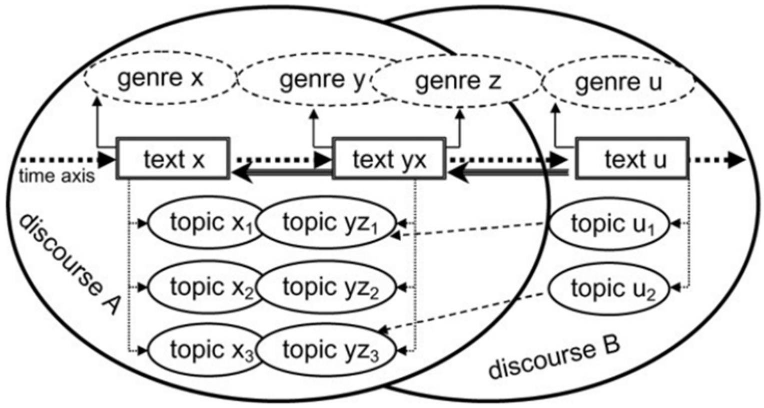
The laws are analysed with the discourse-historical approach and thus with a focus on the discursive strategies (Reisigl and Wodak, 2001) employed in the legal documents. We adhere to the principle of ‘triangulation’ (Reisigl and Wodak, 2009: 89) and therefore, the texts of the laws are assessed on the background of related data, including interrelated legislative documents and public debates. The discourse-historical approach is three-dimensional: firstly, contents and topics are assessed; secondly, discursive strategies are identified; and thirdly, their linguistic realizations are investigated (Reisigl and Wodak, 2009: 93). The discursive strategies herein examined include nomination - naming actors linguistically, predication – attributing them specific qualities, and argumentation - constructing condensed arguments which lead to certain conclusion rules (Reisigl and Wodak 2001: 31-90).

The discourse-historical approach is three-dimensional: firstly, contents and topics are assessed; secondly, discursive strategies are identified; and thirdly, their linguistic realizations are investigated (Reisigl and Wodak, 2009: 93). The discursive strategies herein examined include nomination - naming actors linguistically, predication – attributing them specific qualities, and argumentation - constructing condensed arguments which lead to certain conclusion rules (Reisigl and Wodak 2001: 31-90).

3. Results and Discussion

In the first part of our three-dimensional discourse-historical analysis, we focused on the comparison of the structure of the two respective documents, with an emphasis on their contents and topics. The discourse topics employed in both documents were grouped under several overarching macro-topics. Wodak (2001) notes that discourse topics are usually interconnected and overlap in their concrete realizations (69), as is shown in *Figure 1* below.

Figure 1. Discourse topics and genres, interdiscursivity



Source: Wodak (2001): 69

In our study, the topic of global leadership of the EU and the US respectively is interdiscursively connected with other, mutually overlapping topics, such as facing challenges, responsibility, and cross-border cooperation; while the use of discursive strategies and linguistic realizations employed in the discussion of such topics differed in both documents.

The two analysed texts overlap in their employment of discourse topics, but our analysis below will demonstrate that these topics are mostly discussed with the use of different argumentation strategies, thus leading to different, sometimes juxtaposed, overarching argumentation schemes. The main macro-topics as well as individual discourse topics of both policy documents are presented below in *Table 1*. While both documents deal with identical general macro-topics, such as biodiversity or the global leadership of the EU and the US as the respective global political leaders, the detailed split-up into individual topics shows that the two documents take different, at some points even opposite stances in their presentation of responsibility and the pertinent challenges.

We have identified the EGD's overall policy as a positive approach towards environmental challenges, where such challenges are viewed as 'unique opportunities' (EGD: 1), and the EU as a powerful international actor is presented as a 'global leader' (EGD: 1, 3) who is able to facilitate 'acting together' (EGD: 2.1.8, 4) in terms of facing environmental challenges.

The USGND identifies almost identical environmental challenges, but these are generally presented as the outcomes of past actions and recklessness of global leadership, rather than as positive opportunities for the future global policies. Environmental 'challenges' explicitly mentioned in connection with 'inadequate resources for public sector workers' to respond to such challenges (USGND: section 3 (2)(D)). Global leadership of the United States is addressed together with the US's imminent role in creating emissions (USGND: section 2), and its resulting responsibility to aid other countries to achieve the goals of the USGND (section 7 (2)(N)).

Table 1. Doctrinal comparison of discourse topics

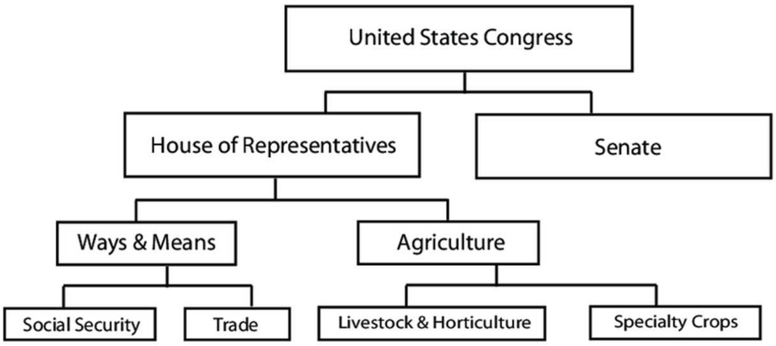
Macro-topic	**Examples of discourse topics in the EGD**	**Examples of discourse topics in the USGND**
Challenges	Urgent challenges as unique opportunities; collective abilities; growth strategies; protection, conservation, and enhancement	Impacts of emissions; environmental and social costs; existing laws; new policies; vulnerable communities
Economic transformation	Sustainable future; climate ambition; secure energy	Fair commercial environments; elimination of monopolies; fair competition
Industry	Circular economy; sustainable products; reusability; maximising impact through digital technologies	Domestic manufacturing; stop transfer of jobs and pollution overseas; fair trade rules; border adjustments
Building, renovating, and construction	Renovation programmes; rigorous enforcement of legislation; energy performance of buildings; energy efficiency investments	Affordable and clean housing
Environmentally friendly food system	New technologies; scientific discoveries; public awareness; demand for sustainable food; reduction of chemical pesticides	Affordable and healthy food; clean water
Biodiversity	Preserving and restoring ecosystems; biodiversity-rich land; biodiversity-rich sea areas; cross-border cooperation; forest strategy; role of oceans; mitigating climate change	Science-based projects that enhance biodiversity and support climate resiliency; restoring and protecting threatened ecosystems
Pollution	Toxic-free environment; quality legislation; role of ground and surface water	Protection of public lands, waters, and oceans; access to nature; identifying emission and pollution sources
Mainstreaming sustainability in policies	Green finance and investment; greening national budgets; price signals; fostering research and innovation	Socioeconomic mobility; labour policies; economic inequality and injustices
Global leadership	The EU as a global leader; acting together	Duty of the Federal Government; United States' responsibility; the US as an international leader on climate actions

Source: EGD and USGND

Note: British spelling standard is used throughout, for the citations of both legislative documents

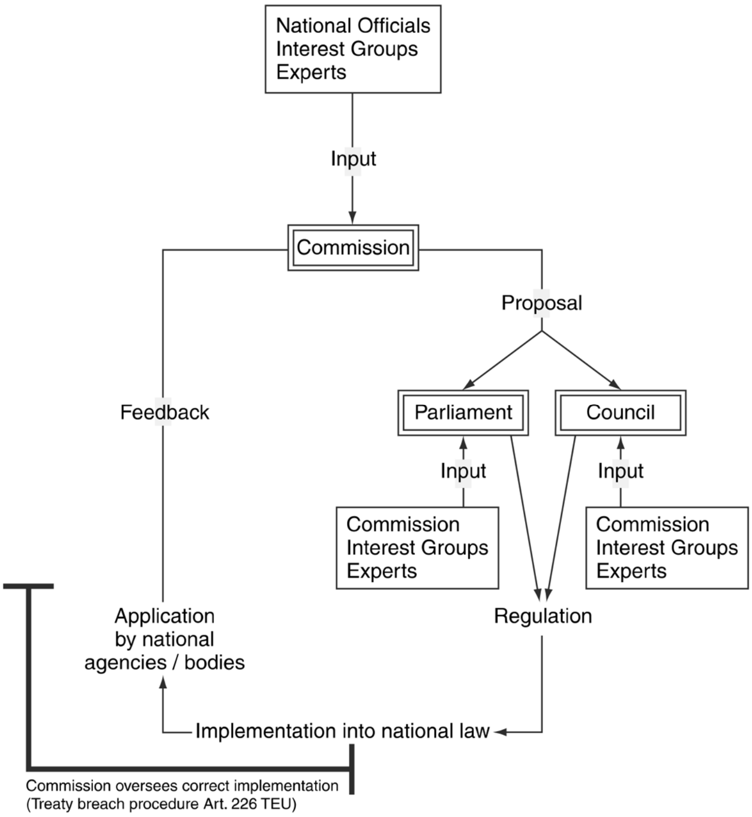
The first part of our three-dimensional analysis pointed to inter-text relations between the two analysed documents. The second part of our analysis with focus on how these topics were dealt with to facilitate different discursive strategies, especially argumentation schemes. The schemes in *Figure 2* and *Figure 3* below show the processes of adopting decisions and initiatives for legislative documents in the US and the EU respectively.

Figure 2. Structure of the United States Congress



Source: Goel et al. *(2007)*

Figure 3. Organizational flow of proposals in the EU



Source: Wodak (2011): 68, adapted from Pollak and Slominski (2006): 121

Following the identification of main discourse topics, our analysis focused on referential and predicational discursive strategies in both documents. We deal with the referential and predicational strategies together, for each respective legislative document, because references and predications are inherently interconnected.

References typically contain predications because referring to certain concepts mostly involves evaluating this concept and attributing certain qualities to the referred objects or actors (Wodak and Reisigl 2003: 386). The referential and predicational strategies used to point to the EU and the US as the main actors and the references to the main environmental challenges are grouped under two major 'macro-strategies' (Wodak *et al*. 2009: 3).

The EU's global leadership as well as the most urgent environmental challenges are mostly framed as positive opportunities and particular challenges are typically addressed together with their possible solutions. While it is made clear that the current environmental challenges are serious and require strong policy responses, the EU's responses to the challenging situations are presented as positive opportunities that can be 'addressed', 'responded to', and even 'prevented' in the future, through appropriate means of EU policies.

Table 2. Referential and predicational discursive strategies and their linguistic realizations in the EGD

Type of reference (macro-strategy)	Linguistic realizations
Global leader	*Global leader on environmental measures* (1); *leads international efforts (1); coordinate international efforts* (1); *stimulate the development of lead markets* (2.1.3); *effective advocate* (3); *global partners* (3); *leading donors of development assistance* (3); *lead markets* (4)
Challenges	*Environmental-related challenges* (1); *response to these challenges* (1); *greatest challenges* (1); *reduction in emissions is a challenge* (1); *complex and interlinked challenges* (1); *twin challenge* (2.1.3, 2.1.4); *increasing renovation rates is a challenge* (2.1.4); *address this challenge* (2.1.5); *challenge with current production patterns* (2.1.6); *interlinked challenges* (2.1.8); *investment challenge* (2.2.1); *challenges require a strong policy response* (2.2.1); *challenge is beyond the means of individual Member States* (2.2.3); *capacity to understand and tackle the environmental challenges* (2.2.3); *global challenges of climate change* (3); *addressing the global climate challenge in a meaningful way* (3); *environmental challenges are a significant threat multiplier* (3); *challenges for a number of states and societies* (3); *prevent these challenges from becoming sources of conflict* (3); *the threat and the challenge of climate change* (4); *responds to the challenges posed by climate change* (3)

Note: Citations from the EGD text are listed in italics, the respective sections of their occurrences are specified in brackets

On the other hand, the USGND strongly emphasises the US's responsibility for its past actions and its role as a global leader is presented as intertwined with its previous leading role in creating pollution and emissions, as is shown below in *Table 3*:

Table 3. Referential and predicational discursive strategies and their linguistic realizations in the USGND

Type of reference (macro-strategy)	Linguistic realizations
Global leader	*Leading role in reducing emissions* (section 2); *the international leader on climate action* (section 7, (2)(N))
Challenges	*Inadequate resources for public sector workers to confront the challenges of climate change at local, State, and Federal levels* (section 3 (2)(D)); *to invest in the infrastructure and industry of the United States to sustainably meet the challenges of the 21st century* (section 7 (1)(C))

Note: Citations from the USGND text are listed in italics, the respective sections of their occurrences are specified in brackets

The argumentation schemes we focused on were related to the respective global leadership of the EU and the US. Interlinked with the nominative (predicative and referential) strategies identified above, the two documents differed in the self-presentation of the main political actors. The EU in the EGD is presented as an important actor in addressing the current challenges and its role is thus framed as mostly positive and aiding in achieving laudable environmental goals.

The EU's role is depicted as indispensable regarding the protection of workers, consumers, and the economy and society in general: 'The EU has the collective ability to transform its economy and society to put it on a more sustainable path. It can build on its strengths as a global leader on climate and environmental measures, consumer protection, and workers' rights' (EGD: 1).

The US, on the other hand, is presented as an important leader in repairing the environmental wrongs it is actually responsible for: 'Whereas, because the United States has historically been responsible for a disproportionate amount of greenhouse gas emissions, having emitted 20 percent of global greenhouse gas emissions through 2014, and has a high technological capacity, the United States must take a leading role in reducing emissions through economic transformation' (USGND: section 2).

Both actors, the EU and the US, are described as international leaders, leading other countries and nations: 'The EU must be at the forefront of coordinating international efforts towards building a coherent financial system that supports sustainable solutions' (EGD: 1). Similarly, the US is said to be the key international entity in 'promoting the international exchange of technology, expertise, products, funding, and services, with the aim of making the United States the international leader on climate action, and to help other countries achieve a Green New Deal' (USGND: section 7, (2)(N)).

The EU's leadership is additionally pointed to as an important actor within the EU internally: 'In addition to launching new initiatives, the Commission will work with the Member States to step up the EU's efforts to ensure that current legislation and policies relevant to the Green Deal are enforced and effectively implemented' (EGD: 2.1).

The EU's role is first presented as a general framework: 'The EU will continue to lead international efforts and wants to build alliances with the like-minded. It also recognises the need to maintain its security of supply and competitiveness even when others are unwilling to act' (EGD: 1); and later in more detail with emphasis on individual fields of action: 'A key aim of the new policy framework will be to stimulate the development of lead markets for climate neutral and circular products, in the EU and beyond' (EGD: 2.1.3), '[a]s the EU's share of global emissions is falling, comparable action and increased efforts by other regions will be critical for addressing the global climate challenge in a meaningful way' (EGD: 3).

The vital role of the EU in leading other political entities worldwide is brought up on several occasions, either with reference to international cooperation or with stress on the importance of setting a good example. EU's leadership in international cooperation is mentioned in connection to global carbon markers: 'The EU is also working with global partners to develop international carbon markets as a key tool to create economic incentives for climate action' (EGD: 3); in connection to energy policies: 'The EU will continue to promote and implement ambitious environment, climate and energy policies across the world' (EGD: 3); and in connection to long-term strategies in general: 'The EU will engage more intensely with all partners to increase the collective effort and help them to revise and implement their nationally determined contributions and devise ambitious long-term strategies' (EGD: 3).

The EU's role in setting a positive example for other international entities and states is formulated in connection to 'green procurement': 'Public authorities, including the EU institutions, should lead by example and ensure that their procurement is green' (EGD: 2.1.3); 'The EU should use its expertise in "green" regulation to encourage partners to design similar rules that are as ambitious as the EU's rules, thus facilitating trade and enhancing environment protection and climate mitigation in these countries' (EGD: 3); 'Initiatives to stimulate lead markets for climate neutral and circular products in energy intensive industrial sectors' (EGD: 4).

EU's leadership is also presented in connection to EU's international diplomacy: 'By setting a credible example, and following-up with diplomacy, trade policy, development support and other external policies, the EU can be an effective advocate' (EGD: 3); 'EU to continue to lead the international climate and biodiversity negotiations, further strengthening the international policy framework' (EGD: 4).

EU's diplomatic ties are presented as far outreaching the neighbouring countries and North-Western democracies, and as important for the 'Global South': 'More generally, the EU will use its diplomatic and financial tools to ensure that green alliances are part of its relations with Africa and other partner countries and regions, particularly in Latin America, the Caribbean, Asia and the Pacific' (EGD: 3).

4. Conclusion

The results include the identification of similarities between the two central legal documents as well as differences in the used linguistic practices. The identified nominative and predicative discursive strategies include those which are seemingly neutral such as 'environmental-related challenges' (EGD) as well as those with positive connotations such as 'growth strategy' (ibid.) or negative ones, e.g., 'extreme weather events that threaten human life' (USGND).

Some examples of the argumentation schemes include for example the topoi of 'transforming the society into a fair and prosperous one' (EGD) or 'mass migration caused by climate change' (USGND). The similarities and differences between the two documents are based in the respective legal cultures as well as in the cultural contexts of accepting responsibility for environmental issues.

Environmental justice can be achieved through proper shaping of international law and through leading examples of the strongest international actors and leaders. Public legal discourse plays an indispensable part in proper law-making. While there have been ‘a myriad of political responses’ to climate challenges, at least since the 1990s’ (Stoddard 2021: 655), the humanity is still far from reaching a global environmental consensus, where national, federal (US), European (EU), and international laws would aim at achieving identical goals through identical means. On the contrary, regional development and economic growth still continue to cause ‘synergies and tensions’ (Bachmann-Vargas and von Koppen 2020: 366).

While domestic environmental measures in developed economies are often effective despite economic growth, global measures are still lacking coherence and effectivity (Hausknost 2020: 17). It is important to consider a unified direction internationally in adopting changes leading to environmentally sustainable future (Sovacool 2020: 643).

Critical discourse analysis of the most important legal documents such as the EGD and the GND can aid achieving such goals, necessary for environmentally just society for the future generations of humanity to come.

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NEW CALLS FOR UKRAINIAN AGRICULTURAL LABOUR MARKET

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Annotation: The article assesses employment situation in the agricultural sector of Ukraine and identifies the cumulative effect, caused by emergence of new factors, influencing the employment situation in Ukrainian agricultural labour market and provides a strategy for supporting public policy mechanisms for improving current situation in employment market in Ukraine's agriculture in view of war conflict, economic crisis in the country and closer cooperation with the EU. The results of the analysis of employment trends in the Ukrainian agricultural sector market demonstrate negative tendencies with high share of shade employment. The analysis has also shown that during 2002-2021 such factors as active rural population, demand for employees in agriculture – number of vacancies and labour productivity have the strongest impact on the employment situation in the agricultural sector of Ukraine. During the research, statistical analysis, system analysis (for defining the factors, influencing employment in agriculture), multiple regression analysis (for assessing relation between the employment and the impact of the determined factors on the employment in agriculture of Ukraine have been implemented.

Keywords: Employment, Agricultural labour market, Ukraine, Factor analysis

JEL classification: Q1, Q17, E27

1. Introduction

Russia's invasion to Ukraine, started on the 24th of February 2022, has multiple impacts, and it has radically changed the pre-war situation. The large-scale impacts on the world's agri-food trade and commodity systems are expected. The feed, fuel, fertilizer and of course food are all heavily affected. Upon FAO's preliminary prognoses wheat prices could increase by almost 9%, in its severe scenario – even by over 21% in the short-term perspective, and the additional increase in the number of undernourished people around the world could vary from just over 7,5 to 13 million people in the next several years (Bechdol et al., 2022). Up to 30% of the country's sown area will remain unsown.

Before the Russian invasion, Ukraine exported 90% of its agricultural products through Black Sea ports. However, fierce fighting and occupation of cities in the southeast have blocked access to important routes. Currently, all businesses are trying to refocus logistics on rail services (State Statistical Bureau of Ukraine and Public Radio of Ukraine, 2022).

Before the war Ukraine's agribusiness sector remained the most promising sector of the economy: favourable natural and climatic conditions, agricultural land is covering 68.8 % of the country (41.5 million hectares), the country possesses about 25 % of the world's reserves of black soil, one third of country's population lives on rural territory. All these factors make agriculture Ukraine's largest export industry. In 2021 *agricultural* sector generated approximately 10,0% of GDP and the share of agriculture in export revenues has grown from 26 % in 2012 to 45 % in 2020 (Country Commercial Guide). In 2021 production rate of agricultural enterprises has reached its maximum (19.2%), providing the largest supply (41%) to the foreign exports of Ukraine (Pavlysh, O., 2022).

Ukraine has entered the TOP-4 largest countries exporting agricultural products to the European Union with major export commodities as cereals and oilseeds, fats and oils, processing industry residues (Mission of Ukraine to the European Union. Cooperation in Agriculture 2020-2021). Moreover, the increased importance of agriculture at the international commodities markets has led the inflow of foreign currency and foreign investments into the Ukrainian economy thus strengthening Ukraine's position in the world markets and prospering to general economic growth in the country. Furthermore, recent land reform, structuration of agricultural communities, high and specialized agricultural schools' reforms, involvement into the rural development programs in the context of Eastern Partnership initiative and closer cooperation with the EU in the context of Deep Comprehensive Free Trade Agreement, higher foreign direct investments inflow to the sector have positively affected the situation in the Ukrainian agrarian labour market and are being expected to stop the negative narrative in growing unemployment in the agricultural sector.

Despite the above-mentioned positive features, the number of social-economic and political factors, which more or less have an influence on agriculture sector development, are being observed in the branch. War in the country, lack of state support, economic crisis, constant reduction in rural population, increase in labour migration etc. − all this brings uncertainty to the agricultural sector and enables to reveal its full potential. Agricultural labour market has predictably reacted to the above-mentioned tendencies: the attractiveness of agricultural branch in the Ukrainian labour market has decreased from 20% in 2012 to 14,1% in 2020(Ukraine Statistic Committee). Obviously, this reduction is a composite result of multiple factors – both "traditional" and newly appeared ones. The question is, which of the factors have the highest influence impact on the agricultural the employment market and which ones play the minor role.

The main objective of the research would be to evaluate the multiplicative effect, caused by emergence of new factors, influencing the employment in Ukrainian agricultural labour market and to offer the strategy for supporting public policy mechanisms for improving current situation in employment market in Ukraine's agriculture, taking in account the economic crisis in the country and European integration course.

To reach the main objective, the following partial objectives should be fulfilled:

- assessment of situation in the agrarian labour market of Ukraine: current state, problems, trends, recent changes, possible risks and perspectives;
- assessment of factors, influencing employment rate in the agriculture and the degree of their impact on the employment situation in the Ukrainian agrarian labour market;
- to offer a strategy for supporting public policy mechanisms for improving current situation in employment market in Ukraine's agriculture.

Figuring out the factors with the highest impact on employment in agriculture in Ukraine and their potential influence on the development of Ukrainian agricultural market in connection with the further integration with the EU will allow to prove or disprove the following hypothesises:

Hypothesis 1. The economic and political crisis has a negative influence on the employment in agrarian sector of Ukraine.

Hypothesis 2. Economic factors have the strongest impact on the on the employment in agriculture in Ukraine.

The issues of employment in the agricultural sector of Ukraine are being widely presented in the works of such Ukrainian and foreign scientists as Becker (2009), Bukharina (2021), Shyshkin (2021), Bezpartochna (2021), Dankevych (2017), Deffontaines (2021), Faryna (2021), Furman (2021), Gerasymova (2019), Gnybidenko (2015), Gorlachuk (2017), Belinska (2017), Furman (2021), Nolte (2016, 2017), Malik(2019), Chibuzor (2020), Hrumak (2018), Kukel (2020), Kuryltsiv (2017), Herrmann (2017), Moldavan (2021), Patyka (2021), Shubalyi (2021), Shulha (2021), Chamberlain (2016), Tomashuk (2020), Fox (2018), Sumedh (2012), Vasylieva (2021), Yakubiv (2019), Yekimov (2021), Yurchuk (2021), Zbarsky (2020).

According to Bukharina, Shyshkin and Onyshchenko (2021) it is required that Ukrainian government should develop effective mechanisms for national agricultural producers support to attract both more personnel and to increase productivity and thus to be competitive to foreign farmers on the world agrarian market. This strategy also requires the modification of management methods in agribusiness enterprises and more effective personnel approach. Onegina V. et al. (2020) also stands for importance of additional investment into the human capital in agricultural sector as the basis for higher productivity, and in case of Ukraine – it has a special importance in view of strategic value of this sector for the economy of the country.

Hrumak, Vovk and Kindrat (2018) are seeing the employment problem from the long-term perspective horizon, especially in case of high rural youth unemployment and its possible negative effect on the whole economy in the future. Chibuzor (2020) emphasizes that aagriculture refers to sectors of the economy that can provide employment to young people who are the most affected by unemployment (56% of the unemployed out of all rural youth). A significant proportion of rural youth move to cities, which explains the increase in urbanization, or simply emigrate from the country. This trend can be overcome by increasing the share of budget training in agricultural specialties, so that young people can get a qualified education, and most importantly - can apply their skills in agriculture. However, the main reason lies in the lack of jobs with competitive wages.

Shnyrkov, Mazurenko and Stakanov (2021) share the similar view on necessity of youth employment support and emphasizing the danger of active labour resources migration, that may lead to the loss of "a key resource of the country – human capital".

According to Shubalyi et al. (2021) and Kukel, Roleders and Semchuk (2020) structural reforms in the economy (especially, in agriculture), land and property reforms, digitalization of society; state regulation of labor potential etc. belong to the main factors, influencing the employment processes in Ukrainian agricultural sector and explaining why the economic activity of rural population remain "undeveloped" comparing to world standards.

Detailed analysis of factors, influencing the employment in the Ukrainian agricultural sector, is provided by Patyka et al. (2021). The following factors are considered to have the negative trend on the employment: changes in the structure of agricultural production (for example, sharp increase in crop production, which is a less labour-intensive industry, and simultaneous decrease in animal production), shortage of vacancies, low labour productivity, low wages, reduction of the economically active rural population, age structure deformation, etc.

The major part of the analytical literature on land reform in Ukraine concerns the problems of higher productivity and competitiveness of Ukrainian agricultural enterprises, through reforming property rights and moratorium on land and the impact of land reform on employment and welfare of rural population is not that widely discusses. Especially it comes with the dissonance of paying greater attention to the agricultural producers' problems and undervaluing the situation of rural population – their motivation, interest, benefits or losses from the land reform, and as the result – their wiliness to be employed in the agricultural sector. The aspects of land reform in Ukraine and its influence on employment in the agrarian sector are presented in works of Dankevych E., Dankevych, V., and Chaikin (2017), Kuryltsiv, Hernik and Kryshenyk (2018), Gorlachuk and Belinska (2007).

Another important factor, influencing the employment situation in the agrarian sector is the emerge of big agrarian holdings. According to Moldavan and Pimenova (2021) it requires the state regulation of the distribution of agricultural land between economic objects, restricting access to land of non-agricultural companies, monitoring rural population being provided with workplaces and preventing of the formation of oligarchic management system in agriculture of Ukraine.

Along with the domestic scientists, the problems of employment in the agrarian sector have been studied by foreign researchers and international organizations (Council of the European Union, Agriculture and Fisheries Council, European Economic and Social Committee. Agriculture, Rural Development and Environment, World Trade Organization, *Food and Agriculture Organization of the United Nations etc.*).

In economics there are many theories, considering the factors, influencing the employment in economics either without the need of state intervention to the self-regulating market - Smith (2010), Say (2017), and also with the need of state's active presence - Keynes (1937), Hansen (1951), Harrod (1948), Schultz (1961), Becker (2009).

For example, Chamberlain and Giger (2016) and Nolte and Ostermeier (2017) reveal the negative impact of large-scale agricultural investment related to the increasing the size of agricultural enterprises and increasing production of capital-intensive crops on employment in agriculture. More positive opinion is shared by Deininger and Xia (2016), Herrmann (2017), standing that in view of recent changes in the context conditions it is possible to presume that large farms may have a future (Deininger and Byerlee, (2012)) and may actually positively effect on welfare and poverty reduction as a result of employment creation.

Sumedh (2012) stands that growth of the agricultural sectors in middle- and low-income countries (including fragile and conflict affected states, which is highly actual for Ukraine now) does not necessarily lead to increased employment and is of the opinion that the link between employment and growth of agriculture is highly context-dependent(Sumedh (2012), pp. 1-2): "The relationship varies as a result of the type of produce (e.g. fruits and vegetables versus cereals), the structure of the business (e.g. small landowner versus larger agribusiness) and the wider economy as a whole". According to Sumedh (2012) increase in share of secondary and tertiary sectors in country's economy, rural-to-urban migration and "income opportunities" outside of agricultural sector may lead to the reduction in the cheap labour supply. Special attention is paid to the smallholder agricultures. They are considered as more labour-intensive, cost-effective, but fragile to in relation to scaled up agricultural activities and keeping quality of employees at a high level.

The effects of direct payments and rural development measures of the EU's Common Agricultural Policy (CAP) on employment in agriculture are presented in the research of Petrick and Zier (2012).

However, in spite of the great scope of scientific research, the issues of determination of the factors influencing employment in the domestic agriculture, need a deeper investigation, especially in view of Ukraine's current political and economic situation. Little research has been done on assessment of influence of factors, determining employment situation in agricultural sector of Ukraine in connection with DCFTA with the EU, free visa regime(its influence on "shadow" labour migration), calls for sustainable development and newly appeared requirements for labour force qualifications, covid situation, political situation in the country and life-standards of rural population, effects of recently appeared in the Ukrainian agrarian market international agricultural holdings, inflow of foreign direct investments into the Ukrainian agrarian sector, land reform consequences for small and medium-sized national agri-businesses. Of course, it's too early to make any presumptions on evaluation of consequences of Russian invasion to Ukraine, but it's clear that they will be drastic and invaluable. Agriculture belongs to the relatively fast-renewable sectors of the economy, the question is that it's the most valuable part – people – will be heavily affected and partially lost both due murders, mutilation and migration. Though the situation remains unclear, the Ukrainian Agrarian Ministry has declared the course on maximal possible agricultural activity in all not affected by the war areas.

2. Materials and Methods

In order to achieve the defined goals, the following research tasks have been set:

- to provide the assessment of current situation and trends in the agricultural labour market of Ukraine;
- to identify basic factors, influencing the employment in the agricultural sector of Ukraine and gradate them according their influence power;
- to offer the recommendation on improvement of the situation in the agricultural labour market of Ukraine in future.

The research is based on the empirical methods. For the evaluation of the situation in labour market methods of classic statistical analysis will be used. Both above mentioned empirical methods, and qualitative methods enable to provide the assessment of transformation processes that have happened in the Ukrainian labour market in view of European integration.

Defining the factors with the highest impact on employment in agriculture in Ukraine is reached by applying system analysis (to figure out the factors influencing the number of people employed in the agricultural sector of Ukraine with their further arrangement into the corresponding groups (political/social/economic factors) and the level of impact of the above-mentioned factors will reached by complex regression model (Fox and Weisberg, 2018; Golnaraghi, S. et al., 2020) with time horizon 2002-2021:

$$Y = \alpha + b_1x_1 + b_2x_2 + b_3x_3 \ldots . + b_nx_n \qquad \textbf{(1)}$$

where:
Y is the value of the Dependent variable (Y), what is being predicted or explained
α (Alpha) is the Constant or intercept
b_1 is the Slope (Beta coefficient) for x_1
x_1 is the first independent variable that is explaining the variance in Y
b_2 is the Slope (Beta coefficient) for x_2
x_2 is the second independent variable that is explaining the variance in Y
b_3 is the Slope (Beta coefficient) for x_3
x_3 is the third independent variable that is explaining the variance in Y
s.e. b_1 standard error of coefficient b_1
s.e. b_2 standard error of coefficient b_2
s.e. b_3 standard error of coefficient b_3

The model allows to estimate the influence of two or more independent variables (number of registered unemployed people in the rural area, demand of agricultural enterprises for the hunting, forestry and agriculture employees, etc.) on a dependent variable(employment) and thus will enable to grade the influence factors upon the level of their impact on employment.

Combination of regression model results with the application of the above-mentioned methods will enable to test hypothesises and to forecast the scenario of the development of employment situation in the Ukrainian agricultural market. For the complete finalization of the research paper the modelling method will be applied to offer the "factor-influencing" model determining the potential for higher employment in agriculture of Ukraine.

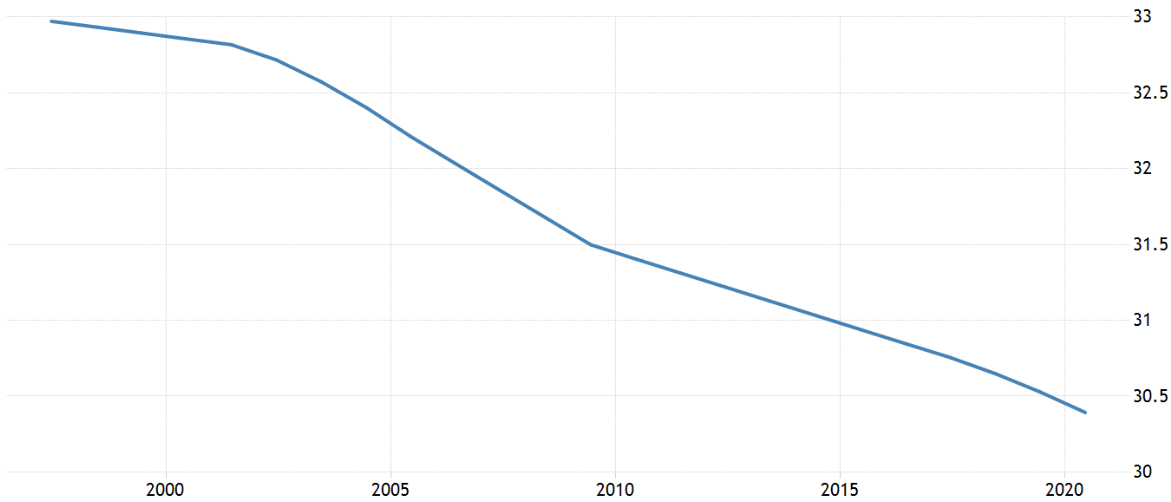
The information base of the research consists of the data retrieved from the State Statistic Service of Ukraine, World Bank and European Statistic Service database.

3. Results and Discussion

The rural population is the basis for the formation of the labour force in the agricultural sector of the economy, the number of which is significantly reduced due to negative socio-economic and demographic processes. According to the official statistics as of 1.1.2021, the total population makes 41,6 million permanent residents, with 29 million of urban and 12,6 million people of rural residents. Comparing to 2002 with 48,6 mln. people, in 2021 the total decrease in population has made 6,9 mln. people (-14,2%), from which the decease has made 3,6 mln. (-11% from urban population in 2002) in urban population and 3,3 mln. (-20,8% from rural population in 2002) (author's calculations on the basis of data from State Statistics Service of Ukraine).

In general, the structure of population 2002/2021 has been steadily changing upwards the growing share of urban population: from 2002 the share of urban population has increased from 67,2% to 70,2%, and the share of rural population has changed from 32,8% in 2002 to 29,8 in 2021(Figure 1).

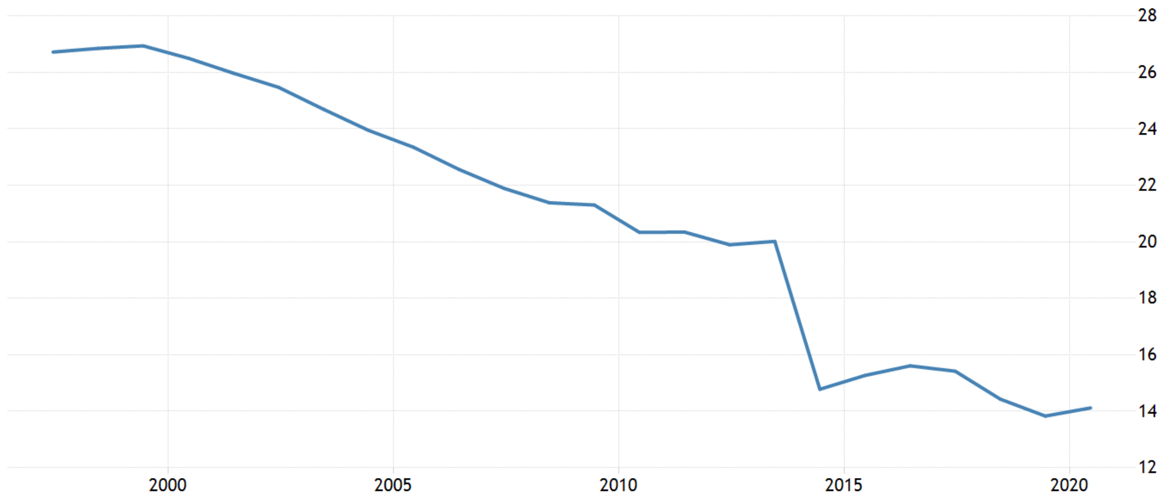
Figure 1. Rural Population (% Of Total Employment)



Source: World Bank

Along with the growing share of agriculture in the economy the share of employment in this sector has been constantly decreasing (Figure 2). In 2002 with record 26%, in 2015 the rate in employment has made 15,26%, in 2016 – 15,6%, in 2017 15,41, in 2018 – 14.87%, in 2019 – 14,48% and in 2020 the employment in agriculture was reported its historical minimal rate – 14,11 % (World Bank, State Statistics Service of Ukraine).

Figure 2. Employment In Agriculture (% Of Total Employment)



Source: World Bank

Controversial character of the current employment situation – steadily decreasing employment rates at constantly growing share of the agricultural sector in the Ukraine's economy might be explained by many factors, depending on their nature.

Political factors:

war conflict in the East of Ukraine since 2014 and war invasion of Russia to Ukraine since 24.02.2022. Stolen equipment, fires, rocket debris on land and fear of work are all realities of wartime. It is very dangerous to return to agricultural trials in areas of active hostilities. Farmers in bulletproof vests and helmets get on tractors and drive in open fields, risking becoming potential targets for air strikes. Many people were forced to leave their homes. The number of people, force to emigrate and people losses are not evaluated yet, though agriculture ranks the 5th place in the most war suffered branches of Ukrainian economy (38% damaged: 15% released by Ukrainian army and 23% is still occupied by Russian army) after Black Metallurgy on the 1st place(57% damaged: 4% released by Ukrainian army and 57% occupied by Russian army), Transport and automotive engineering on the 2nd place(51% damaged: 11% released by Ukrainian army and 40% is still occupied by Russian army), Other production on the 3rd place (47% damaged: 9% released by Ukrainian army and 38% is still occupied by Russian army), Rubber and plastics on the 4th place (39% damaged: 21% released by Ukrainian army and 18% is still occupied by Russian army)(Vyshlinsky, H. et al., 2022). In view of absence of data this factor has not been included into the present model.

Economic factors:

- investments in agriculture, export and import of agricultural products, gross added value in agriculture;
- structure of agricultural production. Within the last years in Ukraine there is a steady trend to increase the share of crop production (which is less labour-intensive than animal production) in the structure of agricultural production from 51,5% of crop production of the total agricultural production to 73,7% in 2018. This, consequently, has led to the decline in livestock and dismissal of workers. Unemployed workers in the short term will not be able to retrain to work in crop production. In addition, crop production does not require such a large number of workers dismissed from animal production.

In the regression model these factors are presented with Demand for employees in Agriculture, Thousand open positions, Percentage to the average monthly nominal wage in the Economy, %, Indexes of agricultural production, %, Labour productivity in agricultural enterprises to the previous year, %, Net Export of agricultural Products, mln. USD, Share of Agriculture in the GDP, %, Ratio of investments to the GDP, Agriculture, %.

Social-demographic factors:

- decrease in the number of rural population and, consequently, lower future labour potential, but it comes into contradiction with the growing share of the agrarian sector in the economy of the country;
- sectoral, seasonal and abroad labour migration, "shadow employment". Within the last years sectoral international and intro-country migration had a steadily decreasing tendency; among the major economic activities, employment in agriculture with 44% lead the position in the "shadow employment" rate, being followed by construction – 17%, wholesale and retail trade, motor vehicles services – 16% (State Statistic Service of Ukraine);

- lower salaries, comparing to other sectors of the economy. In 2021 the average salary (nominal) of a full-time employee of enterprises, institutions and organizations was UAH 17,453, which is 2,7 times higher than the level of the minimum wage (UAH 6,500). The highest average nominal salary was in the field of financial and insurance activities (UAH 31,274), as well as information and telecommunications (UAH 29,963), and average salary of full-time employees in agriculture amounted to UAH 12,827, which 36% less than the average nominal and 2,4 times less than the highest average nominal salary in the country (State Statistic Service of Ukraine);
- land reform and privatization processes with growing number of small private businesses with "informally employed" employees: mostly peasants who have homesteads and are therefore denied registration as unemployed as allegedly employed in the agricultural sector. A similar problem applies to 37% of "informally employed" citizens, at the expense of residents of small towns with similar plots of land (Kramar, O., 2022); lack of state support for small business, lack of investments and programs for youth, etc.

The list of factors, potentially influencing the employment in the agrarian sector of Ukraine can be much longer. Table 1. presents the main data, characterizing the dynamic development of Ukrainian agricultural labour market within the last 20 years: 2002-2021.

The majority of data is collected from the reports of State Statistic Service of Ukraine with some data marked with ^{x} as preliminary prognoses for 2021. Next, the method of correlation and regression analysis was used. Therefore, the research results determine the functional dependence between the factors of product outcome and labour productivity, index of agricultural products and net export of agricultural products, between the gross production and the share on animal products in it.

Table 1. Social-demographic and economic factors, influencing employment in the agrarian sector of Ukraine

Period	**Employment in Agriculture, Thousand People**	**Active Rural Population, Thousand People**	**Demand for employees in Agriculture, Thousand open positions**	**Percentage to the average monthly nominal wage in the Economy, %**	**Migration of Rural Population within the country, Thousand People**	**International Migration of Rural Population, Thousand People**	**Indexes of agricultural production, %**	**Labour productivity in agricultural enterprises to the previous year, %**	**Net Export of agricultural Products, Mln USD**	**Share of Agriculture in the GDP, %**	**Ratio of investments to the GDP, Agriculture, %**
	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
2002	4135,8	10028	7,1	47,3	18359	1067	101,2	117,8	1138	14,5	63
2003	4105,7	9913	7,6	45,5	17752	885	89,0	93,3	304	11,9	71
2004	3998,3	9801	9,4	50	18306	760	119,7	166,8	1031	11,7	88
2005	4005,5	9690	10,4	51,5	17479	573	100,1	114,6	1402	10,3	121
2006	3652,6	9585	8,1	53,1	16928	579	102,5	115,5	1027	8,4	176
2007	3484,5	9507	7,3	54,3	17016	514	93,5	105,6	842	7,2	198
2008	3322,1	9464	4	59,6	15181	429	117,1	143,8	3196	7,6	258
2009	3152,2	9446	2,2	63,3	13607	546	98,2	103,1	3103	7,8	143
2010	3115,6	9433	2,7	63,9	14524	340	98,6	101,0	1942	8,3	130
2011	3410,3	9468	2,9	67,4	14529	341	120,2	124,2	3617	8,2	147
2012	3407,6	9462	2,5	66,6	13567	347	96,1	97,0	6035	7,8	164

2013	3389,0	9439	2,3	69,1	12913	267	113,6	127,3	5398	8,69	137
2014	3091,4	9391	1,6	71,1	10404	229	102,2	109,0	6595	10,15	114
2015	2870,6	8791	1,2	74,8	10233	218	95,2	98,2	7100	12,06	122
2016	2866,5	8736	1,5	75,6	2831	42	106,3	122,6	6958	11,73	178
2017	2860,7	8672	2,2	81,1	4701	63	97,8	98,7	8226	10,18	209
2018	2937,6	8608	2,5	80,8	11463	143	108,2	114,9	8649	10,14	180
2019	3010,4	8537	5,1	83,2	10151	154	101,4	107,0	11325	8,97	164
2020	2721,2	8486[x]	3,1[x]	84	8091	69	89,9	92,3	10400	9,27	110[x]
2021	2360,2	8422[x]	2,6[x]	86,9	8981	77	116,7	92,3	10812	10	137[x]

Source: composed by the author, referring to the data of the State Statistics Service of Ukraine.

[x]State Statistic Service of Ukraine, preliminary prognoses

The results of the analysis of the impact of social-demographic and economic factors on employment in the agrarian sector of Ukraine are presented in Table 2.

Table 2. Results of the regression analysis of the impact of social-demographic factors on employment in Ukraine's agriculture.

	coefficient	std. error	t-ratio	p-value
const	-5106.59	4171.04	-1.224	0.2519
x_1	0.810511	0.286817	2.826	0.0199**
x_2	74.1678	26.6370	2.784	0.0212**
x_3	11.2861	28.6382	0.3941	0.7027
x_4	-0.0119840	0.0258173	-0.4642	0.6535
x_5	0.369563	0.242499	1.524	0.1619
x_6	-10.2228	7.14721	-1.430	0.1864
x_7	8.00988	4.16130	1.925	0.0864*
x_8	0.0143981	0.0541192	0.2660	0.7962
x_9	5.73596	35.0121	0.1638	0.8735
x_{10}	-0.732276	0.897040	-0.8163	0.4354

Mean dependent var	3294.890	S.D. dependent var	493.1720
Sum squared resid	161685.0	S.E. of regression	134.0336
R-squared	**0.965012**	Adjusted R-squared	0.926136
F (10, 9)	24.82309	P-value(F)	0.000024
Log-likelihood	-118.3555	Akaike criterion	258.7110
Schwarz criterion	269.6641	Hannan-Quinn	260.8492
rho	0.086015	Durbin-Watson	1.720672

Excluding the constant, p-value was highest for variable 10 (x_9)

The results of the analysis show that during 2002-2021 such factors as active rural population, demand for employees in agriculture – number of vacancies, nominal wages and labour productivity had the strongest impact (R-squared 0.965012) on employment situation in the agricultural sector of Ukraine. The results of the model do coincide with the results of earlier researches and publications on the above-mentioned topic: people capital, job availability and labour productivity (automation of processes, investments to the modernization of agricultural equipment) have been already mentioned both by Ukrainian and international researchers (Kukel G., Roleders V., and Semchuk, I., 2020; Bukharina, L., Shyshkin, V. and Onyshchenko, O, 2021; Patyka, N., et al., 2021) as key factors, defining employment situation in the agricultural sector.

4. Conclusion

On the assumption of the analysis of the already researches and publications on the above-mentioned topic, it is possible to assume that economic factors might had the strongest effect on employment situation in the agrarian sector during 2002-2021, which approves stated hypothesises on direct relation between economic environment and employment in agriculture of Ukraine.

In view of current political situation, it is possible to presume that political and safety factors may also have a very high importance. It's hard to make any prognoses as actual situation is unpredictable and questions of life and food safety get the highest importance. Additional investments would be required for restoring damaged agricultural households and involving more people to the agrarian sector. Comparing to other branches of the economy agriculture belongs to the fast-renewable ones, so it possibly may restore its potential faster than other branches after the war ends.

For now, Ministry of Agriculture has figured out the following steps, aimed at supporting Ukrainian agricultural businesses:

- allowance to use of all available agricultural land for the sowing campaigns (simplifies the acquisition of land use rights for agricultural purposes in martial law). In addition, preconditions have been created for agricultural production on state-owned lands, which are now in constant use by state enterprises of the Ministry of Agrarian Policy, educational institutions, etc.;
- district military administrations may lease state and communal agricultural land plots for agricultural production for up to one year;
- temporary tax cancellation for land plots located in the territories where hostilities are conducted or in the territories temporarily occupied by Russian armed forces of the Russian Federation, and for areas designated by regional military administrations as contaminated with explosives or fortifications;
- automatic prolongation of leased land relations is for one year without entering information into the relevant registers;
- state of heightened security control and safety of workers during field work. To maintain the safety of workers in the fields, Ministry of Agrarian Policy of Ukraine has launched the Military.feodal.online project, which helps farmers quickly pass information about mined fields to the Armed Forces to neutralize abandoned hazardous objects and to indicate information about the status and problem of the field and coordinates where the inspection and disposal of the object is required;
- additional crediting for agricultural businesses in the amount of the credit guarantee is 80% of the loan amount of the micro, small and medium business entities (except for large business entities).

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USING THE AGRICULTURAL ROBOT TO CONTROL POTATO DISEASES

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Annotation: In modern conditions, technologies of differentiated application of chemicals necessary for the full development of crops, including potatoes, are actively developing. In this field, a special place is occupied by new types of equipment, one of which are robots. The aim is to compare the economic results of the farm by two technologies of protection of potatoes from diseases: a) traditional; b) on precision farming with the use of robots. The technologies were tested in conditions of private farm in Irtysh district (Pavlodar region, Kazakhstan). As novelty are the results of comparative analysis of the use of classical technology and technology based on differentiated fungicide application in the cultivation of potatoes. Using robots, the aeration and hydrological regime of the soil are improved, resulting in fast and uniform overgrowth of field areas. Our robot focuses on four objectives. First, it increases potato yields (by 21.3%). Secondly, the number of fungicides consumed is reduced (by 29.5%). Thirdly, the role of human factor in crop production is reduced, which is accompanied by the facilitation of field work. Fourthly, the ecological orientation of crop production is provided due to light robots, which do not cause shear deformation of soil cover, in contrast to heavy agricultural machinery (tractors). The proposed method accelerates the payback period of the robots and makes it possible to monitor the state of plants in the field in real time.

Keywords: Digitalization, Agricultural robot, Fungicides, Plant diseases

JEL classification: Q15, Q16, Q55

1. Introduction

Considering the introduction of digital technologies in agriculture in many countries around the world, there is a need to assess the impact of such technologies. The digitalization of agriculture provides new opportunities for the growth of the industry through the dissemination of information technology solutions, analytical tools, and cloud data. One of the most important areas of agricultural digitalization is precision farming and implementation of field robotics [5]. We decided to combine these two areas in our project. In Kazakhstan, the problem of improving the competitiveness of domestic entities of the agro-industrial complex remains significant. To solve this problem, it would be advisable to use "smart" technology among as many farms as possible.

The tasks are put forward:

1) to prove the cost-effectiveness of using robots in potato fungicide treatment on the basis of practical tests of the robot in the field;

2) to justify the advantages of using the robot from the position of soil conservation and realization of other useful environmental effects (in comparison with traditional agricultural machinery).

The average air temperature where the private farm is located is -18°C in January and +20°C in July. The sum of active temperatures varies in the range of 2,200-2,450°C per year. The average annual rainfall does not exceed 260 mm.

Soil type – southern carbonate weakly saline heavy loamy chernozems, the content of humus in the soil layer up to 20 cm varies on average from 3.5% to 3.7%. According to the mechanical composition, the soil belongs to loams. Soil density is above average – 1.17-1.28 g/cm^3. The average content of mobile phosphorus in the soil is 164 mg/kg, potassium – 237 mg/kg, total nitrogen – 46 mg/kg. Soil appraisal score is 35.0. The given soil quality parameters indicate the average provision of the farm with soil resources.

Crops grown are potatoes, wheat, mustard, sunflowers, vegetables.

2. Materials and Methods

Experiments were conducted to detect dehydration, diseases (phytophthorosis, alternaria). The place of testing the robot was a potato field of 8 hectares in a private subsidiary farm in Kyzylzhar village, Irtysh district (Pavlodar region, Kazakhstan). The potato variety was "Golubizna". Potatoes reached ripeness in an average of 93 days. In the chemical treatment of plants, the detachment method was practiced: three robots moved across the field from south to north as the soil warmed up and the crop matured. This ensured a high workload of robots during the trials and, consequently, a tighter control of robot reliability.

Until 2019, the farm used the drug Fluacinam to control phytophthora. And in 2020, the farm switched to Bayer's «Infinito» drug. It has a systemic-translaminar mechanism of action [4]. The results of field treatment will be described below.

The potato field was divided into 3 parts: control (without treatments); with treatment by "Infinito" with a sprayer; with robotic treatment by "Infinito". Brand sprayer for the traditional version – “Zubr Grand Master 4000” with a 24 m boom (country of production – Belarus). Our robots were used for the «Infinito» robotic treatment, equipped with a reservoir with valves and sensors for the chemicals (according to the prescribed assignment card).

The mention of products of certain manufacturers, whether patented or not, does not mean that the author endorses or recommends them in preference to other products of a similar nature which are not mentioned in the text.

In the first phase of work on the transition to precision farming, soil samples were taken from the "G-3" field to create and digitize maps characterizing soil quality and properties.

The polygonal extraction method was used to select soil areas territorially confined to the study area. The digitization was performed in the program-technical complex "Cosmos-Agro" (SCANEX GC) using standard tools. This service was used to calculate the areas occupied by each soil plot with a certain trait. In our case, we can note the predominance of soils with a reaction close to neutral. It is an advantage for the enterprise (due to the lack of the need for regular chemical reclamation activities).

We obtain direct costs based on the using technological map for potato. We calculate revenue (R) by multiplying an average price of potato (P) by its total yield (Y):

$$R = P \times Y. \quad (1)$$

Profit (W) is considered to be a difference between revenue (R) and direct costs (C):

$$W = R - C. \quad (2)$$

Payback period of one robot (*PBP*) is calculated by dividing the value of robot (*A*) by the profit (*W*):

$$PBP = A / W. \quad (3)$$

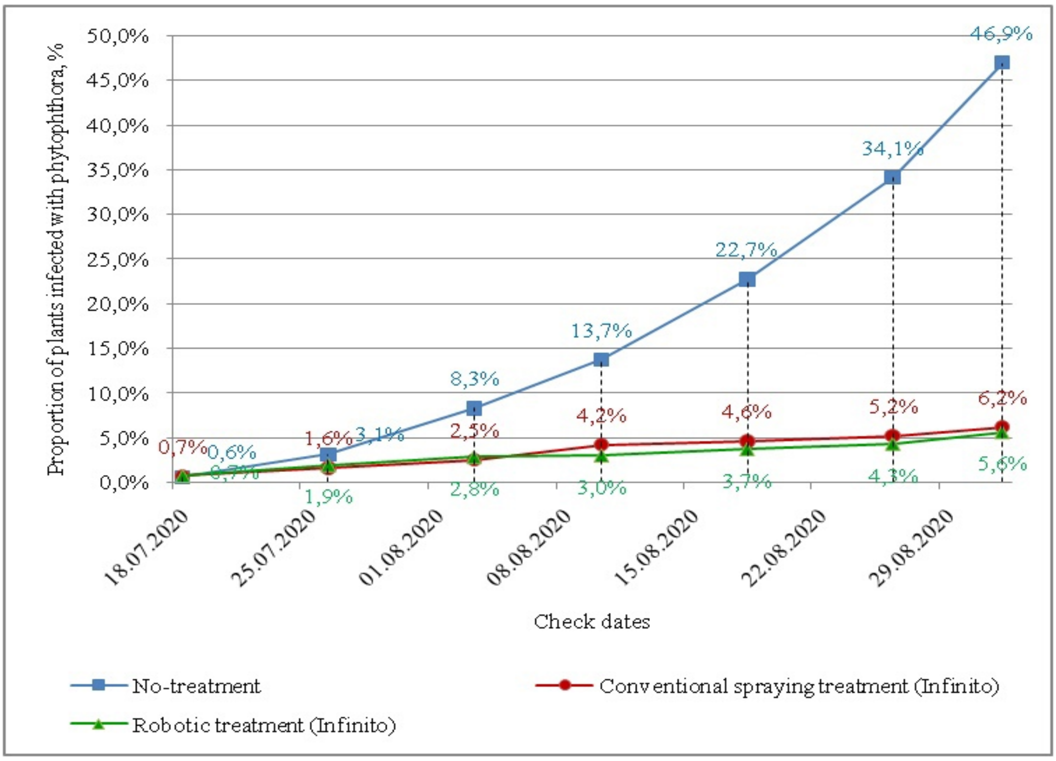
Payback period is expressed in number of seasons when the robotic technology pays for itself.

3. Results and Discussion

We used the robot for selective fungicide application to control potato diseases. It is equipped with a boom for spraying liquid fungicides on the plants.

The preparation "Infinito" successfully shows itself in the prevention of diseases (phytophthora). On September 1, 2020, 46.9% of the potato crops not treated with "Infinito" were infected with Phytophthora. But in the fields where this protection agent was used, the disease incidence rate was in the range of 5-7%. Robots did not make a noticeable difference in plant health when compared with traditional treatment with a trailed sprayer. For example, as of August 26, 2020, the percentage of diseased plants in the field using robots was 4.3%. At the same time, in the field with continuous application of "Infinito" the percentage of diseased plants was 5.2% (Figure 1).

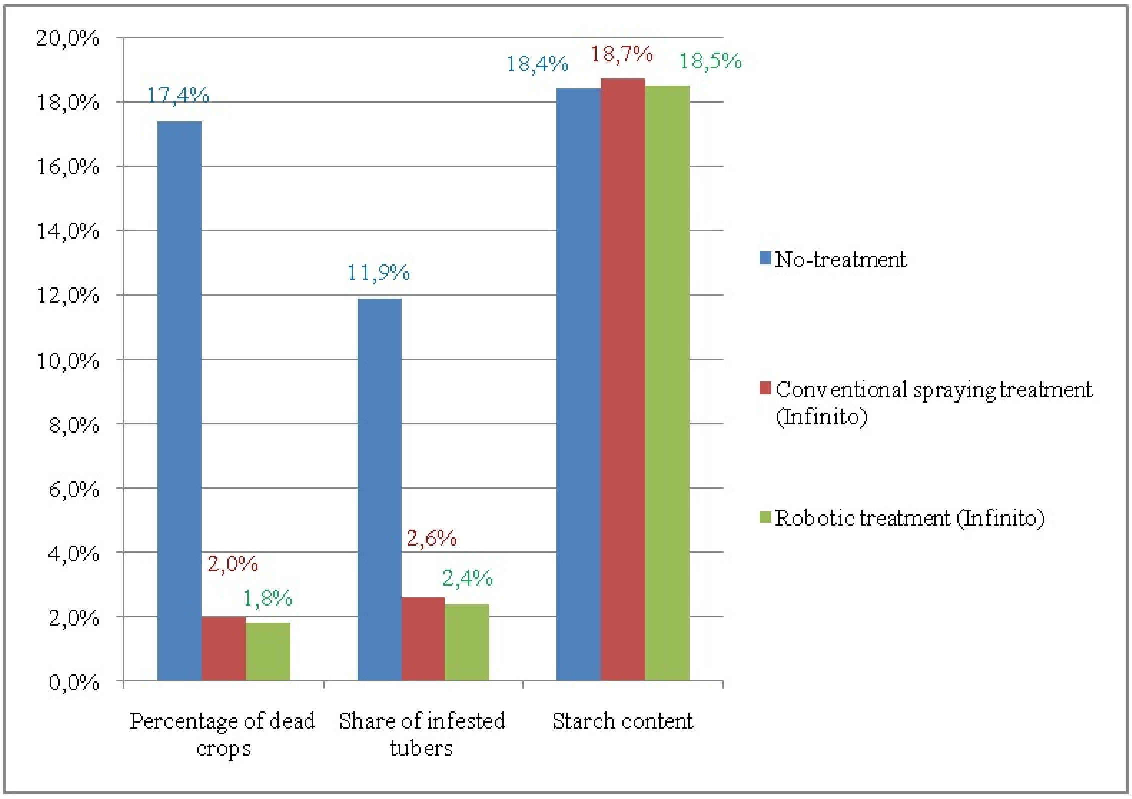
Figure 1. Proportion of potato crops (%) infected by phytophthora in: a) the control field (no treatment); b) the field treated with the traditional sprayer; c) the field treated with the robot



Source: compiled by the authors.

In case of failure of potato protection system, high degree of phytophthora infestation was observed in the field. For example, the proportion of dead crops was 17.4%, while the level of infected tubers was 11.9%. In the fields where the preparation "Infinito" was used, the loss of crop was not more than 2.0%. Starch content in the three variants remained at an average level, in the range of 18-19% (Figure 2).

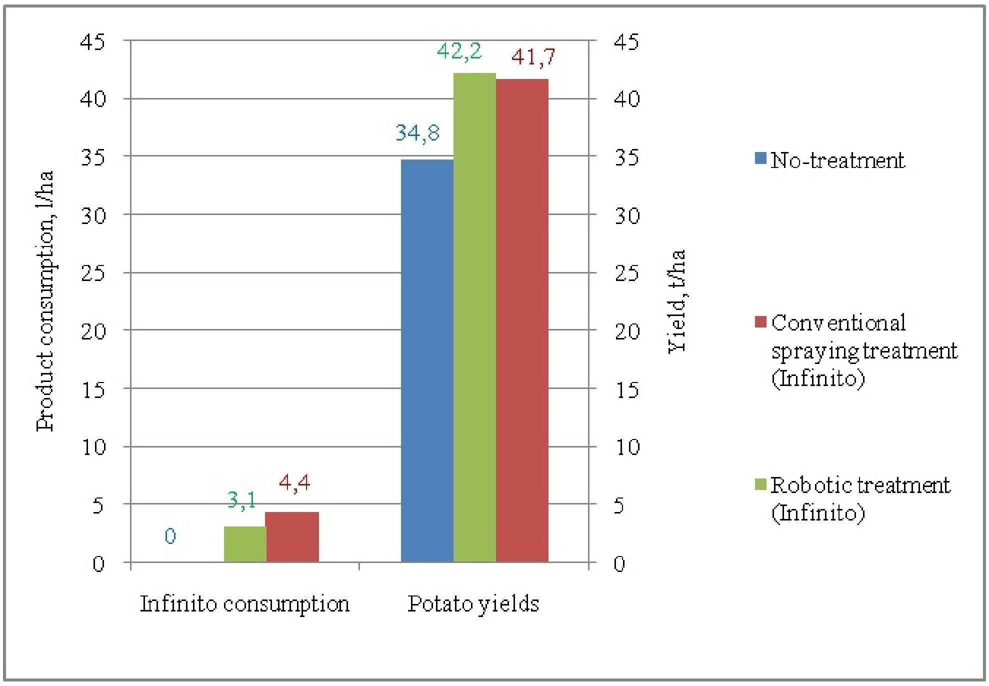
Figure 2. Potato yield losses due to phytophthora leaf blight; proportion of infected tubers; average starch content in potatoes from three different fields



Source: compiled by the authors.

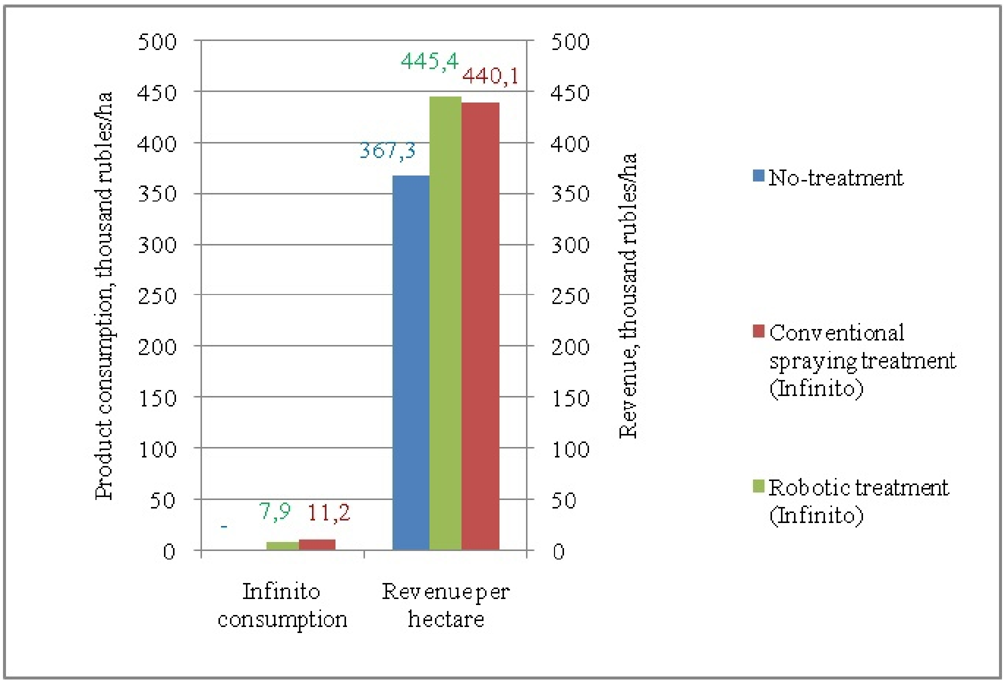
As can be seen from Figures 1 and 2, the robots do not significantly improve the conservation performance of the potato crop when compared to conventional tractor sprayers. In other words, the main objective of the robots was to save plant protection agent. It is expressed in reduction of "Infinito" preparation consumption from 4,4 l/ha to 3,1 l/ha (by 29.5%) (Figure 3). In cost terms, the farmer can save up to 3,315 roubles/ha on the fungicide (Figure 4). Reduction of consumption can be achieved by spot robotic treatments of disease outbreaks – instead of total treatment of fields with tractor sprayers.

Figure 3. “Infinito” preparation consumption (l/ha) and yield (t/ha) from three different fields



Source: compiled by the authors.

Figure 4. Consumption of «Infinito» preparation (thousand roubles/ha) and revenue per 1 hectare by the results of potato harvesting



Source: compiled by the authors.

The use of the chemical in combination with robots leads to an increase in potato yield by 21.3% compared to the variant with no treatment (Figure 4). Calculation of savings on fungicide is based on the price of the preparation "Infinito" – 2,550 roubles per 1 liter. The main benefit of the robots is embodied in the reduction of foreign chemicals (fungicides) in the soil.

This result is obtained through their targeted application – precisely in the location of the affected crops, without spraying healthy crops.

In this way, our robot contributes to the effective detection of plant problems and diseases. Special attention will be given to improving the robot by detecting new types of diseases for other types of crops (peas, peppers, sugar beets). The robot is focused on farmers with fields of 1,000 ha and more.

The robot serves to increase the efficiency of technology, and, in addition, to ensure targeting in the treatment of plant diseases in the field. All this should contribute to the growth of gross crop production, provide the most favorable conditions for technological modernization of the industry and increase export potential.

Thus, the implementation of the described robotics development and admission of agricultural enterprises to it will give the opportunity not only to lead the development measures, but also provide a tool to improve phytosanitary security in crop production.

Robotics has enormous potential for application in precision agriculture. Our efforts have contributed in this direction – by developing a new model of robot and testing it in the field conditions of Pavlodar region.

Robotic decision support for plant protection and cost optimization leads to cost savings for farmers. Taking into account the consideration of a significant part of the factors affecting the yield not separately, but with an integrated approach, it is possible to increase the competitiveness of the economy (due to cost savings). The robot causes a 57% reduction in the cost of buying fungicides, compared to the traditional way of treating the field with a sprayer (Table 1).

Table 1. Comparative cost analysis of treatment with the traditional sprayer and the robot in potato growing

Variant	Consumption rate l/ha	Area ha	Total preparation l	Cost per unit preparation roubles/l	Consumption per variant roubles	Consumption per 1 ha roubles	Cost savings compared with the traditional sprayer
Treatment with the traditional sprayer							
Infinito	0,5	4	2,0	2,890	5,780		
Isabion	1,0	4	4,0	1,970	7,880		
Total					13,660	3,415	–
Treatment with the robot							
Infinito	0,2	4	0,8	2,890	2,312		
Isabion	0,7	4	2,8	1,970	5,516		
Total					7,828	1,957	57,3%

Source: compiled by the authors.

The revenue from the experimental field exceeds the revenue from the control field by 402,185 rubles (Table 2). Given that the cost of one robot is 1.7 million rubles, it pays off in 4 seasons (1.7 million rubles / 402,185 rubles ≈ 4,2).

Table 2. Economic efficiency of potato cultivation in: a) the field treated with the robot; b) field treated with the traditional sprayer

№	Operations and indicators	Units	The field treated with the robot			The field treated with the traditional sprayer		
			Amount	Price per 1 unit (roubles)	Total sum (roubles)	Amount	Price per 1 unit (roubles)	Total sum (roubles)
	Revenue							
1	Area	ha	1.5			1.5		
2	Total income (crop)	kg	62,700	40	2,508,000	46,800	40	1,872,000
	Expenses							
1	Plowing	ha	1.5	4,500	4,500	1.5	4,500	4,500
2	Training	ha	1.5	6,750	6,750	1.5	6,750	6,750
3	Application of organic fertilizers	t	8	5,200	41,600	0	0	0
4	Seedling cost	pcs.	39,000	2	78,000	39,000	2	78,000
5	Landing work	ha	1	6,000	6,000	1	4,000	4,000
6	Weeding	ha	1	900	900	1	900	900
7	The cost of mineral fertilizers	kg	800	25	20,000	800	25	20,000
8	Application of mineral fertilizers	ha	1.5	900	1,350	1.5	900	1,350
9	Cultivation processing	ha	1.5	860	1,290	1.5	860	1,290
10	Hilling	ha	1.5	750	1,125	1.5	750	1,125
11	Irrigation	once	4	450	1,800	4	450	1,800
12	Application of organic fertilizers	once	4	500	2,000	4	500	2,000
13	Plant protection products	once	3	500	1,500	3	800	2,400
14	Harvesting work	ha	1	11,000	11,000	1	5,000	5,000
15	Shipping costs	haul	17	400	6,800	15	500	7,500
	Direct costs, roubles				184,615			136,615
	Revenue, roubles				2,508,000			1,872,000
	Profit, roubles				2,137,570			1,735,385

Source: compiled by the authors.

The total investment for the purchase of 7 robots, software services and additional equipment for the organization of precision agriculture exceeds 12 million roubles. The cost of one of our robot is 1.42 million roubles. However, subsequently these investments will be repaid within 4 seasons.

It is necessary to emphasize such key results of robots' involvement as partial liberation of labor force from tedious and laborious operations on seeding, which will contribute to increase of agronomists' labor prestige.

The work confirmed the high efficiency of the joint use of robots and precision farming system.

The introduction of robots affects the change in the cost structure of producers. In agricultural organizations, in crop production, material costs account for about 60%, of which a large part falls on seeds – more than 25%, mineral fertilizers – more than 20%, protection means – more than 17% [7]. Consequently, robots especially will help to optimize the cost structure in conditions of application of no-tillage.

Positive results from the use of robots can be associated with the general conditions of agricultural development. Bioclimatic potential (indicator of biological significance of climate, showing the biological productivity of zonal soil types [6]) of the northern part of Pavlodar region allows successful development of crop production. Perhaps, in another, less favorable for the industry, the results could be less impressive. When testing the robots in Kyzylorda, Atyrau or Aktobe oblasts, additional conclusions useful for agricultural science can be obtained.

Special consideration should be given to the issues of starting and periodicity of treatments of potato crops with fungicides. B.V. Anisimov, G.L. Belov et al. [2] note that to control alternariosis, treatments can be started when the signs of the disease are detected, and when they do not reach 1% of the whole haulm. At the same time, the strategy of phytophthora control requires that potatoes should be treated with fungicides during the whole vegetation period. While our method involves selective application of fungicides using a robot, the method [2] of phytophthora control involves continuous treatments. This means a higher cost of their method, as well as higher risks of contamination of potatoes with residual substances. In this case, it is necessary to be more careful in the selection of preparations, taking into account their safety for humans and the environment. Another solution to the problem of soil contamination can be the transition to the use of biological preparations to protect plants from infectious diseases [1].

To enhance the protective effect of fungicides, T.A. Derenko [3] recommends adding to them biological fertilizers (in particular, "Isabion").

The decision support system can increase the efficiency of potato protection [3]. It can act as an alternative to robots, helping the farmer in protective measures by issuing the necessary information and recommendations. The system helps to reduce fungicide consumption by reducing the number of potato treatments.

4. Conclusion

The article compares two variants of potato cultivation – the traditional variant and the one based on the principles of precision farming combined with the use of robots. According to the results of calculations, the more effective option from the economic point of view is chosen. In the first season of work on the system of precision farming, the organization will incur higher costs than under the traditional system due to the high initial investment in the purchase of equipment – robots, as well as in connection with the purchase of software required to read and decipher satellite images. Agrochemical survey of soil samples from the fields serves as a separate item of expenditure. In 4 seasons, the investment in the purchase of robots will pay off through long-term savings in fuel and lubricants, seeds, and chemicals.

There will also be an increase in yields and, consequently, an increase in revenue. Integration of robots into precision farming system leads to increased technical and economic efficiency of agricultural operations. Minimizing "human factor," the ability to work in adverse environmental conditions, compliance with lean production principles, and ensuring the preservation of soil fertility also contribute.

Improvements are expected in agricultural workers' health due to the reduction of wind-borne dust (because robots do not trample furrows in the fields and do not raise dust as they work, preventing wind erosion), including eye, respiratory and allergic diseases. Learning how to use field robots will open up new training opportunities for engineers, agronomists, mechanics, and other professions. Testing of new technologies within the farm can serve as an example for the implementation of similar business projects in agricultural enterprises – innovators in the Pavlodar region and other regions of Kazakhstan.

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ANALYSIS OF CZECH FOOD RETAIL PRICES

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Annotation: The aim of the article is find out at the level of individual food retailers in the CR the main extremes in the price level of the examined food basket, in purchasing power, in the average rate of price growth, in price volatility. The aim is also to identify, at the level of specific food items, the main extremes in the average rate of price growth and in the price volatility of the food examined. Furthermore, the aim is to find out at the supranational level the average growth rate of food prices. The subjects of research are the following foodstuffs: apples, bananas, bread, butter, carrots, edam, eggs, chicken, milk, onions, oranges, potatoes, rice, sugar, watermelon. The data collected by the authors were compared with aggregated data sets provided by the CZSO and Eurostat. The basic methods of statistical and comparative analysis at the level of primary and secondary data were used for the analysis of individual data. For the observed period 2011 – 2021, the highest price level was recorded for Lidl (44.50 CZK), the cheapest was Tesco (39.13 CZK). This corresponded to purchasing power - the customer bought the largest volume of monitored food for his salary in Tesco (1,387.83 kg of food) and the least in Lidl (1,196.81 kg) and Billa (1,180.06 kg). Golden delicious apples and carrosts prices grew the fastest during the period under review (up to 32.75%, respectively up to 22.20%, both in Tesco). Sugar prices even rose at a negative rate: -4.49% in Billa and -4.13% in Albert. The highest average food price inflation in the observed period 2011 - 2021 was recorded in Hungary (3.76%) and the Czech Republic (3.14%). The Visegrad Four Countries generally faced a higher increase in food prices than the original countries such as Germany (2.33%) and Austria (2.00%).

Keywords: Czech Republic, European Union, Food prices, Purchasing power, Retail chains, Development

JEL classification: F60, J30, Q10

1. Introduction

The globalization of the world has been the cause of the revolution in agricultural production and food consumption, which has manifested itself significantly in the last few decades. Food can be grown more efficiently, making it more widely available to the world population (Kovárník, Hamplová, 2020). The disadvantage is that most of humanity has at least partially become dependent on food imported from abroad, which can lead to global supply disruptions and food shortages on a global scale during global crises such as the current coronavirus pandemic (Niavis et al., 2021) or, for example, the war in Ukraine. For example, in the EU, the US and Canada, temperate crops such as wheat can usually be found within 500 kilometers. The worst off in this respect are the Nordic regions (where food is poorly grown) as well as large African and South American areas. The worldwide average of this distance is almost 4,000 kilometers. Canada, Australia and the US manage to satisfy the daily caloric needs of their populations with their own production, while insufficient own food production is in China and Russia and almost throughout Africa (FAO, 2022).

The local type of national production with current production methods and consumption habits cannot sufficiently satisfy the demand for food. Increasing the share of efficiently managed domestic production would probably reduce food waste and volume of greenhouse gas emissions, but at the same time it could lead to new problems such as water pollution, water scarcity in very densely populated areas, and it could also lead to vulnerability of countries during poor harvests or large-scale migrations. Current global problems (pandemic, wars) show the importance of food self-sufficiency and the need for local food production (Ivolga, Erokhin, 2021). Risks due to dependence on other agricultural resources (protein, animal feed, energy) also need to be assessed.

Food in general is by its nature one of the so-called essential goods. People have to spend for them, even though they have tried to save their money significantly because of the coronavirus pandemic (Shortanov, 2021).

Food prices in some EU countries (especially in Central and Eastern Europe) are still among the lowest, but people spend an increasingly substantial part of their monthly income on them (Eurostat, 2022). Poles and Hungarians spend more than 16 percent of their income on foodstuff. Bulgarians spend as much as 19 percent and Romanians more than 25 percent, which is twice the European Union average (Eurostat, 2022).

The Food and Agriculture Organization of the United Nations (FAO) has confirmed the well-known fact that world food prices reached a ten-year maximum in 2021. FAO explained this by the increased demand and limited supply of some foods, which was caused by weather fluctuations, animal diseases (swine fever and bird flu), disrupted trade chains due to the pandemic and labor shortages. (FAO, 2022).

The situation is exacerbated by the energy crisis, which has led to rising gas and electricity prices, which is significantly affecting farmers (Zhu et al., 2021). Gas as a fossil fuel is an important raw material for the production of nitrogen fertilizers, which they use in their activities. This increase then negatively affects the yield and increases the cost of production. Food producers are also struggling with rising energy prices and transfering these costs on to consumers (Bekkerman et al., 2021). This leads to a significant increase in the prices of food, and this increase has been significantly fueled since February 2022 by the war in Ukraine.

In the Czech Republic, in connection with the war in Ukraine, there is talking mainly about rising cereal prices and rising bread prices. However, the war is also significantly reflected in rising prices for other agricultural products (CZSO, 2022).

Russia is currently the largest exporter of nitrogen fertilizers and the second largest exporter of potassium and phosphorus fertilizers in the world (Goretzki et al., 2019). Although trade with Russia has not been completely stopped, importers avoid this country (Eurostat, 2022).

The EU as a whole is self-sufficient in key food groups (FAO, 2022). If we focus on specific countries, then this mainly concerns Germany, Poland and France. The Czech Republic is also one of the European countries that can satisfy (with own production) the daily caloric needs of its population (the Czech Republic has an 80% self-sufficiency rate and thus, according to the FAO definition, the Czech Republic is food self-sufficient). However, food self-sufficiency in the Czech Republic has decreased since the beginning of the 1990s for more or less all monitored commodities - only self-sufficiency in beer production shows an ascending trend (CZSO, 2022; FAO, 2022).

The Czech Republic is at its best in wheat production, where it exceeds 160% in self-sufficiency. The self-sufficiency of the Czech Republic is also reported in a number of other crucial crop commodities, such as sugar. Of animal commodities, pork and poultry meat are reported in the Czech Republic below the level of 80-85% of strategic self-sufficiency. Of the crop commodities, the worst situation is with potatoes and fresh vegetables - self-sufficiency of only 30%. The self-sufficiency of fresh temperate fruit in the Czech Republic is reported at a level exceeding 70% (MZE, 2021).

The governments of the countries of Central and Eastern Europe effort to protect the population from the sharp rise in food and energy prices. In this context, we can mention the reduction of value added tax (VAT) on energy by the government in Poland, Romania and the Czech Republic. Poland has also reduced VAT on foodstuffs and agricultural fertilizers. In addition, Hungary capped the prices of sugar, flour, milk, oil, pork and chicken breast (ECB, 2022). Similar scenarios have occurred or are planned for other EU countries.

The war in Ukraine shows that the Czech Republic's and other European countries' dependence on Russian gas and oil greatly weakens these countries. The Czech Republic itself sends 750 million crowns a day for fuel to the Russian Federation (CZSO, 2022).

The aim of the article is find out at the level of individual food retailers in the CR the main extremes in the price level of the examined food basket, in purchasing power, in the average rate of price growth, in price volatility. The aim is also to identify, at the level of specific food items, the main extremes in the average rate of price growth and in the price volatility of the food examined. Furthermore, the aim is to find out at the supranational level (EU27, Hungary, the Czech Republic, countries neighboring the Czech Republic) the average growth rate of food prices.

2. Materials and Methods

Unique data collection process is the basis for the food price analysis which is used in this article. The data on food prices in individual retail chains operating in the Czech Republic was collected for the last eleven years (2011 – 2021). Monitored super/hyper markets: Albert (retail chain: Ahold), Billa (Rewe Group), Kaufland (Schwarz Gruppe), Lidl (Schwarz Gruppe), Penny Market (Rewe Group) and Tesco (Tesco). More details are given in summary Table 1:

Table 1. Overview of monitored foodstuff items (1kg) and super/hyper markets

Super/Hyper Market	**Retail Chain**	**Monitored Foodstuff (1kg)**
Albert	Ahold	apples golden delicious (unpackaged), bananas, bread Šumava (1,200gr), butter the cheapest (250gr), carrots (unpackaged / packaged), edam 30% (box), edam 45% (box), eggs (10 pcs) chicken (standard), long grain rice, milk the cheapest (1 liter), onions (unpackaged / packaged), oranges, potatoes (unpackaged), sugar (crystals), watermelons,
Billa	Rewe Group	
Kaufland	Schwarz Gruppe	
Lidl	Schwarz Gruppe	
Penny Market	Rewe Group	
Tesco	Tesco	

Source: Own processing, 2022

As can be seen in Table 1, the subjects of research are foodstuffs (1 kg): apples, bananas, bread (1,200gr), butter (250gr), carrots, edam 30%, edam 45%, eggs (10 pcs), chicken, milk (1 liter), onions, oranges, potatoes, rice, sugar, watermelon.

Each individual data collection was carried in all investigated super/hyper markets at one point in time (i.e. within one day). Individual data collection was realized in three-month intervals from 2011 to the present.

The collected data (food prices) were compared with aggregated data sets provided by the Czech Statistical Office and Eurostat. The development of food prices is also influenced by purchasing power in the Czech Republic - the authors were inspired by the concept by Malakhov (2021): In simple terms, this modified purchasing power methodology can be described as calculating the volume (in tonnes) of monitored foodstuffs that the consumer is able to purchase at the average wage (in CZK) in the reference period (observed year). For individual data analyzes were used basic methods of statistical and comparative analysis at the level of primary and secondary data: average indicators (food prices (HICP), wages), average food price growth rate, standard deviation (to detect food price volatility), purchasing power (it was searched the volume of foodstuff (i.e. monitored foodstuff data set), which can be bought for an average wage in the observed year).

3. Results and Discussion

In the monitored period 2011 - 2021, the set of surveyed foodstuffs showed on average the highest price level in Lidl (CZK 44.50), while this price level increased by 0.59% compared to the average period 2011 - 2020 (CZK 44.24). The second highest price level was recorded by the set of food in Billa (CZK 42.93), which was even 0.70% more than the price average (CZK 42.62) for the period 2011-2020. We can also mention Albert (40.85 CZK) and Penny (40.46 CZK). The lowest price level can be observed at Kaufland (CZK 38.69), whose foodstuff data set rose by only 0.05% compared to 2011-2020, and Tesco (CZK 39.13).

Regarding the issues examined in terms of purchasing power, we can say that most goods in the period 2011 - 2021 we would buy on average in Tesco (1,387.83 kg, which is 2.36% more than in the period 2011 - 2020) and Kaufland (1,376.39 kg, which is 2.38% more than in 2011 - 2020). Albert (1,320.72 kg, ie 2.99% more), Penny (1,281.44 kg, ie 1.75% more) and Lidl (1,196.81 kg, ie 3.07% more) can be mentioned on the next place. We would buy the least for the average wage in Billa (1,180.06, ie 2.01% more than in the period 2011-2020). The order of retailers according to purchasing power does not correspond to the logical order with respect to the price level. It can be seen in the opposite order of Albert and Penny, and a similar phenomenon was recorded in the opposite order of Lidl and Billa. This is due to the different growth rate of the average wage during the observed period 2011 - 2021 (on average it was 4.55% year-on-year) and the different price growth rate and price volatility of the individual monitored retail chains. This is confirmed by Peersman (2022), who deals with similar issues at the level of euro area countries.

The average wage in the Czech Republic for the period 2011 - 2021 can be seen in Table 2.

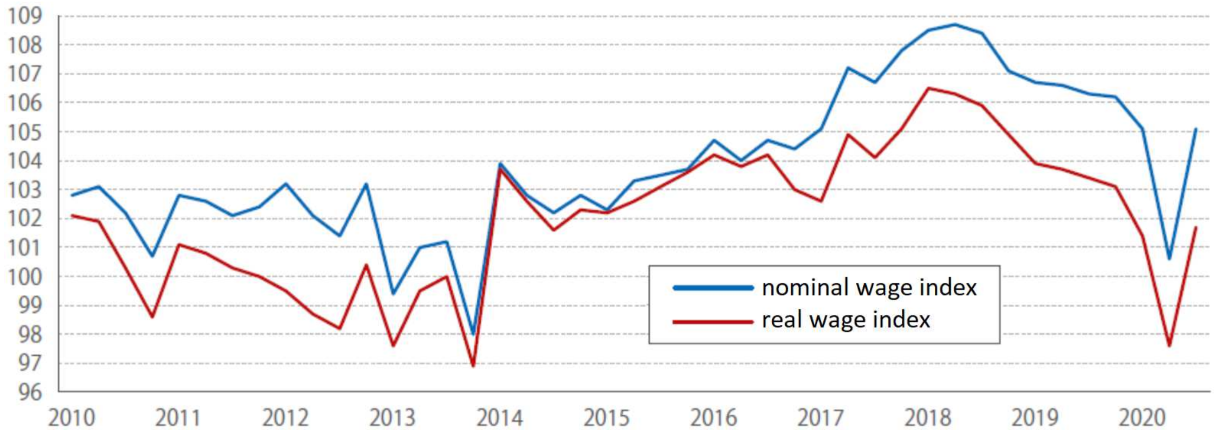
Table 2. Average wage in the Czech Republic (CZK)

year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
average wage	24,319	25,109	25,128	25,686	26,467	27,589	29,504	31,885	34,125	35,611	37,839

Source: CZSO, 2022

The development of quarterly year-on-year indices of nominal and real wage can be seen in Figure 1. In this period under review, the average wage grew the fastest year-on-year in 2018 – the nominal wage by 8.1% and the real wage by 5.9% (CZSO, 2022). The subsequent gradual weakening associated with the economic cycle was sharply interrupted by the coronavirus pandemic in early 2020.

Figure 1. Quarterly year-on-year indices of nominal and real wage (%)



Source: CZSO, 2022; own adjustments, 2022

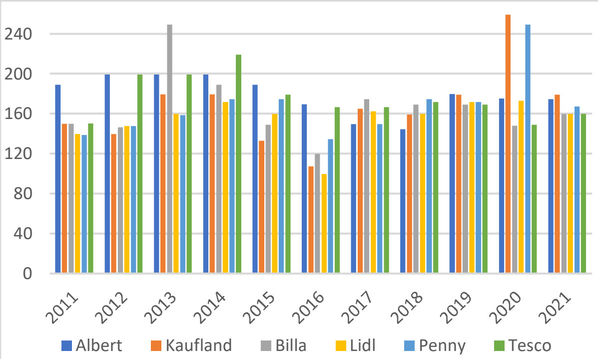
If we focus on the average year-on-year price growth rate of monitored food in the individual retail chains for the period 2011 - 2021, we can see that the highest growth rate of prices was recorded at Tesco (9.17%), while this growth was even 0.05 percentage points lower than in 2011 - 2020 (9.22%). Although Tesco showed the highest average year-on-year increase in food prices, it still managed to keep the lowest price level of goods. This means that there was an effort to bring prices closer to the competition in some way and thus increase margin, but this was not at the cost of losing first place in terms of price friendliness from the customer's point of view. This pricing strategy was also documented in a study by Amountzias (2020), which examines pricing decisions in the UK's food, beverages and tobacco retail sector in 2007-2016. The second highest price growth rate (and a change in the growth rate by -0.48 percentage point compared to 2011-2020) was recorded in Kaufland (7.63%), which was also generally a cheaper retail chain. Next in the order was the expensive Billa (7.23%, ie an increase of 0.65 percentage points compared to the period 2011-2020), Albert (6.60%, ie 1.35 percentage points less than the period 2011-2020), Penny (6.35%) and Lidl (5.28%).

As mentioned above, it is also suitable to focus on the price volatility of the monitored foodstuffs. In this respect, it can be said that the highest standard deviation of prices was recorded for Kaufland (CZK 8.50), followed by Billa (CZK 8.24), Lidl (CZK 7.75), Albert (CZK 7.61), Penny (CZK 7.29). The cheapest Tesco (CZK 6.89) showed a significantly low standard deviation.

A closer look at the level of individual selected foodstuffs shows that the highest rate of price growth in Tesco was recorded for golden delicious apples (32.75%) and carrots loose (22.20%). By contrast, the lowest growth rates: bread (1.42%) and edam 45% (1.43%). In Kaufland, chicken (17.46%), loose carrots (15.51%) and golden delicious apples (15.57%) had the highest average price growth. By contrast, the lowest growth rates: sugar (-2.01%), edam 30% (2.39%) and oranges (2.74%). In Billa, the highest price growth was recorded for eggs (18.60%), potatoes (14.83%) and watermelon (14.30%). On the contrary, the lowest increase: sugar (-4.49%), bananas (-0.07%) and bread (3.07%). As for Albert retail, the highest growth rates were recorded for carrots loose (18.46%) and apples golden delicious (13.02%). On the other hand, the lowest average price rate: sugar (-4.13%) and edam 45% (0.38%). In Penny, watermelon (20.29%) and loose onion (14.99%) had the highest growth rates. On the contrary, the lowest growth: sugar (-1.45%), edam 30% (1.37%) and milk (1.82%). As for Lidl, the highest price growth was recorded for packaged carrots (14.59%), packaged onions (12.71%) and golden delicious apples (12.34%). On the other hand, the lowest price increases: watermelon (-4.75%), sugar (-3.34%), milk (2.47%) and chicken (2.62%).

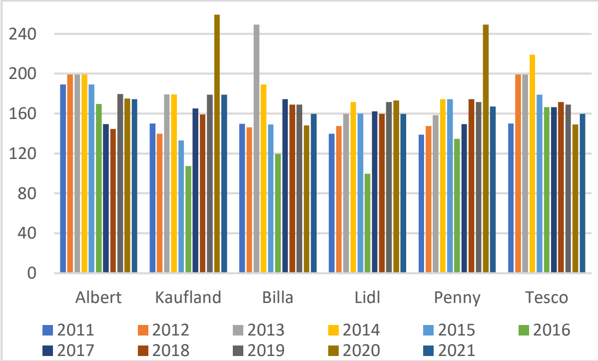
Similarly, it is possible to focus on monitoring the standard deviation at the level of individual food prices in the surveyed retailers. In Kaufland, the highest standard deviation was recorded for edam 45% (CZK 36.78), edam 30% (CZK 22.81) and chicken (CZK 18.92). Lowest standard deviation for Kaufland goods: milk (CZK 2.52) and watermelon (CZK 2.53). In Billa, the highest standard deviation was similar to Kaufland: edam 45% (CZK 31.56), edam 30% (CZK 19.81) and chicken (CZK 15.14). By contrast, the lowest standard deviation: bread (CZK 2.66), bananas (CZK 3.14) and milk (CZK 3.31). For the Lidl retail, the standard deviation values were as follows: again the highest value for edam 30% (CZK 20.73) and edam 45% (CZK 19.95); on the contrary, the lowest values were recorded again for watermelon (CZK 2.06) and milk (CZK 2.27). For the Albert retail, it was possible to trace the highest standard deviation again for food: edam 30% (CZK 29.32) and edam 45% (CZK 18.06). The lowest indicator was in Albert: bread (CZK 1.88), rice (CZK 2.43) and milk (CZK 3.16). Penny showed the highest volatility in goods: edam 45% (CZK 29.44) and edam 30% (CZK 16.88). Lowest volatility in Penny goods: bread (CZK 2.19) and milk (CZK 2.59). Tesco standard deviation at the highest level: edam 45% (CZK 20.97) and edam 30% (CZK 15.32). By contrast, the lowest Tesco values: bread (CZK 2.02) and watermelon (CZK 3.07). It can be said that in all retails, edam cheese (30% and also 45%) showed the highest price volatility (price research of dairy products by Beldycka-Borawska et al. (2021) has shown similar conclusions at EU level for edam cheese), and conversely, this indicator was the lowest for bread (this is also confirmed in the study by Vasylieva (2021) at the level of some EU countries), milk and watermelon. To better illustrate the above analysis, it is possible to look at Figures 2 to 7 below.

Figure 2. 1kg edam 45% price (CZK)



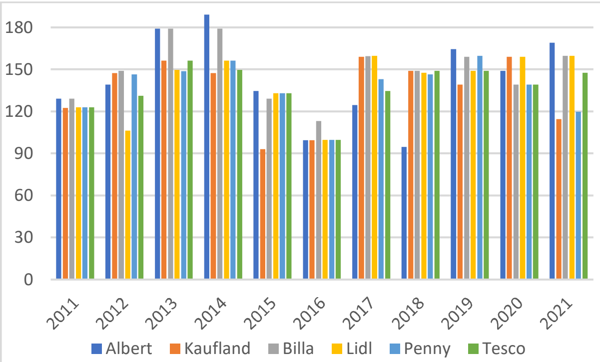
Source: Own processing, 2022

Figure 3. 1kg edam 45% price (CZK)



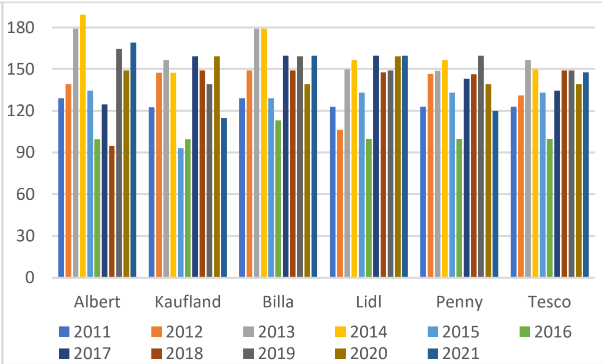
Source: Own processing, 2022

Figure 4. 1kg edam 30% price (CZK)



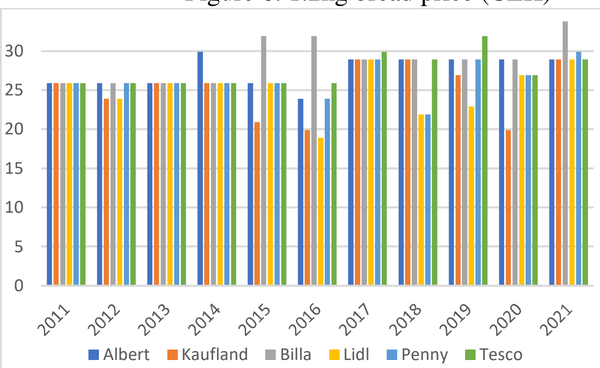
Source: Own processing, 2022

Figure 5. 1kg edam 30% price (CZK)



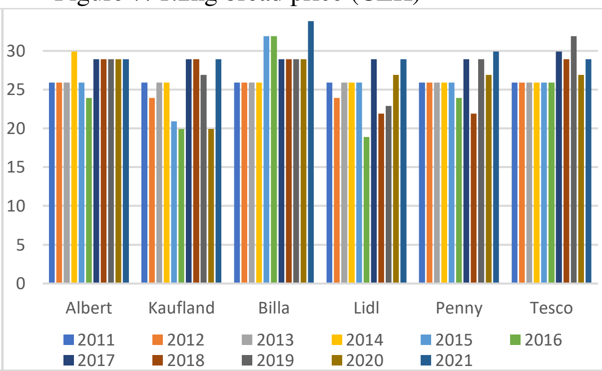
Source: Own processing, 2022

Figure 6. 1.2kg bread price (CZK)



Source: Own processing, 2022

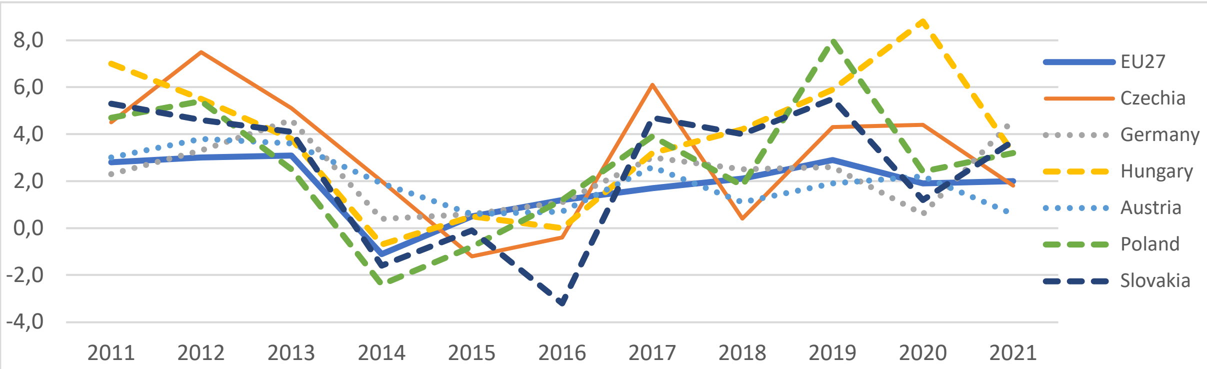
Figure 7. 1.2kg bread price (CZK)



Source: Own processing, 2022

The above-mentioned indicators at the level of individual selected foodstuffs and at the level of visited retail chains in the Czech Republic can of course also be applied at the supranational level, specifically at the EU27 level, focusing on countries neighboring the Czech Republic (and on V4 countries). From Eurostat data (Eurostat, 2022) and based on our calculations, we found that the average growth rate of food prices at the level of the entire EU27 was 1.83% in the period 2011-2021, which was 0.02 percentage points more than in the period 2011-2020. The growth of food prices in selected countries, including the Czech Republic, was higher than the EU average. In descending order, they were: Hungary 3.76%, Czech Republic 3.14%, Poland 2.72%, Slovakia 2.56%, Germany 2.33% and Austria 2.00%. Based on our calculations using Eurostat data (Eurostat, 2022), it is clear that the older EU countries (Germany and Austria) have not experienced such high food price increases as the Visegrad Four Countries. Hungary and the Czech Republic differed from the V4 countries in their food prices rising. This price development was caused, among other things, by high price inflation in both economies, which attacked the highest values in the last 15-20 years (Szyszko and Tura-Gawron, 2021). Szyszko and Tura-Gawron (2021) also examined this issue in their work and presented similar conclusions regarding inflation in the older EU countries. Similarly, Ozcelebi et al. (2021) presented similar outputs in their work on inflation in Eastern Europe. Specific HICP measurements can be found in Figure 8 below.

Figure 8. Harmonised index of food consumer prices (%)



Source: EUROSTAT, 2022; own processing, 2022

4. Conclusion

For the entire period 2011 - 2021, the highest price level was recorded for Lidl (CZK 44.50) and it was found that these prices tend to continue to rise. The cheapest was Tesco, whose food set examined by the authors of this research reached a price level of only CZK 39.13. The above more or less corresponded to the purchasing power, ie in the observed period the customer bought the largest volume of monitored food for his salary in Tesco (1,387.83 kg of food) and the least in Lidl (1,196.81 kg) and Billa (1,180.06 kg).

The average year-on-year price growth rate was highest at Tesco (9.17%). It indicates that although this retail was the cheapest, it also tried to maintain its margins. Tesco was doing so in a way that this retail was not threatened by its competition in the market. The lowest value of the above indicator was recorded for Lidl (5.28%), which is obviously satisfied with its pricing policy.

Food prices were the most volatile for Kaufland and Billa (standard deviations were CZK 8.50 and CZK 8.24, respectively), with Lidl (CZK 7.75), Albert (CZK 7.61) and Penny (CZK 7.29) in the middle about volatility. The cheapest Tesco (CZK 6.89) showed a significantly low standard deviation, thus declaring that it obviously has a long-term pricing strategy at an optimal level.

A closer examination of the level of individual selected foodstuffs showed that the prices of golden delicious apples and carrots grew the fastest (up to 32.75% respectively up to 22.20% in Tesco). On the other hand, sugar often had a negative price growth rate of -4.49% in Billa and -4.13% in Albert, which can be explained by the fact that Billa and Albert tried to attract more customers to their stores in this way.

Edam 45% (standard deviation up to CZK 36.78 in Kaufland) and edam 30% (CZK 22.81 in Kaufland) showed the most volatile prices, in all monitored retail stores. It can be said that bread (up to CZK 1.88 in Albert) and milk (in every retail except Tesco) had the most stable prices in all retails for a long time, which is understandable for such basic foodstuffs.

From a transnational point of view, the price levels of the Czech Republic versus neighboring countries and Hungary (as a member country of the Visegrad Group) were examined. From this point of view, it was found that the growth of food prices in these countries was higher than the EU average (1.83%) for the period 2011-2021: The highest average price inflation was recorded in Hungary (3.76%) and the Czech Republic (3.14%), while other countries showed food price growth below 3%. The Visegrad Four Countries faced higher food price increases than in the original countries, such as Germany (2.33%) and Austria (2.00%).

Acknowledgements

This paper was supported by the Internal Grant Agency (IGA) of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2022B0008 "Economic Governance as a key determinant of macroeconomic development in Africa."

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INCOME INDICATORS OF SLOVAK FARMS IN 2015-2019 AND THE IMPLICATIONS ON FUTURE CAP STRATEGIC PLAN IN SLOVAKIA

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Annotation: The aim of the paper is to assess the development of selected income indicators of Slovak farms over period 2015-2019. We focus on total output, intermediate consumption, gross income, net value added and net income according to the FADN methodology. In the first part of the paper, we compare these indicators with the selected EU member states and with the average of the EU-28 states (including the United Kingdom) in 2019. Agriculture in Slovakia is different to other EU countries, where small farms dominate. This fact has important effect on structure of production as well as total output, intermediate consumption, and farm net value. Slovakia shows good results per farm but weak results per hectare. Common agriculture policy (CAP) in Slovakia in the programming period 2014-2020 was focusing on per hectare decoupled payments. Slovakia decided to transfer 15% of the II. Pillar to the I. pillar which even increased the decoupled payments with significant effects on structure of production but also environment. Therefore, in the second part of the paper we analyze the changes in structure of production and environmental effects of the comparative advantages of large farms in Slovakia. In the new CAP 2023-2027 Slovakia can set several interventions to increase the competitiveness of the whole sector and fulfill national targets of the European Green Deal (EGD).

Keywords: Income indicators, Gross Farm Income, Net Value Added, Common Agricultural Policy, Organic Farming

JEL classification: Q12, Q14, Q18

1. Introduction

The Sustainable Development Goals (SDG) aim to end all forms of hunger and malnutrition by 2030, making sure all people–especially children–have sufficient and nutritious food all year. This involves promoting sustainable agriculture, supporting small-scale farmers and equal access to land, technology and markets. It also requires international cooperation to ensure investment in infrastructure and technology to improve agricultural productivity (Oslo Governance Centre, 2022).

The results of study (Ojo and Baiyegunhi, 2021) show that farmers income is influenced by the perception of the impact of climate change. In addition, membership in co-operatives or associations influence farmers' net farm income, strengthens the ability to provide information on new varieties, farming techniques, pest control monitoring, and climate change among farmers. Generally, the results also indicate that smallholder rice farmers' net income is sensitive to marginal changes in both temperature and precipitation. A number of policy conclusions can be drawn from this study. The promotion of farm techniques and scientific innovations such as climate-smart agriculture (CSA) and the eventual adoption thereof depend on the prevailing socio-economic and climatic conditions.

One of the CAP specific objectives targeting the promotion of the bioeconomy, the future CAP Strategic Plans may include interventions aiming at unleashing a new potential for increasing farmers income and supporting the shift towards a carbon free economy. Using food and feed residues, farm waste or other bio based resources to produce textiles, natural packaging (replacing plastic), construction materials (reducing the use of energy-intensive materials such as steel and cement) or to produce a clean and affordable energy (e.g. through biogas production) could also help the farmers to diversify their income while significantly contributing to the European Green Deal (European Commission, 2020).

In recent years, the European Union has been promoting a multifunctional agriculture. This model assumes agricultural policy, which pursues agricultural production activities as well as objectives related to the performance of other tasks offering benefits for the whole society. They include protection and restoration of natural resources, supporting employment and rural settlement, preserving the cultural character of landscapes, etc. The development of multifunctional agriculture has a positive effect on environment, increases the living standards of the population and the quality of life in rural areas (Némethová and Melišková, 2010).

On the 11th December 2019, the European Commission presented European Green Deal. It resets the Commission's commitment to tackling climate and environmental-related challenges. This involves a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy without net emissions of greenhouse gases in 2050 and economic growth decoupled from resource use. In the framework of the European Green Deal, the Commission adopted Farm-to-Fork strategy, Biodiversity strategy, a proposal for a Climate Law as well as a new action plan for the Circular Economy (European Commission, 2020).

Farm Business Survey data from England and Wales and related study presents effect of agricultural diversity on the stability of farm income across a wide range of different farm types. Results show that increasing diversity of agricultural activities is associated with an increase in the stability of farm income, for dairy, general crop, cereal and mixed farms. Previous research indicates farms with greater agricultural diversity may be in a better position to cope with climate and economic shocks, with crops and livestock exhibiting different responses to environmental conditions and by providing access to a wider range of markets. In addition, increasing crop diversity can also improve pest regulation reducing the need of chemical inputs (Harkness et al., 2021).

A study by Anderzén et al. (2020) provides further evidence that diversification could be an important agroecological strategy for strengthening livelihoods and improving the food security and sovereignty of coffee farmers. This is particularly important considering that in the study more than 70% of farmer households reported experiencing food insecurity, and many farmers perceived their income as insufficient to meet the basic needs of their households. Findings also show that a variety of factors regulate the effects of diversification on farmers' wellbeing.

Study by Wang et al. (2020) examines the effects of economic globalization on environmental degradation (CO2 emissions) for G7 countries for the period of 1996–2017. It further examines the role of financial development, agriculture value-added, and natural resources in the relationship between economic globalization and CO2 emissions. The empirical findings show that economic globalization, financial development, and natural resources increase carbon emissions. In contrast, agriculture value-added decreases carbon emissions.

The need to guarantee efficiency of the agricultural sector and to shape production in order to limit its negative impact on the natural environment is one of the most important priorities of the European Union's (EU) Common Agricultural Policy. In particular, the relationship between efficiency and environmental balance under the policy support for small-scale family farms has not been widely established. Small-scale farms are the basis for the functioning of agricultural sector in many regions of the world. The study by Guth et al. (2022) proved that farms in EU or non-EU are characterized by relatively low technical efficiency and relatively high environmental balance. Thus, it can be concluded that small-scale farms are rather economically weak but environmentally friendly. Therefore, two scenarios seem likely: that the high economic strength of a farm is accompanied by a worsening environmental balance or, conversely, an economically weak farm is characterized by a higher environmental balance.

Another paper (Helfand and Levine, 2004) explored the determinants of technical efficiency, and the relationship between farm size and efficiency, in the Center-West of Brazil. In this region agricultural production and total factor productivity have grown the fastest since 1970. It is also a region characterized by unusually large farms. Technical efficiency is studied with Data Envelopment Analysis and county level data disaggregated by farm size and type of land tenure. The relationship between farm size and efficiency is found to be non-linear, with efficiency first falling and then rising with size. Type of land tenure, access to institutions and markets, and modern inputs are found to be important determinants of the differences in efficiency across farms.

The aim of the paper is to assess the development of income indicators of Slovak farms in the period 2015-2019. We focus on total output, intermediate consumption, gross income, net value added and net income according to the FADN methodology.

2. Materials and Methods

The Farm Accountancy Data Network (FADN), which is a tool for assessing farm incomes and the impact of the EU's CAP, has been in place since 1965. It consists of an annual survey conducted in the Member States of the European Union. Derived from national surveys, the FADN is the only source of microeconomic data that is harmonized. The survey does not cover all agricultural holdings in the Union, but only those which, due to their size, could be considered as commercial (Serenčéš et al., 2018).

In the first part of the paper, we compare income indicators with the selected EU member states and with the average of the EU-28 states (including United Kingdom) in 2019 according to the FADN methodology.

In the second part were analyzed individual data of Information letters of Ministry of Agriculture and Rural Development of the Slovak Republic (IL MARD SR) over the period 2015-2019. Data included approx. 1300 observations annually. Data cover Micro, Small and Medium-sized farms according of EU recommendation 2003/361 for Small and medium-sized enterprises (SMEs) and two groups according to their share of sales from crop and livestock production. These two groups were analyzed separately and were further divided according to their share of sales from organic farming into 4 groups (from 0% to 25%, up to 50%, up to 75% and over 75%). In further analysis we analyze significant differences between the groups of farms. We used the Kolmogorov-Smirnov Test for testing of normal distribution of data. When we reject hypothesis of normality, we used non-parametric tests (Mood´s median test, Multiplate Range test, Kruskal Wallis test) for comparison of medians. Tested indicator was added value per hectare calculated from Income statement as follows:

Added value = revenue from the sale of own products and services + changes in internal inventory + own work capitalized – consumed raw materials, energy consumption, and consumption of other non-inventory supplies – services.

Table 1. Farm represented and Total Utilized Agricultural Area (ha)
(Slovakia 2015-2019)

Year	Farm represented	Total Utilized Agricultural Area (ha)
2015	4 117	458,66
2016	4 084	458,78
2017	4 176	430,92
2018	4 152	445,04
2019	4 101	450,69
Average	**4 126**	**448,82**

Source: FADN database, 2022, author's calculation

In the first part, the article deals with the evaluation of selected income indicators for the last reported period of 5 years (2015-2019) according to the FADN methodology. Based on the latest available data for 2019, the position of Slovak agriculture is compared with the average for the EU-28 countries and individually with Czech Republic, Germany, France, Hungary, the Netherlands, Austria and Poland.

Table 1 contains the number of farms in the sample of enterprises for the Slovak Republic in period 2015-2019, the average number of farms per period and the average area per farm. On average, we evaluated 4 126 farms in Slovakia. The average size of a Slovak farm in the 5-year period is 448,82 ha.

Table 2. Farm represented and Total Utilized Agricultural Area (ha)
(Selected EU countries in 2019)

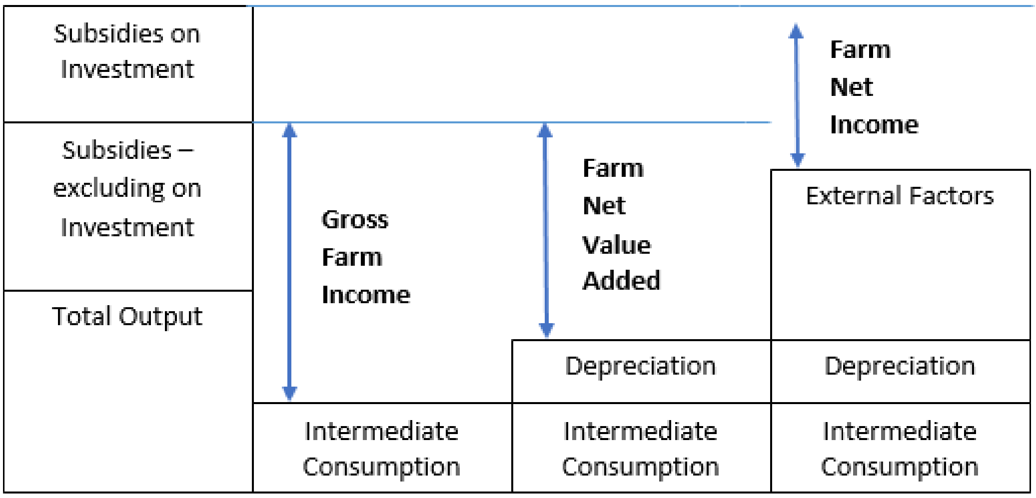
	Farm represented	Total Utilized Agricultural Area (ha)
Czech Republic	18 161	193,17
Germany	179 235	93,26
France	297 459	88,83
Hungary	111 171	44,38
Netherlands	46 740	39,54
Austria	70 734	33,29
Poland	733 869	19,64
Slovakia	4 101	450,69

Source: FADN database, 2022, author's calculation

Table 2 also shows the number of farms in the sample for selected EU-28 countries and the average farm size.

In this article we compare following indicators: total production, current subsidies and investment subsidies, intermediate consumption, depreciation, external factors (labor costs, rents and interest), gross income per farm, net value added and net income per farm. The indicators are expressed per farm in euros, or as a percentage.

Figure 1. Gross Farm Income, Farm Net Value Added and Farm Net Income



Source: authors

Figure 1 expresses the calculation of gross income per farm, net value added per farm and net income per farm.

3. Results and Discussion

Average farm size differs across EU countries. The average land area in 2019 per farm in the Czech Republic is 193,17 ha, in Germany 93,26 ha, in France 88,83 ha, in Hungary 44,38 ha, in the Netherlands 39,54 ha, in Austria 33,29 ha, in Poland 19,64 ha and in Slovakia 450,69 ha (Table 2).

Table 3. Total Output, Intermediate Consumption and Farm Net Value Added per hectare (Slovakia 2015 - 2019)

Year	Total Output	Intermediate Consumption	Farm Net Value Added
2015	1 090,75	853,83	336,92
2016	1 298,56	889,83	524,13
2017	1 262,86	968,22	388,39
2018	1 357,57	1 016,27	446,00
2019	1 373,87	1 063,44	447,81

Source: FADN database, 2022, author's calculation

Large fields in Slovakia pose risks to environment. They also reduce biodiversity and increase the risk of erosion. The average size of a field in Slovakia is 12 hectares, which is the largest in the European Union. Large fields without green lanes worsen the impacts of wind and water erosion, increase the heat and thus increase the likelihood of droughts. Since animals have fewer options to hide, the biodiversity of the area is reduced. The worst situation is in the Danubian Lowland in southwest Slovakia and the protected bird areas. A low diversity of crops, the majority of which are wheat and corn crops, poses another problem. Slovakia's abundance of monoculture fields is the result of collectivization and the plowing of the boundaries typical during communism. The monoculture fields are also being extended due to decupled CAP subsidies, which support only a small portion of ecosystem services offered by the agricultural land. Monocultures simplify the planting and harvesting of crops, eliminate species competition and increase the cultivated area. In the short-term, it maximizes profit (SME, 2020).

Table 4 compares total output, intermediate consumption, net value added per farm per hectare of land for 2015-2019 for Slovakia and selected EU countries in 2019.

Table 4. Total Output, Intermediate Consumption and Farm Net Value Added per hectare (Selected UE countries in 2019)

	Total Output	Intermediate Consumption	Farm Net Value Added
Czech Republic	1 718,43	1 312,56	219,28
Germany	3 039,12	1 977,13	501,92
France	2 342,95	1 499,73	469,09
Hungary	1 750,65	1 152,37	497,84
Netherlands	14 911,43	8 769,20	2 709,79
Austria	3 051,49	1 837,67	949,17
Poland	1 709,22	1 077,19	543,48
Slovakia	1 373,87	1 063,44	37,39

Source: FADN database, 2022, author's calculation

The total production per hectare in Slovakia in 2015 to 2019 showed year-on-year growth and increased by 79%. However, by comparing the level of total production per hectare of land with selected EU countries, Slovakia shows the lowest value of 1 373,87 EUR.

Intermediate consumption per hectare of land in agricultural enterprises in Slovakia is also growing in 2015-2019 (growth of 80%). A comparison of intermediate consumption per hectare of agricultural land in Slovakia in 2019 with selected EU countries also documents the lowest value 1 063,44 EUR.

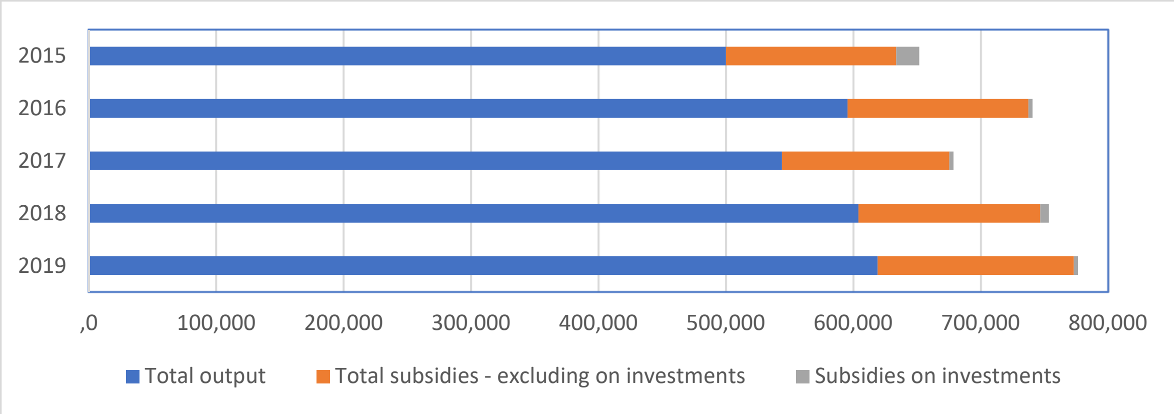
The net value added of agricultural holdings in Slovakia per hectare of land in 2015-2019 recorded year-on-year growth (the highest in 2016) and increased 1,3 times. Assessing the level of net value added for agricultural enterprises in Slovakia in 2019 with selected EU countries, we again confirm the lowest level of 37,39 EUR.

Farms in Slovakia mainly focus on primary production with only small share of products with higher added value (milk, cheese, meat, special products, local products, unique products). Increase in value added would potentially increase employment in rural areas (Serenčéš et al., 2016).

Total production and subsidies

Total agricultural production represents the values of crop and livestock products, services for primary agricultural production and inseparable non-agricultural secondary activities. Figure 2 shows the development of total production and subsidies per farm in EUR in Slovakia in period 2015-2019.

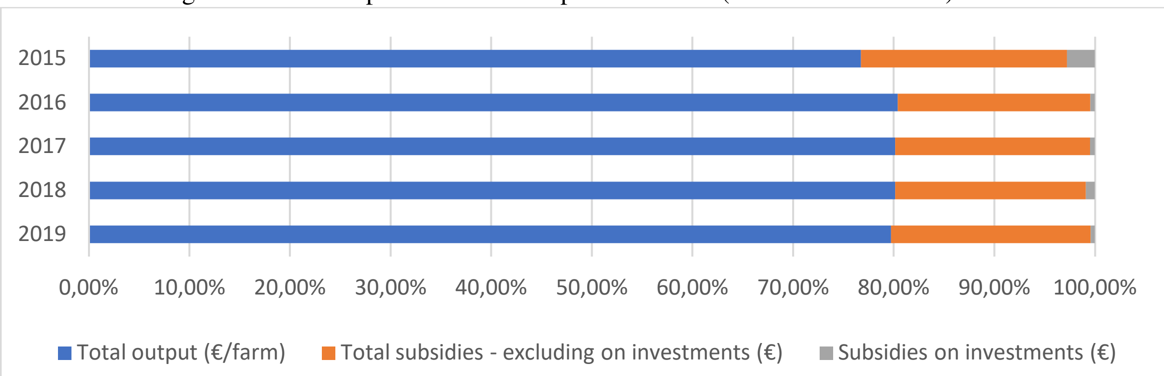
Figure 2. Total Output and Subsidies per Farm in € (Slovakia 2015-2019)



Source: FADN database, 2022, authors

The total production in Slovak agriculture in 2019 increased by 24% compared to 2015. Current subsidies (total subsidies-excluding on investment) increased the most in the last year (2019). In 2017, compared to 2016, there was a decrease of 7,28%.

Figure 3. Total Output and Subsidies per Farm in % (Slovakia 2015-2019)



Source: FADN database, 2022, authors

Subsidies to support investment in agriculture recorded a decrease in the period 2015-2019, and in 2017 subsidies on investment reached the lowest level per farm 3 225 EUR (2017/2015 index is 0,18). (Figure 2)

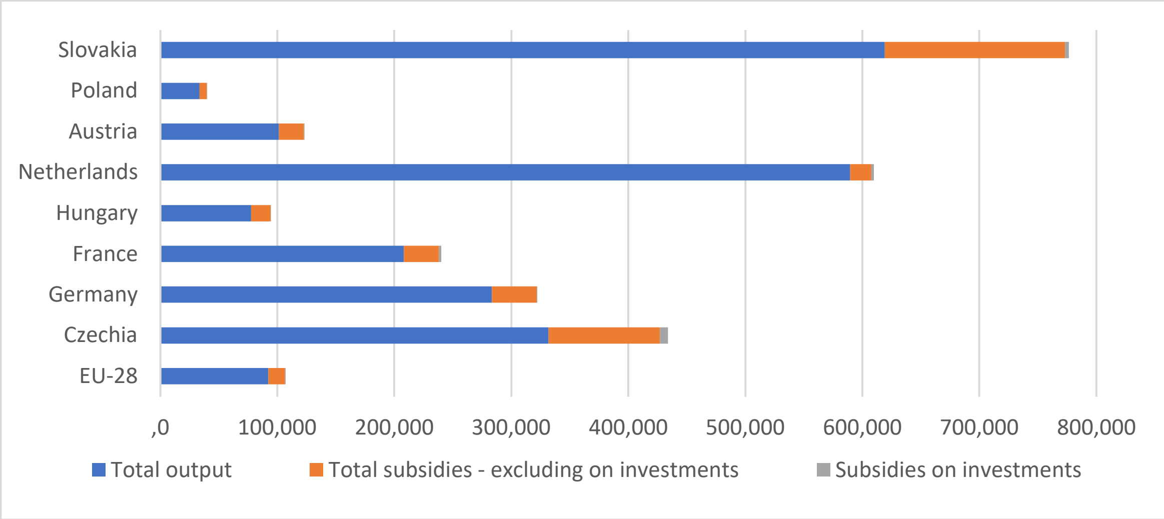
Table 5. Total Subsidies-excluding on investments / Total Output in %
(Slovakia 2015-2019)

	2015	**2016**	**2017**	**2018**	**2019**
Slovakia	26,68	23,80	24,16	23,62	24,88

Source: FADN database, 2022, author's calculation

The share of current subsidies in total agricultural production in Slovak agriculture was declining in 2015-2019.
Decrease in share of these components by 6,74% can be attributed to increase in total agricultural production and stagnation of subsidies in Slovak agriculture (Table 5, Figure 3).

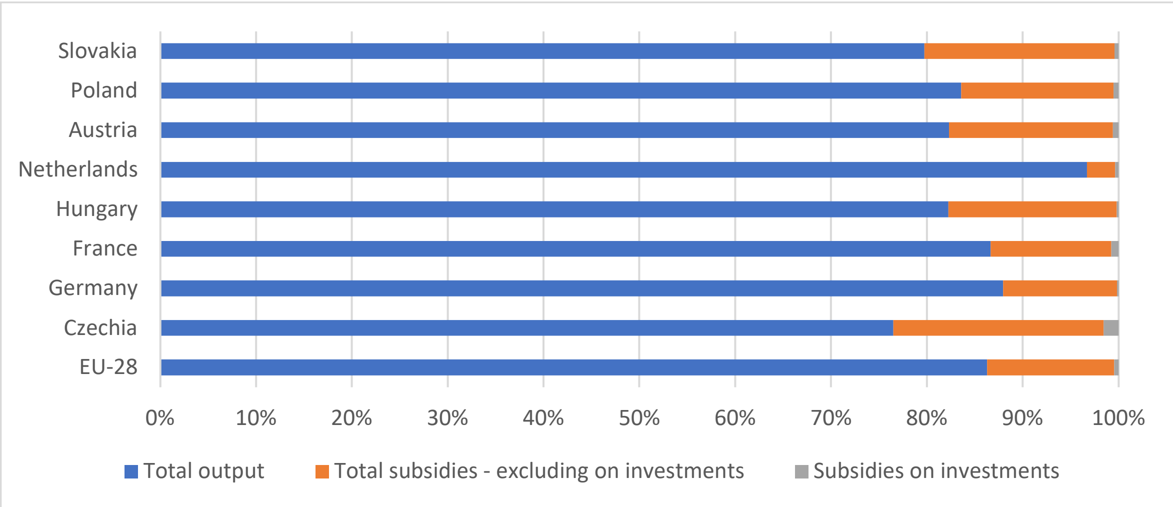
Figure 4. Total Output and Subsidies per Farm in € (Selected EU countries in 2019)



Source: FADN database, 2022, authors

By comparing the share of total agricultural production and subsidies within the selected EU countries, we can conclude that Slovak agriculture (farm) has the second lowest share (79,74%) of output in output + subsidies, after the Czech Republic (76,50%). Other countries such as the Netherlands (96,70%), Germany (87,97%) and France (86,65%) show significantly higher shares of output in output + subsidies. (Figure 5).

Figure 5. Total Output and Subsidies per Farm in % (Selected EU countries in 2019)



Source: FADN database, 2022, authors

Intermediate consumption, depreciation and external production

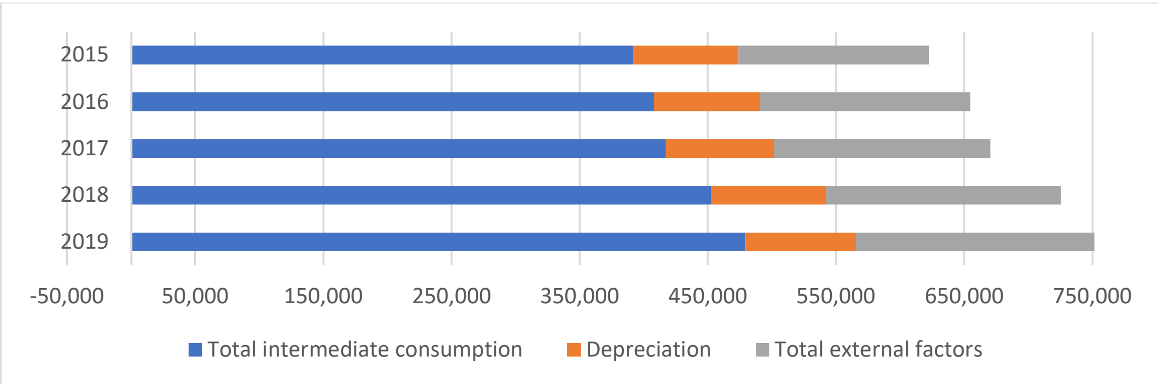
Varoščák and Grznár (2010) state that intermediate consumption represents the value of the consumption of purchased materials, services and energy, including consumption of products and services that are supplied, shortages and damage to inventories and other costs incurred. For net profit, intermediate consumption is considered as a decisive component. An important aspect for the development of intermediate consumption in agriculture are rising prices of inputs.

Parvin et al. (2022) present a simple framework to evaluate how machinery size and soil compaction levels are linked to net revenue. Increasing machinery capacity is associated with lower harvesting costs but also with increasing machinery weights that result in more severe soil compaction. This reduces crop yields and increases environmental cost in terms of increased nitrogen leaching, greenhouse gas emissions and surface run-off. Study found that there was a privately optimal machinery size, corresponding to an optimal level of soil compaction, at which farmer net revenue is at a maximum. In contrast, the net benefits for society were the highest for the lowest possible compaction level and decreased with increasing machinery size (increasing soil compaction). Environmental costs were primarily associated with greenhouse gas emissions. Study found that the compaction level if either producer prices were higher, harvesting costs savings from larger machinery were smaller, or if farmers were charged for (part of the) environmental costs.

The development of intermediate consumption, depreciation and external factors in period 2015-2019 in Slovakia is shown in Figure 6.

Intermediate consumption in Slovak farm in EUR increased from 391 618 EUR (2015) to 479 283 EUR (2019), which represents an increase of 22,4% in the period 2015-2019. Depreciation also recorded an increasing trend from 2015 to 2018, when it increased by 9,62% and in 2019 compared to 2018 it decreased by 4,27%.

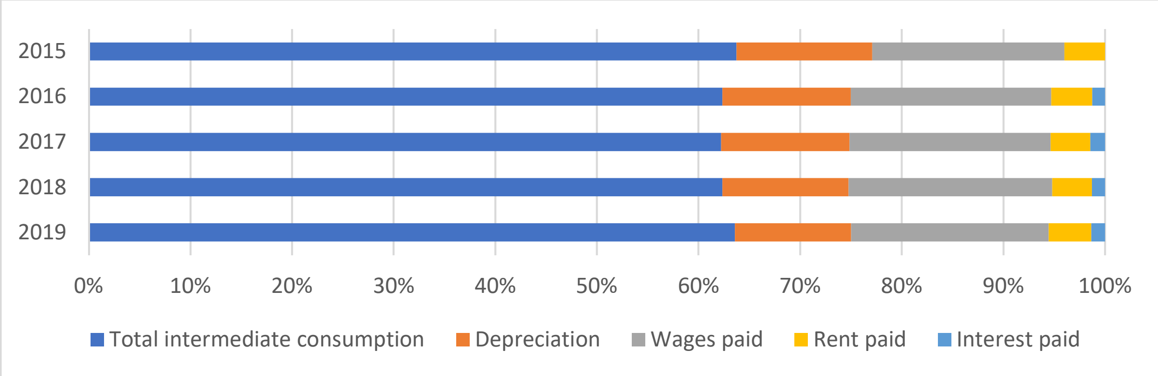
Figure 6. Intermediate Consumption, Depreciation and External Factors (Wages, Rent and Interest paid) per Farm in € (Slovakia 2015-2019)



Source: FADN database, 2022, authors

Consumption of fixed capital is defined as depreciation. External factors are wages, rent and interest paid. External factors increased from 148 733 EUR (2015) to 188 263 EUR (2019), which represents an increase of 26,6% in the period 2015-2019.

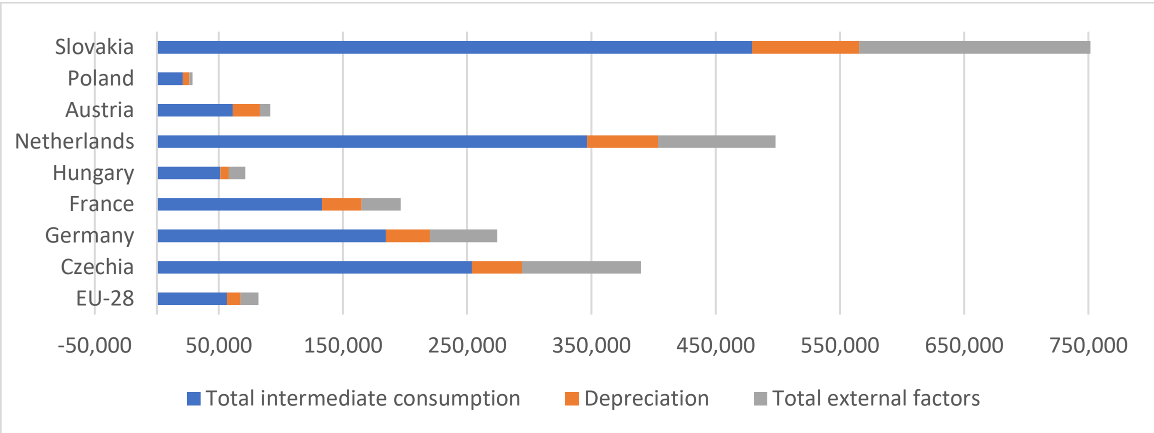
Figure 7. Intermediate Consumption, Depreciation and External Factors (Wages, Rent and Interest paid) per Farm in % (Slovakia 2015-2019)



Source: FADN database, 2022, authors

Figure 7 represents the structure of costs in percentage. Wages are the largest item within the external factors. Within the period 2015-2019 wages recorded an increasing trend (by 25,9% in 2019 compared to 2015). In external factors, the slight increases were also recorded in items of rent as well as in item of interest paid. The interest paid contributed the smallest part of the structure of external factors, as well as total costs.

Figure 8. Intermediate Consumption, Depreciation and External Factors (Wages, Rent and Interest paid) per Farm in € (Selected EU countries in 2019)

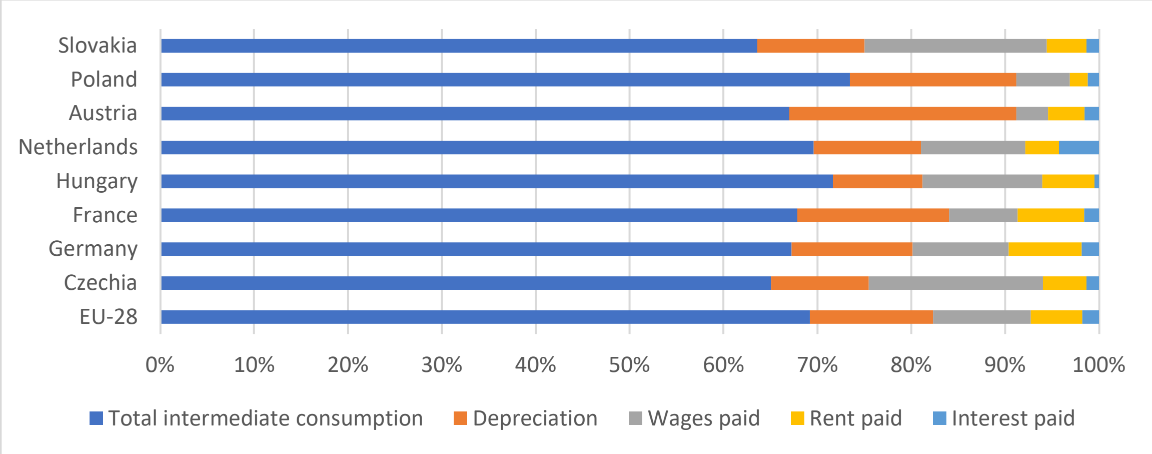


Source: FADN database, 2022, authors

The share of Intermediate Consumption, Depreciation and External Factors (Wages, Rent and Interest paid) per Farm in EUR and in % in selected EU countries are in Figure 8 and 9.

Within the external factors, Poland (83,40 EUR/ha) and Austria (92,55 EUR/ha) have the lowest values per ha (in 2019) in the item – Wages paid. In Slovak republic it is 324,83 EUR/ha (the third highest value among the compared countries. In the item – Rent paid, Slovakia shows the second lowest value per ha (70,42 EUR/ha) after Austria (28,05 EUR/ha). Interest paid per ha in Hungary is the lowest value (7,68 EUR/ha) and in Slovak republic it is 22,47 EUR/ha (second lowest value among the compared countries).

Figure 9. Intermediate Consumption, Depreciation and External Factors (Wages, Rent and Interest paid) per Farm in % (Selected EU countries in 2019)

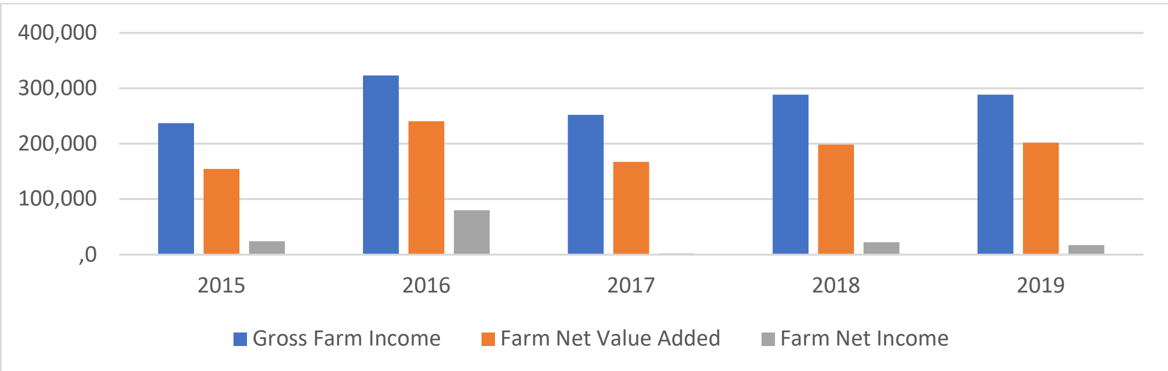


Source: FADN database, 2022, authors

Gross income, net value added and net income

Viable farms contribute to the resilience of agricultural and food systems. Farm income is a policy-relevant proxy for this viability. The authors Finger and Benni (2021) point out three key aspects of farm income: first, the *income issue*, focusing on (average) income levels; second, the *variability issue*, focusing on income risks faced by farmers; and third, the *inequality issue*, focusing on the heterogeneity and (in-)equalities of farm incomes. First, the income issue: (average) income levels are a frequently used indicator to proxy the general well-being of farms and the farming sector. Second, the variability issue: the variability of income over time reflects the income risks faced by farmers. Volatile income levels reduce the well-being of risk-averse farmers and reduce farmers' incentives to produce, invest and innovate. Third, the inequality issue: the distribution of income across the farm population is relevant to assess the heterogeneity and (in-)equalities of incomes.

Figure 10. Gross Farm Income, Farm Net Value Added and Farm Net Income in €
(Slovakia 2015-2019)



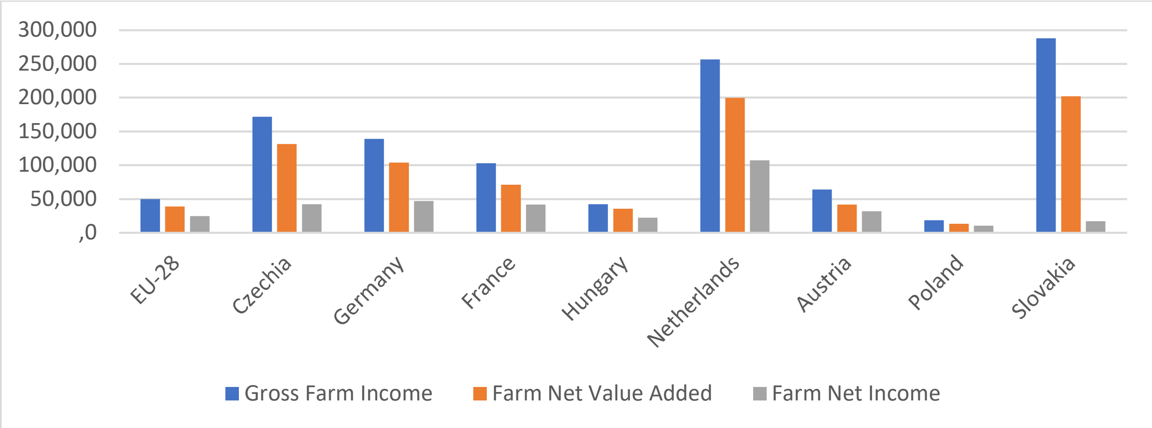
Source: FADN database, 2022, authors

The development of gross farm income, net farm value added and net farm income in 2015-2019 in Slovakia is shown in Figure 10. In 2015-2019 the mentioned indicators achieved a decreasing development trend, except for 2016. Farm net income in 2019 decreased to 16 852 EUR compared to 2015 (23 898 EUR). The highest value was achieved in 2016 (80 178 EUR per farm) and the lowest in 2017 (2 009 EUR per farm).

According to Varoščák and Grznár (2010) net income from business in agriculture is a synergistic effect of the reproductive process of agriculture, it means of agricultural production activities, agricultural employment, state and EU agricultural policy, agricultural land yields and financial capital.

Value added is the part of the value of production created by the producer's activity. The peculiarity of the added value of agriculture is that its final value is reduced by taxes on products and increased by subsidies on products (Varoščák and Grznár, 2010).

Figure 11. Gross Farm Income, Farm Net Value Added and Farm Net Income in €
(Selected EU countries in 2019)



Source: FADN database, 2022, authors

Among the compared EU countries, the Slovak republic achieves the highest value of Gross Farm Income, but at the other side paradoxically the second lowest value on the Farm Net Income after Poland. This is mainly related to the lowest reported values in terms of total production and intermediate consumption compared to selected EU countries and also with the highest average area per farm compared to other EU countries, which are characterized by a smaller area of land per farm.

Value added per farm based on IL MARD SR

In this part of paper, we analyze individual farm data from the dataset of Information letters of Ministry of Agriculture and Rural Development of the Slovak Republic (IL MARD SR) over the period 2015-2019. We used data only for legal entities, farms accounting in simple accounting were excluded. In our sample all farms meet the criteria for EU recommendation 2003/361 for SMEs (Table 6). The main factors determining whether an enterprise is an SME are staff headcount and either turnover or balance sheet total. We applied these criteria for individual firms only (we didn´t researched, if the farms are the part of a larger group).

Table 6. The main factors determining whether an enterprise is an SME

Company category	**Staff headcount**	**Turnover**	**Balance sheet total**
Medium-sized	< 250	≤ € 50 m	≤ € 43 m
Small	< 50	≤ € 10 m	≤ € 10 m
Micro	< 10	≤ € 2 m	≤ € 2 m

Source: EU recommendation 2003/361,

Subsequently, the farms were further divided into two groups according to their share of sales from crop and livestock production. If their share of sales from crop production was over 50 %, we included the farm to crop production. We can observe (Table 7), that dominate micro and small farms with crop production.

Table 7. Number of farms divided to SMEs criteria and their share of sales from crops and livestock production (Slovakia 2015-2019)

SMEs	SHARE CROPS	2015	2016	2017	2018	2019	Total
MEDIUM	CROP	73	79	66	60	57	335
	LIVESTOCK	73	66	72	67	68	346
MICRO	CROP	412	423	405	449	525	2214
	LIVESTOCK	168	152	170	172	198	860
SMALL	CROP	361	368	361	359	378	1827
	LIVESTOCK	237	219	232	227	231	1146
Total		**1324**	**1307**	**1306**	**1334**	**1457**	**6728**

Source: IL MARD SR, 2022, author's calculation

We tested added value per hectare according to the production over the all period 2015-2019. Crop production farms showed higher added value per hectare in comparison with livestock production farms. In median values it was even 5 times higher. The reason of this state was that livestock production has been loss-making for a long time, which caused a decrease in the number of cattle as well as pigs in Slovakia. The Mood´s median test (and Multiplate Range test) confirmed statistically significant differences between these two groups. We used these non-parametric tests, because we rejected the assumption about normal distribution based on Kolmogorov-Smirnov Test.

Table 8. Added value per hectare according to the production over the all period (Slovakia 2015-2019)

Production	**Count**	**Median**	**Lower quartile**	**Upper quartile**
CROP	4376	160	0	376
LIVESTOCK	2352	30	0	227
Total	**6728**	**113**	**0**	**329**

Source: IL MARD SR, 2022, author's calculation

We examined both groups separately, dividing them into 4 subgroups according to their share of sales from organic farming from crop or livestock production. We use groups from 0 to 25%, up to 50%, up to 75% and over 75%.

In Slovakia crop producing farms with share of sales from organic crop production to 25% dominated (Table 9). They had higher value added per hectare in comparison with farms in other groups except for group with share of organic production from 50% to 75%. But in this group were only 9 observations. Kruskal-Wallis Test didn´t confirm the statistically significant difference in the sample but based on Multiple Range test significant difference between farms with organic to 25% and organic over 75% was confirmed.

Table 9. Added value per hectare of crop production farms according to their share of sales from organic crop production (Slovakia 2015-2019)

Crop production	**Count**	**Median**	**Lower quartile**	**Upper quartile**
Organic to 25%	4159	163	0	369
Organic 25% - 50%	8	78	0	744
Organic 50% - 75%	9	657	25	836
Organic over 75%	200	77	0	614
Total	**4376**	**160**	**0**	**376**

Source: IL MARD SR, 2022, author's calculation

In last analysis we focus on livestock farms with organic livestock production. Situation was very similar with organic crop production. In the Slovakia farms with organic production to 25% dominated and reached highest value added per hectare in comparison with other groups. Kruskal-Wallis Test confirmed the statistically significant difference in the sample and Multiple Range test confirmed, that difference was between farms with organic to 25% and organic over 75%.

Table 10. Added value per hectare of livestock production farms according to their share of sales from organic livestock production (Slovakia 2015-2019)

Livestock production	**Count**	**Median**	**Lower quartile**	**Upper quartile**
Organic to 25%	1806	67	0	273
Organic 25% - 50%	8	52	35	110
Organic 50% - 75%	7	0	0	93
Organic over 75%	531	0	0	44
Total	**2352**	**30**	**0**	**227**

Source: IL MARD SR, 2022, author's calculation

4. Conclusion

The aim of the paper was to evaluate the development of selected income indicators of Slovak farms for period 2015-2019 and their comparison with the results of selected EU countries in 2019.

Among the selected countries, Slovakia is characterized by large farms, with the highest average area per farm (450,69 ha). The lowest average area per farm in 2019 has Poland (19,64 ha).

Despite the fact that in indicators such as total production, intermediate consumption and net value added, farms in Slovakia recorded an increase in values in 2015-2019, compared to selected EU countries, the Slovak republic shows the lowest value in these indicators. For example, net value added per ha in Slovakia in 2019 reached a level of only 37,39 EUR/ha. The Czech Republic has the second lowest value of 3219,28 EUR/ha. The highest value 2 709,79 EUR/ha was reached in Netherlands with an average farm size of 39,54 ha.

Total production as well as current subsidies in Slovak republic for the period 2015-2019 has an increasing development trend, while investment subsidies decreased in the period. The share of current subsidies in total production achieved a slight decrease. After the Slovak republic the second highest share of subsidies per farm is achieved by farms in the Czech Republic, the lowest subsidies per farm are in Poland.

Intermediate consumption plays an important role in valuation of the farm net income. Intermediate consumption in Slovakia increased in 2015-2019 but among the EU countries it reached the lowest value per ha. Also in the case of depreciation and external factors indicators.

Among the compared EU countries, the Slovak republic achieves the highest value of Gross Farm Income, but at the other side paradoxically the second lowest value on the Farm Net Income after Poland. This is mainly related to the lowest reported values in terms of total production and intermediate consumption compared to selected EU countries and also with the highest average area per farm compared to other EU countries, which are characterized by a smaller area of land per farm.

The size of the farm significantly affects the results achieved by selected income indicators in Slovakia compared to other EU member states. Small farms are the basis of the agricultural sector functioning in many regions of the world. Although they are economically weaker, but they are more environmentally friendly. Large farms appear to be more technically efficient.

Subsequently, our analysis showed that the criteria for SMEs are met by almost all farms in Slovakia. Statistical testing of farms based on individual data from IL MARD SR showed that crop production farms showed higher value added per hectare in comparison with livestock production farms. The farms with lower share of sales from organic farming from 0-25% dominate in Slovakia and reached higher added value per hectare in comparison with other groups. It was also confirmed that only small share of farm has share of organic production over 25%. To increase value added per hectare in Slovakia subsidies to livestock production and organic farming in new CAP period 2023-2027 in Slovakia should increase.

As many studies suggest, we can state that greater agricultural diversity of farms leads to greater income stability. Diversifying farm incomes by using food residues, animal food, agricultural waste for further processing (e. g. for the production of building materials, packaging, textiles or energy), or the finalization of products, the providing of services, etc. it can also contribute to the environmental protection and new set objectives of the EU CAP. More income-stable farms are better able to react to the climate or economic change.

Economic globalization has caused deterioration of the environment. It is necessary to support the sustainable and multifunctional agriculture, to protect and restore natural resources, to preserve the cultural character of the country, to support young farmers and the creation and functioning of farmers associations, to improve access to land, technology, scientific innovation and the market, which can also have a positive impact on the environment, ensuring food security, food quality, increasing the living standard of the population and the quality of life in rural areas.

Acknowledgements
This paper was supported by VEGA project 1/0735/21 Role, financial needs and risks of small farms in Slovakia, by the Operational Program Integrated Infrastructure within the project: Demand-driven Research for the Sustainable and Innovative Food, Drive4SIFood 313011V336, co-financed by the European Regional Development Fund and project APVV-18-0512 Food value chain and unfair trading practices.

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COMPLEX USABILITY EVALUATION - A STUDY OF ELECTRONIC FORMS FOR TAX RETURN IN THE CZECH REPUBLIC

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Annotation: Due to the general need for sustainable development, even governments try to transform their services into an online environment. It is necessary to ensure that users find quality products or services on their websites and an environment that is easy to use. The present study's main objective was to evaluate electronic forms for personal income tax returns in the Czech Republic and identify the most suitable solution for subsequent development and use in practice. More, this evaluation is needed as the first step in terms of obtaining suitable data for the automatic evaluation using machine learning methods. The study was conducted in cooperation with the General Financial Directorate (GFD) based on contract research. Seven forms and applications for tax returns were analyzed and evaluated by experts according to three different target groups of users as defined by GFD. The testing was performed using a combination of usability methods. The results showed that modern applications have significantly higher usability. Interestingly, we identified that the usability of PDF forms was better than the current applications (EPO). The study also demonstrated the need to combine usability methods, both in the expert evaluation and in testing with users.

Keywords: Usability, UX, Tax return, Form, Multi-criteria decision analysis

JEL classification: H24, L86, M15

1. Introduction

Albeit e-government has seen steady growth, it can still benefit from better user engagement. Usability and credibility are believed to be among the factors that influence this engagement (Huang & Benyoucef, 2014). In addition, the same authors confirm in their study that there is a close correlation between usability and credibility, as e-government websites with high usability were perceived as having higher credibility and vice versa. The study conducted by Wirtz and Kurtz (2017) has shown that by offering public services that enable citizens to handle their concerns fully electronically without having to appear in person, the competent public authority positively impacts the intention to use e-government portals.

Analyzing user behavior using eye-tracking devices seems to be an effective method for user testing (Lai et al., 2013). Strohl et al. (2015) argue that forms and disclosures are a central component of business and customer interactions. According to the researchers, the forms often lack good visual organization or clear and concise language. They state that eye-tracking serves as an excellent tool for evaluating and improving paper and electronic forms. Acquiring basic information about the user's needs influences the selection of the design patterns which match the user's requirements. Most frequently, many possible solutions can be found, and the appropriate choice must be made. Collecting and analyzing the eye movement data may also be helpful in the user interface assessment (Harezlak et al. 2015).

According to Nielsen (2000), a set of characteristics influences a user's system acceptability. These characteristics include: ease of learning, the efficiency of use, memorability, error frequency, and satisfaction. As Larsson (2021) points out in her study, poorly designed forms can significantly increase the stress of the user who uses them. These acceptability characteristics seem to be even more critical in the form environment, which is why we also focused on them when conducting the study.

The main objective of the presented study was to analyze and evaluate electronic forms for personal income tax returns in the Czech Republic (later named simply forms) and identify the most suitable solution for possible subsequent development and use in practice. Based on contract research, the study was conducted in cooperation with the General Financial Directorate (GFD). Specifically, it focused on identifying usability issues for each form hosted in the GFD online environment, and the user can use it to complete their tax liability online.

Another objective of this study is to collect the necessary data to apply machine learning methods in the upcoming research. Retrieved user data can be labeled in the subsequent analysis and thus quantified to some extent (Wynn and Still, 2011). It is then theoretically possible to apply machine learning methods to the quantified data, as was shown in the studies by Yin et al. (2018), Fuhl et al. (2020), and Rakhmatulin et al. (2020). However, as Desolda et al. (2021) stated, for a more accurate predictive model, an increase in the number of samples is desirable in the training phase, as well as the increase in the number of participants in the data-collection phase. Therefore, this study also serves to achieve this particular goal.

2. Materials and Methods

A prerequisite for performing this study is a suitable combination of several methods in the field of usability and UX. A prerequisite for combining several methods is to obtain as much data as possible with the broadest possible range, which can reduce the limitations of some methods. However, even the methods used have their specifics, and their application is addressed, among other things, in the discussion chapter.

The entire study was conducted from May to July 2020. Altogether, seven forms for tax returns were tested and evaluated. The study was divided into three following main parts:

- the first part of the study consisted of an expert evaluation conducted by six UX/usability experts;
- the second part was focused on usability testing with end-users (represented by test participants);
- data from both parts were analyzed and evaluated within the realization of the third part of the study.

The second and the third part of the study were implemented with respect to three target groups on which the GFD focuses in particular:

- **Group No.1** represented six students or young people who filed their tax returns for the first time.
- **Group No.2** represented six employers who had filed tax returns in the past and dealt with more complex life situations.
- **Group No.3** represented six self-employed individuals who filed the declaration regularly or for the first time.

Evaluated Forms

The overview of the studied applications and forms is available in Table 1. We studied two publicly available interactive PDF forms (F1, F2), three variants of the publicly available application called EPO (F3, F4, F5), one commercial application selected by GFD as a reference for research purposes (F6), and one application prototype provided by GFD (F7), which is not yet publicly available.

The tax return forms for individuals in the Czech Republic are provided in two variants based on the type of income. The first variant (number 25 5405/D) is designed for people who had income only from employment contracts in the year in question. The second variant (number 25 5405) is intended for all other situations. The variants are indicated in Table 4. Forms were evaluated concerning the specific target user group as indicated in Table 5.

Table 4. Overview of the forms tested regarding the form variant. The Variant is the official designation assigned by GFD for tax forms.

Form number	Name	Variant
F1	Interactive PDF form	25 5405/D
F2	Interactive PDF form (for individuals with income from independent and/or dependent activity)	25 5405
F3	EPO application without a guide	25 5405/D
F4	EPO application with guide	25 5405
F5	EPO application without a guide	25 5405
F6	Commercial application onlinepriznani.cz	Both variants
F7	Application prototype	25 5405/D

Source: own, 2022

Table 5. Evaluation of forms with respect to the user target group. X means which form was tested by which target group.

	F1	F2	F3	F4	F5	F6	F7
Group No.1	X		X	X		X	X
Group No.2		X		X	X	X	
Group No.3		X		X	X	X	

Source: own, 2022

It is clear from Table 2 that not all groups should have used all the forms. The specific use of the forms results mainly from the assignment of the given scenario. When Group No. 1 implemented more straightforward assignments only from employment contracts in a given year. Groups No. 2 and No. 3 addressed a much more complex scenario. Groups No. 2 and No. 3 thus used the same forms, although the layout of the script was different.

Part 1 - Expert evaluation

Expert evaluation has been conducted by four usability experts. The experts wrote a protocol for each of the forms evaluated. The experts conducted three well-established methods. Heuristic evaluation as defined by Nielsen (1994), Evaluation of conformity with recommendations for web forms by Nielsen Norman Group (NN/g) as defined by Whitenton (2016), and Formal usability inspection as complexly described by Wilson (2014).

For each of the ten heuristics, the experts set a list of findings within the heuristic evaluation. Each finding was supplied by a severity rating in the range of 0 to 4 as defined by Nielsen (1995), where:

- **0** = I don't agree that this is a usability problem at all.
- **1** = Cosmetic problem only: need not be fixed unless extra time is available on a project.
- **2** = Minor usability problem: fixing this should be given low priority.
- **3** = Major usability problem: important to fix, so should be given high priority.
- **4** = Usability catastrophe: imperative to fix this before a product can be released.

A laboratory session was conducted after individual evaluations. Severity ratings were discussed and normalized. All findings were evaluated, and redundant issues were removed.

The recommendations by NN/g consist of ten statements. Experts evaluated each statement and its conformance to a particular form using the following scale:

0 – fully complies;
1 – complies; improvements can be suggested;
2 – complies in most cases;
3 – mostly unfulfilled;
4 – unfulfilled, serious issue.

For formal usability inspection, we have set twenty-four rules of thumb. The experts evaluated its fulfillment using the following scale:

0 = NO;
1 = YES;
- = not applicable.

Part 2 - Usability Testing in the Usability Laboratory

Laboratory and environment

The testing with end-users (test participants) was conducted in the Usability Laboratory at HUBRU (Human Behavior Research Unit) under the Czech University of Life Sciences Prague (CZU Prague). We used a configuration with two test rooms and one monitoring room. Both test rooms were equipped as follows: standard PC running Windows 10 operating system; 24inch full HD screen; standard mouse and keyboard; 60 Hz eye-tracker Tobii Pro X2-60; secondary screen for moderator.

During the tests, each participant was in the laboratory room with only a moderator. The screen and events in the laboratory room were transmitted in real-time to the secondary screen for the moderator and the monitoring room, where experts on usability and tax issues were present. Everything was also recorded for further analysis and more accurate verification of the results if necessary.

Testing scenario

Test participants within each target group received a specific "life situation" in the form of a scenario. The life situation described each participant's particular group and personal information, e.g., name, birth date, birth number, employment, incomes, donations, insurance, children, wife, etc. So, participants were given the life situation and instructions for the User-task scenarios method. In addition, users received all the necessary documents needed for the tax return submission in the real form, such as proof of income, confirmation of study, blood donation certificate, etc. All instructions, data, and documents were provided in the electronic form to allow proper eye-tracking monitoring and attachment to the tax forms. Participants within a target group always solved the same scenario (received the same life situation).

Testing methods

The Usability Laboratory testing with users was generally based on a usability evaluation. Specifically, we used four well-established methods. The primary method was User Task Scenarios (also called Usability testing) as defined by Moran (2019). Participants get a set of tasks to perform using the tested software within this method. The moderators did not interact with the participants during the session. Therefore, immediately after that, a Retrospective Think-Aloud (RTA) was conducted to validate identified issues. This procedure is recommended by some authors in order to, for example, avoid interference with eye-tracking data (Prokop et al., 2020). To maintain accurate and high-quality measurement by eye-tracking while maintaining the benefits of Retrospective Think-Aloud, we decided to use RTA.

In a laboratory, users also filled a protocol for System Usability Scale (SUS) method as initially defined by Brooke (1996).

Users within each target group later participated in the Focus Group session (Powell & Single, 1996) session. The aim of using this method was to enrich the knowledge gained in the laboratory during the session with each participant separately with knowledge based on the mutual interaction of the participants within a particular target group. In the UX field, it can be used to uncover a deeper understanding of designers and design practice to build new knowledge which serves as a reflection towards the improvements of future design activities (Toyong et al., 2020).

Testing procedure

Each target group (as defined in Table 5) consisted of six participants. Therefore, within one day, the test was performed in six sessions (one session for one user). Considering the three target groups, the laboratory testing was conducted within three days separately. Each user session was carried out according to the following procedure:

1. The users were introduced to the whole procedure. They filled out a necessary consent.
2. Users learned about their scenario.
3. Moderator introduced the testing room, equipment, and methods.
4. The Moderator described the exact procedure and necessary instructions to calm and prepare the user for testing.
5. The eye-tracking device was calibrated.
6. The user task scenarios method was conducted.
7. Moderator performed RTA.
8. Moderator provided a paper form for the SUS method.
9. Steps 5 to 8 are repeated for each tested form.

To avoid the dependence of the achieved results given by the previous knowledge of the participants and also their fatigue, each user had a different order of the forms. Due to this fact, each form was tested as the first in a row without the previous knowledge of the participant. The remaining (additional) forms were sorted in a fixed order based on the first form that the participant tested.

All users participated in the focus group session at the end of each day after all user sessions. During the session, along with other questions, participants assessed their preferred form. The final order was used for later evaluation.

3. Results and Discussion

Part 1 – Expert evaluation (K2, K4, K5, K6, K7, K8)

Criterion K2 (Order of forms according to experts' evaluation) was calculated as an arithmetic mean based on the votes of all experts. Each expert sets his own order of the forms. The result is shown in Table 4. The experts preferred forms F6 and F7.

Total results of the experts' evaluation from the Heuristic evaluation (K4), NN/g recommendations evaluation (K6), and Formal usability inspection (K7) are shown in Table 3. It can be seen from the data that forms F6 and F7 have significantly lower total severity (K7 is maximizing). The forms also have a smaller number of highly severe issues. This indicates that the fixes will be less time and resource-consuming.

For the K5, we used a number of accessibility issues and a number of contrast issues found during the Technical evaluation of accessibility. For criteria K8, each usability issue identified during the laboratory testing was evaluated by usability experts using the same scale as for K4 – heuristic evaluation.

Table 3. Results of the expert evaluation

Form	Severities K4	Order	NN/g K6	Order	Formal insp. K7	Order
F1	198	*3*	22	*4*	11,3	*3*
F2	261	*5*	24,3	*6*	10,5	*4*
F3	273	*6*	22	*4*	8,3	*6*
F4	234	*4*	25,5	*7*	9,5	*5*
F5	334	*7*	21	*3*	7,8	*7*
F6	85	*1*	10	*1*	17	2
F7	117	2	14,3	*2*	18,3	*1*

Source: own, 2022

Part 12 – Usability testing in the laboratory (K1, K3)

The preferred order of the users (K1) was determined by their votes during the Focus Group session. The final order was calculated by the arithmetic mean of all respondents. As shown in Table 4, the order voted on by experts and users differs only for forms F1 – F3 and F2 – F4. F1 and F2 are the PDF versions, while F3 and F4 is a web application. Despite the fact, that the experts evaluated better usability of the PDF form, the results indicate that users prefer the online application instead of the PDF.

Table 4. Preferred order of the forms voted on by users and experts.

Target group	Form No.	Order experts	Order users
Group No.1 – Students	F1	3	4
	F3	4	3
	F4	5	5
	F6	2	2
	F7	1	1
Group No.2 – Employers	F2	3	3
	F4	4	4
	F5	2	2
	F6	1	1
Group No.3 – Self-employed	F2	3	4
	F4	4	3
	F5	2	2
	F6	1	1

Source: own, 2022

As can be seen from Table 5, results from the System Usability Scale method (K3) prove the order of the forms users voted directly with one exception. The F5 and F6 forms are of a different order. In this case, the results are very similar. The main reason for this fact is that some members of this target group already had previous experience with the EPO application (F5). Some of them were conservative and did not trust the commercial application (F6).

Table 5. Results of the SUS method.

Target group	Form	Avg. SUS	Order
Group No.1 – Students	F1	40,8	4
	F3	44,2	3
	F4	36,7	5
	F6	82,1	2
	F7	93,3	1
Group No.2 – Employers	F2	51,7	3
	F4	38,3	4
	F5	60,8	2
	F6	85,4	1
Group No.3 – Self-employed	F2	39,6	4
	F4	42,5	3
	F5	55,4	1
	F6	47,5	2

Source: own, 2022

During laboratory testing and further analysis and evaluation, we identified many issues. From the data in Table 6, it is apparent that forms F5 and F6 have a significantly lower number of usability issues. What stands out in the table is the Number of issues of form F5 in group No. 3. On the other side, the severity of issues in comparison to F6 is more than double.

Table 6. Results of the laboratory testing - usability issues.

Form	**Group 1 - students**		**Group 2 - employers**		**Group 3 self-employed**	
	Number of issues	**Total severity**	**Number of issues**	**Total severity**	**Number of issues**	**Total severity**
F1	20	58	x	x	x	x
F2	X	x	15	48	10	33
F3	23	78	x	x	x	x
F4	25	63	19	53	17	40
F5	X	x	17	59	6	22
F6	5	16	6	16	5	10
F7	7	15	x	x	x	x

Source: own, 2022

This study was based on a combination of methods for an expert evaluation with several methods for testing with users. The combination of methods is also supported by the results of the study undertaken by Maguire and Isherwood (2018) who found that heuristic evaluation identifies nearly five times more individual problems than user testing. However, user testing found, on average, slightly more severe problems. While each method had advantages in the test, both methods are seen as complementary to each other in practice. Furthermore, the suitability of the combination of these methods is supported by other studies (Hasan et al., 2012; Tan et al., 2009; Thyvalikakath et al., 2009). The need for a combination of methods is also published by Lewis (Lewis, 2006), who sees this combination as an opportunity to increase the possible detection of usability issues while managing reasonable costs and increasing return-on-investment (ROI).

For usability testing, we used six participants for each target group. Turner, Lewis, and Nielsen (2006) demonstrated that 80% of usability issues could be identified with a sample of five users. More specifically, after the fifth user session, many problems only recur, and fewer and fewer new problems appear. A newer article considers the same number (Nielsen, 2012). Lewis (2006) also confirms this assumption for the Heuristic evaluation of usability professionals – evaluators. Nielsen and Molich (1990) recommended at least three.

Other studies like Virzi (1992) or Alroobaea & Mayhew (2014) indicate the different appropriate numbers of participants for many reasons. Our intention was not to find the maximum possible number of different usability errors but to identify the best possible solution. Taking into account the fact that testing with users is not the only criterion for evaluating forms and also in terms of the overall time required for testing, where relatively large forms and long scenarios are tested, we decided to slightly expand the commonly used number of five participants.

Another method suitable for a comprehensive usability assessment would be the use of web analytics which is also supported by the study of Palomino, Paz, and Moquillaza (2021). We did not get access to this data. For many e-government systems, it is a common problem. Additionally, by the nature of the PDF forms, it is not even possible to obtain such data.

In addition to the identification of usability errors, the combination of methods also yielded some interesting results. For example, some users of Group No.3 (self-employed) reported during the testing that the forms that were rated as the best in the study result were not very clear and forced them to change their thinking. It is likely that their previous knowledge and use of other forms were to blame. However, despite these identified feelings, other methods showed a lower error rate and faster completion by this group of users for the forms they did not like at first glance.

4. Conclusion

The study aimed to evaluate several tax return forms based on a combination of several methods for usability (and accessibility) evaluation. It was not primarily intended to identify as many potential usability errors as possible but to identify several solutions (forms) as best as possible from several aspects and identify the most suitable solution for possible subsequent use in practice. The reason for combining several methods was, among other things, to minimize the possible limits of each method used and, at the same time to make the most effective use of testing of each testing participant. We combined usability evaluation by experts with user testing and the Focus Group method, which also gathers user opinions and ideas.

The results showed that modern applications have significantly higher usability. Interestingly, we identified that the usability of PDF forms was better than the current applications (EPO) provided by GFD. However, slightly different results were observed for the third target group (self-employed). The difference is mainly due to the previous experience of the users. The best results were achieved by the F6 (commercial application selected by GFD) and the F7 application prototype provided by GFD, which is not yet publicly available. However, the opinion of experts and users differs in this case. Experts have identified more usability issues in the F7 form. On the other hand, users rated it as the best overall. The difference is due to a combination of methods.

Although the data has been collated and results have been achieved, there is a need to process the data in an automated way for more efficient comparisons. Currently, audiovisual data from user testing must be processed manually. This is both financially and time-consuming. By developing machine learning-based technology, this analytical phase of UX testing would be significantly faster and thus cheaper. Testing results could also become more accurate, as the human error factor would be de facto removed from the analytical phase. Therefore, the data collected from this study will be used in future research. Within this study, these data have been labeled, and then the new machine learning methods will be evaluated on them.

Acknowledgements

The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2022A0015.

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POSSIBLE IMPACTS OF FARM TO FORK STRATEGY ON THE CROP STRUCTURE IN THE CZECH REPUBLIC

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Annotation: European Union's Farm to Fork Strategy sets the target for year 2030 to reduce nutrient losses to the environment from organic and mineral fertilizers by at least 50% and to reduce the fertilizers use by 20%, while ensuring no deterioration in soil fertility. The goal of nitrogen reduction cannot be achieved only by mere reduction of usage of nitrogen as certain minimal level of fertilization must be maintained. Therefore, the structure of the plants would change. The aim of the paper is to examine how would the structure of the crops in the Czech Republic change if the target of reduction of the fertilizers (in our case nitrogen) use is met. The model of crop structure at the level of the whole Czech agriculture was created and three scenarios were simulated. The most nitrogen-demanding is rapeseed and wheat. Even if the whole rapeseed was replaced by soybeans as a nitrogen-fixing plant (baseline scenario), the decrease of nitrogen use would be only 26.4%. In the first scenario, we assumed that 300 000 hectares of rapeseed is allocated to soybeans (reduction of rapeseed production to 1/4). Then the nitrogen use decreased by 12.6%. Second scenario assumed that rapeseed is substituted by other plants equally and the decrease of nitrogen was only 8.6%. Therefore, change of plant structure cannot be the only way how to achieve the goal of 20% reduction of fertilizer use.

Keywords: Crop structure, Farm to Fork strategy, Nitrogen fertilizer, Mathematic modelling

JEL classification: Q18, C60, Q15

1. Introduction

The Green Deal is the European Union's (EU's) latest growth strategy and action plan, which will meet the challenges concerning climate change and environmental degradation. It is intended to prevent biodiversity loss, to reduce pollution level, and to improve food quality. (Panka et al., 2021). "With the introduction of the Green Deal and in particular the Farm to Fork and Biodiversity Strategies, the European Commission (EC) has accelerated the ongoing transition towards sustainable food systems adding complexity to the analysis of the impact and trade-offs of policies, including the CAP." (Barreiro-Hurle et al., 2021).

The Farm to Fork strategy addresses soil pollution with 50 % reduction in use of chemical pesticides by 2030 and aims at 20 % reduction in fertilizer use plus a decrease of nutrient losses by at least 50%. The Biodiversity Strategy has the ambition to set a minimum of 30 % of the EU's land area as protected areas, limit urban sprawl, reduce the pesticides risk, bring back at least 10 % of agricultural area under high-diversity landscape features, put forward the 25 % of the EU's agricultural land as organically farmed, progress in the remediation of contaminated sites, reduce land degradation and plant more than three billion new trees. (Montanarella and Panagos, 2021) The targets of both strategies are concrete and ambitious and shall be achieved already up to year 2030. In the article, we focus on the reduction of mineral fertilizers.

Overuse of mineral fertilizers can cause environmental damage – e. g. an eutrophication of waters and soils, loss of biodiversity, and drinking water pollution. Concerns about ammonia losses from nitrogen mineral fertilizers are the reason for policymakers to set emission reduction commitments across Europe. (Mencaroni et al., 2021) "Regulatory instruments, such as the Nitrate Directive applied to reduce and manage mineral fertilizers showed scarce results in terms of environmental protection." (Gazzani, 2021) Therefore, the Farm to Fork Strategy of the European Union sets the target for year 2030 to reduce nutrient losses to the environment from organic and mineral fertilizers by at least 50% and to reduce the fertilizers use by 20%, while ensuring no deterioration in soil fertility.

"The amount of nutrients used today per hectare of agricultural land varies a lot from one EU Member State to another due to the diversity of agricultural products and production methods, as well as different climatic zones and soil conditions in Europe." (Fertilizers Europe, 2019) In the Czech Republic, the nitrogen fertilizers use increased since 2009, but since 2016 the amount is decreasing – both in terms of the kg/ha usage and also in total numbers. Last available data are from year 2020 when 81 kg/ha of arable land was used that accounted for 285 436 tons in total. Phosphorus and potassium do not have a clear development trend. There was used 13,5 kg/ha of phosphorus (47 447 t in total) and 7,2 kg/ha of potassium in 2020 (25 373 t in total). (Cenia, 2021)

There is a natural way of a leakage of nitrogen fertilizers. "Small amounts of nitrate must leach into waters, and ammonia and nitrous oxide be emitted to the atmosphere to maintain natural ecosystems." (Goulding, 2002). However, certain amount of nitrogen can leak also due to the nature of the plants. "Inefficient use of fertilizers by crops increases the risk of nutrient leaching from agro-ecosystems, resulting in economic loss and environmental contamination." (Broberg et al, 2017). Nevertheless, sometimes the overuse or misapplication of the mineral fertilizers can cause damage to the environment. "In many parts of the world, intensive agricultural production has contributed, with industry and vehicle use, to the global doubling of "reactive" nitrogen (N) in the environment, resulting in eutrophication (nutrient enrichment), ecosystem change and health concerns." (Goulding, 2002)

The first attempt to have the nitrogen in agriculture under control was a Nitrate Directive introduced in the EU already in 1991. It aimed to reduce water pollution caused or induced by nitrate from agricultural sources. For this reason, four measures were taken: 1) limiting inorganic N fertilizer application to crop requirements; 2) limiting organic manure applications; 3) seasonal restrictions on the application of slurry, manure sand sludge on sandy and shallow soils; and 4) maintenance of farm records that encompass cropping, livestock numbers and fertilizer management. (EEA, 2020) While the mineral fertilizers have been reduced to certain amount, the importance of organic fertilizers and organic matter in soil is stressed. For example, Ducsay, Lozek and Gaborik (2019) show that in Slovakia the use of organic fertilizers is low and the related input of NPK nutrients from organic fertilizers to soil is low too.

Reduction of fertilizers use can be done by not only by mere reduction of fertilization but mainly by more precious soil management, implementation of modern technologies and by changing the sowing procedure in favour for nitrogen-fixing crops. Mencaroni et al. (2021) tested several best available techniques for nitrogen reduction in Veneto region, northeast Italy. Bryson (2022) "argue that to achieve climate neutrality goal set within the European Green Deal and the Farm-to-Fork strategy by 2050 "there will need to be a major adjustment to how food is produced, a realignment in plant health strategies and accelerated innovation across the agricultural sector."

Tremblay et al. (2007) found out that residual of nitrogen found after harvest in the soil was relatively low, so the environmental risks in corn production are related to early season, when the crop uptake of nitrogen is low and the soil is susceptible to intense leaching episodes. They proposed a decision-support system for crop nitrogen management that used a remote sensing and geographic information system technologies.

Modelling the impacts of Farm to Fork and Biodiversity strategies is complicated. There are many unknowns and the goals interact with each other, sometimes there are synergies in achieving the objectives, sometimes they are in opposition. Several large studies have been elaborated, some of them have simulated the impacts of all goals at once, some of them only one at a time. Also, the scope of the studies varies as in some the impact on agriculture is assessed only, in others world-wide context is given. In our article, we focus on the target of the reduction of the use of the nitrogen fertilizer and change in rapeseed sown area. Our results are compared to those studies that also consider crop structure on the country level.

2. Materials and Methods

The aim of the paper is to examine how would the structure of the crops in the Czech Republic change if the target of reduction of the fertilizers (in our case nitrogen) use is met. Particularly we focused on the rapeseed crop and modelled the situation when its sown area decreases. Rapeseed is one of the most demanding crop regarding the use of mineral fertilizers. To achieve the yield of 3.0 t/ha fertilization of 200.0 kg N/ha is necessary. For higher yield of 4.0 t/ha even 220.0 kg N/ha is necessary and for 5.2 t/ha it is 230.0 kg N/ha according to the normative of the Research Institute of Plant Production (Wollnerová, Kozlovská and Klír, 2020). In our model, we consider the fertilization 220.0 kg / ha.

It is estimated that the proportion of nitrogen applied in the form of mineral fertilizers, which subsequently escapes into the air in the form of nitrous oxide, reaches units up to tens of percent. Excessive doses of mineral nitrogen on arable land are unusable crops and thus lead to high emissions of nitrous oxide. Optimizing nitrogen doses, while reducing nitrous oxide emissions, would help reduce groundwater and surface water contamination by nitrates and improve arable farming economics. (Nesňal et al., 2020). Besides, the structure of the crops and sown areas can influence the total nitrogen emissions in the country. Our research focused on this situation as we modelled the achievement of the goal on the country level.

For modelling the simulations of crop structure changes, elaborated a dynamic model of Economic Accounts of Agriculture (EAA) entitled SZU-4_fertilizers was elaborated. EAA is a methodological tool for measurement of the size and economy of the agriculture and is assembled by Czech Statistical Office. It consists of the production account, generation of income account, entrepreneurial income account and components of the capital account. Therefore, we can find here value of the production of the agricultural sector, intermediate consumption, gross and net value added, taxes / subsidies and income from factors. Data were taken for years 2017–2019 and a mean values were calculated because actual data are published with delay.

Data from EAA were complemented by the data about production costs from Cost Survey performed every year among the farmers by Institute of Agricultural Economics and Information. Finally, normative for nitrogen use for crops elaborated by Research Institute of Plant Production was implemented into the model. The model of crop structure covers 98% of the land in conventional agriculture.

Several scenarios were simulated. First one is baseline scenario S0 – base/original state that is compared to others. Scenario S1 is that the whole area of winter rapeseed is converted to fallow, because this crop needs the largest load of mineral fertilizers. It is theoretical scenario elaborated just to see whether the elimination of even whole of the most fertilizer-demanding crop would be sufficient to achieve the goal of 50% reduction of fertilizers use. Scenario S2 allocates 300 000 ha of rapeseed to soya that is an improving and nitrogen-fixing crop. This will imply the decrease of production of rapeseed on ¼. This scenario also supposes that the import of soya to the Czech Republic can decrease in order to increase the self -sufficiency in this commodity. Last scenario S3 also simulates the decrease of the rapeseed production on ¼ (by 300 000 ha), but this time the acreage is proportionally used to plant other commodities.

3. Results and Discussion

The results of the model for the Economic Accounts of Agriculture, i. e. the crop and livestock production, total production, intermediate production and business income in mil. of CZK for the Czech Republic, are displayed at Tab. 1. Last row shows the changes in nitrogen fertilization when different scenarios are applied. Value of crop production is higher than livestock production. Both together with other miscellaneous productions related to those production accounted to 134 775 mil. CZK (average of years 2017 to 2019). Relative changes of values in percentage in different scenarios are displayed at Graph 1.

Table 1. Economic Accounts of Agriculture – baseline S0 and scenarios S1, S2, S3 – value in mil. CZK

Variable	S0	S1	S2	S3
Crop production	74 974.18	62 665.57	74 659.90	75 313.53
Livestock production	51 554.81	51 554.81	51 554.81	51 512.92
Total production	134 775.12	122 466.52	134 460.84	135 072.59
Intermediate production	91 086.33	86 434.01	90 244.99	90 235.42
Business income	17 627.12	9 970.84	18 154.18	18 775.50
Decrease of nitrogen fertilizer	0.00 %	26.41 %	12.13 %	11.89 %

Source: Economic Account of Agriculture 2017–2019, own elaboration (2022)

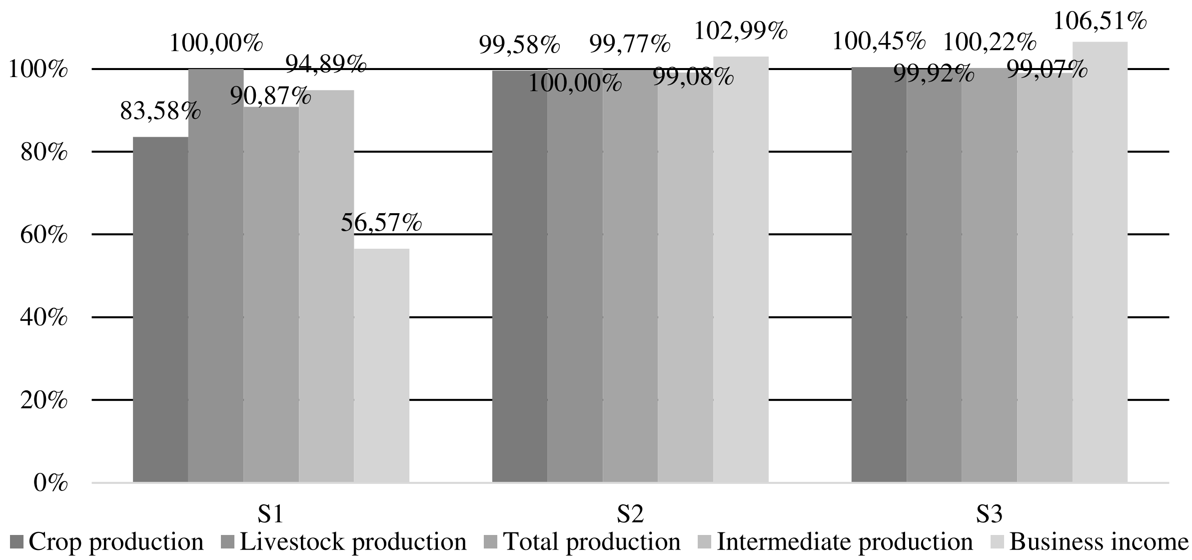
If the whole area is turned to fallow (S1), naturally the crop production decreases, and livestock production does not change. Intermediate production decreases on 94,89 % of the original value. Naturally also business income decreases – this time significantly as rapeseed represents a very important part of the income of agricultural companies in the CR. Even in this very radical scenario, the decrease of nitrogen fertilizer is not sufficient to meet the requirement of 50% reduction. Only 26.41 % could be achieved.

When 300 000 ha of rapeseed is allocated to soya (S2), the nitrogen balance shall be improved as this crop is nitrogen-fixing. The decrease of the nitrogen fertilizer use is only 12.13 %. The crop production in mil. CZK is almost similar (it decreases by 0.42 percentage points (p. p.)

because the price of soya is lower than rapeseed). Total production and intermediate production decreases accordingly, i.e. mildly by 0.23 p. p. and 0.92 p.p., respectively. On the other hand, the business income increases by 2.99 p. p.

Last scenario S3 also simulates the decrease of the rapeseed production by 300 000 ha, but this time the acreage is proportionally used to plant other commodities. Therefore, the crop production even increases by 0.45 p.p., because the decrease of rapeseed production is balanced by production of other crops. In this scenario, the livestock production decreases, but only mildly – by 0.08 p. p. This time, total production increases (by 0.22 p. p.) as same as the business income (by 6.51 p. p.) as other crops generate higher income that rapeseed. In this case, the decrease of nitrogen fertilizer is almost similar as in second scenario – 11.89 %. We can conclude that mere decrease or change of rapeseed production does not bring significant changes in the use of nitrogen fertilizer.

Figure 1. Decrease of production in scenarios S1, S2, S3 as a percentage of S0



Source: Economic Account of Agriculture 2017–2019, own calculation and elaboration (2022)

Changes in a crop structure are displayed in a Table 2. Negative sign means decrease of the production, positive sign increase. If the whole area of rapeseed is removed, the production of oil seeds would decrease by 92% that would imply technical crops would also decrease (by 23%). When the 300 000 ha of rapeseed is allocated to soya, the production of oil seeds decreases only by 23%, and of technical crops by 8%. Last scenario also brings significant decrease of oil seeds production (by 90%) and of technical crops (by 5%), but on the other hand, the production of cereals increases by 24%, of fodder crops by 25%, of vegetables and horticulture products by 7%, and of potatoes by 24%.

Table 1. Changes in crop structure – Scenarios S1, S2, S3 (decrease in comparison with S0) – value in mil. CZK

Crops	**S0**	**S1**		**S2**		**S3**	
Cereals (incl. seeds)	6972.02	6972.02	0%	6972.02	0%	8643.60	+24%
Technical crops	5550.33	4263.68	-23%	5234.34	-6%	5296.11	-5%
Oil seeds (incl. seeds)	1389.14	111.80	-92%	1082.47	-22%	138.68	-90%
Fodder	11355.41	11355.41	0%	11355.41	0%	14203.76	+25%
Vegetables and horticultural products	216.68	216.68	0%	216.68	0%	232.30	+7%
Potatoes (incl. seedlings)	623.94	623.94	0%	623.94	0%	774.32	+24%

Source: Economic Account of Agriculture 2017–2019, own calculation and elaboration (2022)

Our results can be compared to the impact studies of different Farm to Fork or Biodiversity strategies' targets elaborated by various scholars for the European Commission or other stakeholders last year. A study of Henning and Witzke (2021) focused on the impact of Farm to Fork strategy on production, trade, welfare and the environment. Based on CAPRI model, they found out that in case of oilseeds the prices will rise by 18%. There will be also a strong effect on production, when in the EU the oilseed production can decline be 20% and their sowing areas by 6%. The strongest price and production effects were noted due to the N-balance reduction of 50%, i. e. the target that is examined in our paper. However, in our scenarios, the effect is much higher (the lowest in S2, -22%). The net import of oilseeds would increase from -17 to -22 million tonnes in a research of Henning and Witzke (2021). Regarding the public welfare, the adjustment costs would be financed by the consumers and profit margins in oil processing industry will be reduced by 4 bil. euros.

Barreiro-Hurle et al. (2021) also used CAPRI model to see the impacts of Farm to Fork and Biodiversity strategies. In the scenario with combined both strategies' targets without changing the CAP, the supply of oilseeds would decrease by more than 15 %. Oilseed net trade would decline by more than 30 mil. t. Producers prices would increase by 11%. Despite that the costs would slightly decrease, this would not counterbalance the decrease of production, so the revenues from oilseeds would decrease by almost 2 mil. euros. Again, the simulations in our paper show much more significant impact.

Bremmer et al. (2021) found out that the reduction of fertilizers use brings production decline below 15% and price increase below 20%. Due to the nature of our scenarios, the impact was higher – decrease of oil seeds by 92% (S1), 90% (S3) or 22% (S2). In a study of Bremmer et al. (2021), the net imports of maize, rapeseed and citruses shall increase. On the other hand, net exports of tomatoes, apples, olives, wine and hops shall decline. Overall negative impact on the value of production could account to almost 92 bil. euros.

Our simulations show too high reduction of oilseeds production, but still not sufficient decrease of nitrogen from agriculture. We can conclude that approach towards the assessment shall be a holistic and consider all ways how to reduce the nitrogen fertilizer, not only the rotation of the crops. Besides, a completely different way of farming could be applied to minimize the fertilization use – e.g. organic or biodynamic agriculture (see Pechrová (2013) for details about biodynamic agriculture). Fertilizers Europe (2019) states that for optimal crop production it is necessary, on one hand, to avoid soil degradation by addressing nitrogen deficiency, and to optimize nitrogen application, on the other hand.

4. Conclusion

The aim of the paper was to assess how would the structure of the crops in the Czech Republic change if the target of reduction of the nitrogen fertilizers use is met. The model of crop structure at the level of the whole Czech agriculture was created and three scenarios were simulated. However, despite that the reduction of production of rapeseed was significant (replaced by production of soya or of other crops), the reduction of nitrogen fertilizer use was not significant. Even if the whole rapeseed land was left fallow (first scenario), the decrease of nitrogen use would be only 26.4%. In the second scenario, we assumed that 300 000 hectares of rapeseed is allocated to soybean as nitrogen-fixing plant (reduction of rapeseed production to 1/4). Then the nitrogen use decreased by 12,1%. Third scenario assumed that rapeseed is substituted by other plants equally and the decrease of nitrogen was almost equal - 11.9%. Therefore, change of plant structure cannot be the only way how to achieve the goal of 20% reduction of fertilizer use. Mencaroni et al. (2021) draw attention to the fact that nitrogen reduction techniques should be tailored to local pedo-climatic and management conditions. Because it is costly to change land use, tillage practices, or fertilizer use drastically, there have to be implemented a cost-effective mix of various adjustments of farm-level production practices. (Ekman, 2005)

We can conclude that approach towards the assessment shall be a holistic and consider all ways how to reduce the nitrogen fertilizer. Besides rapeseed another nitrogen-demanding crop is wheat. It requires 200 kg N/ha to achieve yield 8 t/ha. Despite that no significant changes are expected in its production, there might be complex changes in the crop structure. Therefore, the challenge for future research is to model more composite and related changes in production of more plants.

Acknowledgements

The paper was created within the project of the Ministry of Agriculture of the Czech Republic, institutional support MZE-RO0918, Internal Research Project no. 1110/2022.

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GREEN DEAL VERSUS POSITION OF THE ECOLOGICAL-ERGONOMIC SUBSYSTEM IN ORGANIZATIONAL SYSTEM

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Annotation: The authors analyze the impact of the Green Deal on price rises, inflation, and the gradual increase in the EU's energy and production dependence. It is important to recall that the disproportionate increase in electricity and fuel prices started long before the outbreak of the war in Ukraine. The main causes are emission allowances and, in particular, emissions trading, the addition of bio-based fuel components, and the high cost of energy production using renewable sources, which is supported by subsidies in a non-market-based manner. The article's authors understand the goals of the Green Deal as tasks or requirements of the ecological-ergonomic subsystem, which is part of an effectively functioning organizational system. At different levels of hierarchy, the organizational system can be understood as an enterprise, the national economy of a country, and the EU economy. The authors conclude that the ecological-ergonomic subsystem cannot have a decisive influence on the effective behavior of the organizational system. It cannot even positively influence the organizational system's behavior in meeting the Green Deal objectives.

Keywords: Management, Organizational system, Subsystems of the 1st order, Ecological-ergonomic subsystem, Components and links, Hierarchy, Hierarchical level, Green Deal, Sustainable development, Economic growth, EU

JEL classification: E19, M11, L20

1. Introduction

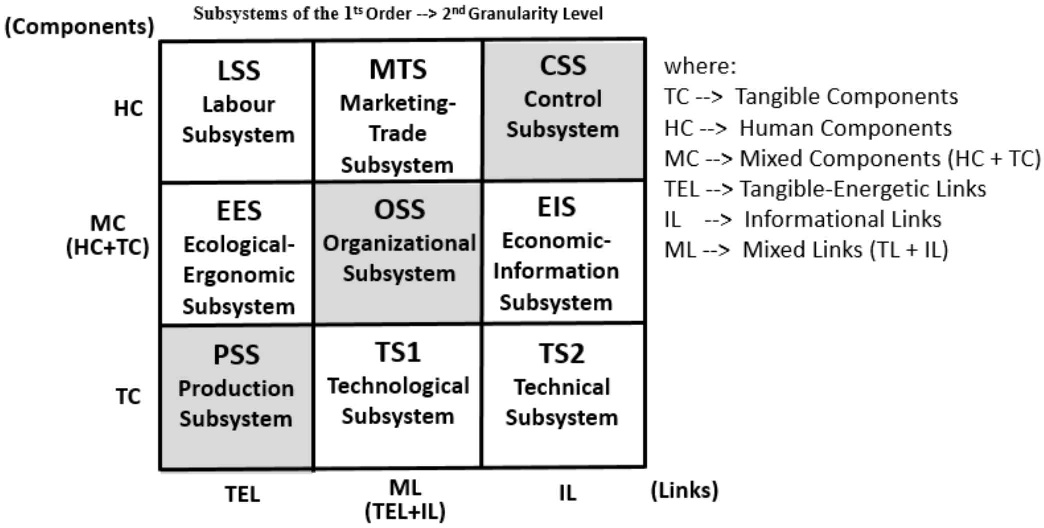
The European Green Deal is the EU's primary and most significant measure toward climate neutrality. This agreement was published in December 2019 (Kougias et al., 2021). The UN COP 25 climate change conference was held under the presidency of the government of Chile and logistically secured by the government of Spain (EUROPA.eu, 2021). The European Green Deal is more than just an initiative for green economic growth. Alongside the European Single Market and Economic and Monetary Union, it is another component of the European economic model (Bongardt and Torres, 2022). The Green Deal has become one of the cornerstones of EU-wide policy (Rodríguez-Espinosa, Navarro-Pedreño and Gómez-Lucas, 2021). It is a plan to support the European Union's transition to a climate-neutral economy by reducing carbon emissions by 55 % by 2030 compared to 1990 and achieving carbon neutrality by 2050 (Sikora, 2021). The EU will have a zero-emission economy (COP25, 2019). The new European Green Deal aims to make the EU the first climate-neutral continent by 2050 (Montanarella and Panagos, 2021). The European Green Deal is a very ambitious strategy. Given the highly turbulent environment, from the demonstrations in Europe to the Covid 19 pandemic, political actors need to identify and understand the sources of turbulence, its real cause, and the potential of possible responses early on if they want to deal with turbulence effectively (Dobbs, Gravey, and Petetin, 2021). According to EUROPA.eu (2021), climate change represents both an opportunity to build a new economic space and the most significant challenge. Through the Green Deal, opportunities for innovation will be created, and new jobs will be created. Based on an analysis of political, societal, and technological developments Hainsch et al. (2022)

conclude that high levels of electrification are inevitable to achieve rapid decarbonization. To accelerate the energy transition, developing new technologies and their deployment in the short term must be in line with solid policy advocacy. According to (Rodríguez-Espinosa, Navarro-Pedreño and Gómez-Lucas (2021)), the EU hopes to become a global leader in climate action, but the external dimension is currently somewhat unclear. Fleming and Mauger (2021) express some lack of confidence in achieving the goal. According to the authors, the total reduction in emissions is a maximum of 47 % by 2030 (EUROPA.eu, 2021), and it is not clear where the additional 8 % will come from to meet the target. This raises whether such ambitious targets, which are not backed up by detailed action plans, can be considered achievable. According to Wolf et al. (2021), significant transformational changes are needed to lead the EU to different solutions to the climate crisis, not just decoupling the environmental impact of economic activity. Rodríguez-Espinosa, Navarro-Pedreño and Gómez-Lucas (2021) focused on research on the state of urban soils and the links between urbanization and human health. They report that more than 60 % of European soils are unhealthy due to human development. However, they did not find data on the percentage of unhealthy urban soils. Although there is a great effort to analyze and improve the sustainability of European cities, it is clear from the existing data that Europe will not meet the Shared Green Deal by 2030. This is probably because there are significant challenges to be met in terms of environmental targets. However, research results from Perissi and Jones (2022) show that the Member States have clearly defined objectives for the Green Deal but not yet the measures that will achieve these objectives. In terms of national policies and financial management, the proposed measures are, according to the authors, still underdeveloped and immature, and the solutions are only partial. According to analysts interviewed by ČTK (2022), the Green Deal in its current form has ended due to the Russia-Ukraine conflict. The emphasis in the energy sector will now be on greater self-sufficiency for the European Union, with experts seeing renewable energy as the way forward. "The Green Deal is over. Supplies from nuclear and coal-fired power stations were replaced by cheap Russian gas. It will not, and LNG (liquefied natural gas) is three times more expensive than Russian gas, and it will be more. The market will take advantage of Russian oil shortages, and prices will increase," said for ČTK Vladimir Stepan, the consultant of ENAS. According to analysts, decarbonization will continue on a more rational and pragmatic basis. Russia's invasion of Ukraine has demonstrated Europe's energy dependence. Delbeke (EIB Climate Chair), Cornillie and Vis (2022) outline five key elements that will influence the Russian invasion of Ukraine and the economic sanctions imposed by the EU on the energy transition in Europe.

2. Materials and Methods

The primary method used in the theoretical part of the paper is the systems approach. The 1st order subsystems of the OS were defined, and their hierarchy and competencies were established with a focus on the position of the ecological-ergonomic subsystem (EES). An organizational system (OS) can be applied to both a company and a national economy because it can be defined by the same components and the same links. The components are represented by people (human component HC), technical equipment (tangible components TC), and mixed components (MC), which form a unity (HC+TC). The links can be defined as tangible-energetic links (TEL), informational links (IL), and mixed links (ML), which form a unity (TEL+IL). Components and links form the system's structure, which acts as a transformer of inputs to the system into outputs from the system. The transformation itself represents the system's dynamic component- the system's behavior. The system's behavior is dependent on the level of inputs (inputs from the system's immediate environment), the goals set by the control subsystem, and the system's structure. This is true at all levels of hierarchy. The organizational system is illustrated in Scheme 1.

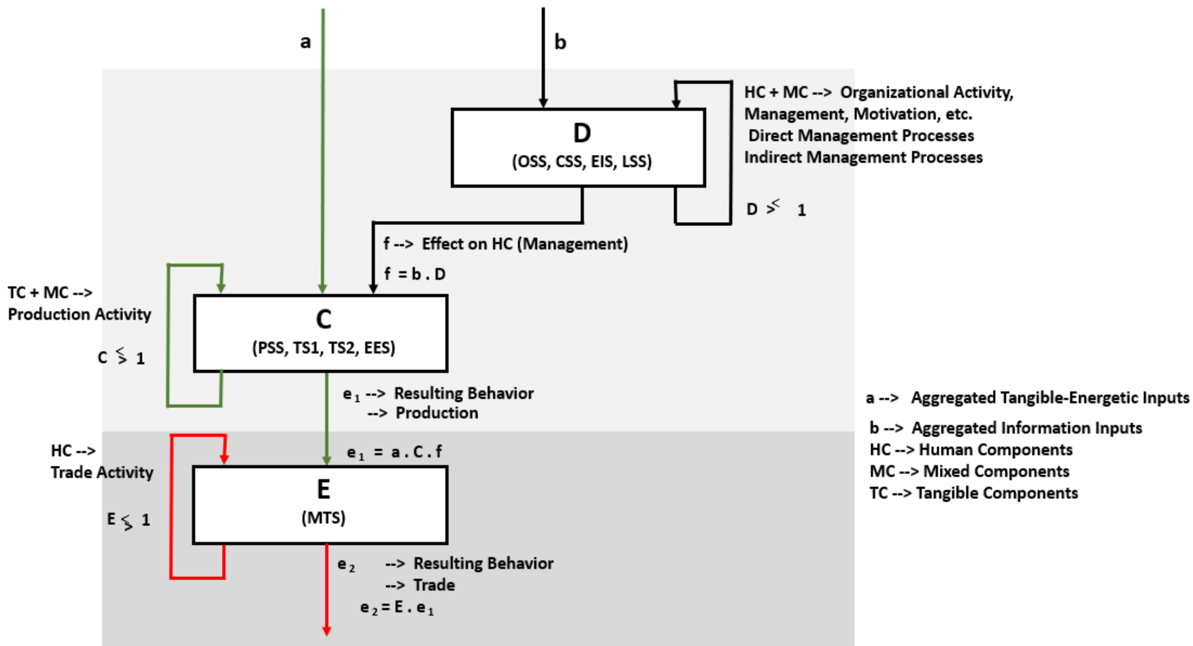
Scheme 1. Structure of the OS – definition of subsystems of the 1st order



Source: Authors, 2022

The behavior of the organizational system is illustrated in Scheme 2. The behavior of the OS depends on the inputs to the system. The aggregated inputs marked in green represent the tangible energetic inputs to the OS. The green color draws attention to the fact that the price of these inputs is heavily influenced by the forced changes due to the Green Deal.

Scheme 2. Behavior of the organizational system (OS)



Source: Authors, 2022

Then the method of logical deduction and induction is used to compare the pillars of sustainable development with the position and role of EES. The relationship between the individual subsystems and their mutual influence was confirmed by evaluating a questionnaire survey of 610 managers.

The following methods will be used to obtain answers to research questions:

I. Can the ecological-ergonomic subsystem (EES) as a supporting subsystem at the fifth hierarchical level have a decisive influence on the behavior of the whole organizational system?
II. Can the ecological-ergonomic subsystem (EES) positively affect the behavior of the whole organizational system?

3. Results and Discussion

The fundamental increase in fuel prices, which is affected by the addition of the bio component to diesel in the long term, and the increase in electricity prices, which are affected and made more expensive by other forced changes - wind farms, photovoltaics, the cancellation of nuclear power stations, the complete shutdown of coal-fired power stations. This trend directly increases the price of essential inputs - electricity by 200 %, natural gas by 400 %, and wheat by 100 %. The numbers are already much worse due to the war.

The rise in the price of these essential inputs has made the actual production activities of almost all OS (enterprises) more expensive. In Scheme 2, this is indicated by the own feedback of the structural variable C. The resulting behavior of e1 will be lower if planned costs are maintained or there must be an increase in the price of products after accounting for the increased costs. This will lead to a further increase in marketing and trade costs as expensive goods will be harder to sell (there was a CZK 11 billion reduction in consumption in the Czech Republic in the last quarter). The increased cost of these support activities will be reflected as a further increase in the price of the product, i.e., in the value of e_2.

3.1 Position of the ecological-ergonomic subsystem (EES) in the hierarchy of OS subsystems

The OS subsystems are interrelated, have different responsibilities, and are subject to a certain hierarchy. The hierarchy of OS subsystems is illustrated in Scheme 3.

In terms of hierarchy, EES is at the 5th hierarchical level with competence of 0.083. The hierarchical arrangement results from the systems approach but is also confirmed by the questionnaire survey (a set of about 600 managers who confirmed the indicated dependencies of the individual subsystems:

$$CSS \rightarrow PS1 \rightarrow TS1 \rightarrow TS2 \rightarrow PS1 \quad (1)$$

CSS → (strategy → new product) PS1 → (selection of the most appropriate technology) → TS1 (assessment of the possible parameters of the technical equipment necessary for the implementation of the technology) → TS2 → provision of the required technical (physical) resources → PS1).

$$[(PS1 + TS1) \rightarrow EES \rightarrow PS2] \quad (2)$$

(PS1 + TS1) → influences or determines the working environment and ecological impacts of production on the company's surroundings (ecological subsystem and ergonomic subsystem – 2nd order OS subsystem) → *EES* → ergonomic demand determines the necessary physical cooperation of people → *PS2*).

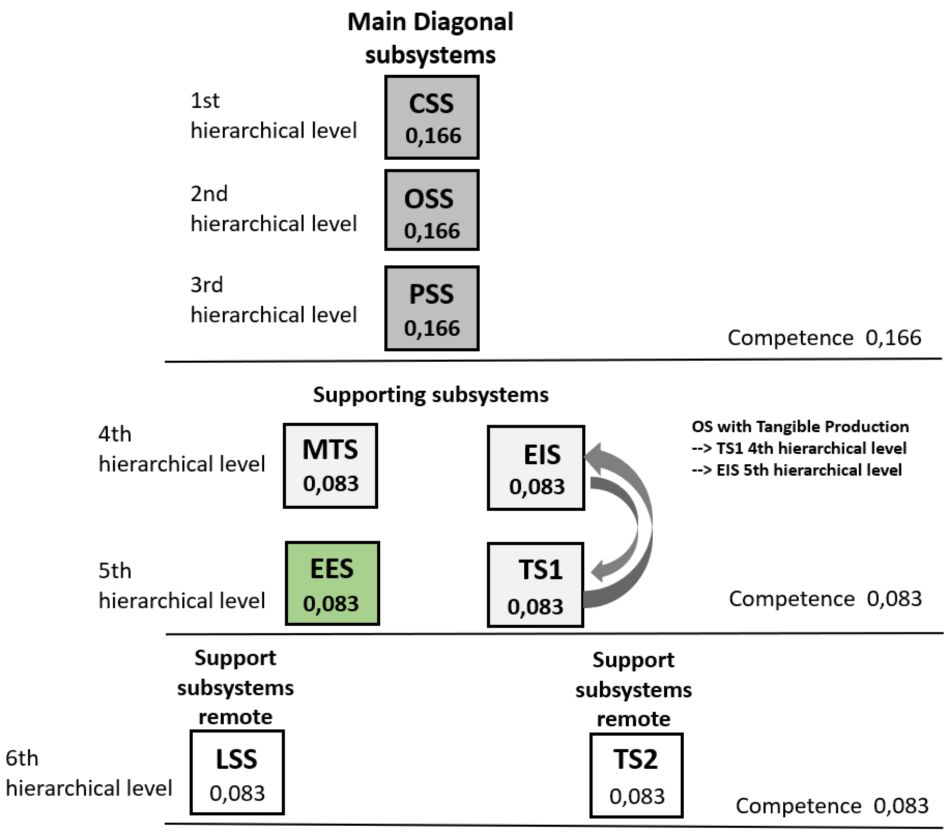
$$(PS1 + TS1 + EES) \rightarrow OSS \tag{3}$$

(PS1 + TS1 + EES) → require the allocation of resources, their subsequent optimization (human, material, financial, time and space resources) → the creation of organizational units where production is realized → *OSS*).

$$(OSS + MOS + EIS) \rightarrow \check{R}SS \tag{4}$$

(OSS + MOS + EIS) → feeds back to the *CSS*, the new organizational units have a new head, reflected in the management structure.

Scheme 3. Hierarchy of 1st order subsystems of OS



Source: Authors, 2022

From the above dependencies and the hierarchical position of the *EES*, it can be seen that the *EES* cannot determine the behavior of the OS. It is not possible to first determine the values and functioning of the *EES* and then look for activities that meet the requirements of the *EES*.

3.2 Natural behavior of organizational systems (enterprises)

According to § 420 of the Civil Code: "Whoever independently exercises on his own account and responsibility on his own account and in a trade or similar manner, with the intention of doing so continuously for profit, shall be regarded as an entrepreneur with respect to that activity."

It is natural for a business entity (EO) to make a profit. The aim is to maximize profit and minimize risk. Between these two poles, the entrepreneur seeks the right, optimal solution.

If obstacles are put in his way, or he does not realize at least an average profit, he will close his business or move elsewhere. The main 'environmental pests' are large multinational corporations. They have sufficient resources, financial and otherwise, to relocate their operations elsewhere where they will not be hindered. This may improve the environment in the EU, but it will reduce production, reduce GDP, make goods more expensive, and only increase the cost of imports. The imports themselves will represent extra pollution. Overall, the environment will get worse. And there will be more energy dependency. It already is to a large extent, in terms of material production. Consistent application of the Green Deal will lead to continued production dependency.

It is naive to think that large and powerful companies (OS) will behave differently. Setting targets that are not aligned with the objectives of the OS is the same as the management system setting nonsensical and contradictory targets for individual subsystems within an organizational system.

With a high degree of aggregation, separate enterprises can be seen as subsystems of the national economy. The setting of objectives cannot only correspond to the wishes of the controlling subsystem but must enable the realization of the target behavior of the system. And the target behavior of enterprises is the realization and maximization of profit. The behavior of the EU at present strongly resembles socialist central planning. Nevertheless, we know from experience that this works very badly and lags behind those economies that do not suppress the natural course of things. Unless the EU's economic policy changes, we can expect a gradual reduction in production, further increases in prices, and a reduction in GDP per capita. All this will lead to a reduction in the population's standard of living. In the future, it will also threaten unity within the EU, which may lead to the break-up of the EU.

3.3 Natural human behavior

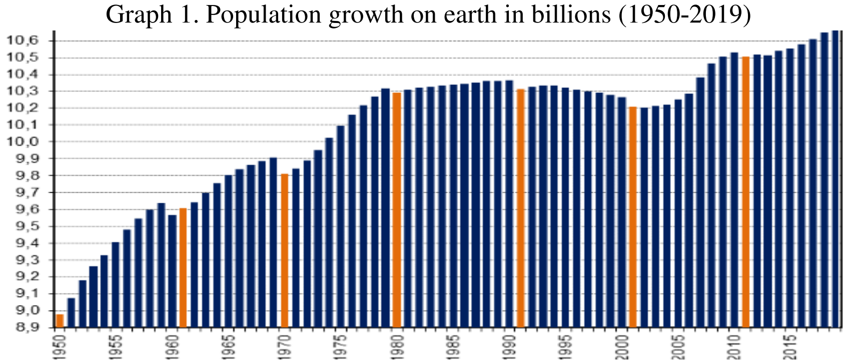
As the most important components of the OS are people. They create values and use values by their behavior and are also consumers of these values. They are part of individual organizational systems (HC), but at the same time, they generate consumption of products of other organizational systems in which they do not work. If the OSs (enterprises) operate according to Green Deal principles, then the living standards of consumers will be reduced.

his will lead to dissatisfaction. The idea that people will voluntarily start to cut back, that they will not mind reducing consumption, that they will understand that this is necessary for sustainable development, that they will give up the freedom to drive where and when they want is as naive as the idea that businesses will give up their profits.

Rynda (2020) stresses that sustainable activities should be guided by the principles of conscious frugality and selective demandingness. He goes on to state that: "a truly higher quality of life, not based on consumption leading to alienation, but on one's own active and creative approach to the world, is made possible above all by a paradigm of conscious frugality that is deliberately able to renounce all that is superfluous."

However, the number of people is constantly growing, Graph 1, and therefore the performance of economies must also grow.

Graph 1. Population growth on earth in billions (1950-2019)



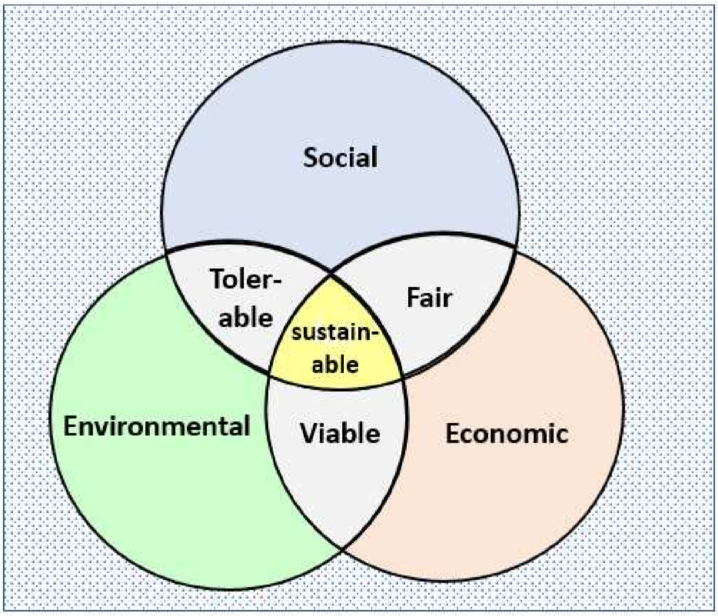
Source: ČSÚ, 2020

3.4 Sustainable development

Sustainable development is a way of developing human society that reconciles economic and social progress with the complete preservation of the environment.

It rests on three pillars: social, environmental and economic, Scheme 4.

Scheme 4. Pillars of sustainable development



Source: MŽP, 2008

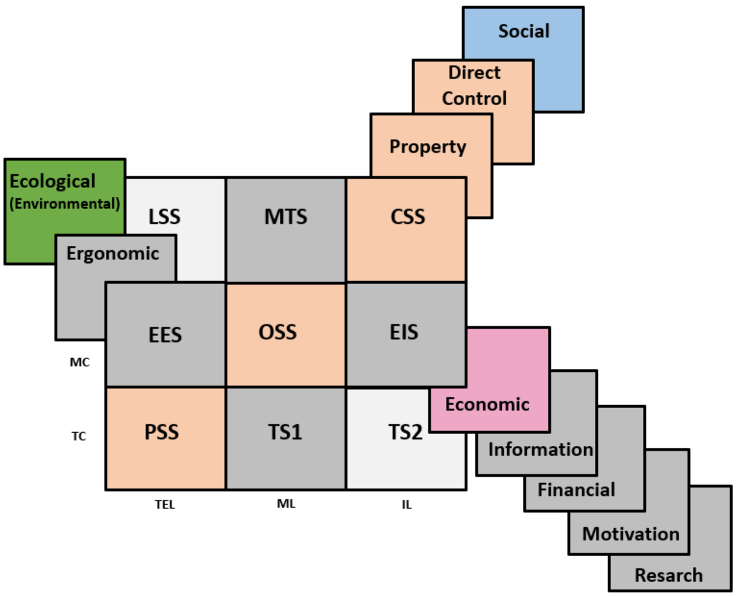
The intersections of the defined pillars are important in Scheme 5:
Social x Environmental → tolerable. Will it really be tolerable for people?
Environmental x Economic → viable. Will it really be viable?

Social x economic → fair. Will it really be fair?
The intersection of all three pillars → sustainable. Will it really be sustainable?

It was mentioned above that with a high degree of aggregation. It is possible to understand a national economy and a business from an organizational system. In organizational systems management theory, these pillars are defined as subsystems. The social, economic and environmental subsystem´s position in the organizational system is illustrated in Scheme 5.

When the level of hierarchy is increased, the interrelationship of the second order OS subsystems can be defined. The ecological-ergonomic subsystem is in a relation of disjunction with the social subsystem, i.e., their interrelation will not be intense, and the intersection "Tolerable" will not be very significant. The intersection of the ecological-ergonomic and economic subsystem is conjunctive, and the mutual influence is strong. The intersection 'Viable' expresses more of a wish because a strong mutual influence does not automatically imply a positive outcome but can also imply a negative, opposite outcome. That the Green Deal requirements will have a negative effect on economic outcomes is obvious. The gradual increase in the cost of production or the rise in prices is clear evidence of this. The rising prices and rapidly advancing inflation will not be fair to most people, much less the rich. So even fairness is highly questionable.

Scheme 5. Position of subsystems in the organizational system at increased hierarchical level



Source: Authors, 2022

4. Conclusion

The article's authors understand the goals of the Green Deal as tasks or requirements of the ecological-ergonomic subsystem, which is part of an effectively functioning organizational system. At different levels of differentiation, the organizational system can be understood as an enterprise, a country's national economy, or the EU economy. The authors conclude that the eco-ergonomic subsystem cannot have a decisive influence on the effective behavior of the organizational system, nor can it, in meeting the Green Deal objectives, positively influence the organizational system's behavior. Nevertheless, the authors of the article are optimistic. Because the right way will surely eventually come to pass, not Brussels social engineers (unelected officials), but new scientific knowledge, science, research, and development will find new ways to solve the current situation, how to produce so that the standard of living does not have to fall and at the same time the environment improves. The article's authors do not know what those discoveries will be and the solutions. However, it is almost certain that everything will be different from what the Brussel´s (Berlin) officials have invented.

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STABILITY AND SUSTAINABILITY OF MARKETING VARIABLES RESPECTING THE GREEN DEAL CONCEPT

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Annotation: The Green Deal brings the need to implement production processes in a more progressive and, above all, sustainable way, with the dominant use of renewable resources minimizing the carbon footprint. These efforts are opposed by current societal problems, not closing the Covid pandemic and the war in Europe. In this challenging situation, for many companies, a necessary condition for economic sustainability is a non-declining market share, a sufficient need for non-declining revenues with a medium-term fixation of average variable costs. Fulfilling these conditions means finding a formal expression of the stability of microeconomic variables for their possibility of targeted regulation. For this reason, the article aims to propose a procedure for formalized management of the stability of yield quantities and market share quantities. For the possibility of methodological repetition, the procedure is applied to the case study of the largest producer of original jewelry with Czech garnets.

Key words: change of conditions; stability of marketing variables; control diagram; eligibility coefficient.

JEL classification: M11

1. Introduction

Climate change and environmental degradation due to the saturation of CO4 and CO2 in the atmosphere are currently being accelerated by the war in Europe (Pereira, 2022). Although the war is still ongoing, there is evidence of severe air pollution and greenhouse gas emissions resulting from the intense fights. Also, warfare activities were conducted in the vicinity of the Zaporizhzhia nuclear power plant (the biggest in Europe) and Chernobyl, increasing the fear of radiation leaks. The biodiversity is being drastically affected due to intense deforestation and habitat destruction with potential implications for wildlife (Adamowicz, 2022). Bombing, trench and tunnel excavations will likely negatively impact soil degradation landscape morphology.

Thus, climate change is caused by the evolution in production efficiency due to the previous Covid pandemic (Sztorc, 2022). There are already two crucial modifications in how production occurs in the economy. One is the total or partial extinction of non-essential production businesses, such as travel, hospitality, banking and financial services, arts and entertainment, personal services, and airlines, to support slowing down the spread of COVID-19 (Phan, 2022). The other is the widespread shift from in-office work to working from home enforced by COVID-19-related lockdowns and stay-at-home restrictions. These changes could have implications for the productivity performance of an economy. Together with the planet's overpopulation, these phenomena pose an existential threat to Europe and the world (Phan, 2022).

The Green Agreement for Europe aims to transform the Union into a modern, competitive, and resource-efficient economy to overcome these challenges (Mountourakis, 2021). Some sustainability factors are explicitly stated. For example, as one of the critical factors, according to (Zhang, 2022), it is noted that by 2050 it will reach zero net greenhouse gas emissions. According to (Dziwok, 2021), economic growth will be decoupled from resource use. No individual or region will be left out. The Green Agreement for Europe also creates the direction of our society after the COVID-19 pandemic. One-third of the € 1.8 trillion investment available under the Next-EU-Generation recovery program and the EU's seven-year budget will achieve its goals. For Europe, becoming the world's first climate-neutral continent by 2050 is a once in a lifetime opportunity to modernize the EU's economy and society and re-orient them towards a just and sustainable future (Hadjichambis, 2022). Research and innovation will play a central role in accelerating and navigating the necessary transitions; deploying, demonstrating, and de-risking solutions; and engaging marketing innovation (European Commission, 2022).

In the twenty years, the evolution of production and marketing positioning was characterized by several innovations, concerning technologies, processes, but also entire production and delivery systems, with radical changes in strategies, total product design, and management of synergies between design, production, and sales (Desalegn, 2022). Cost, time, and quality are the pillars on which was based the industrial competitiveness during that era (Simboli, 2014). In the most recent years, a renewed interest in environmental issues and socio-ethical values has gradually promoted the transition towards the so-called low impact economies. Producers are then required to pursue a more rational and eco-efficient use of resources and reduce production wastes to survive; also the concept of value chain has been often associated with the terms environmental/green or sustainable (Nils, 2022). Various studies have been carried out to encourage companies in including the environment in their strategic and operational decisions making. Industrial Ecology represents the latest and most ambitious attempt to reach this goal; however, a great deal of work remains to be done to achieve this goal (Baumgartner, 2010). As a result, enhancing companies to integrate efficiency and sustainable practices still has a long way to go.

Fulfilment of these conditions means finding a formal expression of the stability of marketing variables for their possibility of targeted regulation. For this reason, the design part presents the methodology for determining the control zones for relative market share and anti-parallel (feedback) management of the marketing value of the brand. The regulation of marketing variables creates efficiency in connecting the development, production and sale of a given product and thus prolongs the sustainability of the business activities.

2. Materials and Methods

We used secondary data, horizontal analysis of the researched organization's profit and loss statement, and statistical data of industrial segments. From a methodological point of view, we determined the control diagrams of microeconomic and marketing variables. For this purpose, we have constructed an I-chart control chart to monitor the process mean of marketing variables at regular intervals from an operation. An I-chart is a control chart used to monitor the process mean when measuring individuals at regular intervals from an operation.

This I-chart uses individual observations instead of analytical subgroups when there is no basis for forming sub-groups (Pfeifer, 2022). It is, therefore, appropriate to use this control chart if there is a long interval between observations becoming available, or the testing is destructive or too expensive for replications. Other graphs, such as the exponentially weighted moving average and cumulative sum, may be more appropriate to detect more minor shifts quickly. In I-chart, each point represents the value of individual observation. The centre line is the process mean. The process sigma is the standard deviation of the individual observations.

We determined the normality in the distribution of controlled variables using the Normal Probability Plot and the Anderson-Darling test to verify the control I-Charts suitability. Then we used the eligibility coefficient and eligibility utilization to determine the potential to stabilize marketing variables. As the last step, we have created anti-parallel control of the brand's marketing value, with an emphasis on the local originality. Many different regulation mechanisms can be used in daily life and professional (e.g. managerial) applications. Two general control principles, both of which include each other, are anti-parallel control and feed-forward control (Bicak, 2021). Anti-parallel control is a control mechanism that uses information from measures to influence a variable to achieve the preferred effect (Bicak, 2021). In this type of control, the variable being controlled is measured and compared with a wanted value. A discrepancy between the actual and wished value has generally been named the error (or regulation error). Anti-parallel control manipulates an input to the system to minimize this regulation error (a more detailed description is for example in (Bicak, 2021).

3. Results and Discussion

We are interested in the ratio of revenues (turnover - company revenue FR) in the company Granát (Turnov) for the management of competitiveness revenue (and stability, intended as time sustainability of profitability); and revenues of the market segment (TR - Total Revenue) for segment jewellery production in the given time. As stated by Peter Drucker the only fundamental variables for the long-term sustainability of a given business are sufficient revenues to cover total costs and factor gains (Drucker, 1999). Relative Market Share (RMS) and the revenues of the TR industry (i.e. the relative market share applied, for example, on the horizontal axis of the Boston Matrix) can be calculated as ($RMS = FR \times TR^{-1}$). It shows the revenue competitiveness of production in terms of marketing effectiveness and efficiency of resource transformation (target costing and derived price levels) under conditions where production generates a stable demand. Suppose the controlled variables (RMS) have a normal distribution over time, then for the RMS tolerance interval. In that case, the total tolerance T is given by the difference between the upper tolerance limit and the lower tolerance limit.

$$T = T_U - T_L \tag{1}$$

Assuming the asymmetrical distribution of the random variable, then the mean value of the tolerance interval setting (nominal value RMS) is (Butt, 2020):

$$\mu = T_0 = \frac{1}{2} \cdot (T_U - T_L) \tag{2}$$

The variability of the controlled variable (RMS) is expressed through dispersion for a certain time interval of product sales (in which only random effects are assumed to occur, i.e. without systematic errors. The estimation is usually performed using the sample standard deviation s_x (Frizziero, 2019):

$$s_x = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2} \quad \textbf{(3)}$$

Where $\overline{x}$ is the mean value of the controlled variable (RMS), thus $\overline{x} = \overline{RMS} = \frac{1}{n}\sum_{i=1}^{n} x_i =$
$= \frac{1}{n}\sum_{i=1}^{n}(FR_i/TR_i)$; n is the number of monitored time periods.

One of the possible characteristics expressing stability, such as marketing and production strategies, is to keep demand within the given regulatory limits using the Six Sigma concept. Or another interpretation can be formulated as Relative market share (RMS) within the given limits. In accordance with the previous description of Six Sigma, we can formulate a coefficient of potential to generate the required demand (revenues or real revenues) by implementing a marketing strategy such as Process Capability cp; and we can further define the potential utilization coefficient to generate the required demand as Process Capability Efficiency cpc.

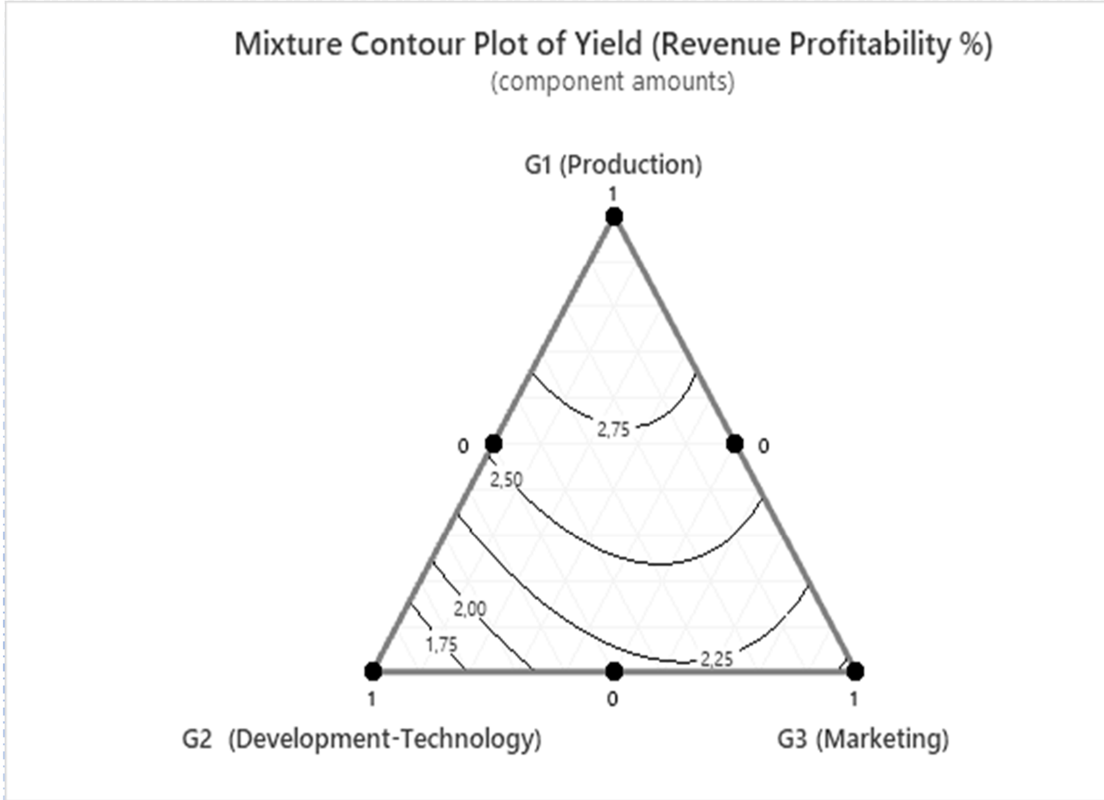
The eligibility factor c_p determines the stability of the yields from the production process, provided that the process is centered (e.g. at the center of the tolerance field T_0). Then the eligibility coefficient can be determined as the ratio of the total tolerance T (given by the difference between the upper tolerance limit T_U and the lower tolerance limit T_L) and the percentage of products lying within the range defined by the tolerance limits ($\mu - 3\sigma$, $\mu + 3\sigma$). If the process is fixed on the center of the tolerance field T_0, then the size of the tolerance interval „$\mu - 3\sigma,\ \mu + 3\sigma$“ corresponds to "six times" the standard deviation (i.e. popularly referred to as Six Sigma); (Pfeifer, 2022).

$$c_P = \frac{USL-LSL}{6\cdot\sigma} = \frac{T_U-T_L}{6\cdot\sigma} = \frac{T}{6\cdot Sx} \quad \textbf{(4)}$$

If c_P is greater than one, then we can theoretically declare the stability of revenues in the observed period is guaranteed, i.e. the marketing process is quantitatively sustainable (Pfeifer, 2022). It should be noted here, of course, that returns are generally a quantity with increasing value preference. So what is the point of regulating it too yields at face value instead of maximizing time? Maximizing revenues regardless of, for example, whether the price *p* is greater than the average variable cost means that it optimizes one quantity at the expense of another, and this situation is usually unsustainable (Holtgrave, 2017). Thus, we usually determine nominal revenues from the price level of the product portfolio at which we maximize the total profit in time, i.e. revenues in relation to costs. In a situation of stationarity (stability of micro e-quantities), total costs and revenues will be linear over time, as well as production volume will be linear over time. In this case, it will not be appropriate to regulate revenues to the nominal value; respectively, maximum returns and profit will have the same values as independent variables. In this case, no yield control (or regulated quantity (RMS)) is required. It is enough to maximize revenues over time (i.e. set the price to the corresponding maximum profit over time with production capacity limitation). However, this is a special case, which in practice only applies for a limited time (the condition is excess demand, dominant market position). In this case, the role of marketing is also reduced to a mechanical calculation of the price level for each product and an information role for customers). In the general case, it is necessary to implement target costing and monitor the profit success of competitors.

And in this case, it is appropriate to use regulated quantities (RMS) as a tool for sustainability and stability of production and marketing processes.

Figure 1. Mixture contour plot for Revenue profitability



Source: own calculation, (2022)

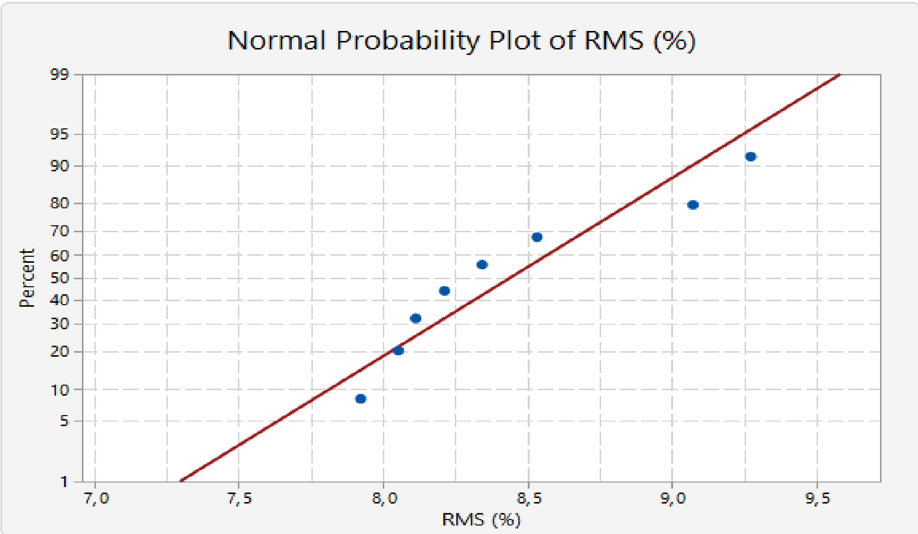
The contour plot in Figure 1 shows how a response variable (Revenue profitability %) relates to three components (the percentage of marketing mix components, which are G1- Product, G2- Development technology, and G3- Marketing based on a model equation). Points which exhibit the same response are connected to produce the contour lines of constant responses. Because a contour plot only shows three components at a time whilst holding any other components and process variables at a constant level, contour plots are only valid for fixed levels of the extra variables. If the holding levels are changed, the Revenue profitability % count's response surface also changes drastically.

In addition to the value of the test statistic, the so-called p-value (p-value) is indicated at the output of each procedure for the statistical test. If: p-value <ALFA (significance level, i.e. maximum probability of type I error - erroneous rejection H0) (chosen 0.05 selected here), we reject the tested hypothesis H_0 at the significance level ALFA, thus: 0.5579 = P-value> α = 0.05: So we cannot reject H_0. We get the same conclusion by visual inspection of Figure 1, where the data adhere well to the normal line. Therefore, these marketing data (company revenues over time) are suitable for methodological regulation. Next, we verify the normality of the controlled variable (RMS), 0.1948 = (P-value)> α = 0.05: We did not conclude that the values in Figure 2 do not represent a normal distribution of data. Therefore, we cannot reject H_0. We came to the same conclusion by visual inspection of Figure 2, where the data adhere well to the normal line.

Therefore, these values of the controlled quantity RMS are suitable for methodical (statistical regulation to nominal value) regulation.

Figure 2. The normal plot shows the normal distribution of the controlled variable RMS over time

Normality Test of RMS (%)



Summary Statistics

N	Mean	StDev	Minimum	Maximum
8	8,4375	0,4911	7,9200	9,2700

Anderson-Darling Test

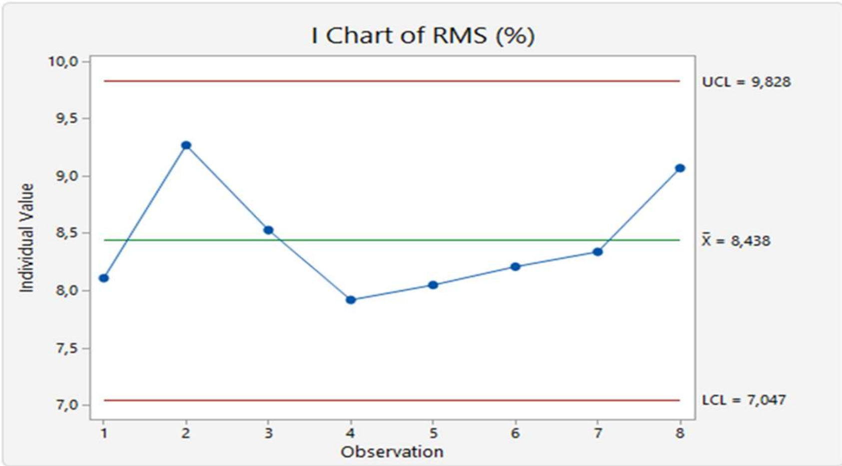
Null hypothesis H_0: Data follow a normal distribution
Alternative hypothesis H_1: Data do not follow a normal distribution

AD-Value	P-Value
0,45	0,1948

Source: own calculation, (2022)

Figure 3. Stability diagram for a controlled variable RMS

I Chart of RMS (%)



Method

Length of moving range: 2

Parameters

Mean	StDev
8,4375	0,4635

Both parameters estimated

Tests for Special Causes

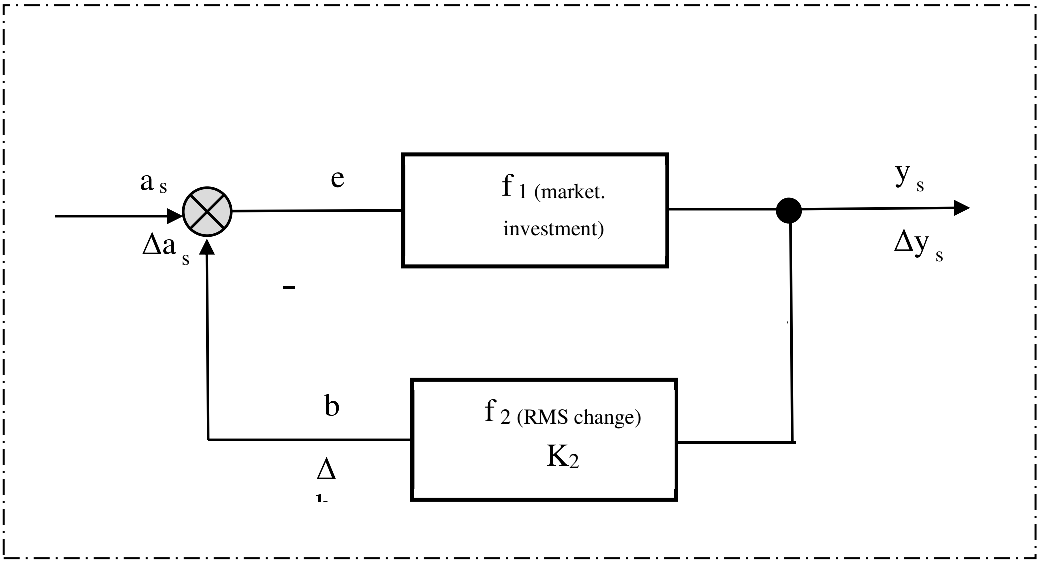
Results for I Chart

Test	Description	Failed Observations
1	1 point > 3 standard deviations from the center line	None

Source: own calculation, (2022)

Anti-parallel management of the brand's marketing value, with an emphasis on the local origin of the brand, is described in the following Figure. For this scheme, the static output sensitivity of the transfer function y_s is derived in the following text.

Figure 4. Stability diagram for a controlled variable RMS



Source: own design, (2022)

The local brand management system consists of a control block (expressing investments in marketing tools for strengthening the local brand) with a static characteristic described by the function f_1 and a static sensitivity K_1. The controlled block (expressing revenues from the sale of a locally produced product, or as in this case, a change in the relative market share of RMS) has from retrospective values an approximated static characteristic f_2 and a static sensitivity K_2. The task is now to determine how in a steady-state (after a transient characteristic caused by a certain, for example, price intervention), the control block will affect the control, i.e. to determine the resulting static properties in the anti-parallel connection of these blocks. The practical significance of this connection is marketing management, where we use marketing tools to regulate revenue from product sales (or we regulate market share, or also the relative market share of RMS). It is clear from the above Figure 4 that the instantaneous control deviation e_s is given by the difference of the required value of returns, or here as = RMS (plan) and the value achieved at that time relative market share bs = RMS (real).

$$e_s = a_s - b_s \tag{5}$$

It is also clear from the Figure 4:

$$y_s = f_1(e_s); \qquad b_s = f_2(y_s) \tag{6}$$

After substituting (5) into (6), we get the relationship between output (actual RMS) and input (planned RMS):

$$y_s = f_1(a_s - b_s) = f_1\big(a_s - f_2(y_s)\big) \tag{7}$$

Equation (7) is an implicit expression of the dependence of actual sales (actual RMS) on the required RMS. If we find out instead of instantaneous values a_s, b_s, e_s, y_s, changes of these values for a given time period (e.g. time t = one month) and we mark these changes of quantities using the symbol Δ, then we can modify the relation (7):

$$\Delta y_s = K_1(\Delta a_s - \Delta b_s) \tag{8}$$

And for the value of Δb_s, according to (6) and replacing K_2 instead of f_2, the following will apply:

$$\Delta b_s = K_2 \times \Delta y_s \qquad \textbf{(9)}$$

After substituting (8) into (9), we get:

$$\Delta y_s = K_1 \times (\Delta a_s - K_2 \times \Delta y_s) \qquad \textbf{(10)}$$

After adjusting (10) so that Δy_s is on the left side of the equation, we get:

$$\Delta y_s = \frac{K_1}{1+K_1 \times K_2} \times \Delta a_s \qquad \textbf{(11)}$$

Instead of $\frac{K_1}{1+K_1 \times K_2}$ we can write K_A, where K_A is the antiparallel binding of the resulting transmission.

$$\Delta y_s = K_A \times \Delta a_s \qquad \textbf{(12)}$$

And the resulting static (under steady-state conditions) sensitivity of the antiparallel bond of the resulting transmission is:

$$K_A = \frac{K_1}{1+K_1 \times K_2} \qquad \textbf{(13)}$$

According to the Figure 3 of the $\overline{RMS}$ control, the average value is 8.438%. This value corresponds to the fixed value of the static sensitivity of the controlled block: $K_2 = \overline{RMS}$ =8.438% = 0.08438. Product attributes expressing its quality is the sum of all percentages (for all quality features) 365%. The sum of the percentages for the brand and local origin is 35.5%. Thus, the ratio (35.5%: 365%) indicates an estimate of sensitivity. If we invest in strengthening the brand with an emphasis on local origin, by how many sales can be expected to increase. Thus (35.5: 365) = 9.726% = 0.09726 = K_1. Substituting these values into (13) we get a specific value for the antiparallel bond sensitivity of the resulting KA transmission:

$$K_A = \frac{0{,}09726}{1+0{,}09726 \times 0{,}08438} = 0.09647 \qquad \textbf{(14)}$$

Thus, for example, with the investment of strengthening the brand of the locality of origin in the amount of CZK 5.5 million, the change in the Δ RMS will be 0.5305%. If we have the current value of $RMS(real) = y_s = 8.438\ \%$ and we want to have a relative market share $RMS(plan) = a_s = 10\ \%$ (our sales to the whole market), then according to (15) (expressed from (11)) it is necessary to invest approximately CZK 16.2 million:

$$\Delta a_s = \frac{1+K_1 \times K_2}{K_1} \times \Delta y_s = \frac{1+0.09726 \times 0.084381}{0.09726} \times (10.000 - 8.438) = 16.192\ mil\ EUR \qquad \textbf{(15)}$$

We can also verify whether we managed this process correctly (effectively from a marketing perspective) during the building of the local brand. Thus, the current market share of 8.438% corresponds to a cumulative investment of approximately CZK 87.5 million (in the observed period t):

$$\Delta a_s = \frac{1+K_1 \times K_2}{K_1} \times \Delta y_s = \frac{1+0{,}09726 \times 0{,}084381}{0{,}09726} \times 8.438 = 87.469\ mil\ CZK \qquad \textbf{(16)}$$

Comparing this investment of CZK 87.469 million provides us with knowledge of the effectiveness of marketing management to strengthen the brand.

4. Conclusion

As a result, we verified the stability of Relative Market Share as well as revenues. We also determined the setting of the action variable to compensate for changed market conditions (especially in the event of a jump in input and energy prices). We also determined the initial conditions for determining the transfer functions for the possibility of feedback regulation of controlled (marketing) quantities and the requirements for methodological transfer to other areas (e.g. agricultural and food production).

Another follow-up proposal to improve the integration between design, production, marketing sales, considerations and the resulting efficiencies in mutual interaction will be used optimization according to the complete factorial design.

Acknowledgements

The authors also gratefully acknowledge the anonymous reviewers for carefully reading the manuscript and providing useful suggestions.

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AGRICULTURE AND EDUCATION 4.0

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Annotation: The rapid development of information and communication technologies has revolutionised agriculture. The main concept of Agriculture 4.0 is the evolution of precision farming through the automated collection, integration and analysis of previously isolated data Farmers must therefore be highly prepared to embrace the upcoming digital changes and increase or acquire new ICT knowledge and skills. ICT tools open new potentials for on-the-job, individual workplace learning, using new methods and models of education such as personal learning clouds or setting up personal learning environments. All of these helps to solve one of the main challenges reducing existing skill gaps. Thereby the key purpose of the study is to identify the term Agriculture 4.0, to determine the potential of automation and the main required skills and modern learning methods that farmers can use for developing and transformation in the framework of Agriculture 4.0.

The main method was the analysis of statistical data characterizing the level of development of the digital Industry, index method, and rating assessment method. To calculate automation potential, McKinsey Global Institute (MGI) broke down all occupations into tasks and activities and estimated what ratio of those activities per different occupation could be automated. Based on this breakdown and the distribution of occupations in various sectors, MGI determined a sector's automation potential for Hungary. We can use and analyse data from the Eurostat database too

MGI's assessing automation potential according to employment numbers indicates that such industries as agriculture (56%), manufacturing (64%), transportation (59%), and mining (62%) experience the greatest impact from automation. MGI's analysis also estimates that globally, as much as 49 percent of current work hours could be technically automated. However, the findings do not mean automated machines will replace 49 percent of jobs. MGI's research indicates that less than 5 percent of occupations can be fully automated with current automation technologies, while a third of the activities in 60 percent of the occupations can be automated. Available estimates, based on the Eurostat database prove that the growing demand for e-skills is a core trend in the labour market. For example, Figure 3 presents that the number of persons employed as ICT specialists in Europe grew by 49% during the period from 2010 to 2019, which was 7 times as high as the corresponding increase (7%) for the total employment in EU-28. This paper finally examines the role and tasks of agricultural digitalization education. The major challenges and possibilities of agricultural digitization are inevitable. This article shows why digitization is necessary for agriculture, and also created a proposal for a Curriculum for agridigitization at BSc level. There are five suggested subjects groups. We think that new education programmes and new approaches to an extension would be also needed to accelerate the transition to digitized agriculture.

Keywords: Agriculture, Education 4.0, ICT, Precision Farming, Reduce skill gaps, Digital education

JEL classification: Q19, I24, I25

1. Introduction

One of the most publicized technological trends in industrial manufacturing is the so-called fourth industrial revolution, or "Industry 4.0" (Braun, Colangelo, and Steckel 2018). This trend involves a change in manufacturing processes due to the integration of information technology and automation. This trend is moving manufacturing processes away from human resources and towards the world of machines.

However, Universal Robots, a leader in the sale of collaborative robots, has also embraced another trend, arguing that in order to maximize the growing individual market demand, human creativity and presence need to be rethought. The key to the "Industry 5.0" trend therefore lies in effective collaboration between humans and robots, exploiting the talents of both parties, where they are best suited. While robots are excellent at participating in mass production processes for standard products, humans are excellent at cognitive tasks or tasks that require manual dexterity or imagination (Shepherd et al., 2020).

The explosion of technology always has a major impact on agricultural production. Whereas in the late 1800s, production was "labour-intensive" with low productivity, today we have reached "smart farming" (Smart Farm Training for Employment (SFATE) report, 2019).

We are now in the Agriculture 4.0 phase (Perez-bedmar, 2018; Gacar, Aktas, and Ozdogan, 2017). This means that smart technologies have become almost standard in production tools, cloud services have made it possible to process large amounts of data, and the valuable information available allows production processes to be optimized. The next step will be Agriculture 5.0 (Jayaraman et al., 2015), the era of "Collaborative Systems", where robotics and artificial intelligence will be integrated Huh and Kim (2018).

Agriculture is facing four main problems: global population growth, finite, or rather shrinking, arable land, climate change and labour shortages (Perez-bedmar, 2018). These make agri-digitalisation the biggest opportunity for agriculture in the next decade, as production using the data and information available to farmers can significantly reduce environmental risks and pressures, while increasing efficiency. The cause of labour shortages is the generational change is becoming an increasingly urgent issue in this sector, as 43 percent of farmers are over 54 years old, while the proportion of those under 37 is only 21.6 percent, half of that.

However, the benefits of such digital developments are still largely unexploited. At the domestic level, the currently available food production capacity is far from being fully exploited (Bilali and Allahyari, 2018), although by organizing processes more efficiently, increasing processing, better serving domestic and foreign consumer needs and responding to solvent demand in a targeted way, the Hungarian food economy has a production potential up to 60% higher than today.

Agri-digitalisation could represent the greatest opportunity for the agricultural sector in the next decade, increasing the efficiency, profitability and competitiveness of production (Füzesi, Lengyel and Felföldi, 2018), and is expected to reduce environmental pressures and production risks.

In the framework of the Digital Success Program, Hungary's Digital Agricultural Strategy has been prepared (Digital Success Program, 2020), which outlines the steps required for the digitalization of the agricultural economy for the next 3 years (CEMA, 2017), in order to ensure that Hungarian agriculture is better prepared to respond to the challenges of the accelerating and inevitable digital transformation (Harvard Business Review, 2015). The objectives set out in the Digital Agricultural Strategy can thus contribute to increasing the profitability of the food economy through the collection and processing of information (Bronson and Knezevic, 2016), the automation and robotization of technological operations, while making efficient use of available environmental resources. This will make the sector more efficient and competitive at international level in the future (Verdouw et al., 2016).

The situation is similar in the food industry. Based on the experts' 80 percent of the challenges facing the industry can be solved by adapting new technologies already used in other sectors

(Füzesi, et al., 2019). However, the survey shows that most food industry players are not aware of the opportunities offered by digitalization and the ICT sector is unaware of the challenges facing the food sector (FAO, 2017). Today, data-driven business decisions have become a prerequisite for competitiveness, as new technology can extract data, visualize relationships and use AI-based algorithms to efficiently support production and business operations. That is why important the education mainly in the field of agriculture (Piwowar, 2018).

The education has an important role in these process. The farmers of the future need to know the benefits of digital technologies. The Digital Agricultural Academy, established under the Government Decision on the Digital Agricultural Strategy 2019, aims to increase digital competence in agriculture, to make precision machinery more widely known and to raise awareness of the use of digital solutions in agriculture, both within and beyond borders. The Digital Academy for Agriculture will provide up-to-date knowledge not only to reduce the labour shortage in the sector, but also to increase production and farm-level efficiency through the use of digital technologies (Sander et al., 2017).

The digitalization is playing an increasingly important role in all areas of life, and the Hungarian agricultural sector must keep pace with the ever more dynamic development of information technology. Agriculture is also an increasingly staff-intensive sector, which means that its competitiveness is fundamentally determined by the digital competences of the agricultural professionals using the tools. The Digital Success Program has always aimed to prepare the different sectors and their staff for the digital transformation (Jánoskuti and Puskás, 2018). The learning materials and knowledge base produced within the Digital Academy for Agriculture are freely available to the Hungarian farming community, thus helping to apply new technologies and digital solutions and increase the efficiency of the sector. According to their intentions, the Digital Academy for Agriculture will be a very important knowledge transfer and cooperation channel, which will help them to map the expectations of agricultural professionals and entrepreneurs even more accurately, as the joint work of all actors can only bring internationally recognized (Andritoiu et al., 2018). Today, the whole of agriculture – in the world, but also in Hungary - is about how to collect as much data as possible and synthesize it to create knowledge that will help agriculture become a truly high-tech sector (Sponchioni et al., 2019).

Finally I try to show a good practice for the digitalization of Agriculture (Zambon et al., 2019). Launched in November 2018, FAIRshare is a project funded by the EU's Horizon 2020 Framework Program, the main objective of which is to prepare farmers for the digital age through capacity building of extension agents, enabling them to access and test existing digital tools and to integrate digital solutions into their extension processes. To this end, an Agricultural Digital Tools Inventory has been developed within the project and will be available from February 2020 after a short registration period. It is a continuously expanding database which currently contains 70 agri-digital advisory tools, a collection of agri-digital tools from different European countries and the possibility to upload new tools.

2. Materials and Methods

The main method was the analysis of statistical data characterizing the level of development of the digital Industry, index method, and rating assessment method. To calculate automation potential, McKinsey Global Institute (MGI) broke down all occupations into tasks and activities and estimated what ratio of those activities per different occupations could be automated. Based on this breakdown and the distribution of occupations are in various sectors. We are investigated the possibility to do in the field of agriculture to increase the farmers knowledge on the field of ICT in Hungary. Finally we can use and analyse data from the Eurostat database (https://ec.europa.eu/eurostat) as a secondary data.

3. Results and Discussion

What we can do to increase the knowledge of the farmers?

3.1. Digital Academy for Agriculture

As we mentioned in the introduction part, the Digital Academy for Agriculture will provide up-to-date knowledge not only to reduce the labour shortage in the sector, but also to increase production and farm-level efficiency through the use of digital technologies.

Fortunately, this was supported by the Ministry of Innovation and Technology to create these courses. There are currently 20 courses available, covering almost all branches of agriculture.

The Digital Academy of Agriculture consists of 20 chapters, which are the followings:

Table 1. The main chapters of the Digital Academy for Agriculture

Title	Goal
Basic of agricultural digitalization	The aim of the course is to introduce those interested and active in the sector to the digital world, covering basic issues such as expected market trends, how precision farming is different from conventional farming, and the benefits of digitalization.
Digital technology and law	The course covers key principles and rules in key technology areas, including social portals, cloud services, drones and e-commerce services.
Digital farm management	The aim of this course is to summarize the main knowledge that contributes to increasing the efficiency of the economy as a whole, in order to make farming more sustainable, by providing practical examples and case studies. The benefits of digital farm management, the products that support it, and data management options are discussed.
E-commerce and sharing economy in agriculture	It provides a summary of e-commerce services that contribute to increasing profitability and competitiveness, and presents sharing economy practices that contribute to increasing efficiency and cost savings to sustain economies.
Food industry, quality assurance (digital traceability systems)	The course will also provide a detailed justification for the need and importance of following the product path, and will demonstrate the advantages of electronic systems over paper-based documentation.

Precision arable farming	The aim of the course is to increase efficiency while reducing costs and increasing profits. The course also covers the technological variations, conditions of application, IT background of different precision farming systems for different crops, as well as the related legislation that governs precision farming practices.
Precision plant protection	It provides information on the use of weed detection sensors, precision weed control, extensive information on research technologies for precision crop protection and recent developments in site-specific application technologies for the management of crop pests, as well as examples of how to apply the technologies.
Precision livestock farming	The aim of this course is to summarize the most important features of precision farming and feeding and to briefly introduce the tools and practices of precision farming.
Precision horticulture, field and greenhouse	The curriculum describes the changes that the appearance of digitalization has brought to the agricultural sector, and discusses cost-saving, efficiency and administrative reduction opportunities that can be easily integrated into the daily life of the farm. Practical examples and case studies will be used to summarize the main elements of knowledge, such as the technical elements of greenhouse vegetable production, the technological elements of vegetables and fruit.
Beekeeping and digitalization	You can read about the state of beekeeping, bee structure, swarming, beekeeping technology, bee diseases, bee breeding and the possibilities of digitalization in beekeeping.
Precision aquaculture	The aim of the course is to introduce those interested and active in the sector to the digital world, by introducing them to the basic issues of precision aquaculture, such as the types of precision fish farming, the most important fish species farmed and the most important technological elements of precision fish farming.
Precision forestry	The course demonstrates through case studies how digital technologies can be a useful tool in a sector working with a complex natural system. First and foremost, in the data collection, recording, analysis and decision preparation tasks of sector actors, but increasingly also in the physical implementation of forest management activities.
Precision viticulture	The course provides a basis for how technological developments in vineyard management can offer solutions for creating more homogeneous growing conditions, and illustrates

	the possibilities and practical benefits of using precision viticulture through practical examples.
Drone use and remote sensing	This course provides an overview of the potential of drones for remote sensing, which can be adapted by practicing farmers for their forecasts or used as a decision support tool on their farms.
Operation of precision machinery	The curriculum will guide you in finding the most appropriate technical level for a particular farm, which you can then apply effectively. The aim is to help the transition of existing equipment to site-specific farming and, in the case of purchasing new machinery, to help the correct selection of the right equipment.
Robots in agriculture	The curriculum will give you an idea of the applications of robot technology. We can learn about the potential of automation and how to work more efficiently. Exploiting the potential of robotization is crucial to ensure that the growing population can feed itself more easily, sustainably and in a more environmentally friendly way.
Digital solutions for rural development	The course summarizes the main knowledge to learn about the application of digital solutions in rural development, including practical examples and case studies, and the related legislation.
Site-specific nutrient management	The course highlights the procedures, techniques and methods that can be used to map the soil conditions and environmental situation of the farm, and to plan the quantities of active substances to be applied to the crop in the most optimal place and time.
Digital services in agriculture	This course provides a summary of the main knowledge that contributes to increasing the efficiency of the economy as a whole, thus making farming more sustainable, such as key digital services, sensor solutions, a national de-icing system, and tools and services for organizing farming.
Predictive machine maintenance and servicing	The course includes information on fleet tracking, remote diagnostics and predictive maintenance

Source: Own edition based on the Digital Academy for Agriculture

3.2. Agricultural and business digitization course

From our side, we have also started thinking about replacing the previously discontinued Agricultural informatics and Business Administration BSc course with a new BSc course, that meets the challenges of the times and at the same time has a gap-filling role. This was the Agricultural and business digitization BSc course. Before planning or founding a new course, the question is which foreign higher education institutions have similar courses. The following list contains the most important foreign higher education institutions where agricultural digitization course takes place at a basic level, independently or combined with business training:

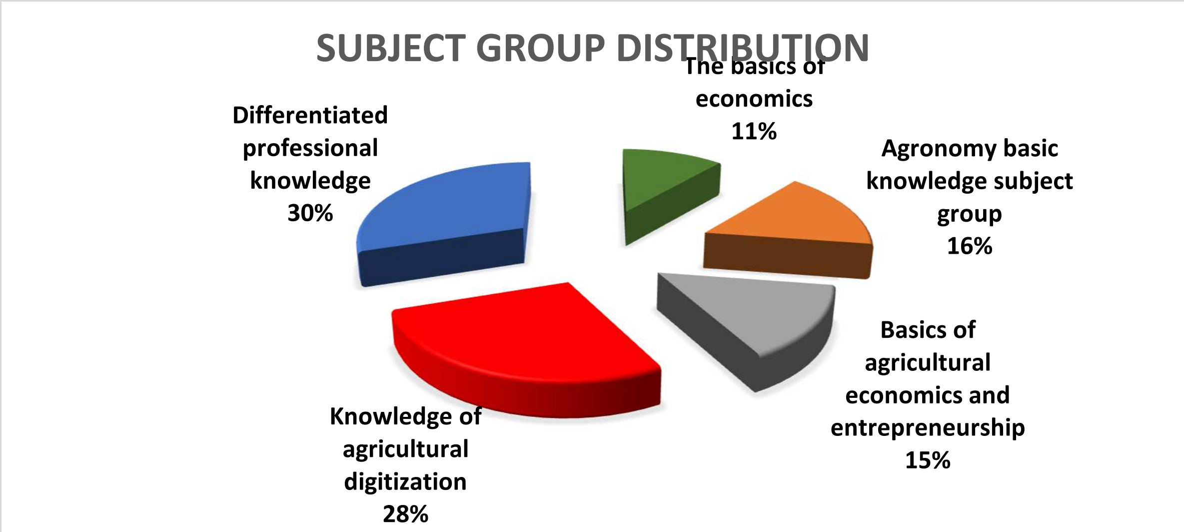
1. Cranfield University,
2. Agricultural University of Athens,
3. University of Natural Resources and Life Sciences (BOKU),
4. University of Southampton,
5. Rotterdam School of Management Erasmus University,
6. University of Edinburgh Business School,
7. University of Bath School of Management,
8. University of Liverpool Lancaster University,
9. University of London, Shobhit University.

All of the BSc-level agricultural digitization courses examined at the international level focus on applied ICT knowledge related to the agricultural sector. It is difficult to find training where agricultural and business digitization would occur together.

Based on the above and using our information, we can say that the agricultural and business digitization course is widespread worldwide, the need for it is not questioned anywhere. In almost all the mentioned institutions, an institute or department manages the course and researches in this field. The course related to Agricultural and Business Digitization does not currently exist in the field of economics (Varallyai and Szilagyi, 2021).

The main parts of the curriculum: digitization, agricultural economics knowledge supplemented with general knowledge (human, social, linguistic, etc.). The course aims to train professionals who can easily navigate on the field of digitization and can explore and solve the arising problems. Digitization is closely linked to the field of agriculture as well as economic, business, which is an important aspect nowadays in the knowledge-based information society. Graduates with a BSc degree must be able to understand the real production, operation and business model, and be able to create digitization models and recognize the digitization technique they wish to use solve the problems. It is necessary to be able to apply suitable digitization techniques in both the agricultural and business fields. Nowadays, it is almost inconceivable for anyone without this knowledge to be successful, whether in agriculture or business. It is an important goal for professionals to understand agricultural and business processes and to be able to support them with IT and digitization tools and to be able to act as experts in these areas. This BSc-level training keeps for 7 semesters, where the 7th semester is the so-called practical semester, which the students spend at an external (agricultural or economic) company. The required total study time is nearly 2000 contact hours and the required credit is 210. The rate of subjects group can be shown in Figure 1.

Figure 1. Subject group



Source: the rate of subjects group, own source

The accepted subject groups:

- Basic knowledge of economics: Gives general knowledge of the field of economics.
- Agronomy basic knowledge subject group: The characteristics of the training determine the required knowledge in the field of agriculture. These subjects are aimed at acquiring knowledge related to agriculture
- Basics of agricultural economics and entrepreneurship subject group: This knowledge underpins the application of digitization in agriculture and business.
- Knowledge of agricultural digitization subject group: These objects underpin the use of digitization tools and methods used in agriculture and business. The differentiated professional knowledge subject group is based on this.
- Differentiated professional knowledge subject group: Students can get specialized knowledge based on previously acquired basic knowledge.
- Free choice subject group: Students can choose 3 subjects from courses of other faculties: The 2 faculties, which also participated in in the training, are the Faculty of Economics, Faculty of Agriculture, Food Science and Environmental Management.

According to our plans, in the initial period, the new training can start at about 20-40 student, which according to the Ministry has a serious future. With the training and agriculture ICT, practice-oriented training can start at the University of Debrecen. The accreditation committee is accepted our plan and it will start this year from September.

3.3. Some examples from the digitalization and skills in Agriculture

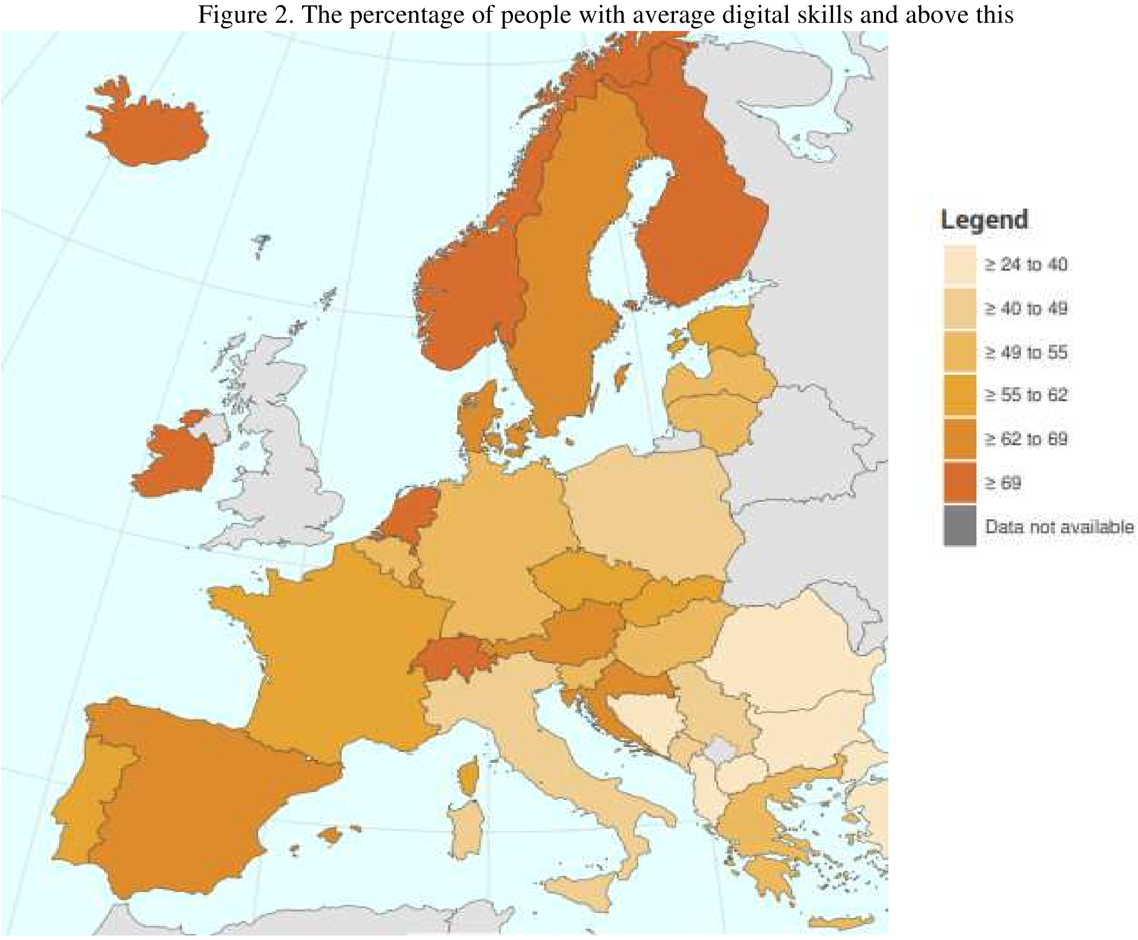
The first step is to check how well households and businesses have access to broadband Internet. Well, in 2021 this was 90% on average for households in the EU, and in Hungary it was 91%, which is about the EU average. The lowest is 75% in Montenegro (it is not EU-member) and the highest is 99% in the Netherlands.

I looked at the same data for companies in 2021. In this case the situation is on average 4-5% better than for households. The worst value is 91% for Romania and the best for Finland, where the value is 100%. Hungary is in the middle of the rank with 94%. From the above, we can conclude that broadband access is better for businesses than for households, but the situation is not tragically wrong. Perhaps it is no coincidence that many companies decided during the pandemic to allow home office work.

Looking at the physical possibilities of connecting to the Internet, the next step is to look at people's digital competencies how they use the different applications.

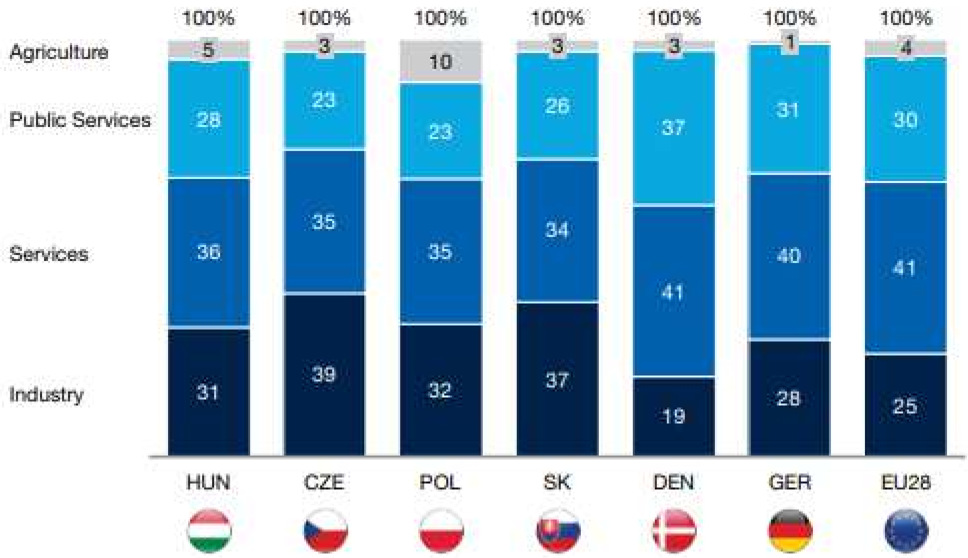
The Eurostat distinguishes more categories between several categories, but from our aspects two are interest for us: the percentage of people with average digital skills and the percentage of people with digital skills above this. The difference between the two skills is around 5-10% in most countries, but for some countries with the lowest digital skills it can be as high as 15-20%, for example in case of Montenegro, which is not even part of the EU. Hungary is also in the middle of this ranking with 49% and the EU average value is 54%.

Figure 2. The percentage of people with average digital skills and above this



Source: Eurostat, 2021

Figure 1. Share of industry is relative high in Hungary compared to the EU28, but the agriculture part is relative small, but slightly higher than the EU28 percentage



Source: MyKinsey Global institute (MGI) survey, 2021

Figure 2 shows that agriculture accounts for only 5% of the industry distribution. Therefore, it is not really possible to investigate what applications are used in agriculture and I could not find any data on this in the Eurostat database.

3.4. Automation processes

The highest probability of automation jobs require lower education levels and include repetitive tasks. This is quite expected while repetitive tasks provide a predictable environment for the machines and they can successfully perform low-skill tasks without any breaks. Deloitte has occupations with the highest probability of automation in the following table.

Table 2. Probability of automation

Probability of automation	Employment
97 %	Secretarial jobs (general)
97 %	Bank advisers and other counter staff
96 %	Telephone operators
90 %	Cashier and ticket vendors
86 %	Post distribution auditers
83 %	Printers
73 %	Agricultural employees

Source: Deloitte 2019

As can be seen in Table 2, the probability of automation in agriculture is 73%, which can be considered a high number.

Technically automated activity by agriculture (forestry, fishing and hunting) in Hungary is 56 % based on the McKinsey data.

MGI's assessing automation potential according to employment numbers indicates that such industries as agriculture (56%), education (77%), experience the greatest impact from automation. MGI's analysis also estimates that globally, as much as 50 percent of current work hours could be technically automated. However, the findings do not mean automated machines will replace 50 percent of jobs.

It can be concluded that the widespread adoption of Industry 4.0 and 5.0 technologies has led to a fairly high level of agricultural automation opportunities (Jánoskuti and Puskás, 2018). Farmers need to be prepared for the upcoming digital change. Workers in the agricultural sector will need to be able to operate and interact effectively with sophisticated modern technology and equipment, robots and related software products in their work, and workers will need to upgrade or acquire new ICT skills and competences. It is essential to develop the necessary digital skills and to be open to the potential new business opportunities and models that may unfold with digital transformation (Smart Farm Training for Employment (SFATE) report, 2019).

4. Conclusion

It can be concluded that the widespread adoption of Industry 4.0 and 5.0 technologies has led to a fairly high level of agricultural automation opportunities. Farmers need to be prepared for the upcoming digital change. Farmers will need to upgrade or acquire new ICT skills and competences. It is essential to develop the necessary digital skills.

We can mention the development of agriculture contributes to the extensive automation of agriculture production and jobs. For example, MGI's experts assessed the automation potential of agriculture, foresting, fishing, hunting in Hungary as 56% of automatable activities. MGI's analysis also estimates that globally, as much as 50 percent of current work hours could be technically automated according to existing technologies. Nowadays the digital education makes it easier to acquire new knowledge and skills in ICT (Grand-Clement, 2017).

What happened in connection of digitalization processes?

1. The Digital Academy for Agriculture will provide up-to-date knowledge not only to reduce the labour shortage in the sector, but also to increase production and farm-level efficiency through the use of digital technologies.

2. We have also started thinking about replacing the previously discontinued Agricultural informatics and Business Administration BSc course with a new BSc course that meets the challenges of the times and at the same time has a gap-filling role. This was the Agricultural and business digitization BSc course. According to our plans, in the initial period, the new training can start at about 20-40 student, which according to the Ministry has a serious future. With the training and agriculture ICT, practice-oriented training can start at the University of Debrecen. The accreditation committee is accepted our plan and it will start this year from September.

3. We investigated the Eurostat data (Individuals and companies) how many percentages use the Internet. On the second step investigated the digital skills of employees. Unfortunately we cannot find any data about the agricultural digital skills and ICT knowledge of farmers in the Eurostat database.

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DEVELOPMENT OF CZECH FOREIGN TRADE WITH BEER ON THE EXAMPLE OF GERMANY AND SLOVAKIA

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Annotation: The aim of this paper is to evaluate the development of Czech export and import with beer and to prove the importance of foreign trade with the most important Czech partners - Germany and Slovakia, and also to quantify the influence of the selected market determinants on this trade. Using the least squares method and using regression analysis, a model estimate describing Czech export and import with beer will be performed. Model verification will be performed using the Jarque-Bera test, the White test and the Breusch-Godfrey test. The basic factors include the Czech crown to euro exchange rate, beer consumption per capita in selected countries, the market concentration index in the Czech Republic, resp. the leader's share of the total domestic market, the consumer price of beer in selected countries and the membership of EU. The data will be taken from the ARAD database, then from the Czech Statistical Office and other databases. These are annual data from the year 2000 till 2021. Using the above methods, the hypothesis of the significance of the influence of individual factors on the import and export of beer in the Czech Republic will be confirmed or refuted. The role of the largest partners - the Czech Republic's neighboring countries in international beer trade - will also be quantified and evaluated, and assess whether these countries are important for Czech beer export.

Key words: beer, export, import, foreign trade, correlation, Czech Republic

JEL classification: C01, C32, Q17

1. Introduction

In Central Europe, brewing is a key element of the entire agri-food sector. Thanks to its rich history, it not only performs a purely production and economic function, but also has a massive impact in several social areas. The study by Rodrigues et al. (2021), Osterberg and Karlsson (2003), Thome et al. (2017) show that in many countries beer plays an important role in socio-cultural life. This paper focuses on the Czechia, Germany, and Slovakia. Beer has the richest tradition in the Czech Republic, there are still many opportunities to expand and strengthen the brewing sector, which are based on the fact that beer is still the most popular alcoholic beverage in this country (Maier, 2016). According to the Brewers of Europe, in 2021 beer consumption per capita in the Czech Republic was 129 l, which is the highest number in Europe. For comparison, in Germany this value was 91 l, in Slovakia only 72 l. In addition, in the Czech Republic and Germany in general alcohol consumption stagnates, showing a year - on - year decrease of 1% in the case of Germany and an increase of 1% in the case of the Czech Republic (Kokole et al., 2022), which is negligible in practice. Important factors influencing the beer market and competitiveness are clearly beer consumption per capita, access to the EU market (ie for selected EU membership countries), the level of beer production and beer history of origin (Török et al, 2020). Studies in Germany have shown the same result - the origin of beer is one of the basic factors that influences consumer behavior. Furthermore, the vast majority of respondents stated that they preferred Czech lager - and again, we are in favor of German conservatism (Meyerding et al, 2019). Dudić et al. (2020) also report on the popularity of beer in Slovakia and preferences regarding lager. There is also an interesting theory according to which it is statistically proven that in countries where meat, potatoes and eggs are preferred, beer is also preferred. While in countries where cheese is popular, wine is preferred (Angerer et al., 2019). The Czechia, Germany and Slovakia are typical "meat" countries, ie countries where meat dishes are part of ordinary and traditional dishes. Access to the EU market is also an important factor, as Bieleková and Pokrivčák (2020) have shown that there is a positive impact of membership in the customs union and the possibility of free trade between union members, unlike non-members. All countries examined in this paper are members of the EU. Also in the case of Germany and the Czech Republic, a large number of registered beers with a protected geographical indication play an important role in beer export (Török et al., 2020). Dependence of export or import at the exchange rate will be verified. Dreyer et al. (2017) argue that an increase in the exchange rate results in a decrease in export and therefore a strategy of stabilizing prices in local currency is applied in order to gain or maintain market share in important markets.

The human factor also plays an important role - conservative behavior is typical for German consumers (Maier, 2019), which is one of the reasons that today Germany is the largest customer of typical Czech lager, worth CZK 1.4 billion. This is followed by Slovakia with CZK 1.1 billion, according to available data from the Czech Statistical Office. According to Brewers of Europe, in 2020, 22% of total export were exported from the Czech Republic to Germany. In the case of Slovakia, this value is 25.6%. It is necessary to mention that more beers are exported to Slovakia, but the higher financial value of exported beer is in Germany. This is due, among other things, to the diversified structure of exported beer brands - Germany has a higher purchasing power and there is more room to place more expensive brands. When we talk about import, it is necessary to mention the consumer price of beer. For beer, this price is stated in principle as for bottled beer, even in the reports of the Ministry of Agriculture. Maier (2012), Richards and Rickard (2021) explain the function of the consumer price in the beer market. However, this is not a decisive factor in the case of consumer behavior - here price acts as a neutral factor (Svatošová et al., 2021).

The Czech Republic is about 133% self-sufficient in beer (Customs Office, CZSO), so it is logical that the Czechia export beer in bulk (a quarter of its production), it also has the prerequisites, but it import a small amount of beer. The value of import in 2020 was 3.4% of total consumption, of which 14% of imported beer was from Germany and 6% from Slovakia.

2. Materials and Methods

This paper contains a time series of 22 observations, from 2000 to 2021. These are annual data, are from the Czech Republic, Slovakia, and Germany. The data are taken from the Czech Statistical Office, the Slovak Statistical Office, the German Statistical Office, as well as from the databases of the Customs Office, the database of the Czech National Bank ARAD and the organization Brewers of Europe. Literary research is carried out by studying papers from scientific databases Web of Science or Scopus.

The econometric export and import model contain two equations. The linear model looks like following:

$$EXP = f\,(const; RATEEUR; RATESKK; CON\_DE; CON\_SK; M) \quad \textbf{(1)}$$

$$IMP = f\,(const; RATEEUR; CON\_CZ; M; CC; CP), \quad \textbf{(2)}$$

where:

Table 1. Description of the variables

Variable	Variable name	Units
EXP	Export	1,000 hl
IMP	Import	1,000 hl
const	Constant	
RATEEUR	Exchange rate CZK / EUR	CZK
RATESKK	Exchange rate CZK / SKK	CZK
CON_DE	Consumption in Germany	L per capita
CON_SK	Consumption in Slovakia	L per capita
CON_CZ	Consumption in Czechia	L per capita
M	EU membership	
CC	Market concentration coefficient	%
CP	Consumer price	CZK

Source: own

The basic unit in brewing is a hectolitre, which is 100 liters. The model uses the exchange rate of the Czech crown against the euro and the exchange rate of the Czech crown against the Slovak crown until 2009, when Slovakia adopted the euro. For this time series to be complete, this course has been recalculated for the years 2009 - 2021. Germany has a full time series, as it switched to the euro in cash in 2002, but adopted it in 1999 (European Central Bank). Consumption is expressed in liters per capita, because it is this expression that can better describe the determinants of the beer market for paper purposes. Another important variable is the fact of the Czech Republic's membership in the EU, the Czech Republic became part of it in 2004. This variable is a dummy variable, Heckman (1978) describes the character of the dummy variables in more detail. The Czech Republic's accession to the EU opened access to the European single market, which undoubtedly affected international trade. While in the past Czech export were dominated by raw commodities, currently Czech export are based, among other things, on ready-made food products (Smutka et al., 2015). The consumer price is stated for bottled beer, in CZK per 0.5 l.

The market concentration coefficient (CC3) is also important for determining the factors influencing import in the Czech Republic. It is the sum of the shares of the three largest companies on the Czech market (according to beer production in hl). The data are provided by the Czech Association of Breweries and Malthouses. CC3 provides an overview of the ownership structure of the market, so that it can be seen that these are not extremes - perfect competition or monopoly, because then the market behaves differently. CC is an instantaneous indicator that provides information on market size and aggregate concentration at a particular point in time. The paper examines the correlation between market concentration and the value of import in the Czech Republic. The time series shows the entry of the third largest company into the Czech market in 2008, when market concentration increased by 12.5 percentage points. The same effect is also present in the value of Czech import, when in 2002 it increased by 165 thousand year-on-year. hl. The reason was the adoption of an agreement on mutual liberalization of the Czech agricultural trade with the European Union in 2000, and gradually, according to the individual phases, the individual stages of the agreement took place (Ministry of Agriculture). In 2009, the value of imported beer doubled year-on-year, partly because in the crisis it was cheaper to import beer from abroad - from Poland, among others, and partly because the expansion of PET bottles began, for which the Czechia had no technology and or brewed beer directly (PET lines were in Hungary) and then re-imported, so it was a re-export.

Linear regression is performed using the least squares method. The essence of the method is to find parameters that minimize the sum of the squares of the deviations of the theoretical and actual values of the explained variable. Mariano (1972) writes about this in more detail. The exogenous variables of EU membership and the exchange rate of the Czech crown against the euro show a slight multicollinearity, which is, of course, logically justifiable and none of these variables will be excluded from the equations. The calculations were performed in SW Gretl and in MS Excel. In the tables, three asterisks in the tables indicate the statistical significance of the variables (where three, two or one asterisks represent level of significance α 0.01; 0.05 and 0.1).

3. Results and Discussion

The model for Czech export looks like this:

$$EXP = 14645{,}5 + 23{,}23RATEEUR - 7{,}85RATESKK - 104{,}86CON\_DE - 0{,}89CON\_SK + 615{,}82M + u \qquad (3)$$

Table 2. Parameters estimates for Export model

	Coefficient	Standard error	t-share	p-value	
const	14645,5	5747,48	2,54	0,02	**
RATEEUR	23,23	85,93	0,27	0,79	
M	615,82	611,45	1,00	0,32	
CON_DE	−104,86	26,20	−4,00	0,01	***
CON_SK	−0,89	44,06	−0,02	0,98	
RATESKK	−7,85	34,20	−0,22	0,82	

Source: own table, SW Gretl, 2022

Structural parameters were revealed by the least squares method. The test determined that beer consumption per capita in Germany was a statistically significant variable in this case. There is a negative correlation between the value of export and beer consumption in Germany. Year-on-year, Czech export are growing, while German beer consumption is declining. It is a paradoxical dependence, but it is not disputed that the statistical significance of the variable only confirms the theory that the German market is key to Czech beer export. However, the negative direction of dependence is not real - there is no causality between the growth of beer consumption and the decline of exported beer. In this case, it is necessary to consider that the beer market has its specifics, and therefore, even if beer consumption per capita in Germany will decrease in the future, Czech beer will still be exported there. It is necessary to mention here that this is a priority financial value of beer, not quantity. Less hl of beer can be exported, but for more money.

This model is explained by exogenous variables from 87%. The White test showed the absence of heteroskedasticity, and the residue normality test showed a normal distribution. Autocorrelation is present (using the Breusch Godfrey test, $p = 0.01$), it is understood as a dependence not between two or more variables, but between a sequence of values of one variable, arranged in time. Autocorrelation does not affect unbiased and consistent estimates, but does not provide the best model estimates.

By dynamizing the model (adding a time trend variable), the coefficient of determination increases to 0.95 and all variables except RATEEUR become significant. This shows that market developments over time play a crucial role in beer export. However, the development of the market cannot be modeled using purely mathematical methods, but also considering a few other factors, which the econometric model is not able to express. The model has the following characteristics:

Table 3. Parameters estimates for Export model with time trend

	Coefficient	**Standard error**	**t-share**	**p-value**	
const	−8136,73	4291,05	−1,89	0,07	*
RATEEUR	55,99	70,82	0,79	0,44	
M	1408,28	402,41	3,5	0,01	***
CON_DE	37,56	18,74	2,00	0,06	*
CON_SK	62,50	22,30	2,80	0,01	**
RATESKK	−32,95	12,58	−2,61	0,01	**
time	246,88	33,04	7,47	<0,0001	***

Source: own table, SW Gretl, 2022

If the CON_DE variable is removed, the estimates look like this:

Table 4. Parameters estimates for Export model with time trend and without CON_DE

	Coefficient	**Standard error**	**t-share**	**p-value**	
const	20484,1	6208,31	3,29	0,01	***
RATEEUR	−187,29	86,18	−2,17	0,04	**
M	−470,65	464,39	−1,01	0,32	
CON_SK	−111,14	28,57	−3,89	0,01	***
RATESKK	−31,43	25,08	−1,25	0,22	

Source: own table, SW Gretl, 2022

After removing of the variable beer consumption in Germany (CON_DE), the variable beer consumption per capita in Slovakia (CON_SK) became statistically significant (Tab. 4). This suggests that in any case for the international trade in beer in the Czech Republic, and especially for export, the consumption (which also expresses the preferences of consumers on foreign markets) of beer in the partner country is important.

EU membership is important only in the case of Germany's partnership, which means that access to the German market has greatly facilitated and intensified since the Czech Republic's accession to the EU. The Czech Republic traded with Slovakia even before both countries were in the EU, and the exchange rate of the Czech crown to the Slovak crown (until 2009) did not affect this. The exchange rate of the Czech crown against the euro was also not significant. One of the main reasons is that Czech export are constantly growing, while the exchange rate is stable. So there is no significant dependence. The same can be assumed in the case of the CZK / SKK exchange rate, moreover, it was valid until 2009.

Overall, it can be deduced that Czech beer export depends on the popularity of beer in Germany and in EU membership and access to the European market. Balogh et Jámbor (2017) have already demonstrated the positive impact of EU membership on cheese market, so it's also beer market case. The calculation also showed that Germany is one of the key trading partners for the Czechia.

So to the conclusions of Bieleková and Pokrivčák (2020) it can be added that Czech export are influenced not only by the common language or border of countries, distance and level of GDP, but also by EU membership, beer consumption in the partner country and market developments over time.

Now we will focus on beer import. In general, beer import in the Czech Republic is low, partly because the Czechia is sufficiently self-sufficient in beer, and partly because the Czech consumer simply prefers Czech beer, partly because it has the highest drinkability (Wakihira, 2020, Čejka, 2011). However, after determining the main determinants, a model was created:

$$IMP = 848{,}87 - 19{,}61RATEEUR - 6{,}51CON\_CZ - 13{,}76M + 19{,}57CC - 43{,}41CP + u \quad (\mathbf{4})$$

The parameters look like this:

Table 4. Parameters estimates for Import model

	Coefficient	**Standard error**	**t-share**	**p-value**	
const	848,87	999,15	0,84	0,40	
CON_CZ	−6,51	3,23	−2,01	0,06	*
RATEEUR	−19,61	20,51	−0,95	0,35	
CC	19,57	5,41	3,61	0,01	***
M	−13,76	98,13	−0,14	0,89	
CP	−43,41	31,37	−1,38	0,18	

Source: own table, SW Gretl, 2022

Czech import are explained by the given variables from 76%. The model has undergone econometric verification and according to the results, statistically significant variables are beer consumption in the Czech Republic (CON_CZ) and market concentration (CC). A concentrated market leads to product homogenization of the market, and therefore consumers are trying to compensate for homogeneity by more heterogeneous import from abroad. There is also a financial reason - cheaper beer is often transported, for example, from Poland. Török et al (2020) state, that global beer trade is rather dominated by commodity-like beer products with lower unit values. The greater the market concentration, the greater the import - there is a direct dependence. Domestic beer consumption per capita is also significant. The higher the consumption of beer per capita, the lower the import. Such a seemingly strange dependence is explained by the fact that the Czech consumer is conservative, prefers Czech lager (Svatošová, 2021) and has no need to import it from abroad with the growing consumption of this beer. Moreover, when the country is 133% self-sufficient, as already mentioned. Other import, such as consumer price, EU membership and the CZK / EUR exchange rate, are insensitive to other variables. Even after adding a time trend variable, which proved successful in the export model, the situation did not change much:

Table 5. Parameters estimates for Import model with time trend variable

	Coefficient	**Standard error**	**t-share**	**p-value**	
const	1497,04	1136,72	1,3	0,20	
CON_CZ	−11,02	4,71	−2,33	0,03	**
RATEEUR	−26,05	18,58	−1,40	0,18	
CC	18,53	5,14	3,60	0,01	***
M	15,39	83,50	0,18	0,85	
CP	6,04	37,78	0,16	0,87	
time	−19,81	14,23	−1,39	0,18	

Source: own table, SW Gretl, 2022

The only changes are that the direction of the dependency on the consumer price (CP) has changed. Thus, over time, the higher the consumer price of beer on the domestic market, the greater the import of beer from abroad, which is in line with economic theory. Otherwise, the coefficient of determination did not change significantly, from 76% to 77%. The development of the market over time is therefore not essential for import, unlike export, from which it can be deduced that the Czech market is rather closed in terms of consumer preferences. As for the interpretation of other parameters - the higher the CZK / EUR exchange rate (ie the weaker the crown), the more import fall. This is in line with economic theory, then there is more domestic consumption. The longer the Czechia is in the EU, the more the value of import increases, which is in line with the theory.

4. Conclusion

The Czechia is very open to beer export and is closed to import, which is due, among other things, to high self-sufficiency and technology. The closure is caused by the Czech conservatism and the great demand for Czech lager. The key partner for Czechia is Germany, which import beer from it with the greatest financial value. Using regression analysis, it was found that beer export is mainly affected by per capita consumption in the partner country, as well as market developments over time and in some cases the exchange rate. This is also due to a factor that is not included in the calculations, but is based on proven literary sources that German consumers are conservative and prefer pils beer.

Import, on the other hand, is insensitive to market developments over time and the exchange rate, but depends mainly on domestic beer consumption per capita and market concentration in the Czech Republic. The domestic beer market is specific and can satisfy domestic consumption. Due to the time trend, changes only the direction of dependence between the consumer price of beer and its import, but this variable is not statistically significant.

It is also necessary to take into account the possibility of licensed beer production, as this will reduce the energy costs of transport in particular. Beer contains over 90% of water, so to save costs and fuel consumption in transport, it is advisable to consider transporting smaller amount of beer with a higher grade, so that the importing breweries can then dilute it according to themselves. This applies to beers where HGB (high gravity brewing) technology is used in production. As for beer production technology and energy costs, Czech beer has the advantage of being protected by a trademark. If the energy intensity of individual production technologies were to be taken into account, it could not be modified or canceled thanks to protection. The Czech beer recipe describes a decoction method of brewing beer, which is more energy-intensive than the infusion method. Thus, large breweries using this technology and exporting beer do not have to worry about having to change their production process in order to save energy.

In connection with the Green Deal, it is necessary to mention another specific feature of the brewing industry. Water is widely used in the production of beer. On the one hand for brewing beer, and on the other hand for ensuring the entire process – from mashing to sanitation to bottling. There were a total of 599 breweries in the Czech Republic in 2021, of which 506 (ie 84%) were microbreweries (Brewers of Europe, 2021). Why is this important in the context of the paper? Because in large industrial breweries the ratio of used water to brewed beer is on average 5:1 (5 l of water to 1 l of beer), while in microbreweries this ratio reaches 9:1 (Czech Association of Breweries and Malthouses, 2022). As part of the global issues that the Green Deal seeks to address, which relate to renewable resources and water in particular, these ratios pose a problem and are the subject of further research. For the Czechia, as a country that is in 6th place in terms of beer produced in the EU, due to its size, the issue of road transport costs, of energy and water consumption in the brewing industry is fundamental.

There is a wider scope for examining the influence of other variables, especially in gravity models, where the influence of geographic variables on the foreign beer market would be confirmed or rejected. However, the aim of this paper was to examine the influence of other selected variables on the export and import of Czech beer.

Acknowledgements
The results and knowledge included herein have been obtained owing to support from the following institutional grant. Internal grant agency of the Faculty of Economics and Management, Czech University of Life Sciences Prague, grant no. 2022A0003.

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ATTITUDES OF CONSUMERS IN THE CZECH REPUBLIC TOWARDS THE EU BIO MARKETING LABEL

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Annotation: Organic production is on the rise in the European Union and in the Czech Republic. This is also reflected in the growing popularity of these products among consumers. Organic products are one of the main categories of the alternative approach in food production and the promotion of this approach is in line with the current green direction of the European Union. The aim of the paper is to identify the main attitude, or the entity of brand value - the knowledge of such products labelled with the EU organic logo, among consumers in the Czech Republic depending on selected socio-demographic characteristics of the respondents. The data obtained from the questionnaire survey included basic socio-demographic characteristics of consumers in the Czech Republic and their knowledge of the European Organic logo. The survey data are categorical and thus processed exclusively with statistical methods suitable for the work with categorical variables - logistic regression and contingency table analysis. The following characteristics have a significant impact on the knowledge of the European organic logo in the Czech Republic: gender, education, net monthly household income and the size of the municipality where consumers live and shop. This knowledge increases significantly with increasing education and net monthly income of respondents, as well as with the size of the municipality where consumers live and shop. Higher knowledge of the European organic logo is also evident among women than among men.

Key words: Cosnusmer behaviour, Organic food, Marketing, Czech organic market, Logistic regression, Pearson's chi-square test.

JEL classification: M1, M2, C30

1. Introduction

Organic food market in the European Union is growing steadily. Increasing share of organic food to conventional food is also one of the European Community's long-term objectives. This makes the topic of organic food on European market a very important issue. The market experienced its greatest growth between 1997 and 2006, when the volume of organic food produced increased by 80% (Ditschun, 2010). Globally, the United States have the largest share of the organic food market (42%), followed by Germany (11%) and France (9%) (Statista US Market of organic products, 2020). Apart from the clear dominance of the USA, Europe is emerging as the world's second most important organic food market. In the Czech Republic, organic food market is also on the rise from the year 2009 (Institute of Agricultural Economics and Information, 2011 and Janssen and Hamm, 2012) with the total turnover of organic products of Czech subjects (including exports) exceeding CZK 4 billion in 2016 total consumption on the Czech organic food market then reached CZK 2.55 billion. In the same year, there were over six hundred registered organic food producers in the Czech Republic, which is 50% more than in 2009, when there were less than four hundred (The Czech Confederation of Commerce and Tourism, 2019). In 2019, according to the Ministry of Agriculture of the Czech Republic, the domestic market for organic products was worth CZK 3.73 billion (Czech Ministry of Agriculture, 2019). The most popular organic products among Czech consumers are milk and dairy products and fruit and vegetables, and the third most popular category of organic foods is identified as processed foods such as spices, mustard, coffee or tea and baby food. (The Czech Confederation of Commerce and Tourism, 2021).

From a consumer behaviour perspective, Kareklas et al. (2014), Yadav (2016) identify two main drivers that lead consumers to purchase organic food. The first driver or reason is to purchase food because of its perceived higher quality and health benefits. The second driver for purchasing food labelled as such is environmental friendliness or e.g. animal welfare etc. Research by Živělová and Crhová (2013) identifies the interest of Czech consumers in organic food.

The aim of the paper is to identify the knowledge of a uniform European brand used to identify European organic food in relation to selected socio-demographic characteristics of domestic consumers, especially respondents' gender, education, income and place of residence. Since January 2022, new EU legislation is being implemented concerning the process of controlling imports of organic food into member states with the aim of unifying control and quality criteria (Czech Ministry of Agriculture, 2022). In the EU, food products are compulsorily labelled with a uniform European logo or "bio label" mark, the knowledge of which is a cornerstone for purchasing organic food products also on the domestic market (PRO-BIO LIGA Association, 2022).

2. Materials and Methods

The research was conducted in 2019. There were 1197 respondents who took place in this research and these respondents divided into categories by gender: 63.49% women and 36.51% men, by education: 7.27% elementary, 59.82% high school, 32.92% university. Respondents were approximately evenly distributed in categories by income and municipality size.

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).

The data were analyzed using the contingency tables analysis, including the Pearson's chi-square test (Agresti, 2002) and Anděl (2005) and Hebák (2007) and Hindls (2003) and Čarnogurský (2021).

3. Results and Discussion

The knowledge of the European BIO logo was analyzed according to several socio-demographic characteristics. Firstly, the effect of all these characteristics together was examined using logistic regression. The values of the ordinal (values can be ordered) sociodemographic characteristics were coded on an increasing scale of 0, 1, 2, 3, ... The values of the nominal gender characteristic were coded 1 - male, 0 - female, and the values of the binary variable Knowledge of the logo European BIO were coded 1 - know, 0 – don't know.

The results of the logistic regression (especially the regression coefficients and their statistical significance) are presented in Table 1.

Table 1. Regression Model Parameters

	Coefficient	Standard error	Wald's statistics	p-value	Lower 95%	Upper 95%
Constant	-2.38	0.37	41.95	0.0000	-3.10	-1.66
Your Gender	-0.53	0.13	16.29	0.0001	-0.79	-0.27
Your Age	-0.06	0.07	0.88	0.3487	-0.20	0.07
Education	0.71	0.12	34.57	0.0000	0.47	0.94
Household Net Monthly Income	0.16	0.05	8.75	0.0031	0.05	0.26
How Many Members Are There in Your Household?	0.03	0.08	0.13	0.7146	-0.13	0.19
Number of Children in Your Household?	-0.12	0.08	2.05	0.1526	-0.28	0.04
What Is the Population of the Municipality Where You Live and Shop?	0.12	0.04	11.01	0.0009	0.05	0.20

Source: own research

Table 1 shows that the following characteristics have a significant effect on the knowledge of the logo European BIO: gender, education, household net monthly income and the size of the municipality where consumers shop (p-value for these variables is less than 0.01). According to the sign of the regression coefficients, knowledge of the logo European BIO increases significantly with increasing education and net monthly income of the respondents, as well as with the size of the municipality where the consumer lives and shops (all regression coefficients have a positive sign). Knowledge of the European organic logo is also significantly higher among women than among men.

Table 2. Model's Statistical Significance

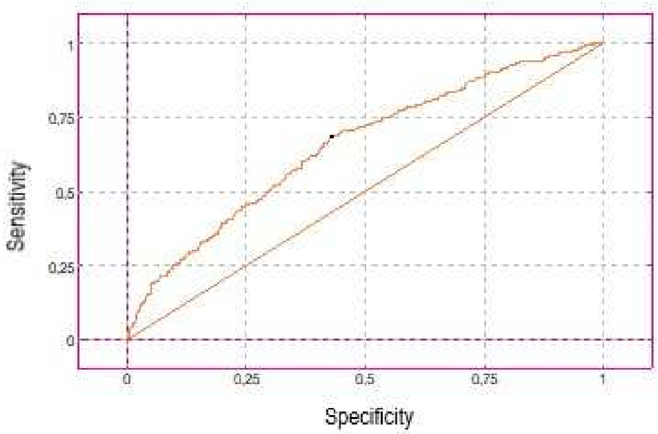
-2 Log reliability:	
Initial model =	1649.82
Final model =	1555.66
Reliability ratio statistics:	
Chi-square statistics =	94.15
Degrees of freedom =	7
Right-tale probability =	0.0000
Interpolation consistency:	
Chi-square statistics =	1195.26
Degrees of freedom =	1189
Right-tale probability =	1.0000

Source: own research

Table 2 shows that the regression model is statistically significant (the p-value of the likelihood ratio test is less than 0.001). Therefore, the hypothesis that all regression coefficients are zero and thus there is no dependence can be rejected. Furthermore, the fit of the model to the data cannot be rejected (the p-value of the interpolation consistency is 1.000).

The area under ROC curve (see Figure 1) is 0.66, indicating acceptable quality of the regression model.

Figure 1. ROC curve



Source: own research

The second step of the analysis is a detailed examination of the partial dependencies of the variable Knowledge of the European BIO logo on each socio-demographic characteristic separately. The logistic regression shows only the average trend, while the contingency table analysis can be used to find any deviations from this average trend in more detail. Only the characteristics whose influence was significant in the logistic regression were analyzed - gender, education, household net monthly income and the size of the municipality where consumers live and shop.

Table 3. Column Relative Frequencies (variables: Knowledge of European BIO logo and Gender)

Column Relative Frequencies	Men	Women
Don't know	59.50%	51.58%
Know	40.50%	48.42%

Source: own research

Similarly, as in the logistic regression, the contingency table (see Table 3) shows that women are significantly more likely to know the European BIO logo than men (48.42% vs. 40.50%). The relationship is statistically significant (p-value is 0.0081, Cramer's V coefficient is 0.08).

Table 4. Column Relative Frequencies (variables: Knowledge of European BIO logo and Education)

Column Relative Frequencies	Elementary	Highschool + high school with GCE	University + post-secondary
Don't know	71.26%	61.03%	38.83%
Know	28.74%	38.97%	61.17%

Source: own research

Similar to the logistic regression, knowledge of the European BIO logo increases significantly with consumer education (from 28.74% for respondents with elementary education, to 38.97% for respondents with high school education, to 61.17% for respondents with university education), see Table 4. The dependency is statistically significant (p-value is 0.0000, Cramer's V coefficient is 0.23).

Similarly, to the logistic regression, knowledge of the European BIO logo increases significantly with increasing household net income (from 41.63% for respondents with income up to CZK 20,000 to 52.22% for respondents with income above CZK 50,000). It can be seen from the contingency Table 5 that this trend is not completely linear, with a slight decrease in the trend for respondents with an income of 20,000 - 30,000 CZK. The dependency is statistically significant (p-value is 0.0195, Cramer's V coefficient is 0.10).

Table 5. Column Relative Frequencies (variables: Knowledge of the European BIO logo and Household Net Monthly Income)

Column Relative Frequencies	Up to CZK 20,000	(20,000; 30,000 >	(30,000; 40,000 >	(40,000; 50,000 >	CZK 50 001 and more
Don't know	58.37%	60.87%	54.61%	49.07%	47.78%
Know	41.63%	39.13%	45.39%	50.93%	52.22%

Source: own research

Table 6. Column Relative Frequencies (variables: Knowledge of the European BIO logo and How many inhabitants does the municipality where you live and shop have?)

Column Relative Frequencies	Up to 2,000 inhabitants	2 001 – 5 000 inhabitants	5 001 – 20 000 inhabitants	20 001 – 50 000 inhabitants	50 001 – 200 000 inhabitants	More than 200 001 inhabitants
Don't know	68.92%	54.55%	55.56%	54.91%	47.66%	47.01%
Know	31.08%	45.45%	44.44%	45.09%	52.34%	52.99%

Source: own research

The familiarity with the European BIO logo mainly grows with the growing size of the municipality in which consumers live and shop (from 31.08% for municipalities with less than 2,000 inhabitants, up to 52.99% for municipalities with a population of over 200,000), see Table 6. In contrast to logistic regression, it is also clear from the contingency table that the trend is again not completely linear; some stagnation in the categories from 2,000 to 50,000 inhabitants, where the knowledge of the European BIO logo is around 45%. The dependency is statistically significant (p-value is 0.0000, Cramer's V coefficient is 0.16).

According to the value of Cramer's V-coefficient, the knowledge of the European BIO logo depends most strongly on consumer education, slightly less on the size of the municipality, while the dependency on net monthly household and gender income is relatively weak.

The results of the research show that the brand of organic food is most often known among respondents with the highest incomes, which is in contrast to the trend found in 2012 and 2013, when the respondents with the highest incomes showed the lowest level of knowledge of this fact (Zámková, Prokop, 2014). Another positive factor for the growing popularity of organic food is the fact that the price differences between organic food and conventional food products are decreasing (compared to earlier years) and this clearly plays a major role in the trend. There have also been major improvements in the organic food offer breadth and depth of the range and in its distribution, which, together with the growing number of organic food producers, has a positive impact on consumer interest in buying organic food (Živělová and Crhová, 2013) and (Czech Ministry of Agriculture, 2019).

4. Conclusion

The aim of the paper was to identify the familiarity with the European brand used to identify European organic food, the so-called "organic label" in relation to selected socio-demographic characteristics of consumers (respondents' gender, education, income and place of residence). The data were processed by methods suitable for categorical data, i.e. logistic regression and analysis of contingency tables. The results of the logistic regression show that the knowledge of the European BIO logo is significantly influenced by the characteristics: gender, education, household net monthly income and the size of the municipality where consumers shop. According to the regression coefficients, it is clear that the knowledge of the European BIO logo grows significantly with the growing education and net monthly income of the respondents, as well as with the size of the municipality in which consumers live and shop. Knowledge of the European BIO logo is also significantly higher for women than for men.

A detailed analysis of the contingency tables showed that women know the European BIO logo significantly more often than men (48.42% vs. 40.50%). Knowledge of the European BIO logo grows significantly with consumer education (from 28.74% for respondents with elementary education, over 38.97% for respondents with high school education, to 61.17% for respondents with university education). This knowledge grows significantly with increasing household net income (from 41.63% for respondents with income up to CZK 20,000 to 52.22% for respondents with income over CZK 50,000). Knowledge of the European BIO logo mainly grows with the growing size of the municipality in which consumers live and shop (from 31.08% for municipalities up to 2,000 inhabitants, to 52.99% for municipalities with a population of over 200,000). All dependencies are statistically significant. Further research may be aimed at examining whether organic food companies are more profitable compared to non-organic companies and whether there is a relationship between profitability and efficiency of these companies (e.g. Hedija et al., 2017).

Acknowledgements

The article was suported by grant of the College of Polytechnics in Jihlava IGS – No.: INT/2022/0006: Analýza nákupního chování spotřebitelů při koupi potravin, biopotravin a regionálních potravin v době pandemie COVID-19

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CONTENT

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B1 History of Economic Thought through 1925
B2 History of Economic Thought since 1925
B3 History of Economic Thought: Individuals
B4 Economic Methodology
B5 Current Heterodox Approaches

C. Mathematical and Quantitative Methods
C1 Econometric and Statistical Methods and Methodology: General
C2 Single Equation Models • Single Variables
C3 Multiple or Simultaneous Equation Models • Multiple Variables
C4 Econometric and Statistical Methods: Special Topics
C5 Econometric Modeling
C6 Mathematical Methods • Programming Models • Mathematical and Simulation Modeling
C7 Game Theory and Bargaining Theory
C8 Data Collection and Data Estimation Methodology • Computer Programs
C9 Design of Experiments

D. Microeconomics
D1 Household Behavior and Family Economics
D2 Production and Organizations
D3 Distribution
D4 Market Structure, Pricing, and Design†
D5 General Equilibrium and Disequilibrium
D6 Welfare Economics
D7 Analysis of Collective Decision-Making
D8 Information, Knowledge, and Uncertainty
D9 Intertemporal Choice

E. Macroeconomics and Monetary Economics
E1 General Aggregative Models
E2 Consumption, Saving, Production, Investment, Labor Markets, and Informal Economy
E3 Prices, Business Fluctuations, and Cycles
E4 Money and Interest Rates
E5 Monetary Policy, Central Banking, and the Supply of Money and Credit
E6 Macroeconomic Policy, Macroeconomic Aspects of Public Finance, and General Outlook

F. International Economics
F1 Trade
F2 International Factor Movements and International Business
F3 International Finance
F4 Macroeconomic Aspects of International Trade and Finance
F5 International Relations, National Security, and International Political Economy
F6 Economic Impacts of Globalization

G. Financial Economics
G1 General Financial Markets
G2 Financial Institutions and Services
G3 Corporate Finance and Governance

H. Public Economics
H1 Structure and Scope of Government
H2 Taxation, Subsidies, and Revenue
H3 Fiscal Policies and Behavior of Economic Agents
H4 Publicly Provided Goods
H5 National Government Expenditures and Related Policies
H6 National Budget, Deficit, and Debt
H7 State and Local Government • Intergovernmental Relations
H8 Miscellaneous Issues

I. Health, Education, and Welfare
I1 Health
I2 Education and Research Institutions
I3 Welfare, Well-Being, and Poverty

J. Labor and Demographic Economics
J1 Demographic Economics
J2 Demand and Supply of Labor
J3 Wages, Compensation, and Labor Costs
J4 Particular Labor Markets
J5 Labor–Management Relations, Trade Unions, and Collective Bargaining
J6 Mobility, Unemployment, Vacancies, and Immigrant Workers
J7 Labor Discrimination
J8 Labor Standards: National and International

K. Law and Economics
K1 Basic Areas of Law
K2 Regulation and Business Law
K3 Other Substantive Areas of Law
K4 Legal Procedure, the Legal System, and Illegal Behavior

L. Industrial Organization
L1 Market Structure, Firm Strategy, and Market Performance
L2 Firm Objectives, Organization, and Behavior
L3 Nonprofit Organizations and Public Enterprise
L4 Antitrust Issues and Policies
L5 Regulation and Industrial Policy
L6 Industry Studies: Manufacturing
L7 Industry Studies: Primary Products and Construction
L8 Industry Studies: Services
L9 Industry Studies: Transportation and Utilities

M. Business Administration and Business Economics • Marketing • Accounting • Personnel Economics†
M1 Business Administration
M2 Business Economics
M3 Marketing and Advertising
M4 Accounting and Auditing
M5 Personnel Economics

N. Economic History
N1 Macroeconomics and Monetary Economics • Industrial Structure • Growth • Fluctuations
N2 Financial Markets and Institutions
N3 Labor and Consumers, Demography, Education, Health, Welfare, Income, Wealth, Religion, and Philanthropy
N4 Government, War, Law, International Relations, and Regulation
N5 Agriculture, Natural Resources, Environment, and Extractive Industries
N6 Manufacturing and Construction
N7 Transport, Trade, Energy, Technology, and Other Services
N8 Micro-Business History

N9 Regional and Urban History
O. Economic Development, Innovation, Technological Change, and Growth†
O1 Economic Development
O2 Development Planning and Policy
O3 Innovation • Research and Development • Technological Change • Intellectual Property Rights†
O4 Economic Growth and Aggregate Productivity
O5 Economywide Country Studies

P. Economic Systems
P1 Capitalist Systems
P2 Socialist Systems and Transitional Economies
P3 Socialist Institutions and Their Transitions
P4 Other Economic Systems
P5 Comparative Economic Systems

Q. Agricultural and Natural Resource Economics • Environmental and Ecological Economics
Q1 Agriculture
Q2 Renewable Resources and Conservation
Q3 Nonrenewable Resources and Conservation
Q4 Energy
Q5 Environmental Economics

R. Urban, Rural, Regional, Real Estate, and Transportation Economics
R1 General Regional Economics
R2 Household Analysis
R3 Real Estate Markets, Spatial Production Analysis, and Firm Location
R4 Transportation Economics
R5 Regional Government Analysis

Y. Miscellaneous Categories
Y1 Data: Tables and Charts
Y2 Introductory Material
Y3 Book Reviews (unclassified)
Y4 Dissertations (unclassified)
Y5 Further Reading (unclassified)
Y6 Excerpts
Y7 No Author General Discussions
Y8 Related Disciplines
Y9 Other

Z. Other Special Topics
Z1 Cultural Economics • Economic Sociology • Economic Anthropology
Z2 Sports Economics
Z3 Tourism Economics