ECONOMIC RESEARCH INSTITUTE
BULGARIAN ACADEMY OF SCIENCES

# ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ

ИНСТИТУТ ЗА ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ НА БЪЛГАРСКАТА АКАДЕМИЯ НА НАУКИТЕ

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# REGIONAL ELECTRICITY TRADE IN SOUTH EAST EUROPE – FINDINGS FROM A PANEL STRUCTURAL GRAVITY MODEL[4]

*The paper discusses whether the electricity trade in South East Europe in 1990-2019 is driven by fundamentals or, like other commodities, one could argue for a speculative movement of electricity flows motivated by factors such as prices. We employ a panel structural gravity model on the example of Bulgaria, Romania, Serbia, Republic of North Macedonia, Greece, Turkey, and Hungary to study the dependence between net exports, generation, and consumption of electricity, as well as the regulations in the field of exporting electricity. We find that domestic consumption of electricity is a much stronger factor than the generation when considering foreign trade in electricity. The construction of power capacity in the countries considered is much more oriented towards the domestic market, which results in an underdeveloped interconnection between them. This is a serious obstacle to the liberalization on the electricity market in the region and its integration into pan-European market structures. It also creates conditions for maintaining higher and volatile electricity prices and, consequently, negatively affects economic development.*
*Keywords: foreign trade in electricity; panel structural gravity model; electricity market regionalization*
*JEL: Q43; F14; R11*

## Introduction

The opportunities for trading in electricity can be studied in two aspects. Firstly, as regards the electricity transactions on the domestic market, and then on the international markets –

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through the market couplings of power exchange operators and electricity system operators that comply with uniform regulations. With the accelerated liberalization and creation of a common energy market in the EU, in fact, the differentiation of the two markets is becoming increasingly difficult due to the specificities of electricity – an undifferentiated product with the same quality (that is not influenced by different sources of generation) and the impossibility of storage, despite the progress of new technologies in this field. This circumstance raises interest on the current conditions of the electricity markets in South East Europe as regards the cross-border trade in electricity. Another interesting research point is the extent to which the electricity market liberalization processes currently have a positive effect on foreign trade in electricity, or it is rather dependent on the local specificities imposed by its generation and consumption.

The issue is also becoming increasingly relevant given the high price volatility of the energy markets, driven mainly by seasonal factors, and the geopolitical risks from early 2022, which have a direct impact on the processes of electricity markets in South East Europe. While household consumption of electricity is more seasonally volatile, industry demand is more predictable and with smaller annual changes. Meanwhile, the low price elasticity of demand is determined by the lack of substitutes (Filippini, 1999). It leads to problems in the functioning of the electricity markets: substantial price jumps and an increase in the 'market power' of certain market participants (Kirschen, 2003), which the liberalization of the electricity market seeks to cope with.

The purpose of the paper is to test the extent to which net exports of electricity in 1990-2019 in Bulgaria, Romania, Serbia, Republic of North Macedonia, Greece, Turkey, and Hungary depend on the local generation and domestic consumption of electricity, using a panel structural gravity model. We aim to find out the impact of the fundamental local factors on the foreign trade in electricity and the extent to which we can talk about a separate cross-border electricity market in South East Europe, or whether it is subject to internally determined processes in the field of electricity. This is important given the fact that international trade in electricity makes it possible to avoid, maintaining a large reserve capacity and importing electricity from neighbouring countries, which have a comparative advantage in its generation; in this way, the benefits of liberalization of the electricity market are to be realized.

The next section of the paper discusses the specificities of electricity trade against the background of ongoing processes of liberalization in the European Union. Section 3 reviews research on the topic and the features of modelling foreign trade in electricity through the gravity model of trade. Section 4 presents the structure of a panel structural gravity model, which we adapt and test considering the specificities of the electricity markets in South East Europe. In conclusion, we comment on the econometric results and draw conclusions about the challenges to the liberalization of the electricity sector in the region.

**Specificities of the Electricity Trade in the EU in the Context of the European Union's Strategy on Energy Sector Development**

A review of the economic research clearly highlights the leading importance of the reforms carried out by the EU Member States in the energy sector – initially at a national level, targeted at eliminating the natural national monopolists, liberalizing the market, and ensuring the security of supply. Aiming at improving efficiency at the microeconomic level, the structural measures were implemented with the vision that liberalized markets automatically create competitiveness and economic growth (Vlahinić-Dizdarević, Galović, 2007).

The first major reforms in this regard took place in the United Kingdom in the 1990s, when the electricity supply activity was subject to privatization and electricity generation was allocated among private companies. The focus of the reforms was on the generation and trading of electricity, so to create independent producers that compete with the state monopolies already established over the years (Rothwell, Gómez, 2003). The main argument was that this would lead to economic benefits and lower prices for consumers (Kirschen&Strbac, 2004). In 1998, the World Trade Organization pointed out that problems could arise due to the partial consideration of electricity only as a commodity or only as a service when liberalizing the market. For this reason, the distinction between the generation, transmission and distribution of electricity can create an imbalance in the drafting of trade rules for different liberalized market segments in terms of trade and some business practices (Pineu, 2004). The possibility of the emergence of double standards in the reformation of the sector imposes the use of uniform trade rules in the liberalization (Eberhard, 2003), which are also essential for the cross-border trade exchange of electrical energy.

The turning point in the development of EU guidelines on electricity markets was the adoption of the first directives in 1996, known as the First Energy Package, concerning the liberalization of the energy and gas Sectors. By 1998, they had been transposed into the Member States' legal systems and aimed to gradually open the local markets to competition. Pollitt (2009) points out that the theoretical basis of EU reforms on the electricity market is based on the theory of free competition that aims to increase competition in generation and retail at a national market level, reduce the market share of monopolists and create regional markets.

During this period, the first serious challenge to the liberalization of the electricity market in the EU emerged – the existing different views on the market mechanisms and market design of the electricity market. Some of these challenges stemmed directly from the structure of the EU itself. In the USA, electricity trading is carried out through the so-called integrated market, where the system operator centrally optimizes the demand and supply of electricity in the network. In the EU, a different market model based on exchange trading has been adopted, considering the differences in the electricity sector of individual Member States in building the Single Market (Cramton, 2017).

Further directives were drafted in 2003 and were transposed into national legislation by 2004, but some provisions did not come into force until 2007. The adoption of this so-called Second Energy Package enabled industrial consumers and households to choose their own electricity and natural gas suppliers from a wider range of competitors. The third liberalization package

was adopted in 2009 with the main goal of consolidating the electricity and natural gas markets and their transition from national to regional, and subsequently to pan-European ones. The idea is that the single market will lead to single demand and supply and prices, as has happened or is happening with the other markets for goods and services in the EU (Georgiev, 2014).

In recent years, the Global Powers have taken decisive steps in accordance with the Paris Agreement. The Green Pact of 2019, also known as the European Green Deal or the European Green Pact, is the EU's most ambitious climate strategy to date. Europe's goal is to become the first carbon-neutral continent by 2050, meaning no net greenhouse gas emissions in 2050. The European Green Pact affirms the European Commission's commitment to address the challenges related to the protection and conservation of the EU's natural environment, as well as the protection of the health and well-being of citizens.

Although between 1990 and 2018, the EU economy grew by 61% in nominal terms, it managed to reduce the greenhouse gas emissions only by 23%. The energy generation and consumption account for 75% of the EU's greenhouse gas (carbon) emissions; therefore, the reform of the energy system becomes the primary task for the climate goals set. To achieve the target for 2030, the update of the Renewable Energy Directive (RED II) proposes to increase the overall target for renewable energy use in the EU energy mix from the current 32% to a new level of 40%. By 2050, a target of 300 GW of wind energy from offshore installations and 40 GW of ocean energy in all the Union's seas is set.

Establishing a functioning internal energy market is seen as fundamental to three energy-related challenges: competitiveness (reducing costs for citizens and businesses), sustainability of the emissions trading mechanism and security of supply. To establish an internal energy market, priority was given to the unification of the technical standards necessary for the functioning of cross-border trade. In many countries, the technical standards differ, which hinders the interconnection of power grids. Support was also provided for identifying and building the missing infrastructure between the EU countries and the infrastructure needed to integrate renewable energy into a grid. Ownership unbundling of the companies responsible for the maintenance and operation of the grids and the companies for supply and generation was considered an important condition for improving competitiveness (European Commission, 2017).

However, it is worth noting that the international environment in terms of electricity generation and pricing is quite complex. In some Member States, in strong opposition to the fight against climate change, the electricity generation from coal receives significant subsidies, which not only favours the electricity generation with a strong negative impact on the environment, but also distorts pricing and financial and economic results in the electricity system (Miljević, Mumović, Kopač, 2019). On the other hand, EU countries follow their own strategies to support renewable energy sources, based on research that environmental protection policies in the field of electricity do not have a negative impact on economic growth (Venkatraja, 2021). Measures are needed and implemented to support emerging technologies, but this is contradictory to the policy of market liberalization and the goal of increasing the competitiveness of the European economy (Byanova, 2021). We can conclude that the electricity market only seems a competitive one, it does not guarantee equal

opportunities for all participants and only capacities that receive subsidies are created (Georgiev, 2018). There is a lack of full integration and coherence in the EU energy policies, despite the increasingly important role of the external electricity market due to the growing demand for electricity from the transport sector and several production activities replacing the use of fossil fuels with environmentally friendly sources, based on renewable energy sources (RES). The results of the rehabilitation of residential buildings also remain controversial, which is the reason why the expected savings from the energy used by households for heating are not observed (Peneva, 2021).

## Literature Review and Specificities in the Modeling of Electricity Trade

The regional integration, similar regulatory frameworks and lack of significant problems related to congestion in the electricity system and cross-border capacities make it possible for more in-depth research on international electricity trade to be done.

Several approaches exist in the professional economic literature that analyze electricity consumption and the factors that influence it. These models are directly related to the exports of electricity, as the domestic electricity consumption can be satisfied both by domestic generation and by imports. For this reason, the factors that determine the electricity consumption are also the factors that determine the opportunities a country to export electricity (Zlatinov, 2018). The electricity consumption is also strongly dependent on the macroeconomic fundamentals – it increases in direct proportion with the increase of incomes, the favourable conditions for economic sectors development and the improvement of the investment environment. That is why we are interested to investigate to what extent purely fundamental factors related to the generation and consumption of electricity also influence international electricity trade, or other factors and preconditions are stronger there.

The authors employ short-run and long-run approaches to studying electricity consumption. The most used of them is the final consumption method. An extended approach is the combination of econometric analysis and final consumption method[5] in which electricity consumption is addressed in different consumer groups. This method provides a better opportunity to analyze sectoral dependencies. The use of such models makes it possible to analyze the electricity consumption of households, industry, services, and the public sector based on the linkages with economic growth, electricity prices, population growth, effect of public and regulatory policies, climate conditions.

In general, the net electricity export depends on the electricity consumption and its prices (Hakkio, Nie, 2014). The generation, distance and transmission capabilities are considered as other important factors for electricity exports. The limits to trade relationships with the increase of distance between countries trading in electricity make it possible to use the gravity model of trade. This approach is based on the theoretical formulations of Anderson (1979) and Anderson & Van Wincoop (2003). In a traditional sense, the gravity model can be defined as one intuitively based on the economic logic that underlies its construction – the

[5] This approach is well-known in the economic literature and used extensively. Its applications as regards the foreign trade of Bulgaria are demonstrated by Stoevsky, G. (2009).

bigger the volume of production and the smaller the distance between the countries, the more they would trade with each other. As Anderson & Van Wincoop (2003) note, the gravity model essentially sets a demand function with constant elasticity of substitution.

Piermartini & Yotov (2016) point out that various effects arising from geography, demography, trade agreements, foreign direct investment, cross-cultural relations, etc., can be investigated through the gravity equation. As regards the international trade in electricity, the model can be employed by assuming that the closer the countries are and an interconnection between them is developed, the greater should be the transfer of electricity, other things being equal. In this way, the main advantages of the gravity model, described by Larch & Yotov (2016), can be utilized, including as regards the foreign flows in electricity:

1. Its intuitive nature (based on Newton's Law of Universal Gravitation);
2. The ability to apply at a macroeconomic and microeconomic level by including several countries, sectors, or companies;
3. Its high predictive accuracy varies between 60 and 90% when using aggregated data for different goods and services.

Relying on the intuitive nature of the gravity model, Antweiler (2016) constructed a model of bilateral international trade, representing the one-way and two-way electricity trade between some US states and Canadian provinces. The authors analyze data on the electricity generation in Canada by low marginal cost plants (HPPs and NPPs) with smaller changes in the output, the domestic consumption in the country, the exports to the USA, the seasonal changes and large profit margin. Based on the model of bilateral trade in electricity developed by Antweiler (2016), one can highlight some important features arising from the specificities of the electricity sector:

- trade is one-way when there is a strong comparative advantage in the generation of electricity and two-way when the comparative advantages between the trading partners are identical;
- trade is two-way when demand for exports fluctuates, and imports follow the gap in the load on the electricity transmission grid between the two countries;
- trading opportunities follow the changes in the electricity demand over time due to seasonal or local effects;
- differences in the size of countries also encourage cross-border trade;
- the volume of trade in electricity is subject to a much sharper decline than that of trade in other commodities;
- the elasticity of ordinary goods is about one, but of electricity it is twice as high because price is not the main factor that determines demand. This is also demonstrated by the analysis of Otsuka (2015) – when the price increases by 1%, the consumption of the industrial and service sectors in Japan changes by 0.15%;
- doubling the distance reduces foreign trade in electricity by a quarter due to system connectivity and various legal and regulatory barriers;

- the greater trade in electricity is impeded by the increased long-distance losses amounting to about 3.5% per 1000 km and the increase in the price of electricity, as a transmission fee must be paid.

Due to the heteroskedasticity in the model proposed by Antweiler (2016), Batalla et al. (2019) use the linear version of the gravity equation proposed by Santos-Silva and Tenreyro (2011). One can draw the following conclusions on cross-border trade in electricity based on the results of Batalla et al. (2019):

- electricity demand is driven by the importing country and not by the exporting country; this shows a strong link between economic activity and energy flows – the GDP of the exporting country is significantly lower than the GDP of the importing country[6];
- electricity prices matter in trading. If the export price of electricity increases by 1%, trade decreases by an average of 0.7%; the same increase in the importer's electricity prices increases trade by almost 1% on average. This result is in line with the standard situation of comparative advantage in international economics.

The models of Antweiler (2016) and Batalla et al. (2019), based on the gravity model of trade, also show that the price does not necessarily reflect the abundance of resources, as in the Heckscher-Ohlin concept. The price of the electricity traded depends on both the long-run comparative advantages and the short-run shortages, which often prove to be a decisive factor. Viewed as a homogeneous commodity, electricity can be assessed in a different way and therefore, the single price law is not valid. Thus, it is possible that pricing will reach very high levels (Antweiler, 2016).

Roy et al. (2000) view electricity as a commodity (based on the markets in Belgium, Germany, and France) that can be traded like all other commodities, but they note that some potential problems arise in the electricity market, such as:

- demand and supply of electricity must always coincide, which is the main reason why market factors cannot respond quickly to changing physical flows of electricity. This problem is called the balancing problem;
- grid restrictions, which are often unpredictable, reduce the possible transactions and create a problem with restrictions.

When studying electricity trading, researchers emphasize the role of the system operator, which is responsible for the reliability of the grid and the provision of additional services related to the security of supply and the quality of electricity. The system operator manages the market in real time, i.e., decisions are made and implemented immediately. Higher price stability can be achieved through bilateral agreements that are made for a longer period. Due

[6] Such a conclusion matters to the periodically appearing plans of Bulgaria to build Belene NPP, due to the possibilities for trading the generated quantities of electricity on the regional market. The high electricity prices in the summer of 2021 showed that the generation base of Bulgaria is, in practice, supported by the exports and not by the domestic consumption, where some of the large industrial producers suspended their generation facilities due to the unfavourable prices.

to the emergence of such challenges to the electricity system, Ji et al. (2016) use grid analysis to study the structure of interconnected electricity grids on a global scale. They aim to identify the national grids that are crucial for the stability of the global electricity transmission system, using data on the international electricity trade from 1990 to 2010. The network analysis shows that geographical proximity, political relations, and landscape have an important role in the formation of trade nodes of countries under the trade in electricity, which also points to the possibility of using the gravity equation. The analysis is applicable to the Eurasian power sub-grid, to which the EU countries belong. It also includes the largest number of countries that develop intensive mutual trade and form separate trading groups. The great dependence of some European countries on the trading partners in the export or import of electricity also comes to the fore.

It should be noted that, when considering trade in electricity, the conditions for its realization are developing much more dynamically than those for other commodities. This is due to the frequent changes in the market organization, which are related both to the economic, engineering, and legislative changes and to the rapid penetration of new technologies in the sector.

## Model Specification of Net Electricity Exports in South East Europe Employing a Structural Gravity Model of Trade

The modified gravity equation to reflect the specificities of electricity trade flows has the following form:

$$NX_{i.j} = c + b_1 Y_i + b_2 Y_j + b_3 \tau_{i,j} + b_4 Reg_{i.j} + e_{i.j} \quad (1)$$

where:

$NX_{i.j}$ is the net exports of electricity;

$Y_i$ and $Y_j$ – the quantities of electricity generated in the two countries concerned;

$\tau_{i,j}$ – a variable reflecting the possibility for transmission of electricity;

$Reg$ – the specific regulations imposed in foreign trade transmission of electricity.

When specifying equation (1), it is worth noting that we use net exports of electricity considering the specificities that imports of electricity may be destined for transit through the country. The variable $\tau_{i,j}$ is more relevant to reflect the interconnection of electricity systems between countries instead of showing the distance between them, as is the case in the standard gravity model. The econometric specificities of dealing with the variable presenting regulations in the model are presented in the next section of the paper.

As Shepherd, Doytchinova and Kravchenko (2019) note, when presented in the traditional way, at least two serious restrictions may arise in the application of the gravity model. First, by focusing only on the distance between the countries, but not on the trade restrictions such as tariffs, quotas and preferential trade agreements, an important aspect of foreign trade is missed, which could significantly affect it. That is why we include a variable in equation (1)

for the regulations in the field of foreign trade in electricity. Second, the traditional gravity model does not consider changes in the relative prices of the product concerned, but only the absolute prices. In the case of electricity trade, this is a very important shortcoming given the price volatility demonstrated in 2021.

Considering the abovementioned restrictions and the current state of economics and econometric methods, the structural gravity model is more commonly based on microeconomic foundations. In our paper, we rely on the approach of building and evaluating structural gravity models of Anderson and Van Wincoop (2003). This is the so-called 'Gravity with Gravitas' model that consists of the following equations:

$$NX_{i.j} = Y_i^k + C_j^k - Y_j^k + (1 - \sigma_k)\left[\tau_{i,j} + Reg - \Pi_i^k - P_j^k\right] \quad (2)$$

$$\Pi_i^k = \sum_{j=1}^{N} \left(\frac{\tau_{i,j}^k + Reg}{P_j^k}\right)^{1-\sigma_k} \frac{C_j^k}{Y^k} \quad (2a)$$

$$P_j^k = \sum_{j=1}^{N} \left(\frac{\tau_{i,j}^k + Reg}{\Pi_i^k}\right)^{1-\sigma_k} \frac{Y_i^k}{Y^k} \quad (2b)$$

where:

$i$ and $j$ are used to denote the countries concerned; $k$ is the specific sector, i.e. electricity sector;

$C$ – the consumption of electricity in the importing country, which determines the need for electricity import;

$Y^k$ – the generation of electricity in the region concerned, such as:

$$Y^k = \sum_{j=1}^{N} Y_j^k$$

where $\sigma_k$ is the intra-sectoral elasticity of substitution;

$\Pi_i^k$ reflects the fact that exports from one country to another depend on trade costs across all possible markets;

$P_j^k$ captures the same fact as $\Pi_i^k$ but as regards the imports.

Equation (2) enables us to reflect foreign trade in electricity in a more realistic way by including important variables such as its consumption and opportunities for differentiated transmission between the countries based on the provided interconnection. The interconnection in the transmission of electricity is reflected by including in our model only countries that share a common border and between which the physical transmission of electricity is possible. This is also achieved by extending the standard gravity equation with equations (2a) and (2b), which demonstrate how specifically the export of electricity depends on the trading conditions throughout the region. This is the way we overcome the specified restrictions of the traditional gravity model.

Given that our goal is to adapt the model to the electricity market in South East Europe, it is necessary to reconsider the inclusion of explicit variables for the regulations and fees for the transmission of electricity. In 2011-2019 Bulgaria was the only EU Member State to tax electricity exporters with a fee of EUR 5 /MWh (VAT excluded), in fact, a hidden duty. At the end of 2018, the Court of Justice of the European Union in Luxembourg ruled on a similar case concerning Slovakia and adopted a decision prohibiting the EU countries from imposing fees on the export of electricity generated on their territory. In 2019 the fee for transmission and access to the electricity transmission grid, paid by electricity exporters, were abolished. According to the Court of Justice of the European Union, the imposition of such fees violates the principles of the free movement of goods within the EU[7]. However, in the case of Bulgaria, such an action stimulated the exports of electricity because to be successfully realized on the foreign energy markets, the price of electricity generated in the country had to be at a competitive level even after the imposition of the hidden export fee. Currently, exporters and importers of electricity are paying administrative fees (to transmission operators, commodity exchange operators, etc.), which are in line with the EU directives. This demonstrates that the regulations in the field of electricity exports have a potential impact on the trade flows, which gives us reason to include such a variable in the model. Meanwhile, we acknowledge that it is quite difficult to capture the impact of regulation on electricity adequately given the economic differences between the countries in the region, the long period under review (1990-2019), the different initial periods of EU membership, and some of them are not yet EU members. To a large extent, this creates the expectation that the effect of regulations in the econometric assessment, which is based on a dummy variable, is unlikely to be properly accounted for.

When evaluating electricity exports, the interconnection is also an important determinant, which requires a special emphasis on the countries included in the model. Another factor that matters significantly for the electricity trade in the region are the prices formed on the energy exchanges in Bulgaria (IBEX), Greece (HENEX) and Romania (OPCOM). The Hungarian Exchange (HUPX) also has a major influence on price levels in the region and acts as a connecting link between the market areas in South-Eastern, Central and Western Europe.

In most cases, the greatest demand, and hence the higher prices, is observed in the Greek and Hungarian markets. The high prices there are not only due to the market coupling, as there has been a correlation of prices before, but mostly to the local specificities and the existence of the so-called bottlenecks. The Greek market has traditionally experienced a shortage of electricity (especially during the summer). The prices in the Hungarian market are higher compared to the Romanian market because it is a traditional importer. In recent years Hungary has emerged as an important energy hub connecting the region with the markets in Central and Western Europe. Given the interconnection provided, we include Serbia, Republic of North Macedonia, and Turkey in the model in accordance with equations (2a) and (2b). The main imports of electricity in Serbia are carried out from Hungary due to the good connection, with deficits being covered by imports from Romania and finally from

[7] More broadly this issue is discussed by Madanski, 2021.

Bulgaria. The Republic of North Macedonia is a transit country (from Serbia to Greece) and a major exporter to the Greek market.

In the Ten-year Network Development Plan of Bulgaria in 2021-2030 by the Electricity System Operator EAD (ESO EAD, 2021), for the first time, attention is paid to the influence of the electricity transmission system (EES) of Turkey in relation to electricity flows in the East-West direction (p. 16). The emphasis is on the predictions of the Turkish system operator TEİAŞ for high growth of new generating sources with a low price of electricity and the possibility of year-round export. As regards Bulgaria, the lack of investments in the construction of large sources of electricity in the electrical equivalent circuit (EEC), which are affordable 24 hours a day, also creates concerns about the Bulgarian export role on the electricity market in the region.

The abovementioned factors would be extremely important because they could increase the transit flows of electricity through the Bulgarian transmission network, turning the Bulgarian-Turkish and Bulgarian-Serbian borders into bottlenecks that would limit electricity trade. It should also be considered that when the coal plants in the Maritsa East complex are closed or reduced (due to the commitments related to the Green Deal), the transit of electricity from Turkey through Bulgaria will be greatly increased. The Turkish electricity transmission network is joined to the EU one and through its actions as a tender operator, ESO EAD offers, and it distributes and provides 50% of the available transmission capacity for the transmission of electricity in both directions between the electricity systems of Bulgaria and Turkey.

## Econometric Estimation of the Model

We transform equation (2) for the purposes of econometric estimation as follows:

$$NX_t = \beta_0 + \beta_1 Y_t + \beta_2 C_t + \beta_3 Reg_t + \beta_4 Fj_t + e_t \quad (3)$$

We use the variable $Fj_t$ to control fixed effects in relation to the other countries in the model compared to Bulgaria. The variable Reg is a dummy one with value 0 if there is no specific regulation in a specific year and 1 if such a regulation exists. Our analysis of regulations regarding the cross-border trade in the electricity markets in the region is based on official documents of the European Commission and energy agencies of the countries under review.

We estimate equation (3) through a panel data technique of fixed effects estimation, using annual data for 1990-2019 from Eurostat for Bulgaria, Romania, Serbia, Republic of North Macedonia, Greece, Turkey, and Hungary. According to Shepherd, Doytchinova and Kravchenko (2019), the most used method for the estimation of the structural gravity model is the panel data technique of fixed effects estimation. The application of this method consists in the inclusion of dummy variables for each exporter and importer in the model, which are added as explanatory variables. This allows us to adhere to the basic assumptions in the Ordinary Least Squares (OLS) model for a consistent, unbiased, and efficient estimator. A potential problem may arise because of the presence of a perfect correlation with the variables for which we have set fixed effects; therefore, in the evaluation of equation (3), we pay special attention to the variance inflation factor (VIF).

In terms of interpretation of the results, it would be more appropriate to set equation (3) in logarithmic form. However, due to the presence of negative values of the net export of electricity, the estimation is based on absolute values of the indicators. We consider that different methods may be applied to transform negative values into logarithms (i.e., to add a constant value to the data or use missing values), but since it is important to reflect whether a country is a net exporter or net importer of electricity, which can best be captured by the absolute value of net exports, we do not make such data transformations. In interpreting the results, we fully account for the fact that we have used absolute values.

Another important point of the econometric assessment is that we use data for countries of different size, economic development, and cyclical phases. This makes it necessary to find a common measure for the data to be compared. Due to these circumstances, we use data on net exports, generation, and consumption of electricity relative to the GDP of the respective countries from the IMF and the Eurostat. Let's recall that our main goal is to assess the extent to which net exports of electricity are driven by domestic generation and consumption, or other external trade factors matter much more. This would tell us whether the region's electricity trade is driven by fundamentals, or, like other commodities, one could argue for a speculative movement of electricity flows motivated by factors such as prices. This indirectly addresses the question of whether national electricity supplies in the region would be affected in times of strong external demand, sacrificing national energy security at the expense of benefits from foreign trade.

The first step is to estimate the correlation between the stationary variables, which is shown in the matrix in Table 1.

Table 1

Correlation matrix of variables used

| Variable | Net exports | Generation | Consumption | Regulation |
|---|---|---|---|---|
| Net export | 1 | 0.328 | -0.022 | -0.042 |
| Generation | 0.328 | 1 | 0.888 | -0.078 |
| Consumption | -0.022 | 0.888 | 1 | -0.044 |
| Regulation | -0.042 | -0.078 | -0.044 | 1 |

The data shows a low positive correlation between net electricity net exports and generation, and almost a zero correlation with electricity consumption. This is probably due to the high levels of electricity transit in the region. In another aspect, we can argue that the export orientation of the electricity sector is not a factor that affects the national energy security. There is a high positive correlation between electricity consumption and generation. This is indicative of the still weak interconnection in the region and of the development of foreign trade in electricity, in which the liberalization processes are still expected to intensify the market. Regarding regulations, as expected, there is no significant effect given their limited application for the period under review and all the restrictions we face to incorporate them in the model.

Next, we check the data stationarity. Given the larger sample size (203 observations) and data specificities, we apply the Phillips-Perron (PP) unit root test. The results show that in the absolute values form, only the net exports are a stationary variable, while in the first differences, all variables are stationary. The results are summarized in Table 2.

Table 2

Result of Phillips-Perron (PP) unit root test of the variables

| | Level Form | | | First Difference | | |
|---|---|---|---|---|---|---|
| Variable | Tau (Observed value) | Tau (Critical value) | p-value (one-tailed) | Tau (Observed value) | Tau (Critical value) | p-value (one-tailed) |
| Net exports | -3.581 | -3.432 | 0.034 | -13.504 | -3.432 | < 0,0001 |
| Generation | -2.754 | -3.432 | 0.216 | -8.398 | -3.432 | < 0,0001 |
| Consumption | -2.866 | -3.432 | 0.176 | -6.944 | -3.432 | < 0,0001 |

**Hypothesis testing**

**H0:** There is a unit root for the series.

**Ha:** There is no unit root for the series. The series is stationary.

**Decision rule:** If the computed p-value is lower than the significance level $\alpha = 0.05$, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

The econometric estimation employing a panel data technique of fixed effects estimation is summarized in Table 3.

Table 3

Econometric results

| Variable | Coefficient | Std. Error | t-value | Pr(>\|t\|) | VIF |
|---|---|---|---|---|---|
| Generation | 0.690 | 0.025 | 27.180 | <0.0001 | 5.823 |
| Consumption | -0.858 | 0.029 | -29.131 | <0.0001 | 5.321 |
| Regulation | 0.267 | 10.735 | 0.025 | 0.980 | 3.452 |

R-squared: 0.904 Adjusted R-squared: 0.899
F-statistics: 605.261 Durbin-Watson test: 1.864
Breusch-Pagan test p-value: 0.083 White test p-value: 0.038

The results show that the net exports of electricity in South East Europe would increase by 0.690 units if the generation of electricity increased by 1 unit, as well as that the net exports of electricity would decrease by 0.858 units if the consumption of electricity increased by 1 unit. As the correlation matrix shows, the effect of regulations is statistically insignificant, and the sign of the variables under consideration, which sets the direction of the relationship between them, is the expected one.

From a statistical point of view, the three variables included (generation, consumption, and regulations) explain about 90% of the variance in net exports of electricity, which is indicative of their fundamental nature and strong effects on the cross-border trade in electricity. The Variance Inflation Factor test for multicollinearity shows that the values obtained for all variables are far below 10, and the Durbin-Watson autocorrelation test has a value of 1.864, showing that autocorrelation between the residuals is not greater than 0. The probability values of the Breusch-Pagan test and the White test for heteroskedasticity allow us to accept the null hypothesis of homoskedasticity.

When analyzing the results, one can reason on the trends they show rather than on their values. This is because we use a panel model where the panel data levels the playing field and given the dummy variables for the regulations. It is noteworthy, however, that domestic consumption of electricity is a much stronger factor than the generation, when considering foreign trade in electricity. This allows us to argue that the construction of power capacity in the countries considered is much more oriented towards the domestic market than towards the regional market, which is also shown by the underdeveloped interconnection between them. This is a serious obstacle to the liberalization on the electricity market in the region, which would also affect its integration into pan-European market structures. In purely domestic terms, this creates the conditions for maintaining higher prices and, consequently, negatively affects economic development.

## Conclusion

The positive dependence of net electricity exports on generation in the region of South East Europe is not surprising given the fundamental relationships between the two. The high exports of electricity, in which mainly foreign companies from the region are involved, encourages investments in generation and employment. Hence, it creates preconditions for even greater growth of electricity generation, which becomes more expensive in view of all imposed initiatives to limit environmental pollution. Thus, a foreign trade transmission of electricity, which relies mainly on local generation, emerges, and combined with low interconnection, leads to higher electricity prices. These processes show the need for greater intensification of the interconnection and point to the serious challenges to the expansion of electricity transit and liberalization on electricity markets. The strong negative relationship between net electricity exports and consumption we find in the region implies a strong seasonal dependence of net exports and volatility relative to consumption, and hence it has a direct price effect. This shows that electricity exports are an additional factor rather than a basis for the development of the electricity market in South East Europe, which has an impact on both the success of market liberalization policies and the dynamics and high volatility of prices. The strong and negative relationship between net electricity exports and consumption reaffirms the essential role of the interconnection in the development of the electricity trading market in South East Europe, which the purely regulatory initiatives for regional integration and harmonization of the regulatory frameworks cannot replace.

To comprehensively evaluate the opportunities for clean exports of electricity from the countries in South-Eastern Europe, Turkey's influence on the region must also be considered. The expected growth of production capacities with year-round export opportunities in the largest regional economy will strengthen the transit component of net exports in South-Eastern Europe and will negatively affect the possibilities of other countries to carry out their own exports, especially given all the restrictions under the EU Green Deal on coal production. The development of electricity capacities in Turkey would have the most direct effect on Bulgaria, which can benefit from the transit flows of electricity through the national transmission network in the east-west direction and thus compensate for the possible closure of the generating capacities of the Maritsa-East complex by increasing dependence on electricity production in Turkey. Turkey's position demonstrates that the potential for foreign

trade in electricity directly depends on the available NPPs, through which not only the foreign trade position can be preserved but also the coverage of the domestic electricity needs can be guaranteed, based on the example of Bulgaria. In this way, the market liberalization and the introduction of similar regulatory practices would have a real impact and would mitigate the volatility of prices in electricity markets, which also significantly affects the macroeconomic stability at a national level.

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# ARRANGEMENT OF DIGITAL LEADERSHIP STRATEGY BY CORPORATE STRUCTURES: A REVIEW[5]

*An ecosystem model of effective solution of the customer management quality issue based on the platforms' (internal and external) interaction is proposed, which indicates that digital platforms are the main tool of digital corporate transformation and regeneration. The key elements of the digital leadership strategy based on the "business model-ecosystem" interaction were identified, allowing determining the main features of the digital leadership strategy and forming the deployment direction within the corporate structure. The "road map" model of digital leadership strategy formation is introduced, the stages' sequence of digital strategy formation is systematised, and its key elements are outlined.*
*Keywords: company strategy; strategic vision; digital leadership; digital solutions; digital platform; the business model of a company*
*JEL: L19; F23*

## 1. Introduction

A new round of technological progress, inherited from the digitalisation of all sectors of the world economy today, aims to accumulate and process information. Under those conditions, the economies of all countries and their sectoral structures face a critical choice (Bukht, Heeks, 2018): development of services and forming new production relations. These principles form the dilemma of the choice of strategies by corporate business structures and

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models of national economic development. According to the work (Bonvillian, 2017), the competitiveness largely depends on which vectors the national economic system chooses, which decisions leading companies make in the national economy, how society sees future consumption (as a source of economic growth) and in what state it meets the digital transformation of the corporate sector, will largely depend on the country's competitiveness and strategic development of the microeconomic base.

Janicki and Goździewska-Nowicka (2018), in their research, show that due to the use of the latest technological developments in informatics, extended data exchange and integration of IT-systems of different organisations increased the competitiveness of the industry. Many scientists research how digitalisation allows to use in the choice of management of two different types of firm-specific assets that are apt to internationalisation – technologies and human capital (Strange, Humphrey, 2018; Banalieva, Dhanaraj, 2019; Gaur, Pattnaik, Singh, Lee, 2019; Wang, Li, 2019).

Additionally, as pointed out (Gillani et al., 2020), today, a serious challenge is that the consumer is beginning to shape their expectations in digital dimensions, preferring digital support, digital promotion, and digital services in cooperation with the manufacturing and service sectors economy.

The external area of the digital economy affects corporate strategy through competitive components. This is expressed in the fact that the factors of increasing the competitive advantage of the corporation become a suitable source of increasing market positions and obtaining strategic advantages.

That approach was used (Kotler, Keller, 2007) to justify the market activity importance (Powell, 2017) to determine the competitive strategy determinants and ways to respond to threats to internal and external changes in a company (Snow et al., 2017), in the feasibility of applying positioning in the digital environment. In this regard, special attention should be made to work (Dodgson et al. 2008), where the transition from the initial identification of strategy as a plan to balance the internal and external environment of a company to the formation of strategies aimed at creating competitive advantage, which, became the result of strategic management. Concurrently, another area of strategic management was developed, the information approach that considered only the importance of the company's internal resources, which became the basis of its efficiency and achievement of planned results (Cano-Kollmann et al., 2016). According to Koch and Windsperger (2017), based on the network-centric view, the firms may achieve competitive advantage by actively shaping the digital environment and by value co-creating of the interconnected firms in the digital environment.

In the digital revolution, industrial companies find themselves in the middle of the digital value chain. At the same time, digital transformations affected both the primary links of such chains (suppliers) through cooperation or cooperation and logistics and the final links of the chains – through logistics systems (Xiaojuan, 2020). With this view of the value chain, one can say that if companies do not take significant steps to digitalise the business, the value creation control will be "in the hands" of the initial or final links within the business chain (Kenney, Zysman, 2016). In today's world, one can see such transformations clearly in the oil and gas sector of the world economy, when all subsequent links are dependent on primary raw materials and the profitability level of finishing units is also inversely proportional to the

original cost of raw materials. The research relevance is that modern industrial structures in developing development strategies must consider changes in the physical nature of the production means, so the digitalisation strategy becomes a tool for realising the new role of a company in transformations under the influence of digital technologies.

## 2. Literature Review

In the initial version, researchers in strategic management (David, 2013; Dess et al., 2005) note that the object of strategic management is not static and changes under processes in its internal and external environment, which fits into the reality of current digital corporate transformations.

Several scientists (Anderson, Markides, 2007; Grinold, Richard, Kahn, 2000) proceed from the evolution criterion of strategic management, arguing that the most acceptable is the provision of the initial ideas about the company's strategy, as a result of long-term goal setting with limited external and internal conditions. Therefore, when a company finds a compromise between external and internal compliance, it becomes its goal in the long run and is reflected in corporate strategy.

According to Richardson & Bissell (2019) and Tidd & Bessant (2014), the digital economy leads to the destruction and crisis of a single concept of development without a concept or model that describes the information interaction of all economic agents for "national prosperity". The "data economy" growth only increases the enormous cost of chaotically collecting unreliable economic information, which overburdens managers at all levels, thus increasingly turning the digital economy into a catalyst for global development. That model is presented in the general concept of the "ecosystem-business model" that balances a company's environment.

Research (Corey et al., 2014; Myers et al., 2012) states that the widespread use of digital technologies features the economy, and this is what began to change the ideology of companies, when strategy became not just a goal rather than "a perspective or business concept", reflected in the business model, providing a new value as a mechanism for long-term development and corporate goals achievement.

According to the research of Larjovuori and colleagues, digital leadership is an ability to expose and develop skills and talents, necessary for engaging all employees of the business in the process of digitising. Within the framework of digital transformation, digital leadership includes "demonstration of the proper behaviour of enterprises and business-ecosystems for strategic digitalisation" (Larjovuori, Bordi, Mäkiniemi, Heikkilä-Tammi, 2016).

Fisk (2002) was the first who advanced the idea of "digital leadership" as the object of research 20 years ago. He claims that the companies are digital if headed by people with qualities necessary for digital leadership. Since then, a great number of researchers investigated the different aspects of digital leadership (Eberl, Drews, 2021).

Also, Eberl and Drews (2021) in their work also presented a nomological network, which defines 13 determinants of digital leadership, structured into categories of organisational

level, individual level and digital leader. Hanafi, Daud & Baharin (2018) proved that there is a significant relationship between leadership style in new modern markets and the emotional intelligence of leaders. Peng (2021) argues that individuals or organisations in the digital age can completely transform companies using digital leadership to ensure the achievement of their goals.

The development of modern digital business requires firms to operate at two different speeds (Bossert, Laartz, Ramsoy, 2014). Firms must continue to operate with traditional speed to meet existing market needs and be faster to explore the new opportunities presented by digitalisation. Operating at higher speeds, firms must use entrepreneurial thinking to generate innovative ideas that create value for customers, quickly develop digital or IT services using advanced technologies, and build organisational capabilities to deliver such services according to customer expectations.

Digital transformation is successful in the long term when the organisation's general goals correspond to the need to introduce new digital tools. In the same way, people accept technological progress only when they understand that it is relevant to their tasks. Managers, especially top managers, have an important responsibility to manage this strategic alignment and the spread of digital culture (Cortellazzo, Bruni, Zampieri, 2019). Through their digital knowledge and experience, digital leadership can help reduce the chances of digital transformation projects failing (Sağbaş, Erdoğan, 2022).

The evolution of corporate strategies and their transformation into a business model is presented in (Geschka, 2015; Lederer, 2016), and researchers (Pedersen, 2018; Seidel et al., 2012) substantiate the position of how companies update their strategy if they implement new technologies, recognising the expediency of a strategy radical update according to the market position. According to them, there is a positive relationship between the change degree in strategy and the implementation stage of advanced digital technologies in general, which implies a close relationship between the technological structure of a company and its development strategy. That close relationship is characteristic of most industries' services, regardless of the implementation stage of those technologies.

The works (Jain, Mnjama, 2016; Volberda et al., 2010) discuss which strategy elements will be updated or redesigned according to the impact of digitalisation and other technological changes. Thus, if new technology emerges, a company must decide whether to adapt to new circumstances (and to what extent) or not and assess the danger of technological shift and the threat of breakthrough innovation.

At the same time, modern scientific literature has not assessed the feasibility of digital solutions and also their consequences in typical corporate strategies. This is necessary to organise the selection of projects focused on the strategy of digital services of companies.

## 3. Methodology

The methodological basis of this study is built based on the following methodological approaches and concepts.

1. The concept of environmental impact on a company. The importance of digital environment analysis for the transformation strategy formation is that the central element of most strategies was and remains the environment concept. That concept develops dynamically in the modern model of strategic plans and means abandoning a representative view of the environment, where the goals and tools for their achievement are considered consistently. The results of the study provide adaptation to the environment. In general, "strategic planning is a process aimed at preparing decisions considering the projected conditions of the internal and external environment, and serves as a tool for preparing such decisions so that they are made quickly, economically and at a minimal cost". The following provisions (Johnson et al., 2006) are highlighted within the concept: a) the strategy development process begins with an environmental analysis. In strategic management, the environment is considered the first element to be studied; b) the environment has an ontological reality. The environment components are considered to be objective and, above all, those that impose restrictions on the company's activities; c) the basic environment elements include micro/meso/macro environment and indicators of the industry development dynamics; d) ensuring the compliance of the internal environment with the external is the key to the success of all activities.

2. The concept of ecosystems and business models. New attention to the environment has led to the revival of the concept of the ecosystem in recent years. A sign of ecosystem differences is the refusal to support the determined concept of the environment, which is a prerequisite for the work. Depending on the strategic choice of the business model, the company integrates activities into the available ecosystem or may create a new ecosystem, determining which part of the environment is relevant to the corporate business structure. Major trends such as digitalisation or new social problems fuel the need for a new approach to value creation and considering corporate value in the digitalisation of the economy. From that perspective, aggregate indicators, such as industries, value chains, or markets, are no longer the ultimate benchmarks. Horizontal and vertical structures are increasingly replaced by ecosystem thinking.

3. Method of system analysis. According to this method, the basic requirements for the development of business strategies remain in force for digital transformation strategy. Those include the next requirements: a) systematic and continuous analysis of the external environment (technological, economic, and political factors, consumer preferences, and competitors); b) considering the internal capabilities and competencies of a company, its digital maturity; c) formation of the company's future vision (services provided, sources of creation and obtaining value, market differentiation factors); d) targets specification based on key performance indicators.

4. The concept of creating corporate value. Within this concept, value creation and value use are correlated with the company's competitive advantages. The key provisions of the concept form a competitive position in available and emerging markets (e.g., replacing goods with services), which design begins. How regulation develops in such markets and how equilibrium is achieved remains the subject of the corporate value creation concept, and the very possibility of achieving equilibrium in digital markets should be included in the company's strategies.

5. Methodological approach to creating/increasing corporate value. The strategic vision is formed based on the value of new digital technologies, so it requires consideration of how value can be created for business by new technology: 1) more efficient resources are used more efficiently; 2) services are provided as efficiently as possible; 3) new business models create a stable generation of cash flow. If the task of efficient resource application is under business intelligence, the effective provision of services shapes the ecosystem development. Creating a new business is the most difficult strategy due to the lack of any significant guidelines for the future, so for an industrial company operating in the market, this approach is not targeted, and the company can participate in such decisions, but within the output of physical products/provision of services. As a result, a "strategy-figure" model is formed, embodied in digital transformation projects. Companies with implemented stages of digital transformation show better results in profits and market value. The essential component of transformation is eliminating problems of processes and systems and the problems that did not create additional value.

## 4. Results

The advent of digital technology has coincided with a wave of companies' initiatives for strategic change and increased stress from widespread technological change. Thus, the peak of globalisation processes, the spread of information and communication technologies, global aging, exacerbation of environmental problems, general digitalisation from industry and public services to the vital activity determine the feasibility of adjusting the current mechanism of strategic management of companies (Kuzmenko, et al., 2014; López García et al., 2019). Those processes may simply coincide in time, but digital technologies cause some changes in both the strategy and its design tools. Among the expected effects of the implementation of digital strategies for the corporation, we can state: 1) strengthening of current competitive positions; 2) increasing the level of consumer satisfaction; 3) expanding the range of goods or services on the market; 4) reducing the level of corporate expenses; 5) increasing the level of economic security and investment attractiveness of the corporation; 6) increasing the level of activity and the field of startup projects and shortening the terms of creation and introduction of new goods/services. The strategy (including digital) is its own project formed based on available corporate long-term plans, development programs, investment, and innovation programs (Pelser, 2014); it cannot result from copying. In this regard, the development methods that answer "how?" and "what?" become increasingly important. Hence, in the classical strategy, "how" is determined by known methods, and "what" is the environment in the digital strategy; both issues become variable.

### *4.1. The dilemma of combining traditional company strategies and digital business environment*

To conduct a comparative analysis of strategies that enable integration with digital solutions, including artificial intelligence, from a variety of business strategies, one can select three basic strategies: 1) growth strategy, 2) cost reduction strategy, 3) blue ocean strategy; (Terblanche, De Villiers, 2019). When those strategies were initially declared as equal in

capacity, several companies initially chose a cost-cutting strategy for digitisation. However, it proved its worth only on a large scale. Fast-growth companies have achieved the greatest success either through a growth strategy (often) or through a blue-ocean strategy (not often). It turns out that the impact of individual digitalisation factors on the overall set of strategies is heterogeneous because of the differences in value creation and shaping of different processes. A significant factor in the effectiveness of the implementation of the digital solutions was the speed of updating new solutions when the new effective solution emerged much faster than the previous solution reached its payback. Hence, in digitisation, one can see that innovation reduces the process's efficiency, but when assessing the automation impact on strategies, that fact should also be considered (Sardak et al., 2021).

Considering the choice of strategies, one can outline two different solutions: 1) the correspondence matrix formation of factors and typical strategies and 2) the formation of a mesh of models when for each factor, a separate model is formed with further integration. In our opinion, program-targeted methods are more suitable for the first approach, and for the second option, the coordination of models is closer to forming the company's business portfolio concept. Given that artificial intelligence and digital solutions are generally manifestations of the digital economy, there could be different effects on business performance under the same factor. Therefore, it is more appropriate to apply matrix models in today's economy, whereas portfolio models will prevail in data collection (Table 1).

First, a general conclusion should be drawn, noting that the greatest advantage is the growth strategy involving intensive development of a company. The high cost of implementing digital solutions harms the choice of cost-reduction strategy because the scale must be very large, which is not yet possible for many businesses (Makedon et al., 2019). The analysis shows that more successful strategies increase revenue (sales) based on digital solutions. Moreover, it is impossible not only to confirm in practice but also to theoretically justify that a one-time reduction in costs as a result of intelligent tools implementation will lead to lower costs (excluding mutual settlements and the Internet of Things) (McAfee, Brynjolfsson, 2017).

The development and implementation of a digital transformation strategy have become a key issue for many pre-digital companies in traditional sectors of the economy, but how such a strategy can be developed remains open (Holfmann, 2010). To form a digital leadership strategy for a modern corporation, we can use the classical approach of J. Schumpeter, which is based on the fact that the strategic task of an entrepreneur is to reform the structure of production due to innovations and new technological solutions (Kholiavko et al., 2020).

For almost a century, the goal remained virtually unchanged, despite numerous interpretations of this view. Therefore, the digital leadership strategy is also within the frameworks of this approach. Despite the repeated enumeration of various benefits, all the changes associated with the digital economy result in the need to reform the production structure. We can conclude that the digital ecosystem has finally combined all the features and came close to revolutionary production transformations. According to the digital model, business benefits from the adaptation speed inside a new environment is the ability to quickly identify relevant trends and make evidence-based fast decisions with their fast implementation.

Thus Meissner et al. (2017) argue that success is driven not so much by technology as by organisational capabilities. These studies introduce the concept of digital leadership of two types: the development of opportunities that develop and implement business models and the probability of transforming the business model. In general, digital leadership can be represented as the development of ecosystem capabilities, and digital leadership strategy can be determined economically by estimating the share of control over the value chain. Figure 1 depicts the author's view on the leadership strategy for the digital economy.

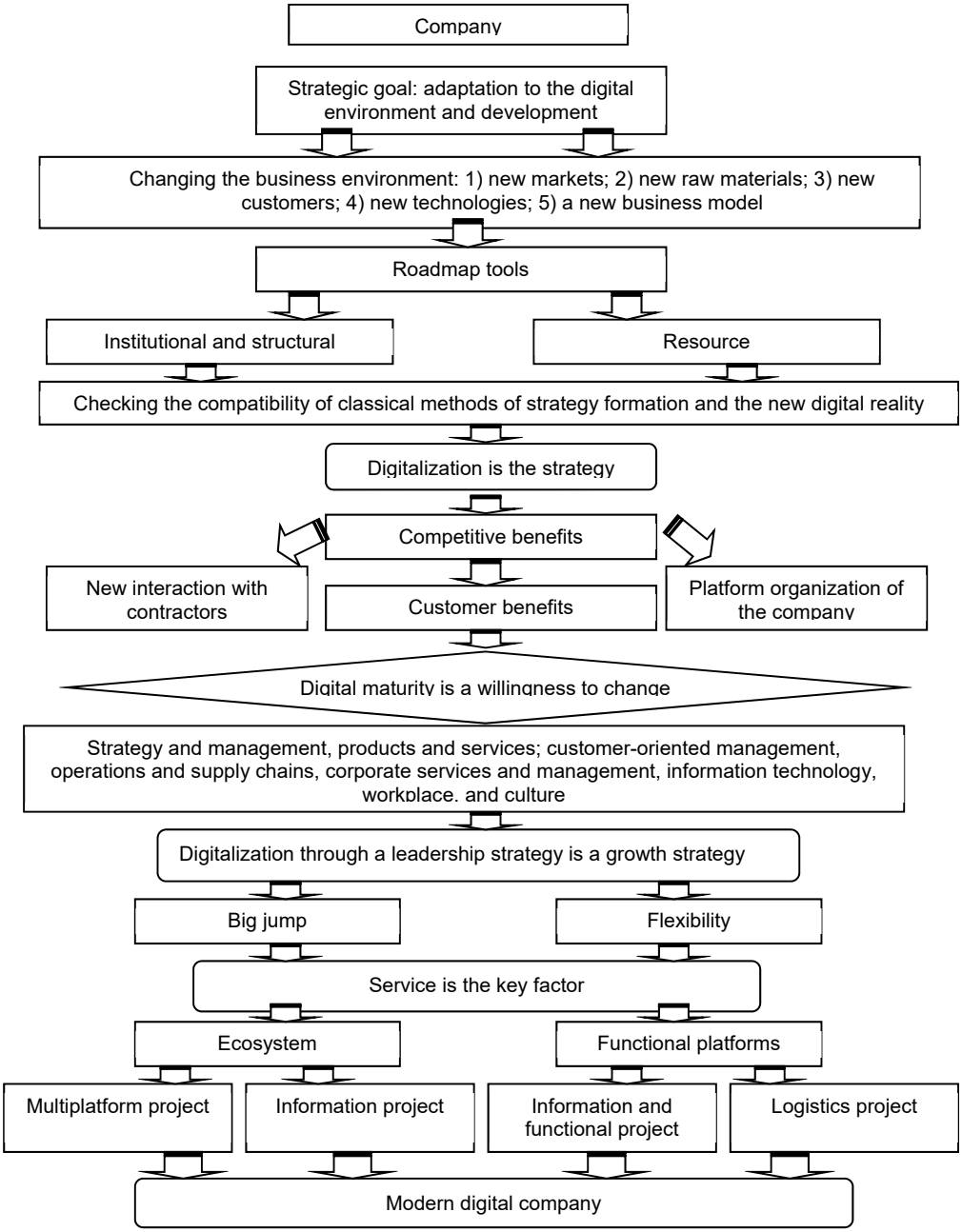
Table 1

Matrix for assessing the digital solutions feasibility or their consequences in typical corporate strategies

| Digital solutions or their consequences are known | growth strategy | cost reduction strategy | blue ocean strategy |
|---|---|---|---|
| 1. Digital resources: | | | |
| • databases; | + | - | - |
| • data processing algorithms; | + | - | - |
| • 5G network; | + | - | + |
| • Internet of Things; | + | + | + |
| 2. Digital costs: | | | |
| • jobs replacement with machines; | - | + | - |
| • jobs replacement by algorithms; | - | + | + |
| • retraining in connection with automation; | - | + | - |
| • retraining in connection with the release; | - | + | + |
| • new jobs (IT and AI). | + | - | + |
| 3. Digital financing: | | | |
| • cryptocurrency; | + | - | - |
| • digital settlements (financial sector); | + | + | - |
| • attracting money to the economy for technological trends implementation; | + | - | + |
| 4. Digital consumption: | | | |
| • pricing based on artificial intelligence; | - | + | - |
| • needs assessment; | + | - | - |
| • needs formation; | + | - | + |
| • the transition of trade to virtual reality; | + | - | + |
| • the transition of trade to augmented reality. | + | - | - |
| 5. Digital decision making: | | | |
| • Artificial Intelligence; | + | - | - |
| • augmented artificial intelligence; | + | - | + |
| • virtual reality; | - | - | + |
| • augmented reality. | + | - | + |

*Source: Hanna, 2020; Ternai et al., 2017.*

Figure 1
Formation of digital leadership strategy within "strategy-digital technologies" concept




*Source: Author's own visualisation.*

The proposed vertical sequential structure of the formation of the corporation's leadership strategy has structural graphic elements of combination (arrows-transitions). These arrows show the meaningful and logical content of the process of formation and further development of the digital leadership strategy. Such an approach contains systematic and justified variability of the operational behaviour of the corporation when implementing and deploying elements of digitalisation of economic activity.

Digital solutions and especially artificial intelligence depend on the strategy type of the company that implements digital technologies. Reasons analysis for the strategies' ineffectiveness proved that the proposed and detailed digital tools, despite their widespread support and promotion, are quite expensive solutions requiring high initial costs and additional current inflows (especially when developing the complementary management concept). The justification degree of such costs attempts to predict them is not entirely reliable due to the experimental nature.

### *4.2. New strategies development based on digital solutions and products*

Despite the widespread popularity of "digital solutions", the artificial intelligence implementation should be addressed by professionals in strategic management, especially in not the first (e.g., medicine and education) but the second or third wave of digitalisation – aircraft, robotics, mechanical engineering, microelectronics (Makedon et al. 2021). The top management functionality, which is responsible for digitalisation in a company, is essential. Enthusiasm for local tools, including digital marketing, does not currently lead to unequivocal confirmation of digital analysis effectiveness. The current view of the evaluation of digital solutions does not yet demonstrate any significant assessment of the artificial intelligence interaction possibility of different companies, which can lead not only to a loss of competitive advantage but also to commercial data leaks (Shelukhin et al., 2021). Given the above problems, a roadmap is proposed for the development of such a strategy (Figure 2).

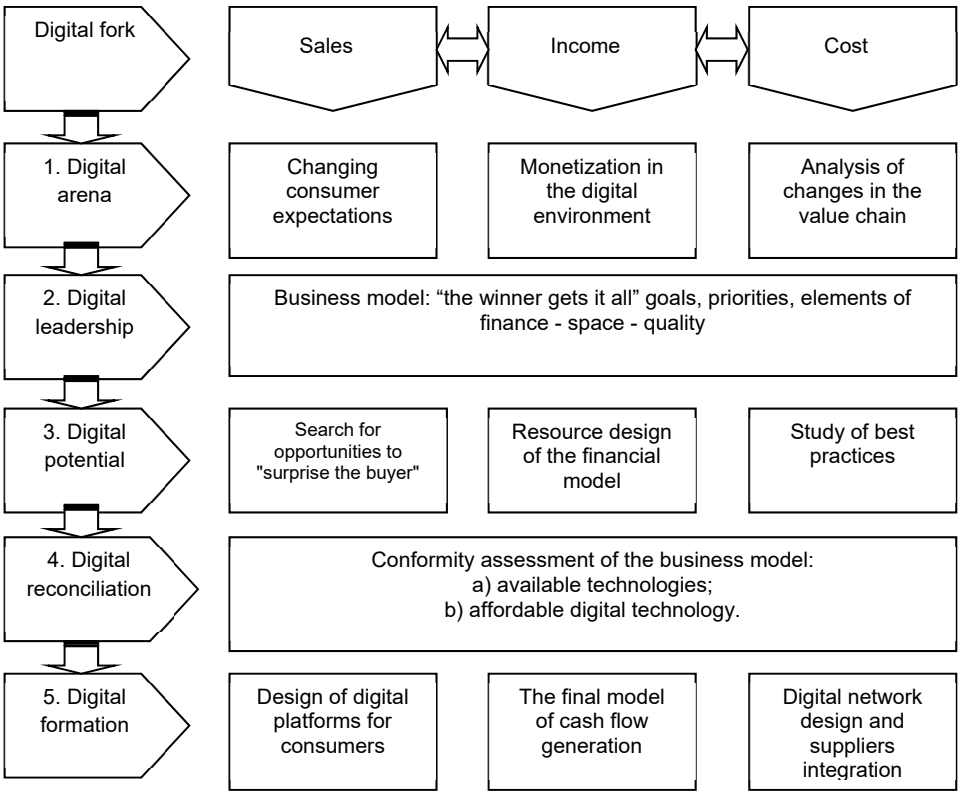
The roadmap is a logical continuation of the "strategy-digital technology" model and demonstrates that the business model becomes a central essential element. We present the "road map" model in the form of a simplified matrix, the title of which is the element – "digital fork". It is the "digital fork" that shows variations in the development and assessment of the leadership strategy by the directions of digital components vertically and basic microeconomic indicators horizontally (sales volume, income, size of corporate value). We believe that this method of strategy formation allows us to step by step identify the most valuable components of the digitalisation of the corporation's activities and see their current or forecasted economic evaluation.

Over the past 15 years, the term "business model" has become more common. Business models paved the way for new business concepts, but they also stimulated the transformation of available businesses. Business models also influence various areas at the research level, such as information systems management or technology management. Today, the term can be used to denote several things that are a source of confusion. Thus, a business model can denote a real attribute of a company, a cognitive scheme, or a conceptual representation of

an activity (Dirican, 2015; Metelenko et al., 2019). In addition to these ontological issues, in our opinion, depending on the context, the business model may indicate a concept, boundaries, or the company's new view and its commercial efficiency. Thus, the perspective expanded in strategy leading to so-called "business model thinking".

Figure 2

The company's roadmap model for developing a digital leadership strategy




*Source: Author's own visualisation.*

Valuation becomes a vital part of the business model. For companies, one can identify three main ways to create business value:

1) more efficient resources to reach maximum effect;

2) more efficient end customers in the value chain are better;

3) new business models create sustainable value.

According to Bayer et al. (2020), the cost proposal is essentially a positioning declaration explaining the benefits provided, for whom, and how to do it exceptionally well. Gawer & Cusumano (2014) note that the cost proposal describes the target customer profile, the

problem to be solved, and why the company will be significantly better than available alternatives. To create a value proposition, it is proposed to implement four steps at the corporate level: 1) defining the tasks to understand whether they should be solved; 2) assessing the problem(s): is the solution to the problem viable? Is this an urgent problem? Is it immediate, covert, or critical? Does this allow open space opportunity (niche); 3) measurement: the rationale is to measure profits, compared to costs, i.e., to attract technologies that offer benefits with minimal change for available processes or environments; 4) creating a value proposition: after passing the stages of definition, evaluation and measurement, the company is ready to formulate its value proposition. Thus, one can form a conceptual idea of the digital business model's elements (Table 2).

Table 2

Components of the company's digital business model

| Components | Component element |
|---|---|
| Value | Achieving the company's development goals |
| Results | Key performance indicators of the company considering the digital transformation directions |
| Key processes | Big Data, consumer preferences based on digital platform data analytics |
| Key resources | Human potential, access to technology, information |
| Key trends | Technological trends along with business digital transformation considering the potential risks of expansion and implementation |

*Source: Bayer et al. (2020).*

Digital innovators can base their value proposition on when implementing additional marketing channels. The Internet and related networks are the main, but not the only, channels for customers. Additional channels expand market access, make products and services more accessible and create added value for customers.

### *4.3. Service model and digitalisation at the company strategy level*

Nowadays, many traditional companies seek to supplement their offerings with various services, a process commonly referred to as "service". Digitalisation is becoming a key factor for service n, as digital technologies ease to connect products, services, processes, and systems, and today the production of many products without proper servicing is almost impossible. Information technology is becoming an integral part of many products. The obtained data can improve the product's functionality or increase productivity in other parts of the value chain. As mentioned, the company's preparation for digital transformation requires many complex changes and affects almost the entire management structure and the applied business models. The adaptation stage is considered the most important in digital transformation at the company level.

Service leads to higher productivity, but the combination of service and digitalisation leads the company to two strategic challenges. On the one hand, there is a need to adapt the platforms that can or offer to implement a service approach within production; on the other hand, it is necessary to assess how the current corporate business model is evolving. The above leads to two interrelated directions of adaptation processes of the company's strategies to the service concept: 1) production organisation of "product-service" complexes based on

traditional industrial companies, and 2) change of business model considering platform potential (Constantinidies et al., 2018; Velychko et al. 2019).

"Service", in our opinion, is a concept that says that the companies that produce marketable products increase the services share provided to consumers, and digitalisation becomes an external environment that implements the service strategy. The main problem, in our opinion, is that not all companies understand the importance of progressive changes in the business model before the implementation of changes in digital production support. Thus, the key task of adapting the company to service should be developing practical recommendations based on the relationship among service, platforms, and business models. Directions of service can be systematised as follows:

- comprehensive offers (product plus service);
- considering the consumer's needs that leads to increased customer loyalty and increase the period of cooperation with customers;
- the combination of "product plus service" creates great value increasing the manufacturer's share in the overall value chain;
- strengthening the manufacturer's competitive position due to the integrated offer, which is especially evident in the service of products with a longer service life;
- continuation of interaction with a customer by production update (replacement by more modern model) at service unity;
- continuing the interaction with a customer by expanding the range of products from one manufacturer with the service unity;
- cash flow stability in the economic dynamics due to continued service.

The services offered in the market can range from fairly simple, like training or basic services for available products, to very advanced, such as when customers no longer buy a real product but pay for the result that creates such a product. To create and provide various services, companies need a set of opportunities that correspond to the new cost situation.

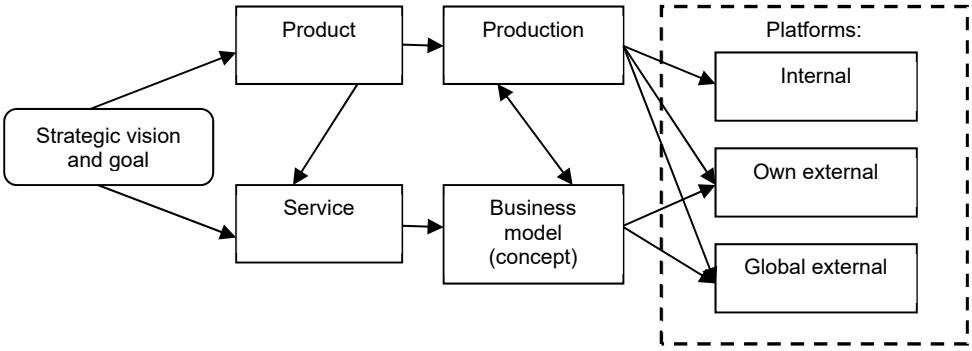
Digitalisation is a key factor in creating services because it allows more complex services to ensure their automatic continuation and succession. Today, the most progressive (and recognised) way to sell services is a platform that provides services, already determining the necessary set of goods that can create new services or ensure succession (Spulber, 2019). The value of the services created by the platforms can exceed available sales opportunities of goods from one manufacturer and provide, under the guise of one service sales of many products from different manufacturers when cooperation becomes digital (Makedon et al., 2020). There is no doubt that all available companies use any business model that is an idea of how value is created, delivered to the consumer, and returned (as part of the value created) as a profit within the cash flow generation.

Another strategic problem is that companies implementing a service strategy must engage in both service and technological innovation. This dilemma leads to private problems implementing a new business model, which manufacturers refuse to accept with the

subsequent risk of increased costs and lack of synergies. The identified dilemma is the key to the organisational support of the digital business model (Stallkamp & Schotter, 2019). Digital service platforms begin to dominate the pressure on the manufacturer, monopolising the market information, while platform information can stimulate the development of new service offerings and limit them. Companies are forced, in the absence of their own platform, to use market information only provided by the platform. In this regard, there is an essential thesis that industrial companies should implement a mixed strategy (Figure 3).

Figure 3

The dilemma of production and business models of a company within digitalisation



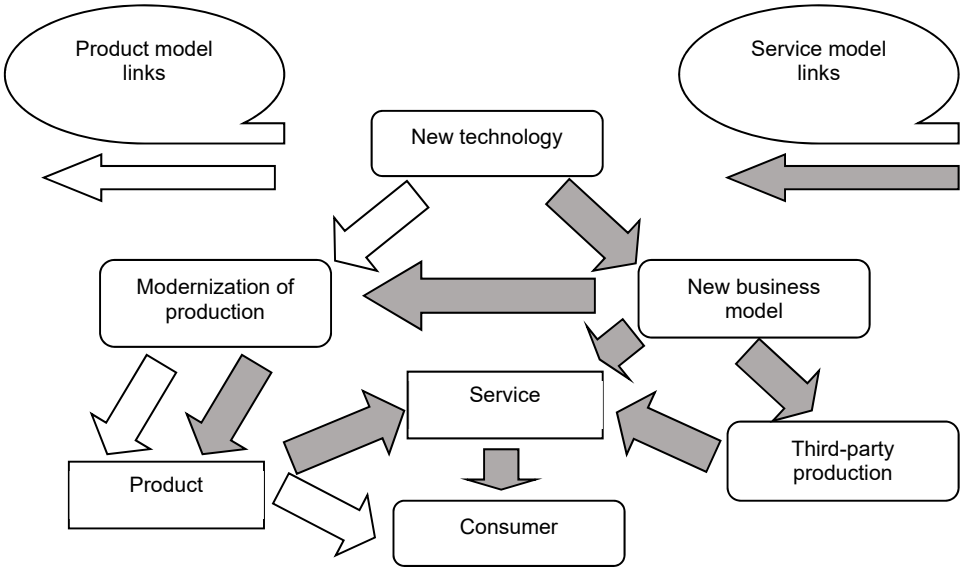

*Source: Author's own visualisation.*

- develop internal platforms to ensure demanded diversity and product renewal;
- develop own external platforms for obtaining reliable market information;
- work with global digital platforms to maintain a competitive advantage in global markets.

In order to build a service platform, companies need to understand how to adapt production to a new strategy and how to manage a new business model for the development of digital platforms (Zhang et al., 2021). While platforms are generally well-known among product strategy-focused vendors, procedures for adapting to service strategies need to be addressed. The fundamental difficulty is the traditional thinking about used business models that requires additional efforts for their reorientation. The importance of including the contours of the future business model is well established in marketing; the triple model (new technologies, new service format, and new business model) requires consideration (Figure 4).

The most important issue is that the early assessment of the new platform business model presented in Figure 4. is essential for deciding on the right volumes and focusing on functionality that delivers value to customers. The coloured arrows show a direct and undeniable causal effect. The uncoloured arrows show a possible or additional (tangent) influence that improves the consequential position, but is not decisive or leading. This type of graphic modelling of the interaction of the transition from the product model to the service model in the activities of the corporation makes it possible to show all the variations and projections of the interaction of the service and product components in a certain strategy.

Figure 4
Changing interaction in the transition from product to service model in companies




*Source: Author's own visualisation.*

According to the business model early assessment, it is necessary to start with a minimum viable platform, which focuses only on the most important part of the platform. In our opinion, this statement is partly contrary to the logic of top-down design used in the centralisation of platform sales, but there is a platforms' conservatism. It is worth noting that available business models seek to limit any change, requiring certain measures to destroy. Such destruction of the current production process and sales model can occur only within the initiative (often entrepreneurial) or a significant local crisis (Ezrchi, Stucke, 2016; Goldfarb, Tucker, 2019).

According to the theory (Thoben et al., 2017), for companies that prefer available market offers, it is difficult to create fundamentally new business models. That points to a paradoxical situation that requires new organisational mechanisms that provide both sufficient autonomy to create new business models and a way to ensure implementation (Williams et al., 2019). Possible organisational decisions can be systematised into four types of strategic adaptation projects of the service model within the company:

1. Initiative ("Type I"), within one unit (available, newly created, or invited external team) based on the idea of one or more initiators who are directly involved in the provision of the services;
2. Initiative plus functional ("Type F"), when at the initiative of external suppliers, the developed concept is implemented in several divisions of a company, usually related to sales;

3. Logistics ("Type L") with the principles of product sharing economics, both in warehouses and in individual consumers. This project type is virtually independent of the main business process and can be launched both inside and outside the company, using only access to resources (finished products and logistics);
4. Multiplatform ("Type M"), fully focused on customer needs and allowed integrating both own business processes and third-party suppliers.

Some initiative project types contribute to operational excellence in after-sales service and services delivery with digital sources. Such digital platforms may be needed to support services, not create new value. In addition, such a platform may be linked to the internal organisation of control over the services provision. Nevertheless, this type of platform and solution occurs only in the secondary market, when buyers' contacts purchase the product.

The multiplatform project type is the most advanced but also the most expensive solution. The cost recovery for such a project, and its success, is not obvious at the initial stage, unlike the first three types of projects. However, in the end, that type of project is a manifestation of the digital economy, which is said to be "the winner gets everything" if the market recognises it. A key feature (distinction) of such projects is connecting different data sources, reusing information, sharing components, and helping integrate information into new solutions. Analysing the four types of projects, one can conclude that those can become the core of the practical strategic adaptation of service for a company, considering the possibilities of the corporate cooperation concept.

One of the key findings is that early cost assessment increases by incorporating features into the business model (before production changes) is crucial. Moreover, the consistent build-up (from Type I to Type M) suggests that a minimally operational platform can yield more results than expecting the most efficient platform, provided there is enough time to create a Type I project. Nevertheless, it is notable that minimalism provides efficiency but limits the completeness of new transformations. The advantage of Type F projects is that they create new business opportunities supported by digital product platforms using a separate business development feature. It is worth noting that those remain conservative for the idea of early integration into a single platform.

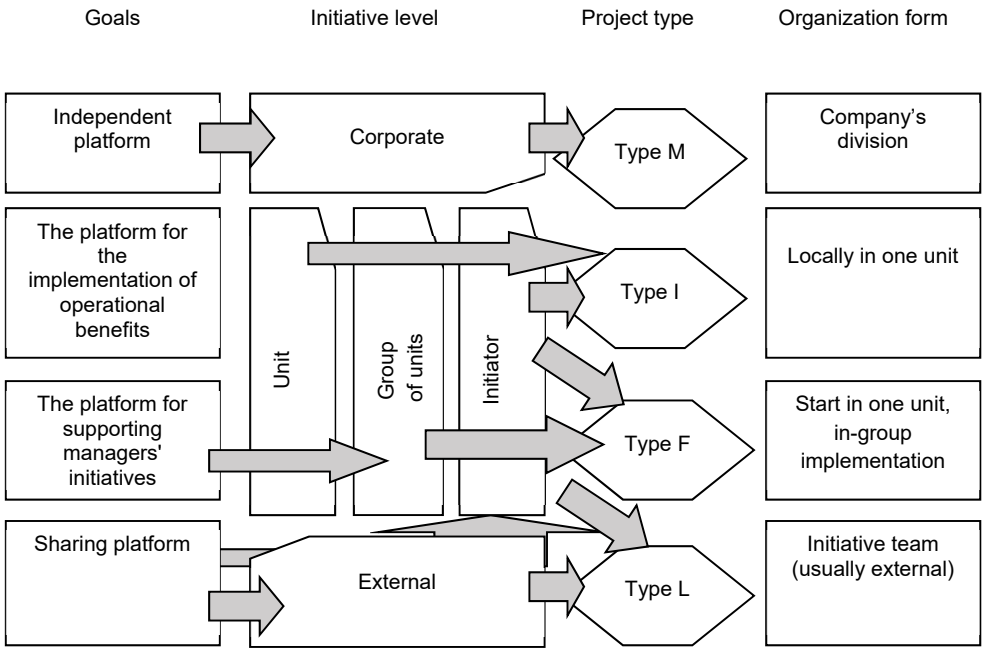
There is no doubt that Type I and Type F projects cannot be implemented without entrepreneurial initiative. Such a necessity at the initial stage is caused not just by the company's internal process or management level. Therefore, for companies, focused on product strategies (and relevant platforms), it is necessary to recommend such organisational forms where the inherited strategic approach can coexist with a more independent entrepreneurial spirit. From our perspective, the companies need "diversity and order in their strategic activities to maintain their viability" and use a corporate entrepreneurship model whereby autonomous strategic behaviour can coexist with more traditional strategic behaviour (Thun, Sturgeon, 2019).

The contradictions between the Type L and Type M projects are radical because, in the first case, the business model initiative does not affect production, and in the other, it is its element. On the other hand, for Type I and Type F projects, the potential synergy between old and new in the company will not be realised, but instead, the need to create the right

conditions for new product offerings increases. Those conclusions allow recommending the following: if resources are available, the Type L project can be a different business solution while implementing another project or running independently. Figure 5 demonstrates the process of arranging the selection of projects focused on the company's service strategy.

Figure 5

The arrangement model of a projects' choice focused on the strategy of the company's digital servicing




*Source: Author's own visualisation.*

In general, the sequence of actions for companies to adapt the service strategy can be presented by the following sequence: 1) results from analysis of digital maturity assessment and conclusions on the readiness of: a) individual units, b) entire corporation, c) interaction with the external environment; 2) choice of leadership strategy; 3) justification of the need for product servicing (as a minimum service level); 4) justification of the need to refuse to purchase and the possibility of purchasing a service (as a higher service level); 5) determining the possibility of cooperation with competitors based on the service platform; 6) assessment of changes in the business model; 7) choosing the type of service platform implementation project; 8) substantiation of organisational forms; 9) integration into a single system of implemented projects.

The proposed sequence of actions indicates the areas where companies should contribute to the strategic adaptation of service platforms. The proposed solutions indicate the areas where

companies should potentially contribute to the advent of new strategic opportunities based on the adjustment of the chosen leadership strategy. Thus, in our opinion, the basic service strategy should be the minimum possible platforms open to further complication and expansion (projects such as "Type I" and "Type L"), despite the attractiveness of multiplatform solutions. At the same time, the projects' implementation should begin with the search for a new business model, rather than the digitalisation of relationships, confirming that their business models correspond to the platform's development, including integration of their platform or the platforms with current business operations. In the future, after implementing platform projects, the company may consider an alternative to creating an ecosystem (mini-ecosystem) or a global system.

## 5. Discussion

As a point of discussion, it is hypothesised a change in all strategy elements in the "digital arena", namely that a new reality surrounds companies – a new business environment, and rapid changes in a digital approach to the environment, abandonment of understanding the environment and the transition to environmental design within the ecosystem. Considering a new view of the environment when adaptation to it is replaced by the interaction design in the digital business environment.

Modern corporations have to choose between the well-known classical set of strategic methods and the digital pressure that is increasingly exerting on business, including state funds. At the same time, the choice of approaches to the formation of strategies has a significant effect on their quality and compliance with the processes taking place, which in turn will affect the results of economic activity. First of all, it is necessary to talk about the change in the strategic corporate landscape and the need to take into account those changes that have arisen in the course of digital development. As it was shown in the literature review, we consider the evolution of development strategies, there have been changes both in the elements of the strategic model and in the methods of tying the elements into a single structure. When solving this task, it turned out to be very important to identify an effective, not theorised, strategic model, on the basis of which the design of strategic relations for a corporation in the digital era is possible. As the analysis showed, two key approaches were formed that confirmed their effectiveness: structural, based on the structure of competitive relations in market segments (sectors) or in industry in general, and resource-based, based on strategic opportunities.

In the digital environment, the strategy development process begins with the business model's effectiveness analysis (as opposed to classical environmental analysis), as the basic blocks of the strategy can choose value chain participants and end with the design of their own environment in a classical approach). We believe that the new in digital leadership strategy is the abandonment of the process of searching for one optimal solution and the transition to broad modelling of market behaviour using digital technologies. Furthermore, the main focus of digitalisation in the near future will be manufacturing companies, while so far, the leaders are info-communication and trading companies (although it is assumed that digital technologies in the public sector may be given priority).

## 6. Conclusions

The paper highlights that competitive advantage in the digital economy is a business model based on the proposition that strategy creates a competitive advantage. It is proved that companies form the potential value of new technologies and digital transformations that they need to implement but cannot instantly transform the business model. The business model of a company becomes an essential reflection of production communication as a relationship among all participants in making a profit.

It was substantiated that the formation of the company's business model is inextricably linked with customer-oriented management based on the interaction of platforms (internal and external). It is shown that platforms are heterogeneous in their structure, and within the strategic choice, one can use several types of platforms (from product to sharing, from knowledge transfer to joint design). Understanding the properties of the business model allows concluding that in the rapid growth of new technologies, horizontal integration strategies (value chains) are preferred. The greatest advantage is given to those companies that can combine digital cooperation within ecosystems with the sincerity of their intentions. At the same time, there will remain vertically integrated companies as those will stimulate the creation of ecosystems to maintain their leadership in the future.

It was shown that evaluating the possibility of creating value for the transition to digital strategy, after analysing the new business environment, understanding competitive advantages, assessing the prospects of customer management, and finding the relationship between cooperation and collaboration, the company must begin to implement a digital strategy, solving three main tasks: 1) assessment of digital maturity; 2) development of a roadmap for leadership strategies; 3) justification of a set of projects to achieve the strategy.

The interaction "business model-ecosystem" concept was developed that defines the main features of the strategy and sets the direction of its development, which is reflected in the developed roadmap for digital leadership strategy and systematisation of the stages sequence of digital strategy and its key elements. It is determined that the most valuable proposal and the most effective business model is service, i.e. the services provision instead of product consumption.

It was demonstrated that the prospect of developing the proposed methods of strategy formation (including digital maturity assessment, development of a roadmap of digital leadership strategy, and formation of a set of projects based on competitive advantage as a service) is an economic evaluation of strategies. Strategies effectiveness assessment should be performed only after the approaches' practical implementation, especially within the interaction "business model-ecosystem". However, methodologically, that assessment should form the ability to measure control in the value chain based on the evidence that the interaction is built on the impact of each participant in the value chain and the success of such impact directly in the business model.

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# INFLATION, INFLATION INSTABILITY AND NOMINAL UNCERTAINTY IN THE BULGARIAN ECONOMY[3]

*The main goal of the paper is to assess the relationship between inflation, inflation instability and nominal uncertainty in the Bulgarian economy in January 2000 – May 2022. Employing the ARCH model, GARCH-M model, EGARCH model and Granger Causality Test we find a two-way causal relationship between inflation and inflation instability. Initially, inflation provokes inflation instability, and inflation instability provokes inflation consequently. Nominal uncertainty is measured by wavelet analysis, which establishes the presence of nominal uncertainty in the Bulgarian economy. Therefore, at certain lags, the inflation instability is transformed into nominal uncertainty. The empirical evidence raises the question of the effectiveness of the Currency Board Arrangements in Bulgaria.*
*Keywords: inflation; inflation instability; nominal uncertainty*
*JEL: E31; C22; C52*

## Introduction

The monetary shocks in the Bulgarian economy in 1997 led to the introduction of currency board arrangements, the main objective of which was to achieve price stability. This has meant a stable inflation process and the prevention of inflationary instability and nominal uncertainty. Inflationary instability and nominal uncertainty should not be induced under a currency board, as traditional monetary policy cannot be pursued. Therefore, the study of the relationship between inflation, inflation instability and nominal uncertainty in the Bulgarian economy under the currency board arrangements is an important and topical macroeconomic issue. Particularly, the importance of inflation instability and nominal uncertainty raises since the inflation in the global, European and Bulgarian economy has started to increase at a very

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fast pace at the end of 2021. The importance of this issue increases, especially for the Bulgarian economy, as in late 2021 and early 2022, the monthly inflation rate in Bulgaria was among the highest in the EU.

The main objective of the paper is to assess the relationship between inflation, inflation instability and nominal uncertainty in the Bulgarian economy. The relationship between inflation and inflation instability is assessed using a four-stage model that includes ARCH methodology, GARCH-M model, EGARCH model and Granger causality test. Thus, the four-stage model constructed using these technical tools provides one of the most reliable estimates of the direction and strength of the relationship between inflation and inflation instability over time. The relationship between inflation instability and nominal uncertainty is estimated by wavelet analysis. The conditional estimation of nominal uncertainty is done by a synthesis of the fractal approach and a priori structuring. A certain abstraction is introduced to represent nominal uncertainty as a hidden signal from the standard deviation noise of inflation, and hence the relationship between inflation, inflation instability and nominal uncertainty.

The basic view is that the relationship between inflation and inflation instability in the Bulgarian economy is bidirectional, i.e. in one lag inflation leads to inflation instability, and in another lag inflation instability leads to inflation. The very fact that such a bidirectional causality is found leads to the conclusion that nominal uncertainty is also reproduced as a consequence of inflationary instability.

Section one critically outlines the main theoretical and empirical approaches to measuring the relationship between inflation and inflation instability. The theoretical concept of the nominal uncertainty measurement approach is also presented.

In the second section, econometric methods for estimating the relationship between inflation, inflation instability and nominal uncertainty are reviewed and discussed, as well as the specifics of the used data and methods for assessing the adequacy of the econometric models employed.

The third section discusses and analyses the empirical results of the estimations of the relationship between inflation, inflation instability and nominal uncertainty.

## Literature Review

The relationship between inflation and inflation instability is first considered by J. Tobin (1965), who found that price volatility affects asset returns. Therefore, the amplitude and the speed of the transition of prices from an inflation trajectory to a deflation trajectory and vice versa create inflation instability. Thus, Tobin manages to bring out the invisible relationship between inflation and inflation instability. A. Okun (1971) adopts Tobin's view that inflation leads to inflation instability. However, based on the understanding that inflation cannot increase over a long period in a stable trajectory, he postulates that in the long run prices always show volatility, which leads to inflation instability. The difference in Tobin's and Okun's views lies in the fact that Okun manages to point out that regardless of the amplitude, inflation increases permanently, and this increase is associated with inflation instability

measured by standard deviation. On the other hand, according to Tobin, inflation instability manifests in cases where the inflation change is abrupt.

The relationship between inflation and inflation instability is also found in M. Friedman (1977), who theoretically reasons the relationship between inflation and inflation variability, manifested in the presence of an average increase in inflation values. The new contribution of Friedman to the theory of inflation instability is the notion that the current values of inflation instability are determined by past values of inflation volatility. This is how Friedman's view builds on the theoretical views of Tobin and Okun. Friedman points out also that the inflation increase is, in many cases, due to monetary policy. Therefore, the monetary policy, if conducted ineffectively, also provokes inflation instability.

Okun's view that the standard deviation of inflation means inflation instability leads E. Foster (1978) to formulate inflation instability as a variable inflation rate expressed as price instability. Therefore, according to Foster, the faster the volatility increases as inflation rises, the greater the inflation instability is reproduced. In fact, with this logic, Foster does not further develop Okun's theoretical views, but stands on his theoretical positions. Even Foster adopts from Okun the variable by which inflation instability is measured, namely the standard deviation.

The views of Friedman and Tobin are found in the theoretical position of L. Ball (1992), who, with his statement that inflation instability occurs both in an inflation process and in a deflation process, starts from Tobin's position and further develops it. Ball also adopts Friedman's view that the conduct of monetary policy can lead to inflation and inflation instability when the monetary policy is subordinated to political rather than economic goals. Expanding on Friedman's view, Ball argues that the lack of predictability in the conduct of future monetary policy leads to future inflation instability.

J. Tobin (1965), A. Okun (1971), M. Friedman (1977), E. Foster (1978) and L. Ball (1992) consider the inflation instability metaphysically and fail to understand its essence, and therefore fail to show the elements the inflation instability creates. They do not understand that inflation instability is divided into measurable inflation instability and unmeasurable inflation instability. Measurable inflation instability takes the form of risk that can change the expectations and decisions of the economic agents. Unmeasurable inflation instability contains an unpredictable random element that can be defined as nominal uncertainty. According to Okun, measurable inflation instability can be measured as the standard deviation of the inflation growth rate. This idea is applied by Foster, who concludes that the results show a good approximation of the proximal expression of inflation instability. Okun's approach, through which he expresses the instability that arises from inflation, is adopted by many authors, like D. Logue and R. Sweeney (1981), who attempt to practically assess inflation instability. They derive the instability from the average inflation rate relative to the standard deviation of the rate of inflation. On the other hand, however, Logue and Sweeney criticise Okun by pointing out that his approach covers only the current inflation instability, not the future one. In fact, the critical view of Logue and Sweeney is sound, but on the other hand, practical forecasting of future inflation instability is difficult to realise, because the probability of the statistical adequacy of possible forecast values of the future inflation instability will very likely be some mathematical approximation rather than accurate forecast number. Another critical point revealed in Okun's methodology is the definite static nature

of the method, which does not cover well the change of inflation instability over time. The static Okun's approach arises as a consequence of its technical application, which is based on the method of overlapping moving averages. G. Katsimbris (1985) attempts to solve this problem with the technical application of Okun's approach by replacing the overlapping moving averages with moving average proxy variables that express inflation and its variance. Despite this technical change, Katsimbris fails to measure future inflation instability because he fails to distinguish future inflation instability from possible predictable changes in the inflation dynamics (Jansen, 1989). According to Jansen, it is precisely the failure to cover the parameters of inflation variation over time that is the main problem with the methodology of Katsimbris. For this reason, Jansen adopts the Katsimbris methodology, but he employs an ARCH model. Thus, he manages to assess the parameters of the consequences of the mean variance on inflation and economic growth.

Some weaknesses are found in the methodologies of A. Okun (1971), E. Foster (1978), D. Logue, R. Sweeney (1981). They fail to cover the great probability of inflation instability and also they failed to provide an empirical assessment of the nominal uncertainty. Okun, Foster, Logue, Sweeney and Katsimbris do not reflect the change in the inflation instability over time. The problem of assessing the inflation instability with a greater probability approximation to the real inflation instability is addressed by D. Jansen (1989). Through the application of the ARCH model, he manages to assess the inflation instability as a conditional inflation variance over time. However, Jansen makes no attempt to calculate the nominal uncertainty at all.

Samut (2014) assesses the two-way effects between inflation instability and the different components of the price level through the ARCH model and then applies Granger causality tests and Impulse response analysis. The ARCH methodology, though allowing the conditional variance to depend on its historical values, i.e. covers the inflation instability over time, does not provide accurate parameters if the rate of change of the inflation instability is faster than the model predicts. Also, if the parameters are too much, the assessment procedure becomes difficult and gives an inaccurate direction for the development of the ARCH coefficients. This does not lead to the rejection of the application of ARCH. On the contrary, its use is recommended, but in combination with the GARCH methodology. That is why authors such as Grier and Perry (2000) state that in order to assess the inflation instability with a higher probability of approximation, the time-varying residual variance that captures the essential characteristics of the instability should be assessed. This is possible with the application of the GARCH methodology.

Karahan (2012) applies a similar approach when he studies the relationship between inflation and instability in Turkey. The author expresses the instability quantitatively by the conditional variance of the inflation mean. The relationship between inflation and instability is studied with a general ARMA-GARCH model, which means that instability takes the form of conditional volatility. In fact, Karahan empirically proves the conclusion of Ball (1992) that an increase in inflation leads to an increase in instability (Karahan, 2012, p. 227). Sharaf (2015) also assesses the instability as a conditional variance calculated through the GARCH-M model. He comes to the conclusion that under inflation shocks, instability increases and the increase is on a sustainable trend. Authors like Fountas and Karanasos (2007) assess the instability by the conditional variance of inflation. This means that the residual information

from the inflation process should be covered, so the autoregressive conditional heteroskedasticity to be calculated. The procedure for calculating the autoregressive conditional heteroskedasticity is implemented through the GARCH model.

Fountas and Karanasos raise the important question of determining the type of instability. According to them, instability can be anything but nominal, i.e. to result from inflation, it can also be real, i.e. the instability to arise from real factors. The study of Viorica, Jemna, Pintilescu and Asandului (2014) is interesting. They measure the inflation instability with four models, which are the ARCH model, GARCH model, EGARCH model and PARCH model. The instability is again considered a conditional variance. The authors analyse the relationship between inflation and instability in the case of Bulgaria, Poland, Croatia, Czech Republic, Romania, Hungary, Slovenia, Malta, Latvia, Slovakia, Lithuania, Romania. Apergis (2005) also explores the relationship between inflation and instability, by covering the instability through the GARCH model. The conclusion of the author is that the rate of inflation in the short run creates instability. According to Apergis, shocks that create instability do not lead to large negative effects, i.e. the duration and the degree of the instability are not in threatening proportions to the economic growth and pass quickly. Similar to Apergis (2005), N. Ananzeh (2015) also studies inflation instability through the GARCH model.

Mandeya and Ho (2021) consider the inflation instability as a percentage change in the standard deviation of inflation. Considering this approach to express the inflation instability, the authors take a step back in the possibility to accurately determine the inflation instability, since they measure the instability when the inflation process has already occurred. Mandeya and Ho study the impact of inflation instability on the economic growth of South Africa through assessment of autoregressive distributed lag. They conclude that instability affects economic growth in the short run, while inflation affects economic growth both in the short run and long run. Another important conclusion that Mandeya and Ho draw is that the implementation of inflation targeting leads to ignoring the instability as a factor that negatively affects economic growth.

Golob (1994) studies the dynamics of instability and inflation and concludes that an increase in inflation leads to an increase in instability. That is why, an inflation-targeting policy should be implemented to manage the inflation process and to lead to price stability. Otherwise, the rising instability as a consequence of the rising inflation will have a negative impact on both the nominal and the real economic variables. Terzioğlu (2017) goes even further by arguing that inflation instability confuses and unbalances the distribution function of the price system, which has an adverse effect on the allocation of resources. It becomes clear that inflation instability actually leads to information asymmetry, which in turn leads to false price signals, which lead to irrationality in the allocation of resources. The described process leads to the spillover of instability into uncertainty.

Berger, Grabert and Kempa (2017) study the global macroeconomic instability. The authors use a dynamic factor model, through which they derive the instability as stochastic volatility of the conditional variations of the variables included in the model. The main conclusion of Berger, Grabert and Kempa is that instability negatively affects the economic growth.

In the discussed literature, the instability is measured by conditional variance. According to Jurado, Ludvigson and Ng (2015), deriving the conditional variance from stock exchange index returns or returns of the different stocks does not provide accurate information about the effect of the instability. The authors claims that the instability cannot be accurately measured by the proxy variables because there is heterogeneity in the conditional variance that arises from the cross-section that characterises the variance in returns of all financial assets in the stock market (Jurado et al., 2015). Jurado, Ludvigson and Ng separate the instability from the conditional volatility. That is why they remove the predictable component in the calculation of the conditional volatility, which means that the constant average is removed because it is, in fact, the predictable component. According to the authors, another important element in the study of instability is that the instability requires an aggregate consideration of the variation. Therefore, according to Jurado, Ludvigson and Ng, deriving the unpredictable aggregate element of the aggregate conditional variance is a more accurate assessment of the instability. In the sense of Jurado, Ludvigson and Ng, instability is actually described as the conditional variability of the unpredictable element in the future value of the considered series (Jurado et al., 2015, pp. 1178-1179).

Authors such as Fountas and Karanasos, Karahan, Golob, Berger, Grabert, Kempa, Jurado, Ludvigson and Ng, as well as the other mentioned researchers, do not cover the exogenous variations of the instability. That is why, Piffer and Podstawski (2018) conduct a study that focuses on the exogenous variations of the instability. Piffer and Podstawski technically parameterise the effects of the exogenous variations of the instability with the SVAR model that is applied one time with recursive technology and a second time with proxy specialisation. According to them, the SVAR technology provides a broader and deeper explanation of the exogenous variations of the instability, because the variances of the real variables are better specified. Piffer and Podstawski study real instability, not inflation instability, because ARCH and GARCH methodologies are more suitable for the study of inflation instability. In the study of instability Bloom (2009) applies the VAR methodology. Redl (2017) assume that the instability is the conditional expectation in the time of the squared error of the forecast, which means that the instability is considered variable in the conditions of a stochastic process. That is why he applies the FAVAR model. The study of Bobasu, Geis, Quaglietti and Ricci (2021) synthesises the approaches of Piffer and Podstawski and Jurado, Ludvigson and Ng, as well as Bloom and Redl, and further develop them by constructing a model that assesses the effect of the global macroeconomic instability in the euro area. The author's conclusion is that global macroeconomic instability has a negative impact on the economy of the euro area. Nenovsky, N. et al. (2000) quantitatively measure, by means of a VAR model, the behaviour of inflation under Currency Board Arrangements and come to the conclusion that the rise in the prices of traded goods and real wages are the main inflation factors.

Apart from ARCH methodology, GARCH methodology and VAR methodology and their methodological variants, authors such as Shelton Masimba, Tafadzwa Mandeya and Sin-Yu Ho (2021) apply ARDL methodology to study inflation and inflation instability and their effect on the GDP of South Africa. Despite the large set of econometric instruments applied in the assessment of inflation instability, the best methods are ARCH methodology and GARCH methodology, which allow the inflation instability can be covered most precisely. The variations of GARCH methodology like EGARCH and GARCH models-M model with

a high probability provide credible assessments of the inflation instability. The reason is that ARCH methodology and GARCH methodology best capture the conditional variance, which effectively expresses inflation instability.

Cukierman and Meltzer (1986) derive the instability from the relationship between the response that the economic agents reproduce as a result of the political dynamics. According to Cukierman and Meltzer, instability is a consequence of the uncertainty of political decisions. According to Grier and Perry (2000), the definition of instability derived by Cukierman and Meltzer is characterised as an unpredictable component. Also, Grier and Perry distinguish the variability from the instability because the variability can be predictable while the instability is unpredictable. Therefore, for them, the instability borders on uncertainty.

Cukierman and Meltzer as well as Grier and Perry provide guidance on how the uncertainty can be defined, namely as an unpredictable random event in the setting of a stochastic process. This unpredictable random event is a component of inflation instability and of instability in general, regardless of its dimensions and areas of manifestations.

According to Wiliett ((1951),1901), the instability contains risk. A risk is a random event that has a probability of happening, and when the risk is "hardened", then the given probability will necessarily happen sometime. The fact that the risk will ever happen is a measurable instability, and exactly when it will happen is an unmeasurable instability or uncertainty. That is why, according to Knight (1964), Willett distinguishes between instability and risk, but fails to understand that the uncertainty cannot be quantified through the mathematical parameterisation of the probability of loss. It becomes clear that the instability is a phenomenon that, in the sense of Knight (1964), contains both a risk factor and an element of uncertainty, i.e., uncertainty is a complex composite phenomenon. The element of uncertainty manifests as a random element in the process of developing the instability. This perspective leads Knight to the understanding that uncertainty as a random element of instability cannot be fully expressed through the mathematical theory of probabilities, which parametrises the chance of developing one or another event. In fact, Knight separates the risk from the uncertainty and from the instability, because the instability contains both risk and uncertainty. Uncertainty arises from the free action and ability of a person to make decisions that cannot be covered by the mathematical apparatus. Knight states that the Monte Carlo method is incapable of predicting uncertainty (Knight, 1964, p. 221). The view developed by Knight and Willett that uncertainty arises from human imperfection in making decisions about the future, is also adopted by Mises (1998). He claims that uncertainty appears in the future as a consequence of human action, i.e. the human action is seen as an imperfection of the cognitive and information capacity available to the person. Therefore, the human choice, which is transformed into a future action and future uncertainty, is inextricably linked, according to Mises. The mathematical instruments cannot calculate correctly the probability of whether an event will occur because, as Mises (1998, p. 107) argues, the probability does not always have a frequency characteristic. This means that the probability cannot always be assumed to take the form of a constant event. Mises writes: *"It is a serious mistake to believe that the calculus of probability provides the gambler with any information which could remove or lessen the risk of gambling."* (Mises, 1998, p. 108).

The conclusion from the mentioned quote is that mathematics and even physics, which further develops the mathematical instruments, cannot predict and measure the uncertainty, because in uncertainty there is a synthesis between the unknown and the chance in the future time.

The analysed views of Wiliett, Knight and Mises have their logic which is difficult to be disputed, because the uncertainty in its factual dimensions cannot be assessed accurately. Also, there is no generally accepted definition of uncertainty in economic theory. Therefore, assuming that uncertainty is an unknown random process in the future whose frequency and magnitude cannot be determined, the views of Wiliett, Knight, and Mises that even the physics cannot study future uncertainty are inevitably confirmed. However, in this paper, a part of the goal set is to study the nominal uncertainty. That is why, in order to achieve the goal, a fractal approach and a priori structuring of the uncertainty will be applied (Gradinorov, 2019). A part of the nominal uncertainty will be studied, which will allow extracting information that falls within a strong information interval and will inform the whole process of the nominal uncertainty. The fractal approach is synthesised with a priori nominal uncertainty, which means that certain information criteria will be isolated so to allow elements of the random, unpredictable process expressing the nominal uncertainty to be covered.

Uncertainty can be described by Heisenberg's mathematical equation (Soloviev, Saptsin, 2011):

$$\Delta x \times \Delta v \geq \frac{\hbar}{2m_0} \tag{1}$$

where:

$\Delta x$ and $\Delta v$ are squared deviations from the mean;

$\hbar$ – Planck's constant;

$m_0$ – particle in a mass.

Equation (1) expresses the root mean square deviations of the allocation (location) of *x* and the impulse speed *v* corresponding to a particle of the total mass at rest $m_0$. So, equation (1) illustrates that the product of the location and speed of the impulse forms a particle of the mass of the uncertainty and carries information that indicates the purity and the scale of the uncertainty at a given time. Placing the Heisenberg equation (1) within the framework of the fractal approach and a priori structuring of the uncertainty, and assuming that *x* is the scale and *v* is the frequency and that their interaction is cut in time and space when nominal uncertainty occurs, with certain conventionality a part of this nominal uncertainty can be measured, and the probability of estimating the part of the nominal uncertainty may be significant. It is important to say that when measuring the part of the nominal uncertainty, the already realised values of nominal uncertainty but not the future values of nominal uncertainty are covered.

In order to describe the nominal uncertainty under a given economic system, we made some assumptions in equation (1). It is assumed that a stochastic process is observed, which moves along a given trajectory and is manifested by a dummy variable that registers a certain scale and a certain purity in a certain time period. The scale registers the value of the root mean square deviations, and the frequency registers how many times in the time period and at what rate the root mean square deviations are registered. The dummy variable that illustrates the stochastic process and its manifestations over time, which include the interaction between the scale and the frequency of manifestation of the square deviations, manifested by chaotic volatility and returns, can be expressed by the following formula (Soloviev, Saptsin, 2011):

$$\Delta x_i \times \Delta v_i \sim \frac{h}{m_i} \tag{2}$$

Equation (2) on its left side illustrates the nominal uncertainty, and on its right side illustrates the time and its characteristics over the considered stochastic process.

The uncertainty described by equations (1) and (2) shows that the assessment of the nominal uncertainty can be realised if the parameters scale, frequency and time are simultaneously taken into account. This can be realised by applying the physico-economic instruments of the wavelet analysis. It is wavelet analysis that manages to simultaneously cover scale, frequency and time (Rua, 2012), i.e. it is possible to assess simultaneously, and with great accuracy, the frequency and the time of manifestation of the hidden signal which is the nominal uncertainty. Wavelet analysis allows flexible and adequate resolution of the frequencies and the time of occurrence of the signal (Rua, 2012). In wavelet analysis, the duration of time is tuned to purity, and each point contains all frequencies for the time window it falls into (Rua, 2012). This allows to extract the hidden random signals that express particles of the nominal uncertainty during the given time period. Nix and McNevin (2020) study sectoral uncertainty with wavelet analysis. They come to the empirical conclusions that uncertainty in the monetary, energy and manufacturing sectors is characterised by greater frequency and time. Also, the authors manage to capture the transfer of uncertainty from one sector to another. It becomes clear that wavelet analysis succeeds in capturing the hidden signals of uncertainty. Uncertainty, particularly nominal uncertainty, has the characteristics of a hidden signal that cannot be captured by conventional econometric methods. The wavelet methodology, however, manages to capture part of the uncertainty and extract the necessary information about the dynamics of the uncertainty.

The empirical studies examining the relationship between inflation and inflation instability in Bulgaria are carried out by D. Viorica et al. (2014) and M. Khan et al. (2013). D. Viorica et al. (2014) draw the empirical conclusion that in Bulgaria the relationship between inflation and inflation instability is two-way and according to M. Khan et al. (2013) inflation leads to greater inflation instability in the Bulgarian economy.

The theoretical analysis leads to the following theoretical models explaining the relationship between inflation and its volatility. The first concept is based on the view of Friedman (1977), adopted by L. Ball (1992). The second concept is that of A. Purgerami, K. Maskus (1987) who argue that inflation does not lead to inflationary instability. The third concept is developed by A. Kukerman, A. X. Meltzer (1986), who argue that inflationary instability

leads to inflation. The fourth concept is developed by A. C. Holland (1995), who argues that inflation instability leads to inflation decrease. The derived concepts view inflation as a specific risk that is generated by various factors.

According to Petranov, S. et al. (2020), a specific risk arises from the dynamics of prices of necessities, which leads to an increase in the prices of all other goods and services. Another view of Viorica, D. et al. (2014) is that, in some cases, inflation volatility leads to higher inflation. Raleva argues that inflationary instability is determined by wages, administrative prices (Raleva, 2013), exchange rate depreciation and oil prices (Raleva, 2012). According to Zatinov (2017), inflationary uncertainty on household spending is determined by increasing tax payments. The author argues that the largest inflationary increase is registered in food (Zlatinov, 2017). Garvalova (1998) points out that consumer price increases are predominantly driven by inflation expectations and speculative shocks.

The critical review of the theoretical and empirical literature leads to the following conclusions: an increase in inflation leads to an increase in inflation instability, as well as to the view that ceteris paribus, an increase in inflation instability leads to conditions of nominal uncertainty. Technical parameters can be derived to assess inflation instability and nominal uncertainty. The most suitable for assessing the inflation instability are the ARCH and GARCH models and the wavelet instruments – for the nominal uncertainty.

## Methodology and Specifics of the Study

The period under review is January 2000 – May 2022 on a monthly basis. The data source is the National Statistical Institute (NSI). The variable used to express the inflation in the Bulgarian economy is the annual, monthly difference of the Logarithm of the Consumer Price Index (LCPI). This approach is applied by Khan, Kebewar and Nenovsky (2013).

The study of the relationship between inflation and inflation instability and, accordingly, the effect of the dynamics of inflation instability, is realised through an extended one-dimensional four-step approach, which includes the ARCH model, GARCH-M model, EGARCH model and Granger causality test. The chosen empirical instruments are also applied by Engle (1982), Jansen (1989), Grier and Perry (2000), Apergis (2005), Karahan (2012), Khan, Kebewar and Nenovsky (2013), Samut (2014), Viorica, Jemna, Pintilescu and Asandului (2014), N. Ananzeh (2015), and Sharaf (2015). Inflation instability in the Bulgarian economy is studied simultaneously with several empirical instruments that complement each other and compensate for their technical weaknesses. The nominal uncertainty is estimated using a one-dimensional wavelet methodology.

Stationarity is assessed using Dickey-Fuller Test (Dickey, Fuller, 1979), Phillips-Perron Test (Phillips, Perron, 1988), and the Breakpoint Test. Then ARCH LM test is applied (Hong, Shehadeh, 1999).

ARCH model is described by the following equations (Engle, 1982, p. 988):

$$\gamma_t = \varepsilon_t h_t^{1/2} \tag{3}$$

$$h_t = \alpha_0 + \alpha_1 \gamma_{t-1}^2 \quad (4)$$

$$\gamma_t | \psi_{t-1} \sim N(0, h_t) \quad (5)$$

where:

$\gamma_t$ is variance;

$\varepsilon$ – white noise;

$h$ – variable variance;

$t$ – the time;

$\psi_{t-1}$ – information in a previous period.

GARCH-M (p, q) model is described by the following equation (Hill et al., 2011, p. 528):

$$h_t = \delta + \alpha_1 e_{t-1}^2 + \beta_1 h_{t-1} \quad (6)$$

The exponential GARCH model is described by Nelson (1991, pp. 350-351) with the following mathematical expression:

$$\ln(\delta_t^2) = \alpha_t \sum_{k-1}^{\infty} \beta_k g(z_{t-k}) \quad (7)$$

Wavelet technology is described by the following mathematical expressions (Ramsey, 2002, p. 5):

$$s_{j,k} = \int f(t) \Phi_{j,k}, \quad (8)$$

where:

$s_{j,k}$ is scaling coefficients;

$\Phi$ *(t)* – low-frequency filter.

$$d_{j,k} = 2 \int f(t) \psi_{j,k}, j = 1, \ldots J, \quad (9)$$

where:

$d_{j,k}$ is a difference coefficient;

$\psi$ (t) – high-frequency filter.

The waves “father” (equation 8) and “mother” (equation 9) are complementary and thus cover all the necessary information for the studied process.

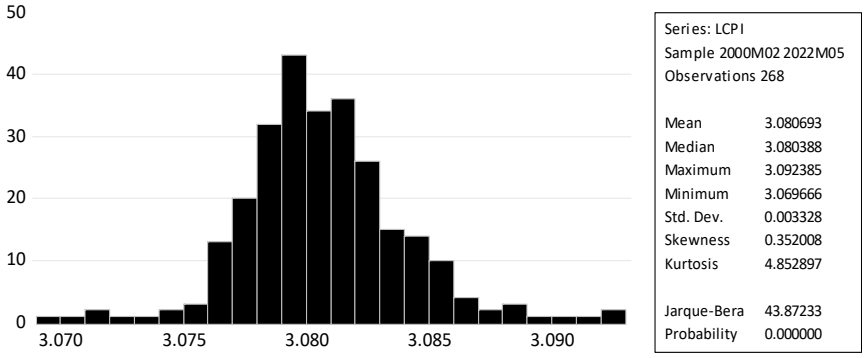
## Empirical Results

The time series expressing inflation (LCPI) in the Bulgarian economy is asymmetrically distributed over time.

The values of the median and the mean are duplicated (Figure 1). This means that the center of distribution assumes predominantly high monthly values of inflation in Bulgaria, which is a sign of the existence of inflation instability that arises from the inflation process in Bulgaria. Inflation takes both low and high values, which means that the inflation transition from low to high values creates great volatility – a sign of inflation instability. This logic is supported by the standard deviation, which manifests through positive asymmetry. The standard deviation is represented by a long right-sided solid tail, which expresses the increasing inflation uncertainty from inflation in the period tending to 2021-2022. The value of the asymmetric indicator, as well as the excess value show that the distribution of the signs in the inflation series is not normal. The frequency distribution is characterised by peaks that are registered by the excess and a right tail, which confirms the presence of asymmetry in the frequency distribution. These two characteristics are indicators of an uneven frequency distribution of the inflation process, which is also confirmed by Jarque-Bera test.

Figure 1

Frequency distribution of inflation for the period 2000/01-2022/05




*Source: authors' calculations; LCPI-inflation.*

The ACF function of the time series, including inflation, registers a fluctuating character that decays and increases its information signals. The PACF function also demonstrates a similar trajectory of manifestation (Table 1). The two functions, demonstrating a variable trend of their dynamics in the different lags, predominantly register decreasing dynamic coefficients, which leads to the conclusion that the stochastic inflation process in the Bulgarian economy is characterised by stationarity, but also by ARCH effects. This conclusion fully corresponds to the possibility of inflation instability, as a consequence of the volatility and the increasing inflation value in the Bulgarian economy.

Table 1

ACF and PACF functions

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|---|---|
| .\|*** \| | .\|*** \| | 1 | 0.433 | 0.433 | 50.912 | 0.000 |
| .\|** \| | .\|. \| | 2 | 0.229 | 0.051 | 65.178 | 0.000 |
| .\|* \| | .\|. \| | 3 | 0.158 | 0.051 | 71.985 | 0.000 |
| .\|. \| | *\|. \| | 4 | -0.051 | -0.180 | 72.710 | 0.000 |
| .\|. \| | .\|. \| | 5 | -0.064 | 0.002 | 73.837 | 0.000 |
| .\|. \| | .\|. \| | 6 | -0.037 | 0.016 | 74.216 | 0.000 |
| *\|. \| | .\|. \| | 7 | -0.080 | -0.042 | 75.974 | 0.000 |
| .\|. \| | .\|. \| | 8 | -0.041 | 0.004 | 76.450 | 0.000 |
| .\|* \| | .\|* \| | 9 | 0.101 | 0.150 | 79.291 | 0.000 |
| .\|* \| | .\|. \| | 10 | 0.103 | 0.031 | 82.294 | 0.000 |
| .\|* \| | .\|* \| | 11 | 0.149 | 0.074 | 88.560 | 0.000 |
| .\|** \| | .\|** \| | 12 | 0.351 | 0.278 | 123.46 | 0.000 |

*Source: authors' calculations.*

The three tests confirm that the inflation series has characteristics of a long-term average value (Table 2). The variations of the different signs do not change over time. This leads to a stochastic process that, despite the random shocks it reproduces, does not lead to a disturbance in the variations of the inflation signs in the long run.

Table 2

Tests for Stationarity and Structural Fracture

| | Augmented Dickey-Fuller Test on LCPI | Phillips-Perron Test on LCPI | Unit Root with Break Test on LCPI |
|---|---|---|---|
| t-Statistic | -10.23604 | -10.19850 | -10.85813 |
| P-value | 0.0000 | 0.0000 | < 0.01 |

*Source: authors' calculations; LCPI-inflation.*

The stationary process is characterised by an asymmetry that realises significant volatility. That volatility forms clusters of manifestation in the different lag windows. The described process fully corresponds to the characteristics of inflation instability, which is a consequence of the significant dynamics of the volatility of inflation in the Bulgarian economy. The dynamics of the stationary process are predominantly characterised by variations that lead in most lag values to a fracture in the stationary process, which, however, returns to its average value. In the period January 2020 – May 2022, there is a large fracture in the stationary process, which turns into a break (Figure 2). It is this structural break expressing high inflation volatility that indicates inflation instability. This means that the ARCH effects should be analysed and will provide the necessary information on whether there is a possibility of inflation instability as a consequence of inflation dynamics.

The presence of information in the residuals is confirmed by the test for ARCH effects (Table 3), which means that there are lagged squares that reproduce trends of structural fractions in the stationary stochastic process of the inflation dynamics. Therefore, this supports the view that the inflation dynamics in the Bulgarian economy create inflation instability. The inflation shock may have been reproduced both in the previous period and in several lags later than the previous period, and nevertheless, the uncertainty could be manifested in the current

period. This logic is argued by $TR^2$statistic and P-value (Table 3). The derived ARCH effects (Table 3) give reasons to apply an ARCH model, which can be ARCH(1), as well as the GARCH methodology, which manages to assess and capture inflation instability much more finely.

Figure 2

Moments of fracture of the stationary process


*Source: authors' calculations.*

Table 3

ARCH_LM Test on LCPI

| Lag | $TR^2$statistic | P-value |
|---|---|---|
| 1 | 10.58296 | 0.0011 |
| 2 | 14.63422 | 0.0007 |
| 3 | 14.67592 | 0.0021 |
| 4 | 21.16844 | 0.0003 |
| 5 | 22.84652 | 0.0004 |
| 6 | 25.70835 | 0.0003 |
| 7 | 28.03037 | 0.0002 |

*Source: authors' calculations; LCPI-inflation.*

The estimated ARCH(1) model specificities have close values of Akaike info criterion and Schwarz criterion, but the z-Statistic weights of the coefficients differ, and yet the trends in all three models are identical. The three specifications of the ARCH(1) methodology confirm that inflation in the previous period leads to an inflation increase in the current period (Table 4). Therefore, the inflation process is self-reproducing as the inflation expectations, created in the previous period, form the inflation in the current period. A part of the effect of the inflation shock takes the form of a hidden signal, which is characterised as unknown in terms of the effects it creates in the Bulgarian economy during the period under review. Inflation provokes inflation instability, which increases because the sign of the conditional variance is positive. The conclusion here is that during the studied period, inflation instability increased. The volatility of inflation over time creates conditions for the risk of inflation instability. The inflation expectations in the previous period affect future inflation and future inflation instability. Another important conclusion is that inflation instability is reproduced as a consequence of its past value in the previous period.

Table 4

ARCH(1) model

| | Dependent Variable: LCPI | | Variance Equation | | Values | |
|---|---|---|---|---|---|---|
| Method | C | LCPI(-1) | C | RESID(-1)^2 | Akaike info criterion | Schwarz criterion |
| Normal distribution | 1.610894 (7.329244) | 0.477115 (6.685776) | 6.84E-06 (11.22907) | 0.244237 (2.272756) | -8.805521 | -8.812161 |
| Student's t | 1.689668 (8.909506) | 0.451496 (7.333165) | 6.24E-06 (5.719081) | 0.371691 (1.947968) | -8.879338 | -8.812161 |
| Generalised error distribution | 1.743030 (124.9614) | 0.434166 (95.91639) | 6.55E-06 (6.917218) | 0.281323 (1.696967) | -8.850379 | 8.783202 |

*Source: authors' calculations; (z-Statistic); LCPI-inflation.*

The three models have nearly equal explanatory power. Inflation increases as a consequence of its past values. Inflation instability is presented as standard deviation and as conditional variance, and in both cases, inflation instability increases in all three models. It is important to note that inflation instability, measured as the conditional variance, is characterised by higher coefficients when measured by the standard deviation. The positive coefficients of the standard deviation and the conditional variance lead to the conclusion that inflation instability in the Bulgarian economy is a factor that manifests itself quite often. An argument for this conclusion is that the standard deviation manages to capture the signal of inflation instability. The degree and frequency of manifestation of inflation instability determine the increase of inflation. Also, an increase in inflation volatility leads to an increase in inflation instability. This view is theoretically postulated by Friedman (1977) and Ball (1992). Golob (1994) and Karahan (2012) obtain similar empirical results. Another empirical result is that the inflation instability is expressed better than the conditional variance (Table 5). The latter conclusion is found in Jansen (1989) and Karahan (2012).

Table 5

GARCH- M (1,1) model

| Dependent Variable: LCPI | | | | Variance Equation | | | Values | |
|---|---|---|---|---|---|---|---|---|
| Method | @SQRT(GARCH) | C | LCPI(-1) | C | RESID(1)^2 | GARCH(1) | Akaike info criterion | Schwarz criterion |
| Student's distribution | 0.788349 (1.930705) | 1.792975 (10.93203) | 0.417205 (7.829615) | 1.94E-07 (1.190511) | 0.036611 (1.495050) | 0.939185 (29.46111) | -8.86989 | -8.77584 |
| Normal distribution | 0.653175 (1.945710) | 1.792953 (10.72755) | 0.417389 (7.688966) | 9.67E-08 (1.485019) | 0.028901 (1.772773) | 0.955645 (53.41031) | -8.84486 | -8.76425 |
| Generalised error distribution | 0.757299 (2.054985) | 1.788762 (99.60269) | 0.418616 (71.63366) | 1.41E-07 (1.187686) | 0.034650 (1.525442) | 0.945598 (34.87059) | -8.86539 | -8.77134 |

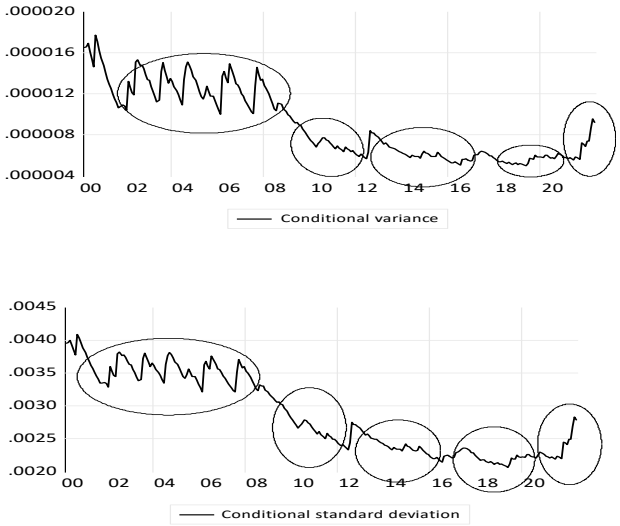
*Source: authors' calculations; (z-Statistic); LCPI-inflation.*

The change in inflation instability is characterised by periods of volatility and periods of relative stability. Therefore, the dynamics of the inflation instability change over time, and this change is grouped into certain cluster formations. The dynamics of inflation instability is characterised by an uneven distribution over time (Figure 3). The inflation instability in the period 2000-2007 shows high volatility, and in the period 2009-2010, the volatility of the inflation instability decreases. In the following years, a period of relative constancy in the

dynamics of the volatility of inflation instability is observed, while a large increase in inflation instability is registered at the end of 2021 and until the middle of 2022.

Figure 3

Dynamics of instability estimated with GARCH-M model




*Source: authors' calculations.*

The relationship between inflation and inflation instability is most fully revealed through the application of the EGARCH model (Table 6). The self-replicating process of inflation increase leads to an increase of inflation instability. The initial inflation shock originates in past lag values but manifests in the current lag by generating inflation instability. Once the inflation shock generates inflation instability, the inflation instability starts to increase. The transformation of inflation shock into inflation instability takes some time. The generation of inflation instability from the inflation shock leads to inflation instability that does not fade as the inflation shock fades. The fading of the inflation instability is realised later than the fading of the inflation shock. It becomes clear that the inflation increase in the current period leads to an increase of inflation instability in the next lag, because the transformation of the inflation shock into inflation instability takes a certain time. The inflation instability starts to fade not only later than inflation fades, but when the inflation fading is considered to be significant. The dynamics of inflation instability are determined by the "feeling" that economic agents take the inflation effect into account as regards their consumption and cost of living. In the first moment, economic agents feel "significantly" the inflation pressure and this predetermines great instability in the following periods. The actions and decisions of the economic agents are determined by the expectations of an inflation increase, which creates instability that will not immediately fade with the inflation fading. The reason is that the behaviour of the economic agents will be characterised as cautious and they will act cautiously. This will create instability in the system, and after a certain period of time, when economic agents change their expectations, the inflation fading will start to correspond with the fading of the inflation instability, i.e. the inflation instability will start to decrease.

Table 6

EGARCH(6,5)

| | |
|---|---|
| A | 1.742793* |
| LCPI(-1) | 0.434190* |
| C | -1.550894 |
| ARCH(1) | 0.551036* |
| ARCH(2) | 0.080306 |
| ARCH(3) | 0.289827 |
| ARCH(4) | -0.560483* |
| ARCH(5) | 0.053503 |
| GARCH(1) | 0.070021 |
| GARCH(2) | -0.510517* |
| GARCH(3) | 0.551922* |
| GARCH(4) | 0.434999* |
| GARCH(5) | 0.323022 |
| GARCH(6) | 0.020325 |
| Y(1) | -0.229544*** |
| Y(2) | -0.071029 |
| Y(3) | 0.130460 |
| Y(4) | 0.133533 |
| Y(5) | 0.267355* |

* statistically significant at 1%; ** statistically significant at 5%; *** statistically significant at 10% LCPI-inflation

*Source: authors' calculations.*

The value of the inflation shock in the previous period does not permanently lead to an increase in the value of inflation in the current period (Table 6). The autoregression coefficients illustrate several trends in the change of the inflation values. The first trend they register is that the past inflation rates do not lead to a significant change in the inflation in the current period. This trend shows that there are exogenous factors that determine inflation, which is inherent to the Bulgarian economy, since it functions under Currency Board Arrangements. This creates conditions for inflation to be imported. The imported inflation is not determined by the past values of the domestic inflation, but it determines the values of the domestic inflation in the current period. The second trend is characterised by a rupture of the relationship between the historical and the current variation of the inflation dynamics. The rupture of the past with the current variation of the inflation dynamics coincides with the outbreak of the Great Recession that caused a prolonged period characterised by deflation shocks in the Bulgarian economy and creeping inflation. The last trend that stands out is a significant positive influence of the historical variation of the inflation dynamics on the current variation of the inflation dynamics. This period coincides with the post-COVID economic recovery of the Bulgarian economy and the subsequent rise in global and domestic inflation. The reasons for the impact of the historical prices on the current prices is the increase in the money supply as an instrument to combat the COVID economic turbulence, as well as the increase in the global prices of fuel and energy and, of course, the increase in the prices of the production materials.

In lag 1, when rising, the inflation leads to a significant increase in the inflation in the current period. This self-replicating rise in inflation leads to an increase in inflation instability. Inflation instability is characterised by high volatility, which goes from positive to negative

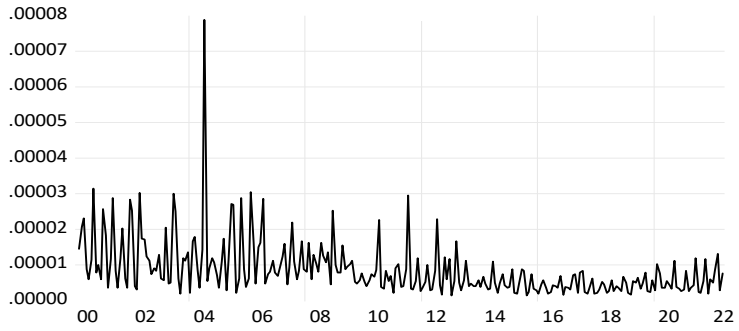
values. The volatility of the instability is difficult to be predicted in the Bulgarian economy, because it is characterised by sharp and sudden changes in both the direction of movement and the magnitude of the manifestation of the instability (Table 6). These empirical arguments support the view that the Currency Board Arrangements and the impossibility of conducting monetary policy in a traditional manner create unpredictability of the ongoing inflation instability in Bulgaria.

The volatility of the inflation instability in some lags depends on the historical volatility, while in other lags, it does not depend on the historical volatility, introducing an element of stochasticity. The random element increases the risk of volatility of the inflation instability and introduces certain uncertainty in the dynamics of inflation instability due to inflation in the Bulgarian economy. The fact that inflation instability in Bulgaria is highly volatile (Figure 4) and that at the same time, in some lag values it does not depend on its historical values, means that there is a random element that leads to the risk of nominal uncertainty.

The volatility of the inflation instability leads to lower incomes of the economic agents, an increase in the prices of goods and services, export of capital from Bulgaria and a decrease in investments, which causes a deterioration of the business environment. Therefore, inflation instability leads to the reproduction of several risks that correspond to each other and that is precisely why unpredictability is created in the Bulgarian economy.

Figure 4

Inflation instability in Bulgaria




*Source: authors' calculations.*

The analysis of the relationship between inflation and inflation instability using the ARCH model, GARCH_M model and EGARCH model leads to the empirical arguments that when the inflation increases, inflation instability is also determined, i.e. inflation dynamics leads to inflationary instability. This view corresponds to the theoretical positions of Friedman (1977) and Ball (1992). On the other hand, the empirical results also provide arguments that inflation instability leads to an inflation increase which contradicts the Friedman-Ball model. The assessment of the causal relationships clearly confirms the empirical conclusions presented (Table 7). The two empirical conclusions do not contradict each other, on the contrary, they even complement each other. This is because, initially, the inflation shock is the factor that reproduces inflation instability. Then inflation instability leads to the generation of inflation.

Table 7

Causal relationship between inflation and inflation instability

| Null Hypothesis | P-value | Lag |
|---|---|---|
| UN does not Granger Cause LCPI<br>LCPI does not Granger Cause UN | 0.9574<br>0.0004 | 1 |
| UN does not Granger Cause LCPI<br>LCPI does not Granger Cause UN | 0.8647<br>5.E-10 | 3 |
| UN does not Granger Cause LCPI<br>LCPI does not Granger Cause UN | 0.0591<br>2.E-14 | 6 |

*Source: authors' calculations; UN-inflation instability; LCPI-inflation.*

In fact, the current study confirms and further develops the Friedman-Ball model, because in a small open economy under Currency Board Arrangements, the processes of inflation and inflation instability in their interaction reproduce each other (Table 7).

The empirical analysis provides grounds for claiming that nominal uncertainty is manifested in the dynamics of the volatility of inflation instability. Nominal uncertainty is a process that remains as a hidden signal in the noise of inflation instability. In the range of the highest frequencies covered by the "mother" waves, 39 wave coefficients are registered, which contain information characterised by unknown values (see Appendix). These unknown values are information that is part of the noise of the inflation instability, but this information is not extracted. Therefore, in this information of unknown content lies the nominal unpredictability or the nominal uncertainty. The strongest frequency, which is covered by the first scale, contains the most coefficients that are outside the standard deviation limit, which means that to the low-frequency ranges, more and more wave coefficients will be added, which will illustrate the presence of hidden information that will take the form of an information signal.

In the medium frequency ranges, the wavelet coefficients increase(with 95 wavelet coefficients being registered in scale 16) and the majority of them remain outside the noise, which illustrates the information that represents nominal uncertainty. Moreover, in the medium frequency range, there is a sign of shaping the transition of noise into a signal that is characterised by volatility. In fact, in the low-frequency spectrum, a signal with unknown information is already clearly outlined, which is expressed by 267 wave coefficients with unknown values. Therefore, an unknown wave signal is identified in the low-frequency spectrum, which is a carrier of unpredictability for the economy and expresses nominal uncertainty. Therefore, this signal can be considered as a consequence of inflation instability, which, containing an unpredictable element, at some point grows into nominal uncertainty. This process of converting the noise, expressing the inflation uncertainty into a signal and also expressing the inflation uncertainty, is actually a transformation of the inflation instability into nominal uncertainty.

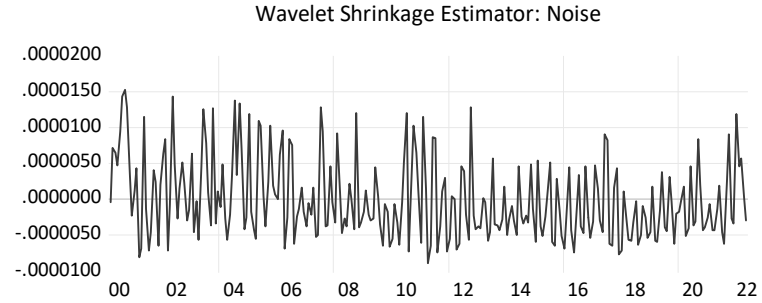
Nominal uncertainty (Figure 6B) is clearly visible when inflation instability is muffled (Figure 6A). The signal expressing the nominal uncertainty is different from the noise, expressing the inflation instability. The nominal uncertainty and its signal registrations are indicated by rectangles when a nominal uncertainty is registered, but it does not lead to large negative feedback effects. The nominal uncertainty is indicated by an ellipse (circle) when it

leads to larger negative shock effects. The nominal uncertainty is depicted by an ellipse in the trajectory of a rectangle when the nominal uncertainty leads to negative shocks whose end cannot be determined exactly and there is also a presence of overlapping risks or crisis events with an unknown end and of different nature, as well as a gradation of crises,

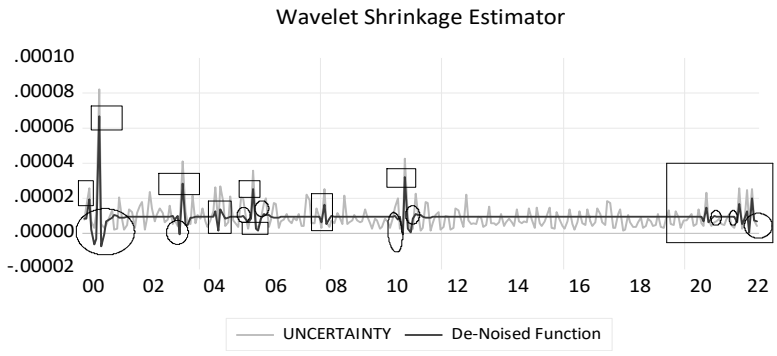
Figure 6

Revealing the signal expressing the nominal uncertainty

*6.A. Inflation instability*




*6.B. Nominal uncertainty*




*Source: authors' calculations.*

In 2000, 2003, 2005-2006, 2007 and 2010-2012, nominal uncertainty was registered in the Bulgarian economy, which is a consequence of the inflation instability, and in turn, is a consequence of higher inflation. The causes of inflation, and respectively inflation instability and nominal uncertainty, are the increase in the prices of basic goods, external inflation, the ECB policy of money printing and the Currency Board Arrangements, which, when foreign exchange reserves increase, lead to an increase in the money supply.

In January 2020 – May 2022, there was an overlap of crises that led to nominal uncertainty. The reasons for the gradation of inflation into inflation instability and the gradation of inflation instability into nominal uncertainty are the increase in government expenditures as a measure to combat COVID-19, the liberalisation of the electricity market, the lack of diversification in the energy sector, the external inflation and the rising fuels prices on the international markets caused by the war in Ukraine, which generates a large inflation shock

and creates a large nominal uncertainty. It becomes clear that several risk factors, determining the nominal uncertainty accumulate and overflow. Therefore, the nominal uncertainty is determined by inflation instability and inflation. The lags, in which nominal uncertainty is determined, are characterised either by galloping inflation or by a sharp change in the trajectory of inflation, which is characterised by high volatility. This leads to turbulent inflation instability, which in turn is characterised by very high volatility and also causes nominal uncertainty.

The nominal uncertainty in the high-frequency range registers the largest coefficient, which constitutes a little more than half of the value of the aggregate nominal uncertainty in the period under review and leads to a moderate accumulation of nominal uncertainty. Again, in the high-frequency spectrum, the scale of the nominal uncertainty coefficient decreases. This decrease explains a small fraction of the value of the total nominal uncertainty, but has a significant effect on the accumulation of nominal uncertainty in the current period. Such a trend persists until the end of the high-frequency spectrum. The nominal uncertainty has the largest value in the high-frequency range, then the value decreases and increases again, but does not reach the scale of the initial value. In the low-frequency spectrum, the nominal uncertainty does not have a significant impact on the economic system. Therefore, it can be concluded that in the short and medium run, nominal uncertainty has a significant impact on the economic system (Table 8).

Table 8

Decomposition of the hidden signal

| Scale | Variance | Rel. Proport. | Cum. Proport. | Lower | Upper |
|---|---|---|---|---|---|
| W1 | 3.26e-11 | 0.5874 | 0.5874 | 2.59e-11 | 4.22e-11 |
| W2 | 1.88e-11 | 0.3387 | 0.9261 | 1.37e-11 | 2.75e-11 |
| W3 | 2.11e-12 | 0.0380 | 0.9641 | 1.33e-12 | 3.67e-12 |
| W4 | 1.31e-12 | 0.0236 | 0.9877 | 6.88e-13 | 3.19e-12 |
| W5 | 6.83e-13 | 0.0123 | 1.0000 | 2.54e-13 | 2.97e-12 |

*Source: authors' calculations.*

The nominal uncertainty is a consequence of the excessively increasing inflation instability. An interesting fact is that under Currency Board Arrangements in Bulgaria, there are processes like inflation instability and nominal uncertainty. This fact contradicts the concept of the currency boards, which should not allow processes like inflation instability and nominal uncertainty.

## Conclusion

The empirical study shows that inflation in Bulgaria leads to inflationary instability. It is also empirically shown that inflation instability leads to inflation. The results are similar to the studies of Viorica, Jemna, Pintilescu and Asandului (2014), who argue that there is a bidirectional causality between inflation and inflation instability in Bulgaria. The results obtained from the present study, especially regarding the finding that inflation leads to inflation instability, overlap with the results of Khan, Kebewar and Nenovsky (2013). Examining the case of Bulgaria, the authors conclude that the theoretical proposition of

Friedman (1977) and Ball (1992) that inflation increases inflation instability is valid for Bulgaria.

An important result of the study is that inflation instability leads to nominal uncertainty. The novel contribution of this study is that it provides empirical evidence on the existence of nominal uncertainty in the Bulgarian economy. It is empirically demonstrated that inflation instability creates nominal uncertainty. Thus, the question arises – why inflationary instability and nominal uncertainty are realised under a currency board arrangements, given that these processes contradict the main objective of introducing currency board, namely the achievement of price stability? On the other hand, it is not possible to achieve price stability in the presence of inflation instability and nominal uncertainty. It is obvious that the currency board should not allow the inflationary process to lead to inflationary instability and nominal uncertainty. However, empirical results show that inflation instability and nominal uncertainty are reproduced in the Bulgarian economy, which calls into question the effectiveness of the currency board itself. Therefore, the impact of the currency board in Bulgaria on the inflation process can be characterised as ineffective.

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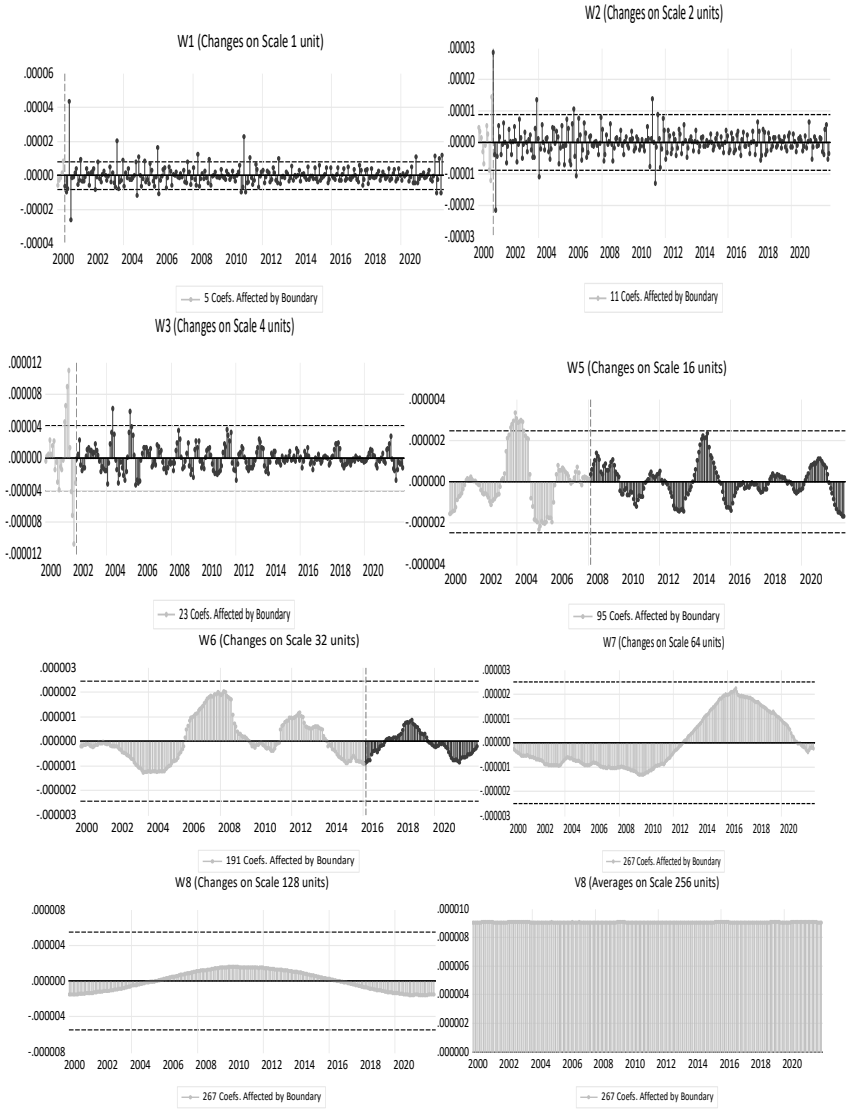
**APPENDIX**

Discrete wavelet transformation of inflation instability




*Source: authors' calculations.*

ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# CIVILISATION PRINCIPLES OF TRANSFORMATION OF VALUES OF ECONOMIC AND SOCIETY DEVELOPMENT UNDER THE CONDITIONS OF ARTIFICIAL INTELLIGENCE EXPANSION[3]

*The article explores theoretical and methodological issues of defining the essence, functions and role of civilisational principles in the assurance of centripetal processes of restoring key forms of human civilisation activities, highlighting allowable limits of constructive transformation of values of economic and social development. The article pays great attention to economic and philosophic comprehension of principles and forms of the origination of a brand-new reality in the system of social and economic relations under the influence and pressure of the modern technological revolution. It reveals the particularities of methodological approaches to the essence analysis, trends in the development of new forms of human functioning in the context of Revolution 4.0, the digital economy and the active deployment of artificial intelligence.*
*Keywords: digital economy; artificial intelligence; nanotechnological revolution; human-centred development paradigm; transhumanistic paradigm; development benchmarks; humanitarian constant; framework for ethics principles; identity transformation, labour.*
*JEL: B40; I3; J08; O1; O3; P10*

## 1. Problem Definition

Rapid globalisation of economic and social systems and the same rapid development of Industrial Revolution 4.0 actualise such a kind of social needs as the preservation of fundamental civilisational principles of functioning and development of humankind – a unique, socially defined and consciously formed entity of reproduction and evolution of social and economic relations, which is able to perceive, comprehend and transform the world around in their interests. Satisfaction of such kind of needs in the context of dualism

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establishment of the paradigm concept of strategic ways and conditions of social development, human development causes the urgent necessity to implement an efficient human-centred economic policy (Breque, Lars, Petridis, 2021). However, the theoretical model, platform, strategic goals of this policy are impossible without comprehension and adoption of principles of coordinating civilisational achievements and social development benchmarks with systematic challenges of scientific revolution manifested in artificial intelligence, technological method of production based on the digital economy, problems related to co-existence and interaction between people and the smart machine in all spheres of social life. A complex of such challenges and problems sparked a deep interest in the search for answers to some of the issues set by contemporary growth.

### *1.1. Research goals*

Modern competition for the future is the competition of new quality, featuring the triunity of competition a) for positioning the present in the future, b) for positioning the future in the present, c) for positioning the future of certain objects in the future by means of the future. Some scientists stress that "…beyond active and new intensive exploration of the future, comprehended scientifically supported complex approach to future building, targeted allocation of resources for future exploration, the humankind is destined to disappear, even in case of keeping sufficient living conditions on the Earth (Selivanov, 2016).

Such understanding of principles of comprehending the depth and complexity of problems faced by globalised society in the midst of rapid qualitative changes in all elements of the technological method of production and, consequently, in the system of social and economic relations allows us to pointedly define the *key goals of our research*. They include, firstly, the theoretical and methodological rationale of the necessity to preserve and develop in the future established in the present civilisational principles and benchmarks of the existence of people and humankind as a unique form of biosocial organisation of society as a living, creative and passionate body. Secondly, to determine and justify the necessity to set up substantial basics of civilisational principles of the new technological age, which are imperative in the context of manifestation and development of artificial intelligence role.

### *1.2. Civilisational principles of the new technological age as a research goal*

In particular, positioning the future in the present allows us to suggest the analysis and rationale of the below-listed key, in our opinion, *civilisational principles of the new technological age as a relevant scientific problem and goal of future research*:

1) recognition of the leading role of people in their and social relations with artificial intelligence;
2) establishment and development of the culture of communications with artificial intelligence based on cultural imperatives and cultural standards that define the rules based on the philosophy of priorities and values, which ensure the widest opportunities for social development and personal advancement in the new architectonics of subject-

object (or, in case of recognising the artificial intelligence's right to the subjectivity, subject-subject) relations;

3) cultural dualism when the conflict between traditional and new cultures of economic relations reduces to a minimum;

4) the equal access to the field of labour for all people who get constantly possibility to improve their skills. Remarkably, automation in new technologies and AI-related fields must be deployed with the creation of new workplaces with labour-intensive tasks. Types and areas of labour activities are defined by the consensus, which fundamental principles include the freedom of access to labour for each person of working age and are defined by society;

5) adjusting the economic policy of countries to adapt and take into account the diverse interests of society, people and businesses, to social stabilisation and consensus in the conditions of the AI-technologies deployment model of the digital economy;

6) ensuring human-centrism as a critical principle in the value-oriented development of society;

7) mitigation and minimisation of social and economic inequalities and colossal stratification of the population by income, by identifying additional opportunities, modern socio-economic policy tools;

8) preventing the subjugation of human being by technology, but on the contrary "freeing" man from excessive work, creating conditions for creative development of man, revealing his intellectual and creative potential to the full extent.

We believe that only the comprehensive implementation of specified goals of research and the research system will ensure, at theoretical and practical levels, positioning of the future of certain objects in the future by means of the future, which is definitely a crucial condition for preserving and developing human civilisation in its diversity and uniqueness.

## 2. Analysis of Recent Publications

In the context of the rapidly increasing diffusion of traditional and digital forms and methods of managing economic processes, processes of creating economic and public benefits, there are fundamental, not always predicted changes in the architectonics of social and economic relations, in the interaction between an individual and artificial intelligence, which sparks an obvious interest of researchers in defining the essence, trends and long-term consequences of these trends for certain countries and regions, globalised society, human civilisation in general. Therefore, we can see an increasing number of publications containing thoughts, generalisations and forecasts concerning the prospects of the further destiny of people and humankind in a brand-new globalised social and technological system.

One can distinguish several areas of scientific thought development among such recent publications in terms of content. Firstly, it is an area whose representatives explore innovative and technological changes, characterising substantial forms and development trends of the

nanotechnological and digital revolution. Authors and publications in this area include, for example, E. Drexler (2014), Alec Ross (2017), John Brockman (eds., 2017), Martin Ford (2016), John Markoff (2016), Klaus Schwab and Nicholas Davis (2018), Ma Huateng and others (2019), Viktor Tarasevych (eds., 2021), Scheer August-Wilhelm (2020).

Another area of research on trends and long-term consequences of the digital revolution in all spheres of economic and social life is related to the analysis of challenges, contradictions and risks that occur and will grow in the future, affecting the character of transformation of value-based principles and values established in society as part of human civilisation evolution. It is, firstly, an exploration of the causes and institutional forms of paradigm dualism in approaches to the understanding of the nature and role of processes taking place in the globalised society. Secondly, the analysis of the efficiency of conceptual models of economic policy aimed at creating conditions for the widest application of artificial intelligence. Thirdly, the focus is on social and economic problems related to the development of new architectonics of the labour market, employment forms, increasing inequality and unfairness in revenue distribution, etc.

It is worth mentioning the following authors of recent publications that deeply reveal the above-said problems and give theoretical and practical tips on solving these issues. For instance, Jeffrey Sachs (2012) says that "the global market economy should have humanistic goals. It cannot be considered as a goal in itself." The most important thing stressed by J. Sachs: "The humanity principle requires us to respect each other in the context of updating and recognition of the priority of the value of people's common destiny and their common hope for dignity, solidarity and sustainable development." (Sachs, 2012, p. 241).

Similar opinions are expressed by many well-known researchers, including K. Schwab (2018); A. Greenfield (2018); A. Atkinson (2018); D. Rodrik (2019); J. Wajcman (2019); Y. K. Zaitsev, O. M. Moskalenko (2018, 2020); Ph. Van Parijs and Ya. Vanderborght (2020); M. Mazzucato (2021); A. Banerjee, E. Duflo (2021); P. Collier (2021).

It is worth mentioning that in the publications of almost all the above-said authors, the refrain is the thought that the principles of the transhumanistic development paradigm cannot function in full force while the economic policy is established by people and for people. It is referred to the replacement of human being with a new kind of employee – homo roboticus, as the latter is non-socialised and won't require social equality, social fairness, etc. According to the majority of researchers, the transhumanistic paradigm of economic development could become priority-oriented only when one fundamentally solves such urgent and complicated political and economic problems as the steady growth of satisfaction of basic needs of all individuals in each state, when the process of deep social inequality is stopped, when one determines tools for efficient protection of priority rights and advantages of the existence of human civilisation. In the examined historical situation (globalisation, Revolution 4.0, problem of dualism while selecting a development paradigm, etc.), it means that the economy and economic policy should remain human-oriented, prevent the removal of people from the system of social relations in favour of mass replacement of human beings with machines in production.

Therefore, one should preserve fundamental principles of the functioning of economic and social systems as the framework and development of human civilisation. Civilisation is

united by the task of establishing worldview possibilities for realising new challenges of progress, new demands and interests, and search for new opportunities for their harmonisation and implementation in the economic policy of states.

## 3. Research Methods

The authors use the methodology of political and economic analysis, an interdisciplinary approach and a partially analytical narrative to explain and deepen the understanding of the phenomena and processes of the transformation of the values of the economy and society at the current stage, which allows to reveal the existing contradictions of socio-economic processes under the conditions of the modern technological revolutions and expansion of AI-based technologies. On the basis of an interdisciplinary approach, an analysis of alternative points of view of researchers on the modern economic reality in its technological and trans-humanist transformation was carried out. The comparison of theoretical and practical views on the civilisation principles and values of the development of human being, economy and society is carried out at the intersection of economics, economic philosophy, economic history, and contemporary political economy.

## 4. Key Findings

### *4.1. An increasing trend in aggressive and individualistic atomisation of society and personality*

In the context of systemic transformations[4] taking place in all life spheres of the contemporary globalised world affected by technological revolutions, we can see an increasing trend in aggressive and individualistic atomisation of society and personality. Such a situation keeps current the problem of investigating preservation conditions,

[4] *Transformation (Latin: transformatio*) is reformation, reincarnation, change in a type, form, properties of something. Such changes can result in the prolongation of functioning of existing economic systems, provision of conditions for their further upward movement, development of system's structural elements without changing its primary motivational levers, as well as the reduction in the period of their existence, acceleration of the shift to downward movement that eventually means system disintegration, its regression, chaos and origination of new ordering, a new living cycle of economic and social development. The contradiction contained in such dualistic principles of social system functioning is solved positively or negatively, depending on the level of civilizational resonance in subjective perception by science, businesses, authorities of challenges, requirements and demands caused by objective logic of the economic development and quality of public response to these demands and challenges. It is worth mentioning that such challenges for economy, society, human civilization caused by Revolution 4.0, nanotechnological revolutions in the 21st century, substantially surpass all problems of systematic social and economic transformations occurring until now in terms of complexity, irreversibility and potential negative (or positive) consequences, as they do not allow moving in an evolutional way. Contemporary industrial and scientific revolutions are actually revolutions, because the dynamic development of artificial intelligence multiplied by new forms of managing the economic reproduction process does not give much time for thinking, mistakes and their correction in order to preserve human civilization as a leading form of the existence of future society.

development of fundamental values of human civilisation functioning in the long-term period and, consequently, understanding the reasons and nature of qualitative changes in these values, potential positive or negative consequences of these values for the economic, social, mental and political development of humankind. Indeed, a range of challenges, risks and problems appearing almost daily in the midst of scientific, technological and socio-technological revolutions is becoming more complicated and unpredictable.

Even the most evident relevant problems such as, for example, the complication of social and economic relations between robotics owners; between owners of robotic solutions and financial capital owners; between employers and employees; between employers and Homo roboticus; between an individual, socialised society and Homo roboticus community; between hired labour representatives on the labour market and in economic activities; between business entities in certain areas, economic life spheres, and specialised Homo roboticus, etc., require immediate solving at the conceptual, theoretically methodical, philosophical, ethical, moral and practical levels of these issues: interests of what social groups, states, businesses will be dominant and prevalent?

Will one take into account the interests of all social groups and social classes in the development process of sectors and forms of artificial intelligence application? What are the fundamental differences between economic and social policy based on the human-centred paradigm in the context of Revolution 4.0 from politics focused on the implementation of the trans-humanistic paradigm?

Besides the solution of these key issues at the deep, fundamental, scientific level, impulsive steps forward in the application of advanced technological capabilities with unknown and even unpredictable social, mental, cultural and civilisational consequences can cause unexpected and, in certain circumstances, disastrous consequences. A lot of scientists believe that technological singularity implies the state and form of economy where people will no longer have to update computers, communication systems and robotic mechanisms. These machines and systems will be reprogrammed on their own. People won't understand how they operate, but everything will function independently (Blummart, 2019, p. 14).

Thus, currently, people successfully use the new analytical instruments and computer algorithms provided by the digital economy to develop new forms of business like ICO (Polishchuk et al., 2018) to find new ways of getting a profit, and a seldom person reckons on the technological singularity as a destabilised issue. So, modern economic philosophers believe "Future is Pandora's box that, unfortunately, one can't help but open." (Yemelin, 2017, p. 350).

However, by invading the unknown and uncontrolled, people, humankind and society enter not just an area of challenges but also an area of global strategic risks when any kind of deviation[5] for undefined reasons, or not stopped and corrected on time, can lead to unfavourable or even disastrous tragic consequences for human civilisation. Therefore, scientists think that "Predicting and detecting the main consequences of the triumphant progress of smart machines and rapid involvement of fascinated and subdued people in this

[5] Deviation [Latin: deviatio – de from + via road] is the deviation from the proper line, the intended course of a ship, plane, etc. affected by any external reasons (Spirkin et all, 1986, p. 148).

pride parade is, probably, the main task of contemporary human sciences." (Yemelin, 2017, p. 352).

Due to these circumstances, the primary objective of defining the essence, forms and boundaries of constructive transformation of values of the development of economic and social systems in terms of revolutionary qualitative changes in the 21st century are to highlight a range of key civilisational principles[6] of human society functioning, while shifting from industrial to post-industrial, information, systematically intelligent manufacturing involving artificial intelligence in particular.

### *4.2. Technological storm: why is society at the edge?*

Philosophic comprehension of principles, laws, forms and prospects of the origination of a brand-new reality in the system of social and economic relations under the influence and pressure of wild waves of the nanotechnological storm causes euphory and thoughtless immersion into prospects and possibilities of this storm among many people. A significant part of society has no idea that we are standing on the edge of modern planetary Oecumene, and what is behind this edge is unknown! Besides, society has come to this edge without adjusting the internal system of values common to the whole society with its contradictions, challenges, paradigm contrast of interests, etc. Today, there is a great theoretical, methodological and paradigm discrepancy in the definition of value priorities of various social groups and classes. Reasons and subjective features are clearly defined by Wolfgang Streeck: "The fundamental asymmetry … is that capital claims for the adequate level of reward are considered as empirically necessary conditions for the functioning of the entire system and similar labour claims as sources of hindrances." (Streeck, 2019, p. 98).

At the same time, it is significant to mention that methodological principles of the human-centred paradigm of future personal and social development were established in this period (19th century). In particular, John Stuart Mill, in his essay "On Liberty" (1859), specified the key civilisational concept of social and personal development: 1) "the free development of individuality is one of the leading essentials of well-being;" (Mill, 2020, p. 57); 2) "the first in importance surely is man himself. Human nature is not a machine to be built after a model, … but a tree, which requires to grow and develop itself on all sides." (Mill, 2020, p. 60).

In our opinion, the scientist's approach to the understanding of the essence, functions and role of human being in civilisational development, firstly, laid the foundation for the understanding of the essence and advantages of the human-centred paradigm of economic

[6] "Principle [Latin: princium – basis, beginning] is 1) key initial position of any theory, science, etc.; governing idea, core activity rule; 2) internal belief, view on things defining the rules of behavior; 3) framework for the structure, functioning of any mechanism, device, equipment." (Spirkin et all, eds., 1986, p. 400). "Principle (Latin: Princium – beginning, origin, basis). Modern science describes the principle as a true provision of large generality. Informative principles are accompanied by methodological principles, for example, logical laws. In ethics, principles mean obligatory settings that people can rely on in their deeds" (Brockhaus, 2010, p. 267).

and social development and, secondly, remains relevant in the context of new challenges caused by Revolution 4.0, digital economy evolution, etc.

It should be emphasised that nowadays, in the midst of the rapid development of the nanotechnological revolution and ambiguous paradigm ideas of the definition of new civilisational milestones of globalised society movement (in particular, promotion of the transhumanistic paradigm in formation of theoretical, practical, political visions of human future), opinions of such scientists and like-minded fellows take on particular significance. They direct to the necessity to ensure contemporary transformation of civilisational development milestones.

Meanwhile, in our opinion, the transhumanist paradigm in the widespread intensive deployment of artificial intelligence technologies or other nano-, bio-, informational, revolutionary cognitive technologies is seriously contradictory and threatening. Let us recall that the essential characteristics of the transhumanist paradigm are directly related to the specific views of an influential group of scientists, politicians, and businessmen on the nature, capabilities, and functions of a person in a technologically united globalised society. In particular, representatives of this system of scientific and applied views reject religious justifications for human existence. They understand the development of scientific knowledge as a prerequisite for man's technological and biological improvement. The human individual is perceived not as the pinnacle of evolution but as an intermediate stage from a physical being to a being that combines informational cybernetic fields and a higher mind. Thus, transhumanism as a techno-economic development concept seeks to overcome man's physiological limitations and perceives the individual as a creature potentially unlimited in his development (Anikin, 2014). It could be perceived in different ways. The author's opinion boils down to the fact that the transhumanist development paradigm does not consider the civilisational principle of such a valuable reference point of development as human-centrism. The latter is a fundamental civilisational value. Therefore, it can lead to a person's loss of identity and individuality. So, in the 20th century, the transformation of economic and social development values were affected by the establishment of a competitive market of competent and highly skilled labour and the need for the mass use of creative, intellectual work.

### *4.3. Human-centeredness, freedom of choice, changes in values in a time of inequalities generated by revolution 4.0*

Human-centeredness is about human development, which means expanding fundamental freedoms to do things people value. The ability of people to choose and do what they want and their goals are ensured by their income and wealth. Human development is determined not only by the choices people actually make; it is also defined by "the freedom a person has in choosing from a set of possible functions, which is called a person's capabilities". According to the Human Development Report 2019, inequality in the global world persists. Inequality in human development remains widespread. According to the United Nations' methodology, inequality is assessed according to two groups of opportunities: basic and improved (extended). The former include, in particular: early childhood survival, primary education, entry-level technology, and resilience to repeated shocks. Convergence appears in core capabilities. Those countries at the bottom with a low level of human development are

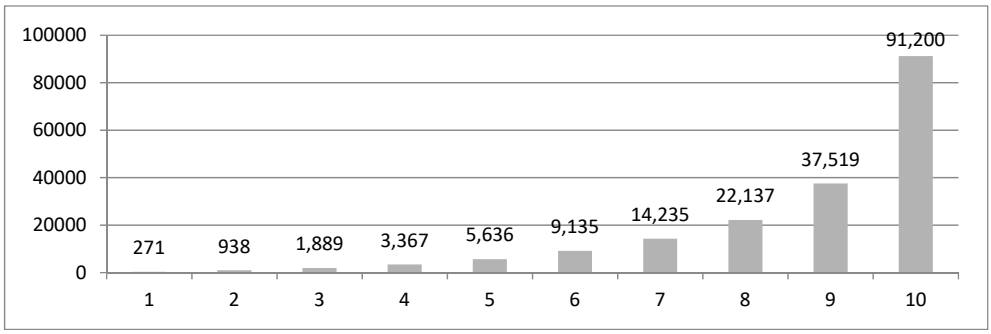
catching up with countries with a higher level of human development. Divergence appears in enhanced capabilities. Gaps in advanced capabilities exceed gaps in basic capabilities or are widening. Thereby, revolution 4.0 creates inequalities because of unequal access to new technologies and capabilities to get new skills to be engaged in types of well-paid labour-intensive work to be competitive in a labour market.

Continuing the analysis of the problems posed, namely the consequences of the introduction of the latest technologies, artificial intelligence, in particular, we note that uneven ownership of such technologies between countries of the world and within countries leads to various types of inequalities: *inequality in income, inequality in access, inequality in skills, inequality of opportunities (educational, economic)*. However, many of the inequalities are correlated with the level of income. According to UNCTAD, over the past 10-15 years, global income inequality has decreased, mainly because large developing countries, mainly in Asia, and especially China, have grown faster than other countries and have begun to catch up in some economic and technological parameters with developed countries. However, the achievement of global equality is threatened by growing disparities within countries, which are increasing in connection with the development of the digital economy. According to statistical estimates, inequality between countries now dominates. In absolute terms, the gap between developed and developing countries has never been greater and continues to widen (Digital Economy Report 2019).

Economic inequality is influenced by many factors, including political processes, where there is a struggle for power and the influence of ideology. What is especially relevant now is the impact of wars and epidemics, which accelerate the widespread use of the latest technologies and their socialisation and application in new forms of interaction in society and the economy. Globalisation and technological changes are long-established factors of income inequality within countries. Nevertheless, these phenomena [globalisation and technological change] have helped to reduce poverty in low-income countries, not only in large, rapidly developing countries such as China and India, but also in many others, including countries in Africa (Human Development Report 2019; Jaimovich, Siu, 2019; Global Productivity, 2020).

Figure 1

Labour income in PPP$ by decile, 2017



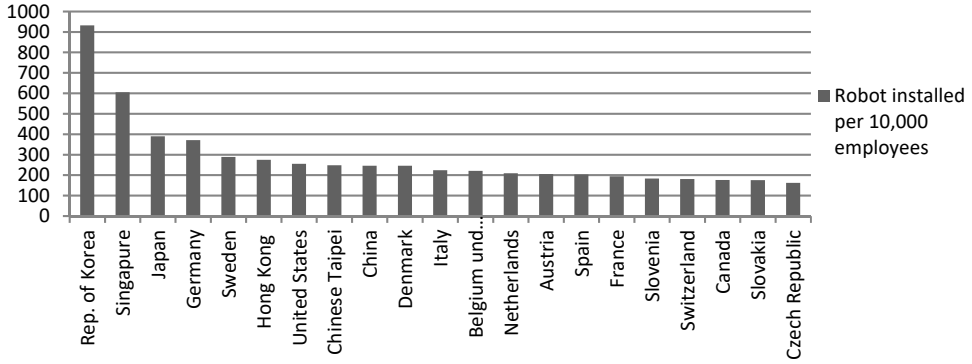

*Source: SDG labour market indicators (ILOSDG). ILO modelled estimates, https://ilostat.ilo.org/topics/labour-income/.*

Let's turn to the statistics of the International Labour Organization (ILOstat). A worker in the poorest 10% earns $266 a year, while a worker in the richest 10% earns $89,703. According to the ILO, the global distribution of labour income is one-sided: a worker in the top 10% earns US$7,445 (PPP) per month, while a worker in the bottom 10% earns only US$22. An interesting fact is that the economic convergence of India and China reduces global inequality, even if inequality does not decrease in either country.

The uneven use of robotics across countries will also affect economic inequality. Developed countries continue to lead the way in the use of industrial robots. According to the 2021 World Robot Report, the usage of industrial robots in factories around the globe is soaring at a high rate: 126 robots per 10,000 employees is the new average of global robot density in the manufacturing industries – nearly double the number five years ago (2015: 66 units). By regions, the average robot density in Asia/Australia is 134 units, in Europe 123 units, and in the Americas 111 units. The top 5 most automated countries in the world are South Korea, Singapore, Japan, Germany, and Sweden, which is seen in the figure.

Figure 2

Robot density in the manufacturing industry, 2020




*Source: World Robotics 2021, https://ifr.org/downloads/press2018/World_Robotics_-_Robot_Density_2020_by_nation.jpg.*

The inequality between developed countries, that is, countries with a high level of income, and developing countries, that is, countries with average and below average and low incomes from the use of frontal technologies is significant and is constantly deepening, the conclusion of which is made in the Technology and Innovation Report (pp. 47-48).

### *4.4. Discussions about artificial intelligence and its impact on the labour status: applying of values*

In our opinion, the attack on a person's identity is taking place in the conditions of the gig economy, where the erosion of his labour rights is taking place under the influence of the expansion of artificial intelligence and frontier technologies. The gig economy is a model of labour relations based on temporary informal employment as opposed to full-time

employment, made possible by the emergence of digital employment platforms, technically implemented through mobile applications, to find workers for "on-demand" work. These are such types of work as Uber, Bolt, Airbnb, and Uklon taxi services. These are also "cloud robots" whose tasks can be performed via the internet anywhere on the planet. For example, a machine learning and artificial intelligence company, CrowdFlower works in a human-in-the-loop mode, cleaning big data and enriching it, which is then used by AI algorithms. It operates on a business model as a SaaS software development company, not a managed service. Given that this work is provided by a platform that brings together buyers and sellers, customers and executors, this mechanism is controlled by artificial intelligence algorithms guided by rationality, optimisation, and efficiency principles. The result of the gig economy is the generation of unprotected forms of employment, the so-called precarisation of work.

On the other hand, people in many developing countries can earn an income, develop new skills, and join professional networks. Although, in our mind, this is a person's compulsion to change, a forced adaptation of a person, which transforms them not always according to their own will. So, while the gig economy provides work in volatile times, it usually does so in precarious conditions, creating a precarious class of dependent contractors and on-demand workers. These workers have fewer labour rights and less bargaining power than salaried workers and may receive low wages for little social protection. In addition, AI algorithms are constantly adjusted in such a way as to minimise costs and adapt to the benefits of tax legislation and the minimisation of mandatory payments by employers to social insurance funds. Jobs in the gig economy compete with more secure traditional occupations such as taxi drivers and hotel workers. This competition between platforms and traditional forms of employment leads to the latter's displacement and exacerbates the problem of insecure employment and the deepening of social contradictions in the labour market in our time. The question arises as to how this will affect economic inequality. If the digital platform workers were poor people, unemployed, or middle-class people looking for a little extra income, then obviously, it would be a question of income growth. However, inequality will also increase if better-paid jobs replace these jobs, or full-time employment is replaced by part-time employment, and if the profits of digital platform owners grow faster than wages.

There is also the issue of marketable skills. If skills across occupations can be sold on the global labour market, wages between countries will tend to converge. Computer coding, digital design, medical diagnostics, and image recognition professions are popular in the global market. This allows you to join the global labour market. However, at the national level, the impact on inequality is more ambiguous because tradable work is usually reserved for low- and middle-income occupations. People in professions such as bankers, lawyers, and doctors are likely to be protected by the country's market regulation. The business also takes care of top managers already working in the global talent market.

The gig economy can exacerbate gender inequality, as women perform the lowest-paid jobs there. An ILO survey on digital platforms shows that, on average, women represent only one in three workers; and in developing countries, only every fifth worker. Another study found that while women work more hours on the platforms than men, they earn only about two-thirds of what men do (The Global Labour Income Share, 2019).

Under any circumstances, man and society find their manifestation and realisation in the process and results of work. This fact allows us to argue that labour, in all of its varieties and

forms, can be referred to as fundamental civilisational principles of establishment, functioning and development of human society at all historical stages of its movement, because any action, activity of people and society is primarily labour.

Within such activity over the course of the well-known recorded humankind history, one has set up civilisational principles and benchmarks of human participation in labour. Henry Ford also talked about the role of labour functions for the development of people: "labour and only labour is able to create values. An economic principle is labour. Labour is a human element that benefits from fruitful seasons"; "A moral principle is human right to labour. … only labour, just labour leads to the correct way towards health, richness and happiness." (Ford, 2018, pp. 12-13, 17).

There is a discussion that AI reduces labour demand. This discussion emphasises an important aspect of the relationship appeared between AI and automation that it provides. In an age of rapid automation and digitalisation, will deteriorate labour demand and workers will be particularly badly affected if new technologies are not raising productivity substantially. For this, they must be great to increase the productivity of related fields but not so-so. A new digital reality is expected to create new tasks for labour and increase productivity. In another case, if there are so-so automation technologies, labour demand declines: the displacement is there, while powerful productivity gains contributing to labour demand are missing (Acemoglu, 2019, p. 3).

This prospect engages contrasting in the reinterpretation of the history of technology and distinguishable standpoints about the future of work. There is room for a contest between automation and new, labour-intensive tasks. It is known that labour demand has not escalated steadily over the period of modern economic growth, which is defined as a period of the last two centuries under the influence of technologies that have made labour more productive in different directions. In contrast, many up-to-date technologies have encouraged removing labour from tasks in which it earlier specialised.

Simultaneously, labour has profited from advances in technologies, because related technologies have concurrently empowered the implementation of new labour-intensive tasks. These new tasks have done more than just restarted labour as a civilisational outcome but enhanced productivity growth (Acemoglu, 2019, p. 4).

This prospect creates a new way of comprehension about the economic capabilities and challenges advanced by AI. The primarily quantity of researchers observes AI as a creation of automation for a wide range of tasks. Among them, there are up-to-date applications helping with cognitive skills such as translation, image recognition, speech recognition, customer support, and the internet of things. But these are not the main modes that AI could be and primarily has to be used.

To keep in mind what chances AI really offers, it should be mentioned several options on the labour-related path. Firstly, in AI deployment must be not only the continuation of automation but counterbalancing innovations to create new tasks. If only AI generates automation, it will negatively impact labour, which can be accompanied by a reduction in labour engaged in the production process, productivity decline and increasing income inequality.

Secondly, room for human labour in AI-based automation still exists. Such areas as speech recognition and hand-eye coordination can be automated by AI technologies, but they don't remove all human skills from those fields. The limitations of AI-based automation are felt. But researchers see a true way out of these limitations by understanding AI as "… a technology platform, it can be developed for much more than automation." (Acemoglu, 2019, p. 5). Moreover, AI-based technologies can reconstruct the existing production processes with the creation of labour-intensive tasks that are high-productive also. To emphasise, it is expected huge societal benefits from AI as a platform and technology that creates new inquiries for labour-intensive tasks. The productivity growth as a result of deploying AI is also expected. It leads to sustainability and solving tasks concerning with it as economic inequality, poorness, unemployment, climate changes, environmental protection, etc. (Artificial Intelligence for a Better Future, 2021)

Platforms, as a result of the development of AI technologies, create a new labour market. On the one hand, it is referred to changes in the organisation of the classic living labour market, which are manifested in the emergence of a "flexible, virtual labour market", "distance relations" between employees and employers, quite rapid increase in the amount of freelancers (only in the USA in 2018, 56.7 million people worked in a freelance mode, which is 36% of country's working population) (Golovenchik, 2019, pp. 307-308). According to the majority of researchers on this problem, one more particularity of the modern labour market (within the first area of its transformation) is the priority of "flexible" and "digital skills" of potential candidates: personal qualities and social skills, for example, the ability to work in a team, curiosity, initiative, critical thinking, self-management, the ability to solve complex tasks, interact with other people, properly set priorities etc. (Ibid, 2019, p. 310).

Another significant area of the transformation of the field and forms of human labour functioning is their changes under the influence of the nanotechnological revolution. In the context of technological revolutions, rapid growth of robotic, digital economy, the need for some of the above-mentioned civilisational labour functions either disappears or transforms beyond recognition, obtaining false, skewed forms. Today, the whole range of leading corporations, such as Magic Leap, Microsoft, Hoaloha Roboticus, Google, DeepMind and others, are shifting to the next technological wave. In Japan, it is called Society 5.0 (the fourth one was information, the third one – was industrial) that will be based on the combination of physical and cyberspace technologies in a single complex. It means unifying of robotic systems, bio and nanotechnologies, photonics, quantum equipment and a human-machine interface with advanced solutions of engineering cybernetics, artificial intelligence, big data, Internet of Things, etc. (Lebedeva, 2019, pp. 22-23).

By the way, in 2016, such challenges and threats, probably for the first time, gained quite distinctive mass-specific forms when "Foxconn, a Chinese manufacturer of electronics, hired 40,000 robots, reducing 60,000 employees, as well as planning to increase the rate of automation by 20-30% per year and replace all of its product assemblers (at least half a million) in three stages. According to McKinsey, one will be able to automate human labour at the cost of 2 trillion dollars using existing technologies in the coming years. Up to 2036, one will be able to automate from 2% to 50% of labour expressed in person-hours and up to 46% to 99% up to 2066. More impressive forecasts are provided by scientists from AI Impacts, Future of Humanity Institute (Oxford University) and the Department of Political

Science (Yale University) due to the results of 2017's major survey. By estimations, researchers with a 50% probability believe that artificial intelligence will outpace people in all tasks within the next 45 years and automate all human workplaces in 120 years. Meanwhile, Asian respondents expect these events much earlier than North Americans (Golovenchik, 2019, pp. 313-316, 319). At the same time, researchers express a reasonable opinion that one can totally agree with and that, unfortunately, is not perceived by those building a strategy of global economic and social development: "The development of economic digitalisation and capitalisation processes will give a positive effect for society only if comparing with economic socialisation processes. It implies substantial changes in the social system, evolution of activity types related to the leisure time sector and formation of new human abilities", which causes a range of problems and challenges for society." (Grytsenko, 2018, p. 15).

Simultaneously, such concerns exist according to the process of new technology diffusion. This warning regarding the too-fast adoption of advanced technologies is also expressed by Guo Kaitian, Senior Vice-President at Tencent (a leading company engaged in digital technologies estimated at 256.6 billion dollars). He believes that "adoption of technologies is a quite expensive process while their deep impact on society is much more complicated than people can imagine. It is referred not only to the enhancement of manufacturing efficiency. The impact of technologies goes far beyond its boundaries, destabilising the structure of social division and allocation of labour." (Ma Huateng et al., 2019, p. 13). Statistical figures show that daily consumption of scientific and technological progress products results in the loss of the main thing – a human being, their needs and demands. Evidence suggests that the majority of people can't keep pace with the extreme development of technologies. At the same time, society as a group of individuals has to advance, mature and become controlled. Well, scientific and technological progress is one of the main forces of human society advancement. Another similar force is the human propensity to self-analysis (Ibid, 2019, pp. 14, 16).

Besides challenges, problems and contradictions accompanying the process of qualitative systematic transformation of any technological method of production, key risks in the context of the scientific revolution and digital economy include the decline, or even the loss of totality of such civilisational labour function as its affordability and continuity of reproduction for the significant number of people worldwide. It will definitely complicate human socialisation processes, conditions for self-actualisation, creative development and turn many people into outcasts and pariahs within operating society.

In our opinion, in case of perceiving such an attitude, we will have to admit the beginning of the actual end of history, namely human civilisation. Fortunately, in reality, the reverse process takes place: sense-making labour functions in the context of the Fourth Industrial Revolution are just expanding. So, for instance, André Gorz stresses that "employees are not just owners of their external human resources (i.e., abilities defined by employers), but products of self-production, which keep working on self-creation." (Gorz, 2010, p. 27). Thus, it is reasonable to state that actual "sense-making" functions in the context of the global digital economy do not disappear but, on the contrary, even in the case of dualisation, dualism (human-centered/transhumanistic paradigm), become actual, obtaining brand-new forms of

manifestation and a new intended purpose in the system of strategic target setting of human civilisation development.

We can see the substantial transformation of such a civilisational labour function as realisation and recognition of the need for interaction among different people, teams and states in the labour process due to the emergence of a new type of human relations in production, economic activities – human beings and artificial intelligence, robots and the system of robots. How will this aspect affect human adaptation to new relations in the labour process, what will this relationship look like – subject-to-subject or subject-to-object, and who will play a role of subject in these relations? This question can be answered only using self-analysis.

What requires comprehension is the focus, boundaries of such a civilisational labour function as development and assurance of the space for trust between economic (and social in its new forms and conditions) life entities. According to the results of global research called 'The 2020 Edelman Trust Barometer', "the majority of the population (56%) worldwide thinks that capitalism in its current form causes more damages than benefits; three-quarters of inhabitants feel unfairness in society and desire changes. Negative views on capitalism primarily dominate in developing countries, in Thailand (75%) and India (74%), although more than half of respondents are their followers in many developed European countries: France (69%), Italy (61%), Spain (60%), the Netherlands (59%), Germany (55%), the UK (53%). People consider the government institution as the least fair (57% of the global population)." (Biryukov, 2020, pp. 18-19).

Such a level of trust worldwide to key political and economic institutions challenges caused by rapid development and application of artificial intelligence leads to intensifying contradictions in the whole traditional civilisational systems, which requires a new methodological paradigm of grounding potential ways of coming out of society's crisis.

Meanwhile, the same complex problems are caused by the fast integration of such revolution achievements as artificial intelligence into real economic life. Its diffusion causes a whole range of methodological, moral, ethical and practical questions, such as: How to deal with trust in artificial intelligence, and robots when they make managerial decisions? What will be their attitude to decisions made by people in the manufacturing process, to the necessity to create not just material and non-material benefits, but moral benefits? What if this will decline the role of the trust institution in social and labour relations at all levels of the social division of labour? Who will define the degree and viability of the creative character of labour?

### *4.5. Economic philosopher's comprehension of the new paradigm of human civilisation: values and ethics approach as more than practice one*

At the beginning of the 21st century, a new strategic paradigm of human civilisation development was conceptually formed, seemingly attractive and tempting: the creation of a superhuman, new forms of human existence, etc., which will definitely lead to fundamental qualitative changes in values of all areas of social and economic life worldwide if this paradigm is implemented.

To emphasise, attitudes and approaches to recognition of the existence of fundamental values, civilisational principles and benchmarks, "which have a necessary and absolute character, and are not subject to the flow of time", their essence and role in the preservation and constructive development of human civilisation, are mostly aligned among researchers of different times and nations. Some researchers believe that there is also "the background for our moral values in modern society" (in other words, globalised, information, digital society, etc.) when dominating is the thought that it (society) can do without morality, as the private interest will lead us to the nirvana of mass prosperity, when "greed is a good thing (Collier, 2021, p. 80). Such basic values, in author's opinion, include "six values appearing to be common for people who live in the most diverse corners of the world, and none of them comes from the mind. Care for near ones and freedom are, probably, the primary values from the perspective of evolution. Fidelity and respect for sacred things were established as values keeping a group. Justice and hierarchy standards were developed as a way of order preservation in a group, while respect was the reward for their compliance. Our values are significant, because the fulfillment of our obligations required by them is more important than the satisfaction of our desires." (Collier, 2021, pp. 80-81).

In terms of understanding and recognising the persistent, eternal role of mutual interaction of the essence and functions of the particular level of values and fundamental values, quite interesting is the viewpoint of Francis Fukuyama (2020). He provides original and reasoned arguments for existence, even in the context of dynamic and, to a certain degree, biased, unconscious, remonstrative atomisation of the individual as a member of the society of this sustainable interaction.

Scientists, defining the essence and role of culture in the establishment of civilisation and principles of its functioning, consider a constructive concept, according to which, "a human being is a creature abiding by the rules, which is mostly distinguished from animals by having culture, primarily the block of rules, which determine external boundaries for its personal individual activity." (Sztompka, 2013, p. 271). To summarise, the majority of culture definitions stress that it focuses on a proper, expected in this society lifestyle, describes how people should act, what may not coincide with what they would like to do, and how they behave in practice.

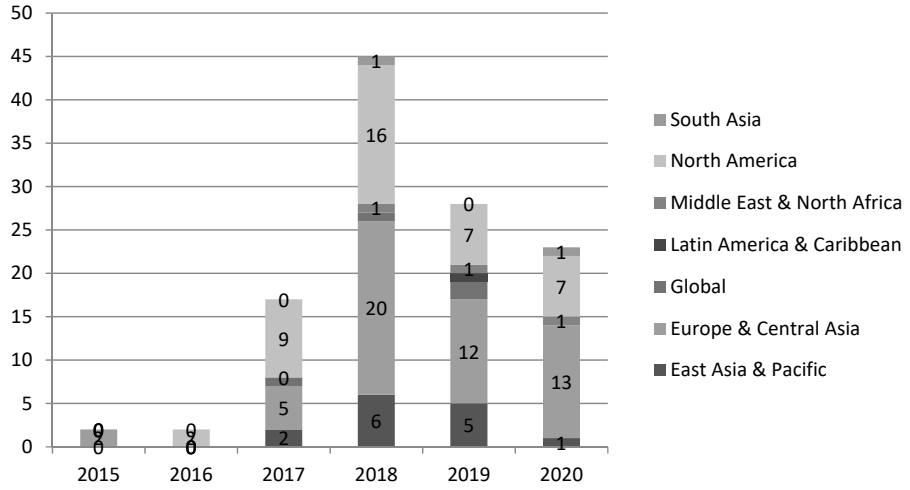
In the context of the nanotechnological revolution, when the idea of creating a new human being, overhuman, homo roboticus, etc., is expressed more and more obvious, culture as a civilisational principle and civilisational milestone become vitally important in the struggle for preservation, or vice versa, for change in the identity of human being, human society, human civilisation. In fact, people as key figures in the functioning and development of existing civilisation contain qualities that make them extremely stubborn and flexible, even to hurricane mega-changes in nature, technologies and society. This feature was mentioned by G. Hegel, stressing that a human being as an individuality retains an endless multiplicity of relationships belonging to the certain content of human nature.

To confirm our conclusions, it is remarkable to address the data in the ethical principles of AI deployment. As written in the AI Index Report, 2021, researchers from the AI Ethics Lab (the USA, Boston) invented a ToolBox that calculates the increasing number of AI principles. Notably, a total of 117 documents concerning AI principles were brought out between 2015

and 2020. Data reveals that Europe and Central Asia have the highest number of publications as of 2020 (52), followed by North America (41) and East Asia and Pacific (14) (Figure 3). In terms of rolling out ethics principles, 2018 was the clear high-water mark for tech companies – including IBM, Google, and Facebook – as well as various UK, EU, and Australian government agencies.

Figure 3

Number Of New Ai Ethics Principles By Region, 2015-2020



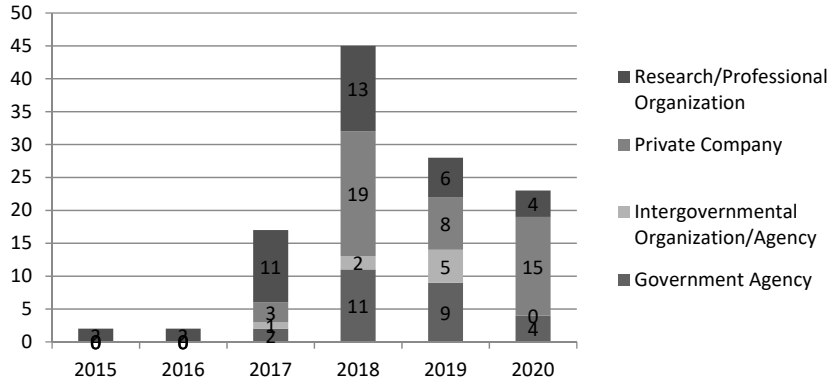

*Source: AI Ethics Lab, 2020 | Chart: 2021 AI Index Report, p. 130.*

The ethical issues of AI are prevalently deployed in beings' life within the current decade and are subject to scrutiny. So far, to emphasise the growing interest to integrate values in the assessments of AI outcomes, the data collected in Artificial Intelligence Index Report 2021 demonstrate the particular interest in this research. As one knows, AI-based technologies can lead to negative consequences, among them the violation of labour rights, discrimination on gender, opaque decision-making, lost the human identity under automation, etc. Due to existing value challenges and ethics in their basics, the task of creating responsible and fair AI innovations has arisen. The open data and analysis made by Stanford University Human-Centered Artificial Intelligence show a growing proliferation of papers describing AI principles and frameworks within media (Figure 4).

According to the Stanford University team's search in NetBase Quid, the analysis of 60,000 English-language news sources and over 500,000 blogs in 2020 on AI ethics issues demonstrate that there were 3,047 articles about AI-related technologies. Remarkably, the articles use words such as "human rights," "human values," "responsibility," "human control," "fairness," "discrimination" or "nondiscrimination," "transparency," "explainability," "safety and security," "accountability," and "privacy." (Artificial Intelligence Index Report 2021).

Figure 4

Number Of New Ai Ethics Principles By Organization Type, 2015-2020




*Source: AI Ethics Lab, 2020 / Chart: 2021 AI Index Report, p.130, https://aiindex.stanford.edu/ai-index-report-2021/.*

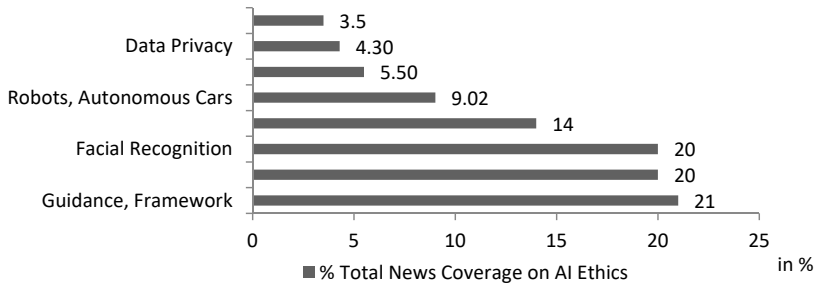
In comparison, ethical issues, as shown by studies since 2015 (Figure 4), have been incorporated into regulatory documents by governments, private companies, intergovernmental organisations, and research/professional organisations. These documents define the ethical problems of using artificial intelligence in practical activities. These documents contain the principles of assessing the relationship between business entities regarding the deployment and application of AI in organisations of various types. In essence, these principles of relationship management in the context of artificial intelligence are about respecting the rights and freedoms of employees and preventing discrimination that may arise in connection with the use of AI. But this is only the beginning of ethical management in the application of artificial intelligence. Therefore, experts determine their vagueness and do not make their application mandatory due to the weakness of the institutional base (Artificial Intelligence Index Report 2021; Henz, 2021).

Figure 5 represents that papers concerning AI ethics guidance and frameworks peaked at the record of the most printed news topics (21%) in 2020, accompanied by research and education (20%) and facial recognition (20%). The less cover AI ethics topics were AU explainability (5.5%), data privacy (4.2%) and enterprise effort (3.5%).

All this data confirms the preciseness and practical orientation of this research. The presented problematic options for the transformation of particular values in the conditions of the new socio-technological reality testify, firstly: about the need to recognise such a process and systematic preparation for entering it and the corresponding adaptation of civilisational norms and orientations of human life and society in a new environment; secondly, about the need to use the established traditional civilisational principles of the economy and society for their preservation and development in the interests of man. We are obliged to proceed from the recognition, understanding and desire to implement the strategic goal of any qualitative changes in the technological method of production to make the life of man, human civilisation more comfortable, safer, and more promising.

Figure 5

News Coverage on AI Ethics (% of Total) by Theme, 2020




*Source: NetBase Quid, 2021Artificial Intelligence Index Report. Stanford University. Human-Centered Artificial Intelligence, p. 131.*

## 5. Conclusion

Among such particular and fundamental civilisational values, we include the following basic values, which have economic and non-economic (social, political, legal, democratic values) prerequisites for their provision:

1. Life and health of a person, their honour and dignity as the highest economic, political and social values and priorities of the state and society. The preservation and development of these values of humanity must be ensured in the system of deployment of high technologies, such as artificial intelligence and machine learning, and their algorithms, which can have an aggressive marketing character and serve the interests of capital owners in the post-capitalist economic system. It makes rational sense to use the means of public administration and the legal system of the state to prevent and limit the deployment of technologies that directly or indirectly threaten the life and health of a person, humiliate their honour and dignity, limit their right to private life and individual freedom, and/ or nullify the civil right to selective (limited, regulated) access to personal data.
2. Human knowledge and skills should remain dominant in the new economic and technological reality. They must also be complicated by AI-related technologies. For example, the following are ways of ensuring the specified value: legal and economic protection of labour rights; creation of conditions for professional development and retraining of employees to get equal access to getting labour-intensive skills; the primary right of a person to a workplace that can be computerised and automated; the development of adaptive human labour systems, namely government support for employers who retain human-based jobs as opposed to computerised, automated jobs, or the development of hybrid workplace systems where successful business practices coexist with serviced workplaces artificial intelligence technologies and human intelligence, human knowledge and skills.

3. "Free development of individuality" (according to Mill) involves revealing the full potential of a person, both physical and creative, professional and intellectual. The economic and political systems of countries should contribute to this through equal access to starting opportunities under the conditions of revolution 4.0. The guide to action for developed states is the principle of two-dimensional justice, where the key factors are ensuring economic independence and participation of members of society in decision-making, preventing the humiliation of their human dignity, and guaranteeing social status through the distribution/redistribution of material goods, creating conditions for equal respect and equal opportunities (primarily in education) (Fraser, 2003).
4. Respect for diversity and identity, and social justice. Humanity is moving towards tolerance in the management of all spheres of human life, where there should be recognition of the advantages of differences and diversity, pluralism of opinions, and approaches in the economy. Intellectualization, morality, spirituality, responsibility, socialisation of subjects of economic and social life, aiming at ensuring optimality in the ratio of the market and social justice at the micro and macro levels, etc., should be the key value orientations of economic and technological changes.
5. Peace and security. Civilisational values of good and evil, which means the prevention of war, any form of aggression by some states against others, including hybrid wars using AI technologies, threats to national security, and threats to invade the sovereign territories of states. The value of the good correlates with the economic maxim – the prevention of extreme poverty and inequality, the economic values of the modern economy are based on ethical principles of using AI-related technologies, which means incentives and motives for the principle of human-centeredness in the implementation of economic and social policies.

To conclude, even in the context of rapid development and systematic adoption of artificial intelligence in all spheres of economic and social life across the globe, we should rely on the recognition, understanding and aim to implement the strategic goal of any qualitative changes in the technological method of production: to make living conditions of human beings and human civilisation worldwide more comfortable, safe and promising.

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# STOCK INDICES AS INDICATORS OF MARKET EFFICIENCY AND INTERACTION[5]

*The efficient market hypothesis dominates in the studies on the effectiveness of stock market performance, one illustration of which is the presence of calendar anomalies of different nature. The advent of the Adaptive Market Hypothesis calls into question both the presence of such anomalies and the effectiveness of the stock market. To confirm the effective market hypothesis, the time series behaviour of the rates of return of the most significant global stock indices and a local Ukrainian PFTS Stock Index has been investigated in the work. According to the study results, the efficient market hypothesis has not been confirmed; the results partially confirm the adaptive market hypothesis. To confirm the hypothesis that global stock markets have an impact on local stock exchanges, a pre-selected sample of time series of stock index rates of return was used. The Granger causality test was used for this purpose. To determine whether the time series of the dynamics of the stock index rates of return are stationary, the advanced Dickie-Fuller test was used since it takes into account the possible autocorrelation in residuals. The Phillips-Perron test was used as well.*
*Keywords: S&P; NIKKEI; DAX; FTSE; PFTS; day-of-the-week; calendar; anomalies; effect*
*JEL: G10; G15*

## Introduction

The modern stock market is an important component not only of the country's financial market, but of the country's economy as a whole. The highly liquid stock market, along with

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the country‘s efficient banking system, can stimulate economic development primarily by attracting funds from investors. At the same time, in most studies, the hypothesis of efficient markets assumes that the previous prices of a financial asset cannot be used for forecasting future prices, and therefore the price of financial assets changes accidentally, due to the appearance of new information, since the price contains all the existing information on the market. However, the studies conducted on the example of different stock markets with different development levels showed the presence of calendar anomalies of different nature, called as the day-of-the-week, January, turn-of-the-month, Halloween and Dekansho-bushi effects.

Despite the considerable amount of researches, this problem is still the focus of attention for scientists from all over the world. Gradually, additional factors of various nature were introduced, such as the market conditions – recovery or decline, the quality of financial assets – high-quality or purely speculative, the level of market development - developed, developing or frontier market, etc. For today, there is no general consensus as to the presence of such calendar anomalies, as well as the effect of investor sentiments on decision-making regarding the transactions in financial assets. Moreover, in the early 2000s, a new Adaptive Market Hypothesis emerged, which, in contrast to the efficient market hypothesis, casts doubt on the existence of an efficient market. According to this hypothesis, investors act rationally, but mistakes can be made, however, they learn to adapt to the dynamic market environment, that is, the periods of market efficiency alternate with the periods of its inefficiency, which manifests itself in the market conditions, profit-making conditions, number of market players and so on. In turn, the presence of calendar anomalies indicates that markets are not constantly efficient, so the efficiency changes over time. The adaptive market hypothesis confirms that such adaptation, as well as innovative tools, are the result of competition between investors and natural selection in favour of more powerful players. That is to say, the adaptive market hypothesis confirms that effective market and market anomalies can coexist.

For Ukraine, like for most countries, this problem is very pressing, despite the low development of the local stock market, but in such conditions, the problem of calendar anomalies can be further exacerbated. In addition, for the Ukrainian stock market, its integration into the world stock market is becoming increasingly important, as well as the justification of the presence or absence of influence from world stock exchanges. The reasonable existence of such influence will allow to make more exact forecasts concerning the functioning of national stock exchanges. All of the above-mentioned material has determined the relevance and purpose of the study.

## 1. Literature Review

The issue of the formation of effects and certain patterns that frequently occur in the stock markets is the focus of researchers from different countries, and such effects can occur, both in the well-developed global stock markets and emerging and developing ones.

Regarding the developed markets, the historical evolution of monthly anomalies – the January effect, the December effect and the Mark Twain effect in the stock markets of the

USA, UK, Japan, Canada, France, Switzerland, Germany and Italy has been systematically investigated by Plastun A. at al (2020) using different statistical methods (average analysis, Student's t-test, ANOVA, the Mann – Whitney test and a trading simulation approach). The January effect was recognized as the most widespread among the three monthly anomalies, but it was determined that it existed in the mid-twentieth century and was typical for the US stock market. Since then, it has no longer manifested itself. At the same time, other calendar anomalies still exist and appear in stock markets as the December effect in the Canadian stock market and the Mark Twain effect in the UK stock market. Moreover, the calendar effects can appear in emerging markets, too, and that is why these studies are interesting not only scientifically but also practically.

As regards the anomalies appearing in the middle of the month, the study by Rosenberg M. (2004), in view of the basic research by Ariel, R. A. (1987), found that the effect of the month has a direct relationship with the business cycle, which is important for the systematic study of the market sustainability issue.

Rounaghi M. M. and Zadeh F. N. (2016), using the ARMA model, compare the S&P 500 and the London Stock Exchange and note that both markets are efficient and have financial stability during periods of boom and bust.

Khan M. S. R. and Rabbani N. (2018), having analyzed bidding data on the Japanese market from 1979 to 2018, firstly concluded that calendar anomalies in the Japanese stock market were not detected. To do that, they used the least squares method or a generalized form of autoregressive conditional heteroscedasticity. After that, for more detailed analysis, the authors arranged the same data into relevant ranges which corresponded to the UP and DOWN market conditions. Applying the same methods – the least squares method and the generalized autoregressive conditional heteroscedasticity revealed the presence of different calendar anomalies (the day-of-the-week, January, turn-of-the-month, Halloween effects), but these anomalies were observed only when the market went up, but when the market went down these anomalies in the Japanese market were never observed.

Chiah, M. and Zhong, A. (2019) analyzed the day-of-the-week effect on the example of twenty-four countries from four regions of the world (Europe, North America, Global excluding the US and Pacific), taking into account the proposed by Asness, CS, Frazzini, A., Pedersen, LH (2019) a quality-minus-junk factor, at that profitability, growth and safety are the main attributes of quality. As a result, they concluded that investors made more optimistic market forecasts for speculative securities on Friday, as their mood was significantly improved and on Monday, the situation looked more pessimistic, as investors' mood was also pessimistic.

Wats S. (2019), having examined the situation on the stock market of India for the period from 1997 to 2016, which is considered to be one of the emerging markets, has concluded that despite the fact that the Indian economy is growing rapidly, India's stock market is inefficient and does not fully ensure the performance of its functions. The reason for this is the lack of sufficient highly liquid assets, as well as an adequate number of investors. Among all possible anomalies that may occur in the stock market, the study identified some calendar anomalies, such as the day-of-the-week effect.

Obalade, A. A. and Muzindutsi, P.-F. (2019), on the example of stock markets in Africa, prove the presence of calendar anomalies when the situation in the market changes, that is, bull and bear market situations. They state that some anomalies appear in one situation and disappear in another one, thereby confirming the adaptive market hypothesis.

Tevdovski D. at al. (2012) studied the day-of-the-week effect from 2006 to 2011 on the example of five countries from South Eastern Europe (SEE): Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia and Serbia in the most recent period characterized by a bear market conditions. Applying a regression with dummy variables, the so-called Analysis of Variance (ANOVA) model, as well as the Wald test showed that this effect appeared only on the Croatian and Bulgarian stock markets, as the average daily profitability of leading national indices on Monday was lower than on other days, which was not confirmed for other countries in the sample.

In view of the active development of the Islamic financial market in recent years, the presence of calendar anomalies in the stock markets of Islamic countries is also becoming increasingly important to investors. Khurram MU at al. (2019) investigates the effectiveness of the financial markets, their integration and shock transmission channels in the example of eight stock markets of the Islamic developing countries of D-8 group, established in Turkey in 1997, comprising Pakistan, Bangladesh, Iran, Indonesia, Malaysia, Turkey, Egypt, and Nigeria. The study period covered 2011-2016. Unit Root Test, Serial Correlation Test, Runs Test, and Variance Ratio Test were used in this study to evaluate the market effectiveness as well as Johansen Cointegration Test, Granger Causality Test, Vector Error Correction Model and Impulse Response Test were used to prove the presence of financial integration between the stock markets and shock transmission. The study concluded that the markets were poorly performing and that there was only a short-term benefit for investors. A. Alotaibi and A. Mishra (2017) determined the degree of international integration of stock markets in the region of the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates) on the basis of data generated by 2002–2013 period. The presence of significant fluctuations in the indices of stock markets of these countries was substantiated, which is formed under the influence of local risks, according to the authors.

Taking into account the ambiguity of the research results of the functioning of stock markets and their compliance with the hypothesis of an efficient market in the early 2000s, there are works that indicate that investors in the stock market can act rationally. The works of A. Lo (2005, 2007, 2012) should be singled out among the works in which the hypothesis of an efficient market is questioned and the hypothesis of an adaptive market is substantiated. In particular, it is noted that markets may not always be efficient, but they are usually competitive and able to adapt depending on how the market environment and the number of investors change over time.

Regarding the Ukrainian stock market, rational and irrational investor behaviours were analyzed and a situational approach was used to avoid losses (Kushnir, 2016). In addition, Caporale GM at al. (2019) studied the effects of force majeure (economic force majeure, social, natural and man-made disasters, as well as the acts of terrorism) on pricing in the stock market of Ukraine and specified that the market absorbs all information and transforms it into prices except for the cases of natural and man-made disasters. Shkolnyk, I. et al. (2017)

studied the problems of ensuring the protection of investments of individual investors in the stock market of Ukraine, studying the experience of countries with developed stock markets. In another paperwork by Shkolnyk, I. (2021), studying the development trends of the stock market of Ukraine for the 2015-2020 period under the influence of global stock markets, we argued that the dynamics of trading on stock exchanges of Ukraine is 50% determined by the situation on stock exchanges of American region.

Regarding the studies of the mutual influence of world stock indices on the formation of Ukrainian stock indices, it should be noted that I. S. Blahun and I. I. Blahun (2020) conducted a study based on data for the 2010-2017 period and found a unilateral impact on the PFTS index by the global stock indices Standard & Poor's Global Ratings, NIKKEI 225, FTSE, DAX, WIG, as well as the presence of long-term balance between the PFTS index and the group formed from these indices. At the same time, starting from 2018, the results of the reform that implements the regulators of the financial market of Ukraine are becoming more tangible, so the results obtained in this work may not coincide with the results obtained earlier.

Given the limited number of studies on the appearance of anomalies in the Ukrainian stock market, there is a need for such studies. In addition, it is important to specify whether there is a relationship between the local Stock Exchange PFTS, which is one of the largest stock markets by the traded volume in Ukraine, and the global stock markets.

These three countries are relatively small and underdeveloped in terms of their geographical size and population, geopolitical importance, market size and aggregate demand, production, investment, export, and technological potential. According to many non-economic indicators (political stability, democratization, liberalization and institutionalization of society, law, infrastructure development, safety, security, investment, compliance with environmental and social standards, efficiency of the legal system, human rights respect, etc.), as well as economic indicators (purchasing power, rate of economic growth, foreign trade balance, current account deficit, public debt, inflation rate, unemployment rate, public expenditure, investments, etc.), they are characterized by a long-term transitional crisis of structural type.

## 2. Methodological Approach

This study was based on the data of the time series behaviour of the rates of return of the most significant global stock indices – Standard & Poor's Global Ratings 500, NIKKEI 225, FTSE 250 and DAX. A local PFTS Stock Exchange was selected to conduct this research. The choice was also guided by the fact that the PFTS index, taken into account when analyzing the stock market conditions in Ukraine, is formed in view of trading on this stock exchange. The study period covered 2014-2021. Data were processed using eViews and MatLab program.

The study was conducted as follows. Firstly, a data extract of daily rates of return for these indices over a specified time period was made. Then the determined rates of return for the stock indices were divided into five groups: the first group - the trading week of each month, between the $5^{th}$ and the $11^{th}$ day of the month; the second, third and fourth groups are,

respectively, the second, third and fourth full weeks of the month. The fifth group includes the weeks, which cover the end of one month and the beginning of the following one. As for the fifth group, it covers the weeks that fall before the 5th day of the month. For each of the groups, the average rate of return for the week was calculated on the basis of values of the index during the fixing at the last session of the week.

Based on these data, the weekly rate of return for each stock index was individually determined, and their normalization was carried out by the formula:

$$R_w = \frac{I_2 - I_1}{I_1} \quad (1)$$

where:

$R_w$ is the average rate of return per week;

$I_1$ is the index value during the fixing at the last session of the previous week;

$I_2$ is the index value during the fixing at the last session of the current week.

The obtained normalized indicators are used for all calculations in order to establish the presence/absence of the impact of the state of world stock markets on the situation developing in the Ukrainian stock market.

The Granger causality test was used for this purpose. To test the time series of the stock index rates of return for their stationarity development, the augmented Dickie-Fuller test was used, since it takes into account the possible autocorrelation in residue. The Phillips-Perron test was used as well. Both tests are the tests for unit roots; that is, the equations of the autoregressive time series model have roots that are equal to a unit modulo. The cointegration tests were also conducted.

For a more objective result as to the relationship between the figures analyzed, nonlinear dependencies are identified using fuzzy databases. The model of fuzzy logic inference is an approximation of the input-output dependence based on the linguistic rule "IF ... THEN". An adaptive neuro-fuzzy inference system (ANFIS) based on Takagi-Sugeno fuzzy inference system is used for this purpose (Takagi, Sugeno, 1985). ANFIS model was proposed by Jang, J.-SR (1993), and is a multilayer neural network with direct signal propagation. The relationship between the input $X = x_1, x_2, \dots, x_n$ and the output y is defined by a fuzzy database, using the following rules:

$$IF\ x_1 IS\ X_{1,i}\ AND \dots AND\ x_{n_x}\ IS\ X_{n_x,i}\ THEN\ y = f_i\left(x_{1,}\ \dots, x_{n_x}\right), i = 1, \dots\ n_r \quad (2)$$

where:

$X_{1,i}, \dots, X_{n_x,i}$ – linguistic value in the antecedent of the ith rule;

$f_i\ (x_1, \dots, x_{n_x})$ – function in consequence of the ith rule.

The output in the model is defined as follows:

$$y = \sum_{i=1}^{n_R} \omega_i(x_1, \dots, x_{n_x}) \cdot f(x_1, \dots, x_{n_x}) / \sum_{i=1}^{n_R} \omega_i(x_1, \dots, x_{n_x}), \quad (3)$$

where:

$\omega_i(x_1, \dots, x_{n_x})$ – degree of implementation of the ith rule.

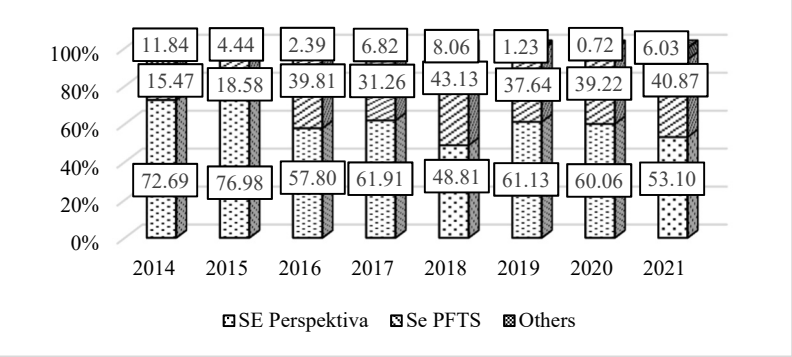
In this model, the database is hybrid; that is, its rules contain fuzzy sets and it is written as a clear linear function. In the model, several linear laws can be executed at the same time, but with different significance.

## 3. Conducting Research and Results

To assess the situation on the local Ukrainian market, the indicators characterizing the trading on the PFTS Stock Exchange, which was one of the first stock markets created in Ukraine, were used. Before the crisis of 2008, it was the stock exchange of the largest share of trading, and such situation had been observed since the early 2000s. Then, the share of trading on the PFTS Stock Exchange gradually decreased to 15% in 2014, which was a crisis for the Ukrainian economy, primarily due to some political factors. In general, since 2012-2014 stock market transactions were concentrated on two stock exchanges – SE PFTS and SE Perspektiva. After 2014, the situation was gradually balanced and as of 2021, the share of the trading on the SE PFTS was 41%, and on the SE Perspektiva – 53%. At the same time, the PFTS index has been calculated in Ukraine for a long time, it is taken into account by financial market regulators in Ukraine when building macroeconomic forecasts, it can form a sufficient sample, which can be compared with data from global stock markets.

Figure 1

Structure of trading on the stock exchanges of Ukraine




*Source: compiled by the author according to the data of the National Securities and Stock Market Commission.*

Based on the formed data extract of daily rates of return of world stock indices and the PFTS index, it can be stated that a clear trend in the behaviour of the rates of return on any stock exchange during the whole analyzed period was not observed.

In the context of individual indices, no patterns of anomaly manifestation at the beginning or at the end of the month were established, so it could be argued that the condition of the studied markets within the period from 2014 to 2021 cannot be considered rather effective. That may be due to the post-crisis period for markets, as well as due to changes in the Ukrainian market in the legislation governing the functioning of stock markets.

Table 1

Effect of the week for index rates of return by year

| Indices | I group | II group | III group | IV group | V group |
|---|---|---|---|---|---|
| PFTS | | | | | |
| 2014 | 0,0299 | 0,0099 | 0,0120 | 0,0129 | 0,0347 |
| 2015 | 0,0056 | -0,0063 | -0,0086 | -0,0269 | -0,0119 |
| 2016 | 0,0252 | -0,0031 | -0,0206 | -0,0014 | 0,0101 |
| 2017 | 0,0139 | -0,0031 | -0,0011 | 0,0162 | 0,0082 |
| 2018 | 0,0053 | 0,0019 | 0,0188 | 0,0168 | -0,0032 |
| 2019 | 0,0104 | -0,0107 | -0,0033 | -0,0208 | -0,0128 |
| 2020 | 0,0044 | -0,0101 | 0,0058 | 0,0103 | 0,0029 |
| 2021 | 0,0052 | 0,0047 | 0,0062 | 0,0014 | 0,0015 |
| FTSE | | | | | |
| 2014 | 0,0154 | 0,0111 | 0,0136 | 0,0130 | 0,0166 |
| 2015 | 0,0034 | -0,0046 | -0,0013 | 0,0061 | -0,0106 |
| 2016 | 0,0080 | 0,0058 | 0,0001 | -0,0034 | 0,0173 |
| 2017 | 0,0109 | 0,0033 | 0,0066 | 0,0041 | 0,0111 |
| 2018 | 0,0054 | 0,0082 | 0,0036 | -0,0036 | -0,0048 |
| 2019 | 0,0020 | -0,0009 | -0,0028 | 0,0093 | 0,0007 |
| 2020 | 0,0041 | 0,0053 | -0,0038 | 0,0161 | 0,0021 |
| 2021 | 0,0014 | 0,0013 | 0,0038 | 0,0023 | 0,0028 |
| DAX | | | | | |
| 2014 | 0,0163 | 0,0128 | 0,0062 | 0,0181 | 0,0073 |
| 2015 | -0,0107 | 0,0130 | -0,0045 | 0,0027 | -0,0104 |
| 2016 | 0,0225 | 0,0032 | 0,0107 | -0,0007 | 0,0084 |
| 2017 | 0,0121 | 0,0117 | 0,0091 | 0,0030 | 0,0071 |
| 2018 | 0,0105 | 0,0104 | 0,0082 | -0,0100 | -0,0094 |
| 2019 | -0,0037 | 0,0055 | 0,0035 | 0,0139 | 0,0073 |
| 2020 | 0,0026 | 0,0083 | -0,0150 | 0,0204 | 0,0009 |
| 2021 | 0,0061 | 0,0081 | 0,0070 | -0,0009 | -0,0027 |
| S&P | | | | | |
| 2014 | 0,0157 | 0,0084 | 0,0152 | 0,0092 | 0,0058 |
| 2015 | 0,0114 | -0,0069 | 0,0054 | -0,0007 | -0,0098 |
| 2016 | 0,0060 | 0,0100 | 0,0032 | -0,0023 | 0,0202 |
| 2017 | 0,0116 | 0,0066 | 0,0084 | 0,0085 | 0,0121 |
| 2018 | 0,0134 | 0,0078 | 0,0041 | -0,0039 | 0,0010 |
| 2019 | 0,0070 | -0,0029 | 0,0032 | 0,0018 | 0,0049 |
| 2020 | 0,0045 | 0,0037 | 0,0008 | 0,0075 | 0,0026 |
| 2021 | 0,0044 | 0,0039 | 0,0056 | 0,0001 | 0,0052 |
| Nikkei | | | | | |
| 2014 | 0,0125 | 0,0107 | 0,0116 | 0,0027 | 0,0052 |
| 2015 | 0,0076 | -0,0034 | 0,0007 | -0,0112 | -0,0071 |
| 2016 | 0,0062 | 0,0075 | -0,0036 | -0,0021 | 0,0298 |
| 2017 | 0,0050 | 0,0054 | 0,0226 | 0,0271 | 0,0089 |
| 2018 | 0,0144 | 0,0095 | -0,0037 | -0,0047 | 0,0068 |
| 2019 | -0,0010 | 0,0001 | 0,0123 | 0,0064 | 0,0104 |
| 2020 | -0,0095 | -0,0049 | -0,0025 | 0,0137 | 0,0096 |
| 2021 | 0,0082 | 0,0040 | 0,0008 | 0,0010 | 0,0068 |

*Source: compiled by the author.*

Since 2015, Ukrainian financial market regulators such as the National Securities and Stock Market Commission and the National Bank of Ukraine have implemented a number of reforms aimed at clearing the financial market from illiquid and speculative financial assets,

as well as creating economic and technological conditions for the entry of foreign financial assets into the Ukrainian stock market and the possibility of transactions by Ukrainian investors. Similar conclusions can be drawn from the results obtained as the effect of the week and the effect of the day (Appendix A and Appendix B).

The next step is to test the hypothesis about the essential impact of global stock markets, namely – the US market with the Standard & Poor's Global Ratings 500 impact index, the Japanese market with the NIKKEI 225 impact index, the UK market with the FTSE 250 impact index and the German market with the DAX impact index, on the dynamics of the formation of stock index rate of return on local markets on the example of the Ukrainian market using the PFTS index. The series of stock index rates of return with a time lag in calculations equal to 2 were made using the Granger causality test (Table 2).

Table 2

Causality test for the series of stock index rates of return

| Null Hypothesis: | | F-Statistic | Prob. |
|---|---|---|---|
| S&P 500 | S&P 500 does not Granger Cause PFTS | 1,2982 | 0,3261 |
| | PFTS does not Granger Cause S&P 500 | 0,8615 | 0,4944 |
| FTSE 250 | FTSE 250 does not Granger Cause PFTS | 0,0394 | 0,9752 |
| | PFTS does not Granger Cause FTSE 250 | 1,2193 | 0,3721 |
| DAX | DAX does not Granger Cause PFTS | 0,0134 | 0,8985 |
| | PFTS does not Granger Cause DAX | 0,8142 | 0,4754 |
| NIKKEY_225 | NIKKEY_225 does not Granger Cause PFTS | 3,3505 | 0,0856 |
| | PFTS does not Granger Cause NIKKEY_225 | 0,8962 | 0,5241 |

*Source: compiled by the author.*

The study was conducted in two ways: firstly, it was determined whether the PFTS index contributes to changes in the Standard & Poor's Global Ratings 500, NIKKEI 225, FTSE 250 and DAX indices, and secondly, whether the global indices are retroactive in effect. The time lag 2 was taken for these calculations. At that, the null hypothesis about the nexus between the rate of return of the PFTS index and the rate of return of world stock indices should be taken into account. There was no significant improvement in the quality of the model due to the inclusion of the PFTS index rate of return in the list of indices of powerful global stock markets. The obtained results showed that in the first case, the probability of the PFTS impact on the selected world indices is insignificant and ranges from 0.3721 – as for FTSE 250 index to 0.4944 – as for S&P 500 index.

At the same time, a different dynamic can be observed with an inverse effect. The situation here is ambiguous, as the NIKKEY 225 index (almost 92%) and the S&P 500 index (67.39%) are characterized by the highest probability of impact on the local stock index; in other words, the dynamics of the PFTS index rates of return is determined by the situation on the Japanese and US stock markets. However, the DAX and the FTSE 250 indices, with an impact probability of 10.1% and 2.5%, respectively, do not have any influence on the PFTS index. Thus, there is an impact of world stock indices on the local index, but this influence is selective. Despite the fact that geographically Ukraine is a part of Europe, nevertheless, ties with European stock markets are not confirmed. Also, Shkolnyk I. (2021) reached the same result in their work using other models and basing on trading volumes in regions that accumulate trading volumes on stock exchanges of the US and European regions.

In addition, the impact of the US market can intensify in the future, since, after changes in the legislation of Ukraine, in 2020, the stock exchanges have the opportunity to carry out transactions with foreign financial acts, which have mainly American origin.

To justify the linkages between global and local indexes, the cointegration tests, which determine the PFTS index rate of return as a dependent variable, were used (Table 3). The highest dependence between the PFTS index is manifested with the FTSE 250 (71%) index, unlike the previous stage, and S&P 500 (65.4%), which in the previous stage showed almost the same result.

Table 3

Equations and cointegration tests. Dependent Variable: PFTS

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| S&P 500 | 0,6537 | 0,3128 | 1,6781 | 0,0812 |
| NIKKEY_225 | 0,3264 | 0,2025 | 1,1823 | 0,2126 |
| FTSE 250 | 0,7108 | 0,3171 | 2,1051 | 0,0451 |
| DAX | 0,0294 | 0,2517 | 0,1043 | 0,9322 |
| | S&P 500 | NIKKEY_225 | FTSE 250 | DAX |
| R-squared | 0,0745 | 0,0351 | 0,1052 | 0,0003 |
| Adjusted R-squared | 0,0745 | 0,0351 | 0,1052 | 0,0003 |
| SE of regression | 0,0115 | 0,0117 | 0,0113 | 0,0119 |
| Sum squared resid | 0,0052 | 0,0054 | 0,0051 | 0,0056 |
| Log-likelihood | 124,5261 | 122,4151 | 123,9813 | 120,7158 |
| Durbin-Watson stat | 1,9062 | 1,8934 | 1,8243 | 1,8485 |
| Mean dependent var | -5,06E-06 | -5,06E-06 | -5,06E-06 | -5,06E-06 (It is advisable in the Excel output file to choose a numeric format to get lack of E and replace these numbers in a line!) |
| SD dependent var | 0,0235 | 0,0235 | 0,0235 | 0,0235 |
| Akaike info criterion | -6,0632 | -6,0132 | -6,0761 | -5,9851 |
| Schwarz criterion | -6,0198 | -5,9679 | -6,0518 | -5,9541 |
| Hannan-Quinn criter. | -6,0532 | -6,0073 | -6,0771 | -5,9843 |

*Source: compiled by the author.*

The augmented Dickey-Fuller and the Phillips-Perron tests, which are unit root tests and enable to evaluate the quality of the regression model, were used to test the time series for stationarity development. The obtained results are shown in Appendix C. Since the probability value according to the results obtained by the Dickey Fuller and the Phillips-Perron tests were 0.0000 for all stock index rates of return, the null hypothesis that says that time series are non-stationary, was discarded, and it could be argued that stock index rates of return are stationary series, which are of the first-order integration, and therefore the model is appropriate. In addition, McQinnon's t-Statistic value in all indices without exception was less than an absolute ultimate value for the significance level of 1%, 5%, and 10%.

The last step of the study is determining the integration of the PFTS index with the group of world indexes. The results are presented in Table 4.

Table 4

Equations and cointegration tests (PFTS index as a dependent variable, cumulative effect of world stock market indices). Dependent Variable: PFTS

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| S&P 500 | 0,0008 | 0,6568 | 0,0013 | 0,9895 |
| NIKKEY_225 | 0,0985 | 0,2819 | 0,3481 | 0,7297 |
| FTSE 250 | 0,9051 | 0,54391 | 1,6651 | 0,1044 |
| DAX | -0,3083 | 0,2752 | -1,2521 | 0,2173 |
| R-squared | 0,1451 | Mean dependent var | | -5.06E-06 |
| Adjusted R-squared | 0,0745 | SD dependent var | | 0,0235 |
| SE of regression | 0,0127 | Akaike info criterion | | -6,0632 |
| Sum squared resid | 0,0052 | Schwarz criterion | | -6,0182 |
| Log-likelihood | 124,5261 | Hannan-Quinn criteria. | | -5,930783 |
| Durbin-Watson stat | 1,9062 | | | |

*Source: compiled by the author.*

As it was in the previous step, the formed time series were tested for stationarity. In this case, the probability value according to the results of the Dickey-Fuller test and the Phillips-Perron test was 0.0004 and 0.0000, respectively, which means that the time series nonstationarity was not confirmed, the McKinon t-Statistic value for the Dickie-Fuller test (-4.77) has less value than the absolute values of the ultimate value for the significance level of 1%, 5%, and 10%, the similarly expanded value of the adjusted t-Statistic value for the Phillips-Perron test (-6.6) has less value for the threshold (Table 5).

Table 5

Summary results of the Augmented Dickey_Fuller Unit Root Test and the Phillips_Perron Unit Root Test Cointegration tests (cumulative effect of world stock market indices)

| Augmented Dickey_Fuller Unit Root Test | | | | |
|---|---|---|---|---|
| | | t-Statistic | Prob. | |
| | | -4,7651 | 0,0004 | |
| Test critical values: | 1 % level | -3,6213 | | |
| | 5 % level | -2,95442 | | |
| | 10 % level | -2,6193 | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| BI(-1) | -1,1247 | 0,278286 | -4,6912 | 0,0000 |
| D(BI(-1)) | 0,3087 | 0,2212 | 1,3923 | 0,1737 |
| D(BI(-2)) | 0,1672 | 0,1525 | 1,0104 | 0,3195 |
| C | -0,0021 | 0,0018 | -1,1246 | 0,2689 |
| Phillips_Perron Unit Root Test | | | | |
| | | Adj. t-Stat | Prob. | |
| | | -6,6014 | 0,0000 | |
| Test critical values: | 1 % level | -3,6101 | | |
| | 5 % level | -2,9014 | | |
| | 10 % level | -2,5932 | | |
| Residual variance (no correction) | | | 0,0002 | |
| HAC Corrected variance (Bartlett kernel) | | | 7,25E-05 | |

*Source: compiled by the author.*

Thus, it can be argued that the time series are stationary and the model is adequate. Therefore, the impact of world stock market indices on local stock markets can be proved, in particular, it is the case of the Ukrainian stock market.

Based on the fuzzy approximation theorem by Kosko, B. (1994), it can be argued that any mathematical system can be approximated by a fuzzy logic system. It is quite obvious that the dependence of the PFTS indices on the dynamics of other indices, in particular, the FTSE and S&P indices should be considered nonlinear. Therefore, for better justification of the relationship between the studied indices, Takagi-Sugeno model is used, which provides several consistent steps in implementation. The entire set of profitability observations for each of the three stock exchanges is represented by a set of values with a length of 2994, which is further respectively divided into two samples – training one (2396) and test one (598).

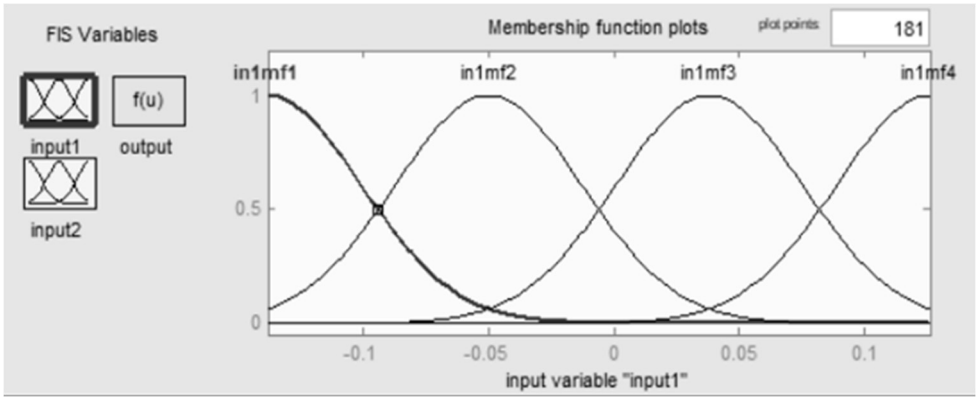
Takagi-Sugeno fuzzy inference system is generated based on the test sample. In particular, term sets are defined for both the input variables (FTSE and S&P) and the dependent variable (PFTS); the membership function is defined for each term. The task of constructing the membership function looks like this. There are two sets: a term set $L = \{l_1, l_2, \dots, l_m\}$ and a universal set $U = \{u_1, u_2, \dots, u_n\}$. The fuzzy set l for determining the linguistic term lj on the universal set U has the form:

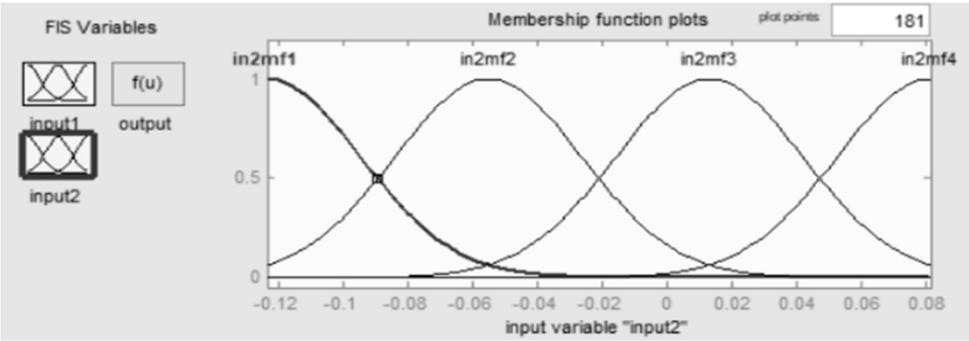
$$\widetilde{l_j} = \left(\frac{\mu_{l_j}(u_1)}{u_1}, \frac{\mu_{l_j}(u_2)}{u_2}, \dots, \frac{\mu_{l_j}(u_n)}{u_n}\right), j = \overline{1, m.} \quad (4)$$

The Grid partition method gives the initial fuzzy inference system (Figure 2-3). According to this method, the membership functions of the fuzzy terms are uniformly distributed within the range of changing input and output variables. The number of membership functions and their types are determined (in our case, for each of the terms of all input variables, the normal type of distribution was determined).

Figure 2

Takagi-Sugeno fuzzy inference model





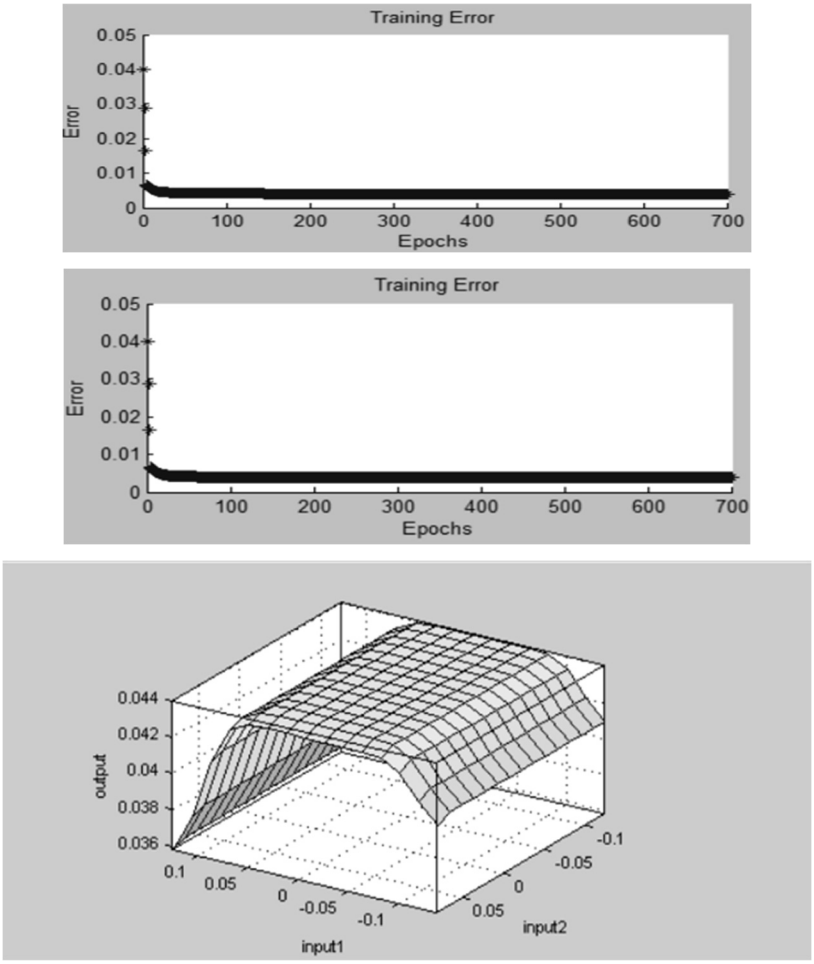

*Source: compiled by the author*

The rule system in Takagi-Sugeno fuzzy inference model looks like this:

1. if (input1 is in1mf1) and (input2 is in2mf1) then (output is out1mf1) (1)
2. if (input1 is in1mf1) and (input2 is in2mf2) then (output is out1mf2) (1)
3. if (input1 is in1mf1) and (input2 is in2mf3) then (output is out1mf3) (1)
4. if (input1 is in1mf1) and (input2 is in2mf4) then (output is out1mf4) (1)
5. if (input1 is in1mf2) and (input2 is in2mf1) then (output is out1mf5) (1)
6. if (input1 is in1mf2) and (input2 is in2mf2) then (output is out1mf6) (1)
7. if (input1 is in1mf2) and (input2 is in2mf3) then (output is out1mf7) (1)
8. if (input1 is in1mf2) and (input2 is in2mf4) then (output is out1mf8) (1)
9. if (input1 is in1mf3) and (input2 is in2mf1) then (output is out1mf9) (1)
10. if (input1 is in1mf3) and (input2 is in2mf2) then (output is out1mf10) (1)
11. if (input1 is in1mf3) and (input2 is in2mf3) then (output is out1mf11) (1)
12. if (input1 is in1mf3) and (input2 is in2mf4) then (output is out1mf12) (1)
13. if (input1 is in1mf4) and (input2 is in2mf1) then (output is out1mf13) (1)
14. if (input1 is in1mf4) and (input2 is in2mf2) then (output is out1mf14) (1)
15. if (input1 is in1mf4) and (input2 is in2mf3) then (output is out1mf15) (1)
16. if (input1 is in1mf4) and (input2 is in2mf4) then (output is out1mf16) (1)

Figure 3

Dynamics of fuzzy inference system training using ANFIS neural network

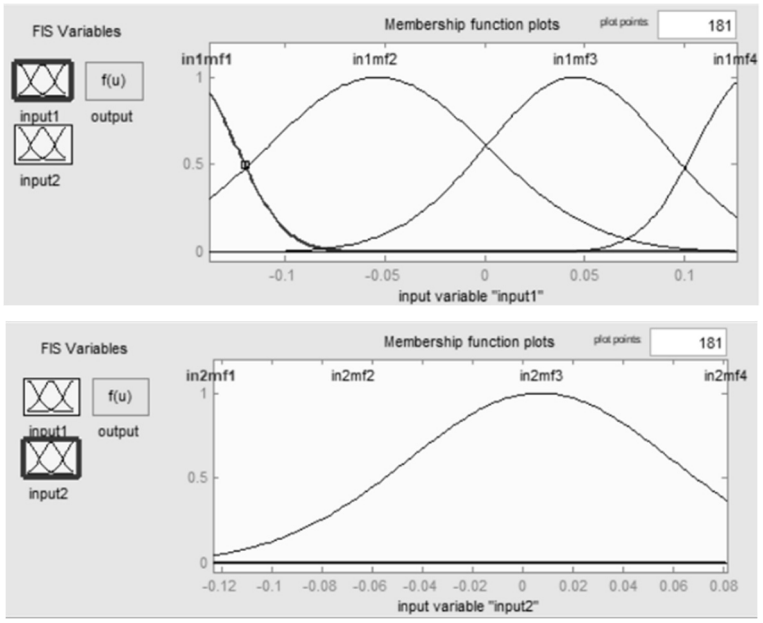



*Source: compiled by the author.*

According to the results of the training, average error of 0.0040298 and 0.0039193 was obtained. After determining the optimal parameters of the input variables, the following results were obtained (Figure 4). Thus the synthesized system of fuzzy inference as a neural network for the generated sample of PFTS, FTSE and S&P indices has the following form. To verify the results, the value of the final variable in the test sample was determined (Figure 6).

Figure 4

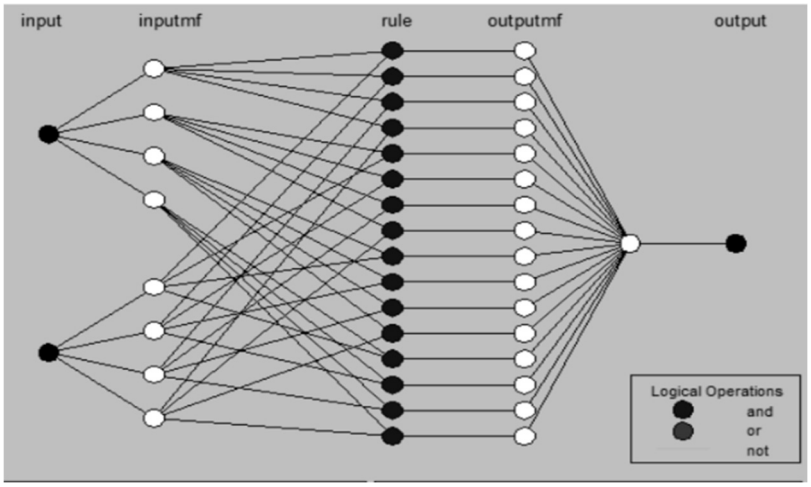
Membership functions of the fuzzy terms of one of the input variables after determining their optimal parameters




*Source: compiled by the author*

Figure 5

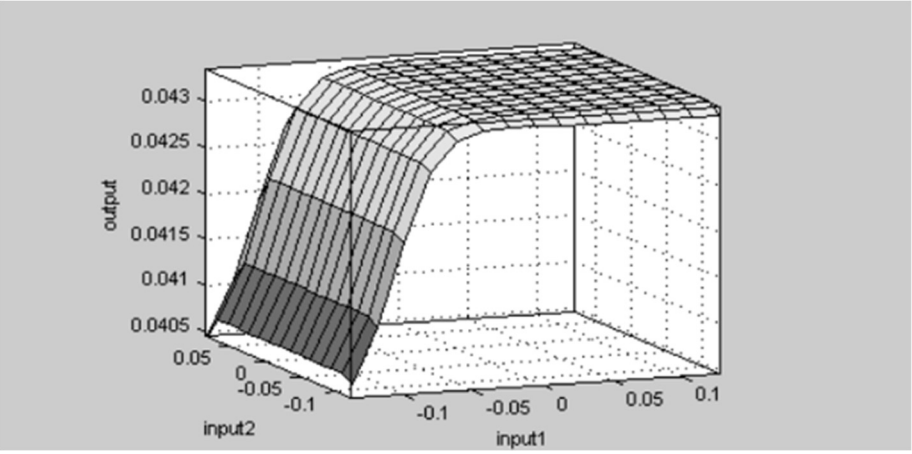
Synthesized fuzzy inference system of ANFIS network




*Source: compiled by the author*

Figure 6

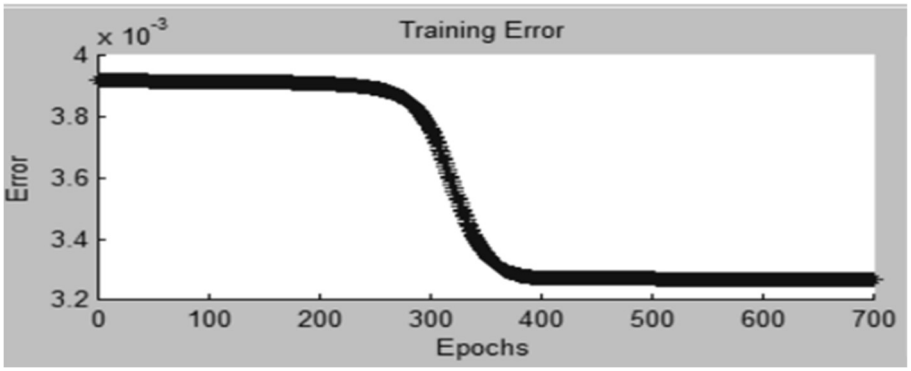
The value of the final variable in the test sample




*Source: compiled by the author.*

Figure 7

Dynamics of testing fuzzy inference system using ANFIS neural network based on the test sample data




*Source: compiled by the author.*

The analysis of errors in the studied and test sample makes it possible to claim that the constructed model of the dependence of index dynamics on the studied stock exchanges is adequate. The calculations of the theoretical values of the final variable by Takagi-Sugeno fuzzy inference model, as well as their comparison with the actual observational data, enabled to obtain an average error value of 0.0032685, which, in our opinion, is an acceptable result and also indicates sufficiently well-defined system parameters of the fuzzy inference system that models the dependence of the PTFS on the FTSE and S&P.

## Conclusion

Thus, the behaviour of the daily rates of return of the world stock indices such as Standard & Poor's Global Ratings 500, NIKKEI 225, FTSE 250, DAX, as well as the local PFTS index, which were grouped in five trading weeks, showed that calendar anomalies, which are the evidence of the efficient market hypothesis, have not been revealed. In addition, there was no clear trend in the behaviour of the rates of return on any stock exchange during the whole analyzed period.

As a result of the test, the hypothesis about the impact of global stock indices on local stock indices in the example of the SE PFTS was confirmed only for the US S&P 500 (67.39%) and the Japanese NIKKEY 225 (almost 92%) indices. At the same time, the DAX and FTSE 250 indices, with a probability over 90%, unlikely have an impact on a local index. This has objective circumstances since, on the one hand, the stock market of Ukraine is small in size, and on the other side, it is as open as possible to Ukrainian and foreign investors and is gradually integrated into the world stock markets.

The cumulative effect of world stock market indices on the PFTS index as a dependent variable showed a close link between them. Therefore, it can be stated that the global stock markets determine the Ukrainian stock market. Testing the proposed hypothesis using Takagi-Sugeno fuzzy inference model revealed the impact of the FTSE 250 and S&P 500 indices on the PFTS index.

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APPENDIX A

Effect of the week for index rates from 2014 till 2021

| Index | 1-7 | 8-15 | 16-22 | 23+ |
|---|---|---|---|---|
| PFTS | -0,0058 | 0,0297 | -0,0283 | 0,0176 |
| FTSE | -0,0172 | 0,0138 | 0,0289 | 0,0039 |
| DAX | -0,0106 | 0,0179 | 0,0297 | 0,0327 |
| S&P | 0,0004 | 0,0276 | 0,0343 | 0,0071 |
| Nikkei | 0,0091 | 0,0045 | 0,0329 | 0,0261 |

APPENDIX B

Effect of the day for index rates from 2014 till 2021

| Index | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| PFTS | 0,2874 | 0,2993 | 0,6153 | 0,7712 | 0,8481 |
| FTSE | 0,0104 | 0,0106 | 0,0098 | 0,0051 | 0,0235 |
| DAX | 0,0268 | 0,0304 | 0,0231 | 0,0239 | 0,0286 |
| S&P | 0,0319 | 0,0286 | 0,0262 | 0,0285 | 0,0386 |
| Nikkei | -0,0813 | -0,0924 | -0,1088 | -0,0935 | -0,1491 |

APPENDIX C

Summary results of the Augmented Dickey_Fuller Unit Root Test та Phillips_Perron Unit Root Test

| Index | | Augmented Dickey_Fuller Unit Root Test | | | | Phillips_Perron Unit Root Test | | | |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 | | | t-Statistic | Prob. | | | Adj. t-Stat | Prob. | |
| | | | -5,9325 | 0,0000 | | | -5,9113 | 0,0000 | |
| | Test critical values: | 1 % level | -3,6113 | | | 1 % level | -3,6113 | | |
| | | 5 % level | -2,9138 | | | 5 % level | -2,9138 | | |
| | | 10 % level | -2,6107 | | | 10 % level | -2,6017 | | |
| | | Coefficient | Std. Error | t-Statistic | Prob. | Coefficient | Std. Error | t-Statistic | Prob. |
| | S&P 500(-1) | -0,9676 | 0,1661 | -5,9325 | 0,0000 | -0,9676 | 0,1661 | -5,9325 | 0,0000 |
| | C | 0,0018 | 0,0009 | 2,0141 | 0,0513 | 0,0018 | 0,0009 | 2,0141 | 0,0513 |
| NIKKEY_225 | | | t-Statistic | Prob. | | | Adj. t-Stat | Prob. | |
| | | | -7,4924 | 0,0000 | | | -7,4924 | 0,0000 | |
| | Test critical values: | 1 % level | -3,6103 | | | 1 % level | -3,6103 | | |
| | | 5 % level | -2,9237 | | | 5 % level | -2,9237 | | |
| | | 10 % level | -2,60142 | | | 10 % level | -2,6014 | | |

| Index | | Augmented Dickey_Fuller Unit Root Test | | | | Phillips_Perron Unit Root Test | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Coefficient | Std. Error | t-Statistic | Prob. | Coefficient | Std. Error | t-Statistic | Prob. |
| | NIKKEY_225(-1) | -1,2005 | 0,1625 | -7,4924 | 0,0000 | -1,2005 | 0,1625 | -7,4924 | 0,0000 |
| | C | 0,0024 | 0,0014 | 1,6851 | 0,0944 | 0,0024 | 0,0014 | 1,6851 | 0,0944 |
| FTSE 250 | | | t-Statistic | Prob. | | | Adj. t-Stat | Prob. | |
| | | | -6,9302 | 0,0000 | | | -7,1032 | 0,0000 | |
| | Test critical values: | 1 % level | -3,5214 | | | 1 % level | -3,5214 | | |
| | | 5 % level | -2,8987 | | | 5 % level | -2,8987 | | |
| | | 10 % level | -2,6107 | | | 10 % level | -2,6107 | | |
| | | Coefficient | Std. Error | t-Statistic | Prob. | Coefficient | Std. Error | t-Statistic | Prob. |
| | FTSE 250(-1) | -1,10127 | 0,1561 | -6,9302 | 0,0000 | -1,0112 | 0,1561 | -6,9302 | 0,0000 |
| | C | 0,0021 | 0,0009 | 1,4341 | 0,1977 | 0,0021 | 0,0009 | 1,4341 | 0,1977 |
| DAX | | | t-Statistic | Prob. | | | Adj. t-Stat | Prob. | |
| | | | -6,4401 | 0,0000 | | | -6,5016 | 0,0000 | |
| | Test critical values: | 1 % level | -3,5961 | | | 1 % level | -3,5961 | | |
| | | 5 % level | -2,9752 | | | 5 % level | -2,9752 | | |
| | | 10 % level | -2,5962 | | | 10 % level | -2,5962 | | |
| | | Coefficient | Std. Error | t-Statistic | Prob. | Coefficient | Std. Error | t-Statistic | Prob. |
| | FTSE 250(-1) | -1,1583 | 0,1643 | -6,4401 | 0,0000 | -1,1583 | 0,1643 | -6,4401 | 0,0000 |
| | C | 0,0019 | 0,0015 | 1,4972 | 0,1634 | 0,0019 | 0,0015 | 1,4972 | 0,1634 |

ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# STUDY OF THE SPECIFIC COVID-19 PANDEMIC EFFECTS ON THE BULGARIAN TOURISM LABOUR MARKET[3]

*The Covid-19 pandemic has significantly affected tourism in the last two years. The tourism industry forms a big part of the world's GDP and is an important industry in terms of employment. The great leakage of qualified, experienced and motivated tourism workers is severe for the future recovery and development perspectives of the tourism business. Tourism-dependent destinations, such as Bulgaria, are the most affected. Almost 11% of the Bulgarian economy is formed by the tourism industry. Some regions, such as the Black sea coast, are one of the tourism most dependent regions in the country as many people see their livelihood in tourism employment. Moreover, as a tourist destination with traditions, Bulgaria's tourism foundation is contained in the experienced and qualified workers in the industry. The main purpose of the present article is to investigate the Covid-19 impact on the Bulgarian tourism labour market due to reveal the future perspectives for its development.*
*Keywords: Tourism; Covid-19 pandemic; labour market; resilience; Bulgaria*
*JEL: J60; J81; L83; Z32*

## 1. Introduction

The current study is dedicated to an extremely current topic, namely "problems with staff in tourism". Its purpose is to check the attitudes and motivation of the participants in the tourism labour market after the Covid-19 pandemic.

The subject of the study is the assessment of the consequences of the Covid-19 pandemic for those employed in the tourism industry.

The object of study are the two tourist regions – Varna and Burgas Black Sea coast. In order to achieve the set research goal, the authors set themselves the following tasks:

- To evaluate the impact of the Covid-19 pandemic on the tourism industry;

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- To analyse the specific consequences of the Covid-19 spread on the tourism labour market;
- To investigate and evaluate the opinion of employers and employees towards the consequences of the pandemic for employment in the tourism industry;
- To outline the possibilities and future scenarios for tourism resilience and to make recommendations to minimise the negative effects of the pandemic.

The following research methods were used for the implementation of the research tasks – analysis and synthesis, desk research, observation, secondary data analysis, survey among employers and employees, etc.

## 2. Covid-19 Crisis – An Assessment of Its Impact on the Tourism Sector

The Covid-19 pandemic significantly impacts the global economic, political and socio-cultural systems. Health communication strategies and measures (e.g. social distancing, travel and mobility bans, community lockdowns, self- or mandatory-quarantine, etc.) have halted global travel, tourism and leisure (Sigala, Marianna, 2022).

The tourism sector is one of the worst affected by the impacts of Covid-19. International arrivals have increased by just 4% in the second year of the pandemic; with 1 billion fewer arrivals when compared to pre-pandemic levels. 63% of experts from the World Tourism Organization (UNWTO) believe the sector won't fully recover until 2024 (World Economic Forum, 2022).

Figure 1

International tourist arrivals worldwide


*Source: World Tourism Organization (UNWTO).*

Moreover, as 2021 drew to a close with severe limitations to travel still in place, the World Tourism Organization (UNWTO) reported that international tourist arrivals increased by just 4% last year, remaining 72% below 2019 levels. That equates to more than 1 billion fewer international arrivals compared to pre-pandemic levels, keeping the industry at levels last

seen in the late 1980s. Prior to the coronavirus outbreak, the global tourism sector had seen almost uninterrupted growth for decades. Since 1980, the number of international arrivals has increased from 277 million to nearly 1.5 billion in 2019. As the chart for Global Travel shows, the two largest crises of the past decades, the SARS epidemic of 2003 and the global financial crisis of 2009, were minor bumps in the road compared to the Covid-19 pandemic (Statista, 2022).

Marinko, Skare and D.Soriano summarise their study results and conclude that the impact of Covid-19 on the travel tourism industry will be incomparable to the consequence of the previous pandemics. Depending on the dynamics of future pandemics (from April 2020), the best-case scenario shows that the travel tourism industry worldwide will drop on average from -2.93% to -7.82% in the total GDP contribution. Jobs in the travel tourism industry will decrease by -2.44% to -6.55%. The estimated lost inbound tourist spending ranges from -25.0% to -35.0%. Total capital investments fall from -25.0% to -31.0% (Marinko Skare, Soriano, Rochon, 2021).

As many countries introduced travel restrictions to contain the spread of the virus, travel across the world significantly declined from 2020 onwards. The financial repercussions of the coronavirus have already begun to manifest themselves within the tourism industry. In 2020, global revenue from the travel and tourism industry was estimated to drop from a forecasted USD 711.94 billion to USD 568.6 billion, representing a decrease of over 20%. The region predicted to see the highest decline in revenue was Europe, decreasing from USD 211.97 billion in 2019 to roughly USD 124 billion in 2020 (Lock, 2022).

According to the World Tourism Organization (UNWTO, 2022), the consequences of the pandemic on tourism worldwide could be reduced to:

- Tourism is one of the sectors most affected by the Covid-19 pandemic, impacting economies, livelihoods, public services and opportunities on all continents.
- Export revenues from tourism could fall by USD 910 billion to USD 1.2 trillion in 2020. This will have a wider impact and could reduce global GDP by 1.5% to 2.8%.
- Tourism supports one in 10 jobs and provides livelihoods for many millions more in both developing and developed economies.
- In some small island developing states, tourism has accounted for as much as 80% of exports, while it also represents important shares of their national economies.
- As many as 100 million direct tourism jobs are at risk, the labour-intensive accommodation and food services industries that provide employment for 144 million workers worldwide are the most affected.
- Small businesses (which form 80% of global tourism) are particularly vulnerable.
- Women, who make up 54% of the tourism workforce, youth and workers in the informal economy are among the most at-risk categories.

The coronavirus pandemic is developing extremely dynamically in Bulgaria as well the end of the first and the beginning of the second quarter of 2020. The intensity of the process of

globalisation in recent is the main prerequisite for the rapid spread of this crisis worldwide. For countries such as Greece, Cyprus and Croatia, where tourism accounts for more than 20% of GDP, the economic damage is more than significant. Countries such as Italy, Slovenia and Bulgaria have also suffered a significant hit, where the industry accounts for about 12-13% of the GDP of these countries.

The hotel and restaurant sectors are most affected in terms of loss of employment and volume of services offered, as their impact on other economic sectors is significant. The recovery of the sector depends to the greatest extent on how quickly the pandemic will be controlled (Ministry of Tourism, 2022). Travel restriction measures in Bulgaria imposed since the beginning of 2020 and introduced social distancing measures have had a significant negative impact on economic activities that rely on physically close interactions between people. This adversely affected air transport and led to its drastic contraction. In the state of emergency in April 2020, the total number of flights on the territory of the country was -81.2% less compared to the same period last year. The loosening of restrictive measures in the coming months contributed to limiting the pace of decline to -51.2% by November 2020. From the beginning of February 2021, the declines are moving at levels of about -55%. (Ministry of Tourism, 2022). According to NSI statistics on the visits of foreigners to the country, in March and April 2020, an unprecedented decline in the number of trips of foreign nationals was registered due to the suspension of international flights and the closure of land borders. The annual rate of decline in visits of foreigners to Bulgaria in April amounted to -88.9%, and in total, for 2020, the decrease amounted to -60.4% (National Statistical Institute, 2022).

During the period January – November 2021, the total number of tourist visits of foreigners without transit in Bulgaria is 3 504 729, and the number of foreign tourists staying in accommodation places is over 1.8 million. The increase in the total number of tourist visits of foreigners for the first 11 months from 2021 compared to the same period in 2020 is 36.1% (Ministry of Tourism, 2022).

The structure of visits by foreigners is also changing – in 2019, trips for "rest and excursion" occupy 46.7% of the total, while in 2020, their relative share decreased to 27.4%. For the period January-November 2021, according to NSI data, there was a 63.5% increase in visits for rest and vacation and a 16.6% increase in visits for the purpose of business tourism (National Statistical Institute, 2022).

The European institutions are responding to the situation. They focus on gathering the necessary information, conducting discussions with stakeholders, as well as developing situation reports and proposals for resolutions and initiatives in the field of tourism. The most urgent initiatives are: Common standards at the EU level; Consistent and transparent risk assessment criteria; Direct and sector-specific financial support; Tourism Crisis Management Mechanism; EU Strategy for the Development of Sustainable Tourism.

The Covid-19 pandemic rewrote the theoretical and practical statements of tourism. It has already imposed and will continue to impose new trends in world tourism, which are already reflected in the demand and supply of tourist products. The pandemic also poses major changes in consumer behaviour and attitudes in search of tourism products and services. There are changes in terms of: motives, goals, thinking, value system, desires, priorities, ways

of booking and buying, ways of travelling, holiday planning, the final choice of consumers, etc.

All these changes require rapid adaptation, both for producers and consumers. Symbiosis is needed between all stakeholders in the tourism industry to ensure efficient tourism management.

We can conclude that tourism is alive and desired by consumers. Covid-19 marked the beginning of a new stage in the development of tourism, which greatly changed it in terms of demand, safety, secure environment, planning, digitalisation and technology, destination marketing, market behaviour and more. These circumstances are the basis for outlining the challenges facing tourism since Covid-19.

*Products and markets:*

- Development of innovative marketing concepts to ensure sustainable growth in the sector. These concepts should aim for qualitative rather than quantitative growth, as well as balancing geographical and seasonal focus and creating new niche products.
- Promoting alternative forms of tourism that help to diversify the product offer. Diversification of tourism products in conjunction with other sectoral activities, such as agriculture, will create local tourism proposals that help to overcome the difficulties.
- Creating new products and services tailored to specific markets. Focusing on specific target groups (age group, nationality, marital status, etc.) or types of services (adventure, conservation, wellness, cultural tourism, etc.) can open more opportunities for trade and income.

*Investments:*

- Investment in the blue economy, including state budgets, EU funds, trade loans, international financial institutions and capital market financing;
- In addition, better coordination is needed between national and regional authorities, which manage a number of EU programs, as well as more coordination with other international donors and potential private sector investment.

*Research, technology and innovation:*

- Using technologies and innovations in tourism promoting. For example, integrating niche tourism offerings and using mobile applications (e.g. building an ICT platform to connect a culinary route, bird watching and a coastal wellness/spa) can help develop year-round congress tourism. The application of promotional tools and the use of existing travel applications (e.g. TripAdvisor, Booking.com) by continuously uploading information on natural tourism products to selected target groups will help to overcome the negative effects of the pandemic.
- Opening new market opportunities for tourism products through digitalisation. Adopting innovations in the field of ICT, social media and other high-class technological innovations will stimulate new services, access to global market niches and a better understanding of market trends.

- Stresses the importance of establishing or renovating specialised higher education institutions (management and economics of tourism enterprises, tourism professions, maritime schools, cooking schools, etc.), as well as improving the training offered in order to improve the quality of services and products in the field of tourism, the use of new technologies and adaptation to climate change;

In order to make the most of the opportunities offered for tourism development after Covid-19, public and private stakeholders must join forces and work in a single policy framework that considers the EU's new priorities and the challenges identified.

## 3. The Specific Consequences of the Covid-19 Pandemic on the Tourism Labour Market

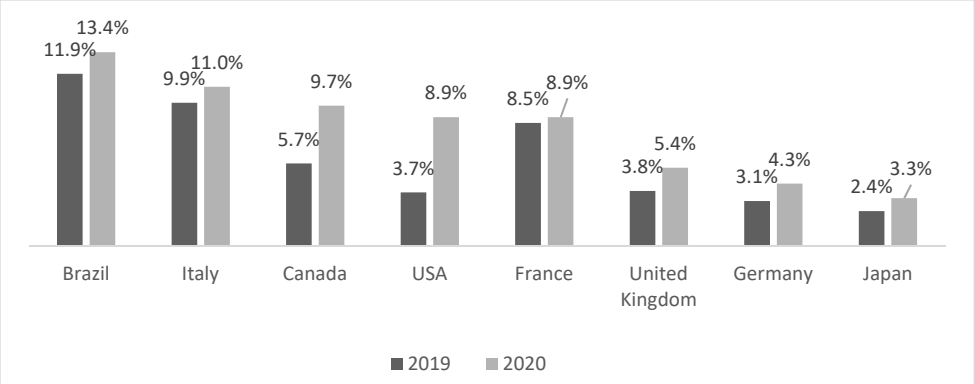
### *3.1. General view of the Covid-19 pandemic effects on the tourism labour market*

To have a better understanding of the Covid-19 influence on the tourism labour market, it is necessary to take a look at the general situation regarding the unemployment rate movement due to the pandemic.

The unemployment rate showed a big increase in a number of states due to the pandemic. Most significantly, it rises in Canada and the United States, where the increase is respectively 4% and 5.2% (Jones et al., 2021).

Figure 2

The unemployment rate movement in countries due to Covid-19, 2019-2020




*Source: Lora Jones, Daniele Palumbo & David Brown, 2021, Coronavirus: How the pandemic has changed the world economy, https://www.bbc.com/news/business-51706225.*

Specifically, in the travel industry, which was most affected by the pandemic, the loss of employment was significant. Research by WTTC shows that 63 million jobs were lost in 2020 due to the pandemic (WTTC, 2021). This is a tremendous loss of 18.5% of the employment in tourism, leaving a lot of families without the needed livelihood. Due to other researches, the decrease in tourism employment is even bigger – 100.7 million jobs fewer in 2020 compared to 2019 (Statista, 2021).

Table 1

Job loss in the tourism industry worldwide

| Region | Statistica (mill) | Statistica (%) | WTTC (mill) | WTTC (%) |
|---|---|---|---|---|
| Asia-Pacific | 63.4 | *34.2%* | 34.1 | *18.4%* |
| Europe | 13.0 | *33.6%* | 3.6 | *9.3%* |
| North America | 8.2 | *32.2%* | 7.1 | *27.9%* |
| Africa | 7.6 | *30.9%* | 7.2 | *29.3%* |
| Latin America | 4.7 | *27.5%* | 4.0 | *23.4%* |
| Middle East | 2.6 | *37.7%* | 1.2 | *17.4%* |
| Caribbean | 1.2 | *42.9%* | 0.7 | *24.7%* |
| TOTAL | 100.7 | --- | 63 | --- |

*Source: WTTC, 2021, Europe: 2021 Annual Research: Key Highlight Total contribution of Travel & Tourism to Employment, https://wttc.org/Research/Economic-Impact, Statista, 2021, COVID-19: job loss in travel and tourism sector worldwide 2020, by region, https://www.statista.com/statistics/1104835/coronavirus-travel-tourism-employment-loss/.*

The difference between collected data could be found in the fact that WTTC explored the jobs directly employed in the tourism industry, and Statista conducted their research about the loss of jobs in the tourism and tourism-related industries, which shows the total impact of Covid-19 on employment and could be defined as more accurate.

According to a report by UNWTO in terms of unskilled labour, the unemployment rise could vary between 0% and 15% where in countries with bigger dependence on the tourism industry, the percentage could be even bigger. Generally, the average rise in the unemployment rate in the tourism industry is 5.5% in 2020. The research shows that a big part of tourism employees, especially by the direct operations in the industry, are unskilled workers (UNWTO, 2021).

Other research in Europe showed that the pandemic also had different effects on each sub-sector of the tourism industry. Data shows that the most significant impact was on the European hotel industry with very low occupancy rates (54%) and extremely low average daily rate (18%) in 2020. The next hit sub-sector was food and beverage, where employment decreased by 30%. The drop in overall turnover in sub-sector travel agencies was 71% in 2020 in comparison to 2019. Eurostat reported a 63% drop in employees from 2.7 million workers in Q4 2019 to 1 million workers in Q4 2020. Other hard-hit sub-sectors were business trip providers, event organisation and international transport. By the last, air transport was totally blocked, with a reduction of 84% in international air traffic in the first months of the pandemic. From 2014 to 2019, one in four new jobs was related to travel and tourism, with over 330 million jobs in the industry, presenting one in ten jobs on a global level. In 2020, that number was reduced, showing a decrease of nearly 18% on a yearly basis (Panteia et al., 2021).

### *3.2. Specific influence of the Covid-19 pandemic on the tourism labour market*

There are some studies on the influence of the Covid-19 pandemic on the tourism labour market, which discover the specific effects and results of the pandemic on the investigated

object of the study (Correia et al., 2020; Lhano et al., 2021; Carvalho et al., 2021; Raimo et al., 2021).

The most interesting of them reveals a more accurate method for measuring the influence of Covid-19 on the unemployment in tourism and the derivative effect on society and economy (Lhano et al., 2021). Instead of taking into consideration the most common "unemployment rate", they use the changes in the number of hours actually worked in the tourism industry, which focuses on the actual changes in labour force participation in the industry. The study reports a positive correlation between Covid-19 cases and the unemployment rate among different nations, which is not a surprising conclusion. More interesting, the investigation concluded that lockdowns did not have a significant influence on unemployment in Southern Europe and evolved the idea that fear from the Covid-19 infection was the main factor leading to people not searching for jobs, which led to an increase in unemployment rate. Tourism has always been related to direct contact between people, which was impossible at that moment. In the tourism industry, front office operation (face-to-face services) is 70% and more of the tourism product, which in pandemic situations harms the opportunity not only to perform the job in a natural way, but also to perform the job at all. The negative impact of Covid-19 has different dimensions due to the circumstance that some of the regions are traditionally touristic areas and a major part of the local economy is generated by tourism business – which is the case with the Black Sea area in Bulgaria. Though, in this paper, the investigation shows that educated and qualified workers have lower unemployment rates through crises than the less acknowledged workers.

Focusing on the influence of Covid-19 pandemic on the tourism labour market in terms of comparison with tourism non-related industries, there is a recent study on this topic (Needham, 2021). International Labour Organization's research highlights the massive Covid-19 impact on tourism employment in Asia and the Pacific. Due to the pandemic, the investigation proved 4 times greater loss in jobs related to tourism than in non-tourism industries in 2020. Moreover, the loss in working hours in tourism-related industries was 7 times greater than in other industries, which proves the statement that a big part of the workers moved into the informal sector. Another study in Canada pointed out other important consequences of the Covid-19 pandemic for the tourism labour market. During the first year of the pandemic, the drop-down of tourism employees in Canada was 22%. As in many other countries prior Covid-19 there was also a shortage of the needed workers for Canadian tourism, which was one of the main limitations of tourism growth. The prediction is that even when the pandemic is over, a big part of the so-called "displaced workers" will not return to tourism, which will affect it dramatically (Tourism HR Canada, 2021).

A valuable study on a post-Covid-19 model for the resilience of the employees in tourism directs the attention of the research to the essence of the main part of workers in this sector – the non-standard-workers and the high sector mobility of these (Martins et al., 2021). The research suggests that many of the employees in tourism perform interpersonal skills, which are also important in other sectors such as trade, teaching, retail etc. This is the basic reason for tourism employees to perform intensive sector-mobility and to transfer their workforce to other relative to their skills sectors. In conclusion, pandemics increase the need for sector-transferable skills and sector-mobile workers, but on the other hand, this could have a disastrous effect on the future of labour in tourism, suggesting the big question if these

workers will return to the tourism industry in a post-Covid-19 situation. In the future, there will be more pandemics (Worldforum, 2019) and the scenario for transferring the workforce from one industry to another is vital to be developed in the best manner.

Taking Bulgaria into consideration, the Covid-19 pandemic caused a severe impact on the labour market in tourism. Generally, vaccinating workers in direct contact with tourists is vital for the recovery of the tourism industry. Unfortunately, in Bulgaria, the process of vaccination is slow, with the lowest levels in the EU – 23.9% compared to 63.7% on average in the EU (Gomez, 2021). The lack of a timely, well-organised official information campaign for Covid-19 and the pros and contras of the certified vaccines sabotaged the vaccination process. Doubts and distrust are limiting from an emotional and psychological point of view, the willingness of workers in tourism to vaccinate. The results are:

- Low confidence of international and domestic tourists in safety and responsibility toward personal and public health in Bulgarian tourist enterprises;
- Low confidence in employees in the tourism industry for working in a safe environment, which leads to the outflow of labour from the industry;
- Low confidence in government and society in the tourism business ability to maintain the risk in the pandemic and provide safe and professional tourism services.

### *3.3. Covid-19 influence on tourism employee's well-being and recovery possibilities*

There is a lack of research papers on the Covid-19 pandemic effects on human resources from the psychological and emotional point of view (Albert et al., 2021; Luu, 2022; Chen, 2021; Huikari and Korhonen, 2020). Most of the researchers in relation to Covid-19 – tourism focus on the tourists and destination economy side, without taking into consideration the big burden of the pandemic for the workers in the tourism industry. A recent study on tourism employees' social and psychological well-being investigated their preparedness to support recovery strategies in the tourism industry (Albert et al., 2021).

Figure 3

Adopted basic cycle of the negative emotional and psychological impact of Covid-19 on employees in tourism


*Source: Created by the authors on Albert et al., 2021.*

The most common situation on tourism labour market, taking into consideration the Covid-19 impact is losing temporary or permanently workplaces. Additionally, the impossibility of governments to provide timely and sufficient measures because not knowing the virus, put workers in tourism in a helpless situation. Therefore, it is important in this situation for tourism organisations to achieve recovery in terms of human resources. The understanding of the term "resilience" in one of the recent researches (Albert et al., 2021) is borrowing

O'Brien and Hope (2010) perception that resilience is the ability to seek out the opportunities that arise during the crisis. This means that three main results are to observe:

- The ability of organisations to adapt to a new terms and conditions.
- The power of crises to "clean" the industry from outdated and inefficient agents.
- The capability to rebuild and create sustainable and prospective business models.

Tourism is highly dependent on well-trained, experienced and qualified workers adding value to the "quality service". In times of crisis, the main purpose of tourism organisations should be the retention of such employees. In this sort of meaning, there is a need for specific human resources management to avoid this negative impact. Sensemaking-motivation, a protected working environment and good communication between the stakeholders are very important.

## 4. Research Methodology for Analysis and Evaluation of the Opinions of Employers and Employees on the Consequences of the Covid-19 Pandemic for the Tourism Labour Market

### *4.1. General patterns of the study – subject, object and purpose of the study*

The analysis and evaluation of the opinions of employers and employees on the consequences of the Covid-19 pandemic on the labour market in the tourism industry were carried out on the basis of a survey. The survey is anonymous, consisting of 3 separate sections for employers, former and current employees in the tourism industry. The section for employers consists of 13 questions, and the sections for former and current employees – 10 questions each. The database of the current survey includes the following main descriptive characteristics provided in *Section 1* of the specially designed questionnaire:

- Identification data – gender, age, monthly income, marital status, affiliation to tourism sectors;
- Information about the employees – experience, remuneration, working conditions, professional qualification, etc.;
- Information about the employer – type of enterprise, size, main activity.

A significant part of the information is also based on the multiple answers in the evaluation cards for employers and employees. This applies in particular to:

- Specific activities carried out by employers and employees;
- Detention or dismissal of employees because of Covid-19;
- Assessments of the state's political actions to deal with Covid-19;
- Hiring new employees;
- The importance of staff;
- Retention and motivation of employees;

- The outflow of employees;
- Covid-19's impact on the future of employment in the sector.

**The subject of this study** is to examine the opinion of employers and workers (current and former) in the tourism industry on the specific effects of the Covid-19 pandemic on the labour market in tourism.

**The first goal of this study** is to systematise information about the problems and future development of the employment in tourism after the Covid-19 pandemic and to develop on this basis:

(1) Methodology for studying the Covid-19 effects on employers and employees in tourism;

(2) Methodology, incl. questionnaires for research, analysis and assessment of the problems of employers and employees in tourism after the Covid-19 pandemic.

**The second goal of the present study** is to analyse the staffing problems due to the pandemic and to outline possible scenarios for reducing the negative consequences. In particular, conducting a study among:

(1) Local government structures at the regional level – in order to establish the current state of existing strategies and programs for tourism development against the background of the pandemic.

(2) Managers of tourist establishments – indicating the typical problems in hiring, retaining and managing employees during the pandemic.

(3) Current and former employees in the tourism industry – problems in retaining, motivating, managing and paying them during the Covid-19 pandemic.

In conjunction with the **research methodology**, for the realisation of the goals of the study, a set of research methods and approaches is used, some of which are: *analysis and synthesis, spatial comparative analysis, induction and deduction, observation, statistical methods, questionnaire survey, method of an in-depth interview*.

The **questionnaire survey** is conducted on the basis of surveys among tourism employees and employers in the surveyed area, as well as interviews with representatives of regional tourism business structures. The study was conducted in the period from 16.01.2022 – 28.02.2022, and it is presented in an online format using the tools of Google Forms Questionnaire. The sources of information are separated into two main groups. **The primary sources** include field research, in-depth interviews and surveys. **The secondary sources** cover mainly scientific works by Bulgarian and foreign authors and specialised publications of business and tourism organisations.

The object of study is **geographically limited** only to the opinion of employers and employees on the consequences of the Covid-19 pandemic in the tourism industry in two tourist regions: *Varna* and *Burgas Black Sea coast*. The choice is purposefully made and linked to the professional experience of the authors.

The object of study is also **nationally limited** to the problems of employers in hiring, retaining and motivating employees in Bulgaria and, in particular, the two mentioned regions

during the pandemic. Therefore, the various sections of the survey are distributed only in the Bulgarian language.

There are also **time limits** for the period of empirical research. They take into account some factors of the external (political, social, and demographic) and internal environment of tourism enterprises, as well as the beginning of the active tourist season in 2022.

The leading **research problem** in conducting empirical research is related to the lack of specialised scientific literature and statistical information on the subject.

In order to collect empirical data in the last phase of the research, questionnaires consisting of four sections were distributed. The questionnaires were sent to non-government organisations in the tourism industry, who were invited to spread the questionnaire among its members; to employers in the tourism industry in partnership with both universities; to both student organisations in the tourism field formed in both universities. After the survey was conducted, it was found that for the purposes of the analysis, the questionnaires of 242 respondents could be used.

A sample approach to the study of aggregates was used to study the opinion of employers and employees on the consequences of the Covid-19 pandemic for the labour market in the tourism industry. The measurement and evaluation of the parameters of the population is mediated due to the fact that only a limited number of representatives of the population are studied. The expediency of the sampling approach is associated with its speed, relatively low cost, lower error rate compared to comprehensive studies. The sample model is a non-target random sampling type, which is widely used in the study of customer satisfaction levels (both – employees and business side). This sample is associated with several circumstances: first, when conducting formulation research; second, when studying sufficiently homogeneous aggregates of units; third, in preliminary tests of field documents (questionnaires, diaries, etc.).

In the current research related to employees, we work with accuracy: *Significance level = 0.05.*

In processing the data from the survey for analysis and evaluation of the opinions of employers and employees on the consequences of the Covid-19 pandemic in the tourism labour market, non-parametric methods were used to study the relationships between variables. Representation is ensured on the basis of similarities and analogy.

### *4.2. Survey questions for the opinion of the employers and employees in the tourism industry*

*Section 2* of the provided empirical study is referred to the employers in the tourism industry. The main purpose of the questions is to give clarity about staff changes after the pandemic, possible schemes of overwhelming the difficulties in the working environment, including evaluation of the government support, their views about hiring new workers and their perspective on the future development of tourism. Twelve specific questions were designed to investigate the opinion of the target group: eight of them are the type choice of given options, with three of them multiple choices possible and four of them are interval scale questions with evaluation from 1 (absolutely not correct) to 5 (absolutely correct).

*Section 3* of the provided research is referred to former employees in the tourism industry. The main purpose of the questions is to clarify the specific reasons for losing their job and to give us a sight of their willingness to return to working in the tourism industry. There are ten specific questions – six of them are choice of given options with two of them multiple choices possible, one of the questions is open to give a short answer, one of them is ratio scale type and the last two are interval scale questions with evaluation from 1 (absolutely not correct) to 5 (absolutely correct).

*Section 4* of the conducted study is forwarded to current employees in the tourism industry. The specific questions are giving insights to clarify the reasons they remained working in the tourism business and to provide their evaluation of the situation after Covid-19 in the tourism industry and their statements for future development and resilience of tourism. There are ten specific questions – six of them are choices of given options with two of them multiple choices possible, two of the questions are ratio scale type and the last two are interval scale questions with evaluation from 1 (absolutely not correct) to 5 (absolutely correct).

## 5. Analysis and Evaluation of the Opinions of Employers Aand Employees on the Consequences of the Covid-19 Pandemic for Those Employed in the Tourism Industry

### *5.1. Employers*

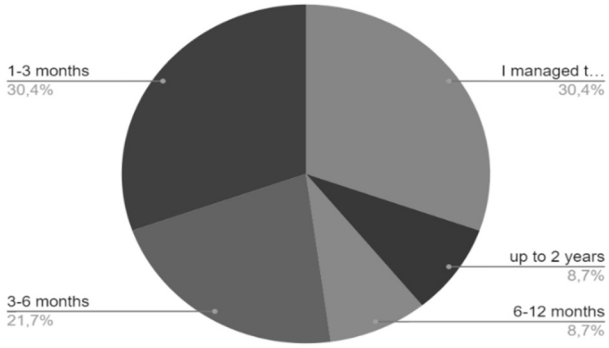
The number of employers who took part in the survey is 48. Their most important characteristics are: 29% are men; 71% are women; 44.7% are aged 16-29, 51.1% are aged 30-49, the remaining 4.2% are aged 50-65; over 75.5% of the employers have a monthly income per family member over BGN 600; 63.8% of them are married or live on a family basis. The distribution of respondents in the tourism sectors is as follows: 33% are in the hotel sector, 30% in the food and beverages sector, 18% are in the tour operator and agency sector, 5% are engaged in tourist transport, 8% provide additional services in tourism, 2% are employed in tourism management authorities, the remaining 4% are in the field of IT services for tourism enterprises. The employers who took part in the survey manage tourist organisations with up to 10 employees (41.7%), up to 20 employees (8.3%), up to 30 employees (12.5%), up to 50 (4.2%), and over 50 (33.3%).

According to employers, their attempts to retain all employees in the organisations after the Covid-19 pandemic have been mixed. Employers who manage to keep all their employees after the Covid-19 pandemic are 30.4% of respondents. However, the same percentage of employers managed to retain their staff only three months after the pandemic, and 21.7% of them made efforts to recruit the full number of employees between 3 and 6 months after the crisis. Another 17.4% of employers make efforts to retain employees for a period of 6 to 24 months.

The surveyed employers share that due to the pandemic, 25% of them are forced to decide to lay off 1 to 3 employees, 12.5% have laid off 3 to 6 workers, another 25% have laid off 10 or more staff, but the largest percentage of employers, 37.5%, did not lay off their employees because of Covid-19.

Figure 4

Employees laid off due to the Covid-19 pandemic (employer's point of view)

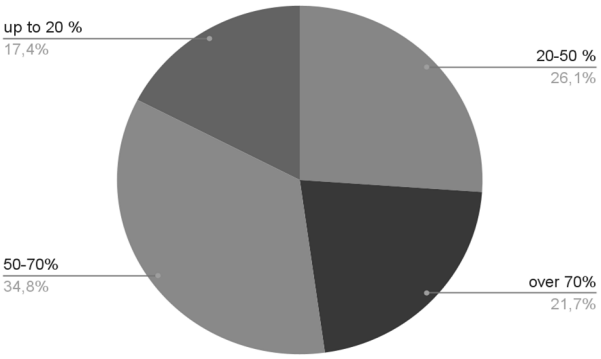



Due to the negative impact of the Covid-19 pandemic, the Bulgarian government proposed preventive measures in the tourism industry to control economic and human resources losses of the enterprises such as "Employment for you", "Save me", "60/40", "Subsidising tour operators for charter flights" and others. From the study of the tourism employer's opinion, state support measures in Bulgaria enjoy low public approval. According to the survey, more than 72% of employers describe as "*absolutely untrue*" that the state's policy actions managed to deal with the consequences of the pandemic for tourism employment; 70% that they are adequate, 66% that they are timely, 48% that they have been tested, 54% that they are effective. According to 56% of the surveyed employers, it is "absolutely true" that the measures are late; 63% of them that they are incomplete; 88% of them that they are incorrect and 92% determine them as inaccurate. As a result, 47.8% of surveyed employers have not applied for any of the government support measures. Another 13% of them applied but were not approved, and only 39.1% applied and received approval. The attitude of employers to the measures proposed by the state, such as "60/40", "80/20" is doubtful, because 92% of the respondents describe the measures as "late" and 73% as "ineffective". However, for 80.5% these government actions are "efficient", for 51% they are "accurate", for 43% they are "clearly regulated".

According to the surveyed employers, the pandemic has led to a decline in the turnover of organisations, as follows (Figure 4): by 34.8% decrease of 50-70%; by 26.1% decrease of 20-50%; by a 21.7% decrease over 70%; by 17.4% decrease to 20%.

When asked which of the following determines the hiring of new employees on a permanent contract for the upcoming season, 56.5% of employers indicate difficulty in finding suitable employees, 39.1% point to reduced turnover, 30.4% uncertainty, 26.1% investments in future periods, and 4.3% volatility. The largest percentage of employers (87%) are looking for potential candidates through job posting platforms. 69.6% rely on friends and acquaintances and only 30.4% use the employment agency as a channel for recruiting staff. There is a low percentage (13%) of respondents, who answered that there is cooperation with universities and high schools in tourism on issues of attracting workers. The Covid-19 pandemic also reduced opportunities to search for people by participating in tourist labour exchanges/ tourist jobs fairs (4.3%).

Figure 5
Decrease in the company's turnover due to the Covid-19 pandemic (employer's point of view)




The answers of the employers prove that the problem with the lack of staff in the sector is serious. Despite the consequences of the pandemic, more than 56% of employers put "lack of tourism staff" first rather than declining turnover or uncertain times. Despite this "lack", however, the surveyed employers are strongly against the "import of staff" in the sector. Over 50% of the respondents' answers were "that they would not take advantage of this opportunity", and the positive answers form 30.4%. These results confirm that the lack of staff in the tourism industry is a constant problem, which due to the pandemic, has been put back in focus.

The retention and motivation of employees in the tourism sector, especially after the Covid-19 pandemic, is a difficult, responsible and important task for employers. According to the survey data, the measures that businesses use to gain and retain employees are as follows:

In the first place (81%) of the respondents put the "correct attitude", in the second place (77.3%) is the "responsible attitude", the third position (68.2%) is for "bonuses and additional benefits". The fourth position was assigned by employers to "employees' salaries" (63.6%), followed by measures such as: "training and competence development" (40.9%), "career growth" (31.8%), "non-financial incentives" (22.7%) and state measures (9.1%). These results also confirm the negative assessment received by employers for the government's tourism support policy. State support ranks last among the respondents as an opportunity to retain, motivate and support employees in their enterprises.

Some of the main questions that need to be answered by our research are: why is there a shortage of staff in tourism, why there are no people willing to work in the sector and what are the problems of employees in the sector? In this regard, we asked the employers participants in the study how they explain the outflow of staff from the tourism sector. According to the data received, the main reasons how employers explain the outflow of staff from the tourism sector are: (They answered "absolutely true") "uncertain environment" (91%); "seasonality" (88%); "low pay" (76%); "non-standard working hours"/"irregular working hours" (64%). With a "true" answer: "'dissatisfaction" (58%); "hopelessness" (54%); "the image of the industry" (42%); "demographic crisis" (40%). An interesting fact

is that the Covid-19 pandemic was ranked last by the respondents as a reason for the outflow (34%). It became clear that the Covid-19 pandemic is not the leading reason for the great staff outflow from the tourism industry, but according to the surveyed employers, it will affect the future of tourism employment in the following areas: it will definitely lead to "reorientation in other branches" (95%), "outflow of employees" (86.5%), it will be a reason to increase the "reluctance to study in the speciality" Tourism" (94%), "lack of qualified staff" (80.4%) and "low quality of service" (60.33%). Employers expect that the Covid-19 pandemic would contribute to the launch of a "new and effective state policy on tourism staff" (48%), as well as "coordinated action between industry, state, and NGOs to address the crisis in tourism staff (52%).

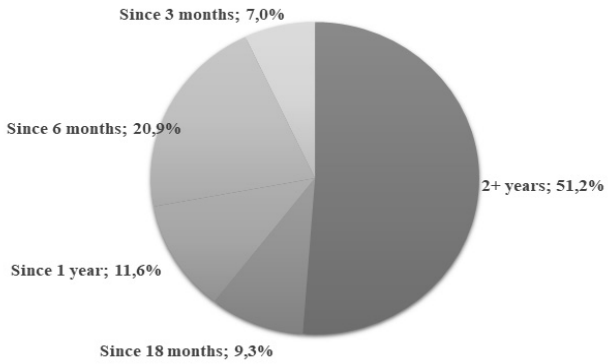
### *5.2. Employees*

Seventy-six of the respondents who participated in the survey were former workers from the tourism industry. From these, 71% declare that they voluntarily left their job and only 29% from them chose the option "involuntarily released from job".

Most of the respondents are not professionally engaged in the tourism industry for 2 years or more (51%). Of all former employees, 22% left or lost their job within the previous 6 months. Equally – nearly 10% of the respondents are not professionally engaged in the tourism industry for not more than 1 year or 18 months, and the smallest share falls on those who lost or left their job within the previous 3 months.

Figure 6

Structure of the former employees in the tourism industry – period of work (former employee's point of view)




From 13 specific reasons for not working in the tourism industry at the moment, 3 of them could be notified as leaders (52% of the former workers), other 3 could be qualified as reasons with great influence (37.5% of the former workers). The other 7 specific reasons have gained fragmentary choices (2 to 4 choices). Of the 3 leaders of answers, none of them can be directly connected with the Covid-19 pandemic. Traditionally the "*low income"* and the "*irregular working hours"* are some of the most announced reasons for workers leaving the tourism industry. Unfortunately, the "*absence of professional development opportunities"* is an essential one and could be indirectly connected with the pandemic and its influence on

tourism development. Of the other three reasons with a big influence on the respondents, two of them are also irrelevant to the pandemic – "*dissatisfaction with a short active season*" and "*feeling underestimated in the working environment"*. The "*uncertainty"*, which is the third reason, could be connected with the pandemic and the uncertain future of the tourism industry.

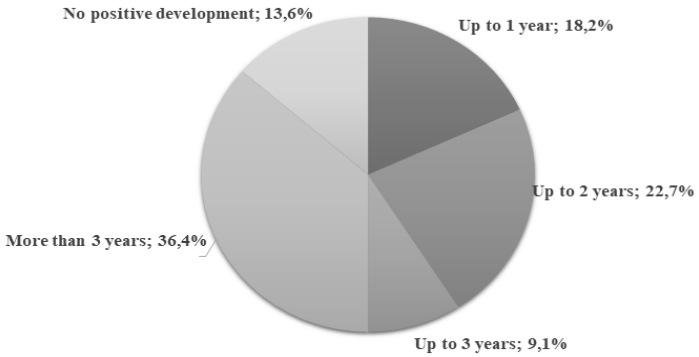
One of the main questions in the current questionnaire section was gaining information about the time period when changes in the working environment occurred after Covid-19. Of all 76 respondents, 64 indicated reduced salary, unpaid leave, extended working hours because of the reduced number of employees, consolidation of working positions and leaving/loss of job in the tourism industry occurred *in the first quarter after the pandemic*. This provides us important information about the type of attitude from an employer perspective – proactive. Few of the respondents have chosen leaving/loss of their job and consolidation of working positions in the period from three to six months after the pandemic. All other answers were given fragmentary – 1 to 3 given answers.

One of the most interesting questions is about the human resources transfer from the tourism industry. The respondents were given the opportunity to share in an open-answer field the industry they are already working in or the one they would like to reorientate. The indisputable leaders here are the IT industry, the retail industry and business process outsourcing (call centres). Others mentioned are the aviation industry, banks and insurance, logistics and telecommunication. Some of the respondents also claimed that they are still seeking for work at the moment, which seems to testify the complicated situation on the labour market because of Covid-19.

Asked if the participants would return to work in the tourism industry, 47.5% of them claimed that they would like to. Another 35% definitely denied such intention and the rest of the respondents could not make a decision at the moment (17.5%). The specific reasons for those, who would return to work in the tourism industry, are the *nature of work* (intensive communication with different cultures), the *job satisfaction in tourism*, and the *experience in the tourism field* they have gained through the years. The other given options –*teamwork* and *qualification*, are selected 14 and 12 times, respectively, which could also define them as reasons with influence.

Figure 7

Former employees' opinion about tourism resilience perspective



Concerning the opinion of the former tourism employees about the time perspective for the resilience of tourism and the tourism labour market, most of them (36.4%) see the time period of *three and more years* as the most probable case. More optimistic views about that have another 22.7%, who see the period of *two years as more* possible. The respondents that see prospective resilience *within one year*, form 18.2% of the respondents, and others 9.1% are seeing the most possible case within *the next three years*. Unfortunately, 13.6% of the respondents are not seeing possible positive development of the tourism labour market after the pandemic at all.

Given the opportunity to evaluate the Bulgarian government's actions for overwhelming the negative impact of Covid-19 on the tourism industry, most of the former employees in the tourism industry recognised them as inaccurate (38 agree/strongly agree), incorrect (38 agree/strongly agree), inadequate (36 agree/strongly agree) and delayed (34). The expectations of how the pandemic is going to impact the future patterns of the tourism labour market from the point of view of former tourism employees are also not optimistic. They mostly valued that there would be an outflow from experienced and qualified workers from the tourism industry (58 agree/strongly agree) and there would be great relaunchment from the tourism industry to other industries (70 agree/strongly agree). Forty-two of them agree or strongly agree with the statement that in the future *there would be unwillingness for young people to study tourism*, other 50 agree or strongly agree that perceptively in the tourism industry wages would keep low levels which would lead to *great absence of qualified employees in tourism* (54 agree/strongly agree) and respectively *low quality of service* (50 agree/strongly agree).

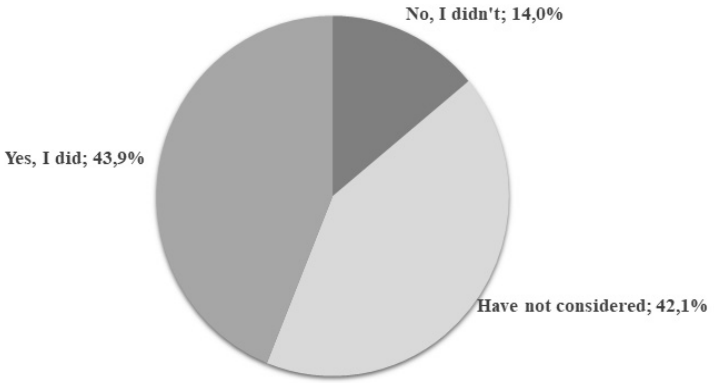
One hundred eighteen of the respondents who participated in the survey are current workers in the tourism industry. Of these, 50.8% declared that they work on a year-round basis in the tourism industry and 49.2% of them are employed as seasonal workers.

One of the recurring questions in the last two sections is aiming to compare the time period when changes in the working environment occurred after Covid-19 between former and current employees. From all current employees, 34 indicated there was *no reduction in salary,* but others 36 claimed the restriction was made in the first 3 months. No *unpaid leave* was pointed out by 42 of the respondents, but 20 of them selected that the restriction occurred in the first 3 months after the pandemic. *Extended working hours* were not also the case for most of the respondents – 56 respondents, but it happened by 48 of them in the first quarter after the pandemic.

Taking into consideration that working with clients in direct contact through a pandemic is working in a risky environment, 94.6% of the current employees did not receive additional benefits for that. Asked if they have been considering leaving the tourism industry after Covid-19, 43.9% declared they have. Optimistically, 42.1% categorically stated that they have not been considering such an option and the other 14% remained neutral. For those, who have considered leaving the tourism industry after the pandemic, the main reasons for that are the uncertainty of the working position due to Covid-19 (34), unjustifiably low salary against unjustifiably high risk (28) and the lack of perspective for professional development because of the unknown future of tourism after Covid-19.

Figure 8

Current employees' considerations about leaving the tourism industry after the Covid-19 pandemic




Taking into consideration the reasons for remaining employed in the tourism industry, the respondents highlight number of reasons – their *experience in the tourism field* (66), the working process due to *intense communication with a different types of cultures* (56), their *qualification in tourism* (54), *the satisfaction* of the type of the work (52), the *teamwork* (50).

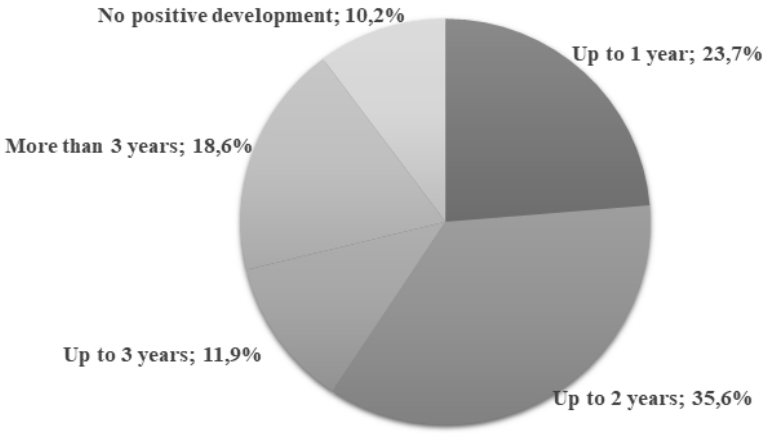
In conjunction with their opinion about the time perspective for tourism resilience, most of the respondents (35.6%) see the time period of *two years* as most possible case. More optimistic views about that have another 23.7% – *one year* as more possible. The respondents that see the prospective tourism resilience within *more than 3 years* form 18.6% of the respondents, and others 11.9% are seeing the most possible resilience *within the next three years*. Unfortunately, 10.2% of the respondents are not seeing possible positive tourism development after the pandemic at all.

The evaluation of the Bulgarian government's actions for overwhelming the negative impact of Covid-19 on the tourism industry from a current employee view, most of them recognised them as inaccurate (50 agree/strongly agree), incorrect (42 agree/strongly agree), inadequate (42 agree/strongly agree) and delayed (44 agree/strongly agree).

Given the opportunity to share their expectations of how the pandemic is going to impact the future patterns of the tourism labour market, the respondents are not optimistic. They mostly valued that there would be an outflow from experienced and qualified workers from the tourism industry (68 agree/strongly agree) and there would be great relaunchment from the tourism industry to other industries (76 agree/strongly agree). Fifty-eight of the respondents agree or strongly agree with the statement that in the future there would be *unwillingness for young people to study tourism*, other 52 agree or strongly agree that perceptively in the tourism industry wages would keep low levels which would lead to *great absence of qualified employees* in tourism (60 agree/strongly agree) and respectively *low quality of service (*66 agree/strongly agree).

Figure 9

Current employees' opinion in the tourism industry about tourism resilience perspective




## 6. Conclusions and Recommendations. Suggestions for Minimising the Negative Consequences

### *6.1. Conclusions and recommendations from the employer's point of view*

After the conducted study among the employers in the tourism industry, the following main conclusions and recommendations can be highlighted as most important:

- The pandemic made employers in the tourism industry work to retain their employees. However, almost half of the respondents (52%) fail to cope with the pandemic pressure on tourism organisations and release people;
- There is a lack of a comprehensive public image and a clear opinion toward the state's policy against Covid-19 influence in the tourism sector in Bulgaria. The state policy regarding the support of the tourism enterprises after Covid-19 is defined by the employers as "incorrect";
- The decline in tourism companies' turnover after the Covid-19 pandemic is over 50%, which makes the specific effects of the pandemic on the tourism sector dramatic. This also corresponds with the international drop (as pointed on paragraph 2);
- A leading problem in hiring new employees in tourism companies is "finding them difficult". Contrary to the above, employers do not accept the "import of staff in tourism", which means that the outflow of staff from tourism because of the pandemic failed to reverse these employers' point of view;
- Therefore, urgent changes against the negative effects of the pandemic in tourism concerning those employed are needed. Exemplary highlights are: government policy in this area; the issuance of urgent government measures directly aimed at those employed

in tourism; the promotion of permanent employment in tourism, supported by a clear long-term vision; plans and strategies for training, development and motivation of staff in tourism during the pandemic; changing the image of the employer in tourism until it becomes a symbol of trust, security, and self-confidence etc. This all will correspond to the European process of generating a common recovery strategy in tourism (as pointed on paragraph 2);

- It is extremely important to work on strengthening the connection between business, higher education and secondary schools, preparing young workers for tourism facing the new patterns of the industry. These opportunities are very underdeveloped and, in such a connection, have significant potential that remains untapped. Young people should be prepared to work in the new tourism conditions after the pandemic. Opportunities are related to concluding contracts, developing joint curricula, developing internship programs, exchanging, determining scholarships and more;
- The study showed that government support does not play a leading role in retaining and motivating tourism employees during the pandemic from the employer's point of view. The Bulgarian government should rethink the measures of state policy in this direction, so that they really contribute to the affected industry and those employed in it;
- The Covid-19 pandemic was ranked last by employers (34%) as a reason for the outflow of employees from the tourism sector. This gives us the feedback to confirm that the pandemic doesn't have a great influence on labour outflow from tourism from an employer's point of view. This result shows us that the problem with the staff in tourism has deep roots, but the Covid-19 pandemic appears as an activator for labour outflow in tourism. This calls for urgent measures based on cooperation between tourism stakeholders with the main aim of attracting and retaining a skilled and experienced workforce in perspective.

*6.2. Conclusions and recommendations from the former employee's point of view.*

After the conducted study among former employees in the tourism industry, the following main conclusions and recommendations can be highlighted as most important:

- Most of the former workers voluntarily left their job and only one-third of them was involuntarily released, which shows us more psychologically based than the economic basis of the situation on the tourism labour market in Bulgaria due to Covid-19. Most of the participants (51%) are not professionally engaged in the tourism industry from the beginning of the pandemic, which can be determined as a proactive protective action. We can assume that the pandemic definitely had a strong influence on workers in tourism to leave their jobs so that they can protect their lives, which is emotionally rather than factually based (as pointed on paragraph 3.3.).
- The reasons for not working in the tourism industry are more traditionally based than directly connected with Covid-19. Low income and irregular working hours have always been announced as some of the most negative sides of employment in tourism. Only the absence of professional development opportunities and the uncertainty could be

connected with the pandemic situation. From our point of view, the participants link the particular negative sides of working in tourism but don`t evaluate the fact that they left their job when Covid-19 has appeared, making the pandemic the main reason for the great outflow of labour from the industry through the last years.

- 80% and more indicate reduced salary, unpaid leave and extended working hours that occurred in the first quarter of the pandemic at their workplace. This gives us an idea of the type of the employer's attitude from the employee's perspective during pandemic – proactive. Before experiencing economic, financial and other difficulties, the employers prefer to apply all possible restrictions to avoid possible involvements.

- One of the practically most important questions in this section is giving us information about the top receptive industries for transferring human resources from the tourism industry. Among these leaders are the IT industry, the retail industry and business process outsourcing (call centres) but also a wide range of business sectors was given. This confirms the suggestion that workers in the tourism industry acquire a wide range of skills, which makes them easily transferable in times of crisis (as pointed on paragraph 3). The main question remains how to keep them or return them after the pandemic, which will be the biggest challenge in the tourism industry through the next few years.

- Arising from the previous conclusion, less than half of the participants (47.5%) would like to return to work in tourism. More than one-third is definitely denying to have such intentions. This shows us that the pandemic caused a severe impact on employers in their value perception about working in tourism. These results we recognise as disturbing, taking into consideration that the leakage of experienced and qualified workers from tourism is not going to be recovered. The main reasons for those considering returning to work in tourism are the nature of work, the job satisfaction and the experience they have gained through the years, which are again more emotional than economic reasons.

- In conjunction with the future of tourism and the possible resilience of the industry, the former workers are pessimistic, taking in consideration that more than one-third (36.4%) are seeing possible recovery of the industry after more than 3 years and another 13.6% are not seeing such at all. The pandemic made tourism employees not only leave the industry, but also not see a perspective in well-being in it.

- Toward the evaluation of the Bulgarian government's actions for overwhelming the negative impacts of the pandemic on the tourism industry, the former employees generally have a negative attitude. They evaluate them as inaccurate, incorrect, delayed, unverified and incorrect. This shows us once again that government support does not play a leading role in retaining and motivating tourism employees during the pandemic. This gives us the belief that the pandemic revealed the time for tourism employers to understand that they are the main figures for staff retention and motivation – government support could only play a supporting role, but when developed and coordinated with the tourism enterprises.

- The expectations of the former employees of the future patterns of the tourism labour market are also not positive. The respondents think that the outflow of experienced and qualified workers will continue and as a result of the great absence of qualified workers,

low quality of the tourism service will be observed. As a specific effect of the pandemic, inevitably, this would lead to lower prices of tourism services, lower income for tourism enterprises and lower wages for tourism employees.

### *6.3. Conclusions and recommendations from the current employee's point of view*

After the conducted study among the current employees in the tourism industry, the following main conclusions and recommendations can be highlighted as most important:

- To the current employees in the tourism industry, the situation with the changing working environment after Covid-19 is quite different. As opposed to former employees, in most cases by them, there were no reduction in salary and no unpaid leave after Covid-19 occurred. However, cases with extended working hours and consolidation of working positions were indicated. The information led us to the conclusion that the pandemic put employees in tourism to make compromises with their working environment because of the uncertainty of the external conditions.
- Given the fact that most positions in the tourism industry include intensive direct contact with clients, the pandemic makes it risky. However, almost 95% of the current employees did not receive any additional benefits for that. Given the attention that most enterprises cut the number of employees, we doubt that there were no such possibilities. Negatively, almost half of the respondents have been considering leaving the tourism industry after Covid-19 because of the risky working environment. The pandemic made employers overthink their future in tourism because of the great health risk for them. Unfortunately, employers don't consider this fact and refuse to perform motivating practices to retain them.
- The main reasons for remaining employed in the tourism industry for the respondents are their experience in the tourism field, the type of working process, job satisfaction and teamwork. Once again, we observe emotionally rather than economically based reasons, which confirms the statement that the pandemic made the tourism labour market participants' behaviour more psychologically driven.
- The time perspective for tourism resilience, most of the current employees see slightly more positive than the former ones. For most of them, the most expected time period is within the next two years and almost one-quarter of the respondents see the possible resilience within one year. Tourism is performing O'Brien and Hope's perception of resilience and is seeking out opportunities that have arisen during the pandemic. We believe that the adaptation to the new terms and conditions, the fallout of the inefficient agents and the creation of modern sustainable business models are to be observed in future.
- The evaluation of the Bulgarian government's actions against the negative impact of the pandemic on the tourism industry by the current employees is not very different from the former employee's opinion. This statement leads us to the thought that government actions weren't developed and introduced in cooperation with tourism enterprises.

Though, in a pandemic situation, this lapse is causing not only disappointment but also a negative attitude toward the whole industry and its future resilience perspectives.

- As given the opportunity to share their expectations on how the pandemic is going to impact the future patterns of the tourism labour market, the current employees in tourism, such as the former one, are not optimistic. From their point of view, there will be continuing outflow of experienced workers from tourism and a great relaunchment of human resources to other industries, which will result in the unwillingness of young people to study tourism and work in the tourism industry, which will result in low quality of tourism services. Once again, the statement that the pandemic caused severe and significant specific effects on tourism is confirmed. To fight against that ongoing negative process, the respondents do not see possible new effective government policy toward human resources in tourism, which once again stresses on the importance of exciting coordinated actions between government, business and non-governmental organisations.

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# VEGETABLE PRODUCTION AS A PART OF BULGARIAN AGRICULTURE[2]

*The importance of vegetable production for the agricultural sector of Bulgaria is determined by the year-round presence of vegetable crops in household consumption and the strong traditions in vegetable production. The problems in the sector are significant and timely intervention is needed to solve them in order to ensure the country's food security. The purpose of the report is to outline the place of vegetable production in Bulgarian agriculture and the trends observed in the sector for the period 2013-2020. Data from the agrarian reports of the Ministry of Agriculture were used, FAO, Eurostat.*
*Keywords: agriculture; vegetable production; trends*
*JEL: Q10; O13; Q18*

## 1. Introduction

Bulgaria is a traditional producer and exporter of vegetable crops. The geographical location and favourable climatic conditions allow the cultivation of a wide range of vegetables with very good quality characteristics. In the 1980s, the export of vegetable crops had an important role in the structure of agricultural exports. After the implementation of the agrarian reform from the nineties of the 20th century, vegetable production began to decline. The main factors for the reduction of vegetable production are the organizational restructuring of agricultural cooperatives, the loss of the Eastern European market, and the limitation of domestic demand for raw materials from the canning industry. Bulgaria is gradually turning from an exporter to an importer of almost all types of vegetable crops and is unable to satisfy the shrunken national market (Valchev, 1999).

With the accession of Bulgaria to the European Union (EU), serious questions arise regarding the future development of vegetable production in the conditions of a single market, with strong competition from products with a higher degree of subsidization (Nencheva-Ivanova et al., 2015). One group of issues is related to the state and the relatively low level of production and competitiveness with which the country entered the EU. The other group of issues is related to the different speed with which individual economic activities in agriculture develop, under the influence of the EU's Common Agricultural Policy (CAP). In-depth

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research is also needed due to the impact that the CAP has had on the sector since the 2003 reform, when the subsidy policy changed from payment for goods produced to payment per unit of area. The result is that the direct payments stimulate significantly more the development of crops such as wheat, which require large growing areas. For crops such as vegetables, income support is not enough and their production continues to decrease (Doychinova, 2017). Therefore, in the second programming period – RDP 2014-2020, the criteria for receiving direct payments are changing (Atanasova-Kalaydzhieva, 2017). During the years of EU membership, the country's agriculture has undergone restructuring in the direction of reducing the number of farms and their consolidation. The farms are divided into large ones – producing most often grains, and small ones – producing vegetables and fruits mainly for personal consumption. The number of large farms is small, while that of small farms is significant. In Bulgaria, the cultivation of crops (wheat, corn, barley) predominates, while vegetable production is reduced to the extent that imports of almost all vegetables are required. In the past, such vegetables have formed a substantial part of the country's agricultural exports (Kostadinova, 2017; Gorcheva, 2016; Dimitrov et al., 2021). Bipolar agriculture is formed, where 1.5% of farms manage 82% of the arable land and mainly grow grains. Traditionally grown crops such as vegetables are noticeably dwindling and there is a danger of cessation of production. For the period 2007-2017 processing of agricultural products has decreased twofold (Nikolova, Linkova, 2020).

There has been a significant decline in vegetable production, which began as early as 2014 and deepened over the years. One of the reasons for this is the insignificant support during the First Program Period 2007-2013 in terms of overcoming structural imbalances in agriculture (Petrova, 2017). In vegetable production, the arable land in 2010, compared to the pre-accession period, it decreased by 47%, and for the same period, the potato area decreased by 37%. The funds from the pre-accession funds of the SAPARD program and other national programs do not arouse lasting interest and do not support the recovery of the sector (Bencheva, 2012).

The growing importance of vegetable crops for the healthy nutrition of the population and also as raw materials for the production of quality processed products are a prerequisite for in-depth research (Branzova, 2019; Krasteva, 2017). The agrarian sector is developed primarily as a resource without adding additional value to the final product. This affects the competitiveness of the sector compared to other sectors of the economy, access to credit and foreign investment. Active state intervention is needed, which could be done through the financing of operating enterprises, provision of guarantee schemes and instruments and implementation of investment programs. It is a paradox that direct revolving financing and lending against subsidies make up about 40% of the total credit resource for agriculture (Vlaev, 2018). Despite the positive return on subsidies in vegetable production for the period 2014-2020, their importance is insignificant (9%) compared to other factors influencing the level of gross production in agriculture (Nikolov et al., 2015).

The production of vegetables is a risky undertaking, as it is subject to climatic changes, in Bulgaria, there are the necessary soil and climatic conditions and the experienced workforce, but the sector is shrinking more and more (Nikolova, 2017). Farms sales increase and decrease irregularly, depending on demand and the level of purchase prices from the previous year. In agriculture, the differentiation of individual products is relatively weak, i.e. it is

difficult to distinguish tomatoes, cucumbers or cabbage from different regions of the country. The differentiation is possible on the basis of specific varieties, zoned in a strictly defined geographical location (Yovchevska, 2019).

The vegetable market is characterized by some volatility in terms of consumption and resource specificity (Ruscheva et al., 2022). Unlike grains, changes in the general economic situation affect the volume of consumption of vegetables. At lower prices, consumption increases as consumers extend the consumption season by canning vegetable crops, and vice versa – at higher prices, consumption shrinks. The instability in the supply and the corresponding dynamics in the prices of vegetables are explained by the possibility of using different vegetables interchangeably (Harizanova-Bartos, Terziyska, 2020).

Problems in vegetable production are deepened due to structural weaknesses of specialized farms, such as seasonal fluctuations in demand, i.e. the bulk of the sales are mainly in the period May – November (Nencheva-Ivanova et al., 2015). Therefore, the use of pricing strategies that are consistent with seasonality is of great importance. Market-oriented pricing strategies are determined by factors such as consumer preference, consumer shopping behaviour and income.

The seasonality and short shelf life of most vegetable crops demand an emphasis on marketing. It is necessary that marketing activities reflect the specifics of the sector. In vegetable production, there is a great risk of wastage; therefore, a very good organization is required in order to minimize losses (Radeva, 2021).

There is no mandatory minimum wage in the Vegetable production sector. In the numerous small vegetable farms, cultivation and most of the activities related to the production and sale of the produce are mainly carried out by the members of the household. Programs for investment support are almost absent in the sector. The need for labour in vegetable production is many times greater than in grain production, for example. The reasons are the greater labour intensity and the need for year-round employment. This is a prerequisite for hiring additional personnel, which is an opportunity to overcome the crisis with the lack of employment in the agriculture sector (Hristova, Ilieva, 2013).

The production and sale of the products require certain labour and material costs. The costs for labour, production, logistics and supply of the product are reflected in the price (Yarkova et al., 2017; Kotseva-Tikova, 2018). As the main element of price, the cost is composed of variable and fixed costs. The grouping of expenses by economic elements makes it possible to determine the cost of production of vegetable crops (Stoyanova, 2007). Material costs include: costs of seeds, planting material; auxiliary materials; fuel, energy, water, maintenance of fixed assets, consumables and packaging. External service costs include: advertising costs; rentals; transport services; repair of durable tangible assets (LDA); property taxes; fees etc. The classification of expenses by economic elements also refers to: amortization expenses; labour; social security and allowances; business trips; exhibitions and fairs, etc. The stimulation of the industries, via various support levers, gives partial results. Vegetable production, where the return on investment happens over a long period, suffers severely in terms of financial support. The result is stagnation in the subsector and an imbalance in agricultural production (Hristova, 2014).

## 2. Analysis of Vegetable Production for the Period 2013-2020

The problem of feeding the world's ever-growing population and the production of agricultural goods is a constant factor driving societal development. Vegetable production, with its great diversity of species, is an important source of products which have a significant role in maintaining the nutritional balance for the population. Being able to grow vegetables in different seasons of the year and different climatic areas contributes to maintaining a natural conveyor belt for supplying consumers with fresh vegetables. According to data from the FAO (Food and Agriculture Organization), the production of vegetables for the market increased and reached 1.148 million tonnes in 2020, which is 17% more compared to 2013. Vegetable production is mainly concentrated in Asia – 879,301 tons in 2019. Approximately the same amount of vegetables was produced in Europe and Africa in 2019, respectively, 84,935 tons and 84,372 tons. China has the leading position in the top ten world producers of vegetables for 2020 with 594.05 million tons, followed by India – 141.2 million tons, the USA – 33.12 million tons, and Turkey – 25.96 million tons. As the world population grows, the demand for vegetables increases, which stimulates the growth of future production.

EU-27 is characterized by highly developed vegetable production. The sector includes a wide variety of different types of vegetables grown in greenhouses and open areas. It demands greater labour costs and uses a greater proportion of seasonal labour than other economic activities in agriculture.

According to Eurostat data, there are 11 countries with the largest volume of production. Spain, Italy and France are leading the way. The Netherlands, Poland and Germany are the next three countries in the EU with the highest yields of vegetables. The first two countries show weak growth rates, indicating that they have reached a balance between production capacity and market realization (Table 1).

Table 1

Vegetable production in leading countries in the EU, thousand tons

| GEO/TIME | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Change 2021:2013, % |
|---|---|---|---|---|---|---|---|---|---|---|
| Spain | : | : | 14520 | 15381 | 15400 | 14878 | 15790 | 15099 | 16305 | X |
| Italy | 12228 | : | 13263 | 13445 | 12879 | 12767 | 12903 | 13307 | 13843 | 113.21 |
| France | 5364 | 5435 | 5354 | 5504 | 5606 | 5708 | 5612 | 5566 | 6248 | 116.48 |
| Netherlands | 4900 | 4972 | 4980 | 4890 | 5405 | 4661 | 5403 | 5344 | 5683 | 115.98 |
| Poland | : | 5853 | 5038 | 5841 | 5923 | 5489 | 5221 | 5001 | 5664 | X |
| Germany | 3505 | 3871 | 3564 | 3815 | 4087 | 3591 | 4048 | 4040 | 4389 | 125.22 |
| Portugal | 1989 | 2299 | 2224 | 2534 | 2586 | 2122 | 2356 | 2515 | 2952 | 148.42 |
| Greece | 3452 | 3226 | 3154 | 3027 | 2853 | 2728 | 2275 | 2535 | 2330 | 67.50 |
| Romania | 2735 | 2666 | 2512 | 2299 | 2498 | 2641 | 2406 | 2340 | 2287 | 83.62 |
| Belgium | : | : | 1990 | 2057 | 2152 | 2088 | 2269 | 2231 | 2263 | X |
| Hungary | : | 1518 | 1606 | 1631 | 1661 | 1525 | 1498 | 1430 | 1351 | X |
| Austria | 609 | 703 | 573 | 625 | 609 | 573 | 625 | 658 | 689 | 113.14 |
| Bulgaria | 450 | 393 | 438 | 669 | 561 | 579 | 555 | 459 | 494 | 109.78 |

*Source: Eurostat, Vegetables, production.*

The changes in the production of vegetable crops in the leading member states of the EU for the period 2013-2020 show that the greatest growth occurred in Portugal – 148.42%, meaning

that the production of vegetables in the country increased by 963 thousand tonnes in 2020 compared to 2013. Germany, the Netherlands and France, also experienced a positive trend in the last year compared to the beginning of the period. The change in vegetable production in Germany was 125.22% or 884 thousand tons more in 2020 compared to 2013. Vegetable production in France increased in 2020 compared to 2013 by 116.48% or 884 thousand tons.

Bulgaria is in 13th place and reports insignificant growth in vegetable production compared to the rest of the EU countries. The physical volume increased from 450 thousand tons in 2013 to 494 thousand tons in 2020, which is a 109.78% change. The development of the sector in Bulgaria lags behind in comparison with countries that are close in size and with similar climatic conditions.

Table 2

Ranking of vegetable production in Bulgarian agriculture

| Indicator/year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| BP from agriculture at producer prices (million BGN) | 8713.8 | 8053.2 | 7605.6 | 7319.7 | 8031.5 | 8155.0 | 8319.1 | 7798 |
| Change 2013r. = 100% | 100 | 92.4 | 87.3 | 84 | 92.2 | 93.6 | 95.5 | 89.5 |
| VAT from agriculture (million BGN) | 3313.8 | 3132.5 | 3039.1 | 2961.2 | 3760.3 | 3663.4 | 3727.2 | 3419.5 |
| Change 2013r. = 100% | 100 | 94.5 | 91.7 | 89.4 | 113.5 | 110.5 | 112.5 | 103.2 |
| BP from vegetables and potatoes (million BGN) | 547.3 | 254.20 | 266.90 | 272.8 | 463.0 | 521.7 | 476.5 | 446.9 |
| Change 2013r. = 100% | 100 | 46.4 | 48.8 | 49.8 | 84.6 | 95.3 | 87.1 | 81.7 |
| Relative share of vegetables in BP of Bulgarian agriculture (%) | 6.28 | 3.16 | 3.51 | 3.73 | 5.76 | 6.40 | 5.73 | 5.73 |
| Relative share of vegetables in BP from crop production (%) | 10.35 | 5.11 | 5.44 | 5.51 | 8.44 | 9.25 | 8.27 | 8.57 |
| Cultivable land in hectares | 3462117 | 3469388 | 3493688 | 3480991 | 3473825 | 3463370 | 3461615 | 3477514 |
| Open areas of vegetables (ha) | 39060 | 30131 | 43914 | 58069 | 39998 | 41846 | 37574 | 33704 |
| Rel. share of vegetable area of arable land (%) | 1.13 | 0.87 | 1.26 | 1.67 | 1.15 | 1.21 | 1.09 | 0.97 |

*Source: Agrarian reports Ministry of Agriculture "Agrostatistics", Own calculations.*

The data in Table 2 shows that the gross output from agriculture at producer prices for the period 2013-2020 was the highest in 2013 – BGN 8,713.8 million, and the lowest in the middle of the period – 2016 (BGN 7319.7 million). The trend is decreasing up until 2016, after which a slight increase can be observed. This trend continues in the following years, however, in 2020 the gross output shrinks to BGN 7,798 million. Thus, 2020 turns out to be the third year (after 2016 and 2015) with the lowest values for this indicator. The change compared to the base year of 2013 is negative. Throughout the period, the values varied between 84% and 96%.

The gross added value from agriculture for the analyzed period was the highest in 2017 at BGN 3,760.3 million, and the lowest in 2016 at BGN 2,961.2 million. The trend, as with gross production at producer prices, is decreasing up until 2016, then an increase, which is maintained in the following years, is observed. In 2020, the gross added value was lower by about BGN 300 thousand compared to the previous year of 2019 (BGN 3,727.2 million). The change compared to the base year of 2013 is negative up until 2016, after which it increases and is in the range between 103% and 113%.

During the period, the gross production of vegetables (including potatoes) did not exceed BGN 550 million per year. In the initial year of 2013, the largest value of BGN 547.3 million was observed. In the following three years the indicator is significantly lower, nearly 50%, respectively BGN 254.20 million; BGN 266.90 million, and BGN 272.8 million. In 2017, there was a significant increase in the production of vegetables compared to the previous year, but the value was smaller than the one at the beginning of the analyzed period (BGN 463 million). An upward trend follows, which slightly decreases at the end of the period and the gross production of vegetables amounts to BGN 446.9 million. The change compared to the base year of 2013 is negative, increasing in the last few years, but remaining around 80% compared to 2013.

The relative share of vegetables in the gross production from agriculture in the period 2013-2020 is in the range of 3% to 7%. In 2013 the relative share was 6.28% and in the following three years it decreased by 3.16%, 3.51% and 3.73% respectively. Since 2017 the indicator has significantly increased compared to the previous years, and this trend is maintained until the end of the considered period. The highest relative share of vegetables in the gross production from agriculture was reported in 2018 – 6.4%.

The relative share of vegetables in the gross crop production in the period 2013-2020 is in the range between 5% and 10%. In 2013 the relative share was the highest at 10.35%, in the next three years, it decreased by almost half and was around 5%. Since 2017, the indicator has significantly increased compared to the previous years and reached 9% in 2018. The increasing trend of the relative share of vegetables in the gross crop production is maintained until the end of the analyzed period. However, the value of the indicator at the end of the period (2020) is nearly 2% lower than at the beginning (2013).

The relative share of gross vegetable production from cultivated land in the period 2013 – 2020 is in the range of 0.8% to 1.7%. In 2013 the relative share was 1.13%. In the following year, the lowest value of the indicator was recorded at 0.87%. Since 2015 the trend has been increasing, with the largest relative share in 2016 at 1.67%. In 2020 the relative share of the area of vegetables from cultivated land was 0.97, making it the second year (after 2014) with the lowest value of the indicator for the period.

The unfavourable trend in vegetable production has and will continue to have a negative impact on the total amount of gross production created in agriculture, since the production per unit area of vegetables is many times higher than the production per unit area of grains, which predominates in the agricultural sector of the country.

Table 3

Dynamics of uncovered cultivated areas (ha) of vegetable crops in 2013-2020

| Basic crop groups/Years | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Change 2020:2013, % |
|---|---|---|---|---|---|---|---|---|---|
| Fruit vegetables | 14892 | 12112 | 18067 | 28543 | 19232 | 17821 | 19393 | 15751 | 105.77 |
| Legumes | 5579 | 2439 | 1452 | 2582 | 982 | 667 | 1153 | 1092 | 19.57 |
| Brassica Vegetables | - | - | 1945 | 3020 | 1848 | 2125 | 2013 | 1677 | - |
| Leafy vegetables | 3725 | 3926 | 1039 | 1131 | 606 | 632 | 695 | 795 | 21.34 |
| Tuber and onion vegetables | 1987 | 1736 | 1869 | 2270 | 3869 | 5779 | 4326 | 3712 | 186.81 |
| Potatoes | 12765 | 10200 | 11017 | 8376 | 12806 | 14096 | 9291 | 9946 | 77.92 |
| Straweberries | 633 | 672 | 756 | 670 | 655 | 726 | 703 | 731 | 115.48 |
| Other vegetables | 443 | 20 | - | - | - | - | - | - | - |
| Total | 39060 | 30131 | 43914 | 58069 | 39998 | 41846 | 37574 | 33704 | 86.29 |

*Source: Agrarian reports Ministry of Agriculture "Agrostatistics".*

Table 3 presents the dynamics of uncovered areas of vegetable crops for the period 2013-2020. Vegetable crops are divided into seven main groups, the largest of which is Fruit vegetables, which includes: tomatoes; cucumbers; peppers; pumpkins; watermelons; eggplants, etc. They occupy the most hectares of land in each considered year of the period, with the largest amount in 2016 – 28,543 ha. In the last analyzed year, the areas with fruit and vegetables were 859 ha more than at the beginning of the period in 2013. The change of the uncovered areas with Fruit and vegetables for 2020 compared to 2013 is 105.77%. In 2014, the area shrank to 12,112 ha, the lowest value of the indicator for the period.

The second largest open area is occupied by the potato crop. For the studied period, the largest areas were in 2018 – 14,096 ha, and the smallest – in 2016 – 8,376 ha. From the beginning of the period, a decrease in the harvested areas was observed until 2016. The following year (2017) recorded significant growth and the areas with potatoes increased to 12806 ha. This trend was maintained in the year after as well. In the last two analyzed years, the areas with potatoes shrank to around 9,000 ha. In 2020 the areas with potatoes decreased by 2819 ha compared to 2013.

Beans, peas, and legumes fall into the Legumes group, which occupied between 667 ha to 5579 of uncovered land in the period 2013-2020. In 2013, the areas with crops in this group were the largest – 5579 ha, in the following years, a significant reduction was observed and 2017 and 2018 were the years with the lowest value of the indicator, 982 ha and 667 ha, respectively. At the end of the period, an increase to about 1000 ha is reported, but this is five times less compared to the beginning of the researched period (2013), or they are 19.57% of the areas in 2013.

Leafy greens include lettuces, artichokes, spinach, leeks, chives, and others. Until 2014, cabbage also fell into this group, but since 2015 another group of vegetables from the Brassica genus has been added and cabbage has been moved into it. This may explain the lack of data for 2013 and 2014 for vegetables from the Brassica varieties, and the subsequent decrease in land cultivated with Leafy vegetables from 2015 to the end of the analyzed period.

The lowest values of the indicator were in 2017 – 606 ha. In 2020 an increasing trend is observed, but compared to 2013, the uncovered areas with leafy vegetables are 21%.

Brassica vegetables include: cabbage, cauliflower, broccoli and brussels sprouts. In 2015, the uncovered areas were 1945 ha, and in 2020 – 1677 ha. A decrease of 268 ha was reported in 2020, which also recorded the smallest size of cultivated land. The largest cultivated area for this group was recorded in 2016 at 3020 ha.

The group of tuberous and bulbous vegetables includes: onions, carrots, garlic and others. In 2013, the uncovered cultivated areas were 1987 ha, and in 2020 – 3712 ha, an increase of 1725 ha was reported. The largest size was recorded in 2018. – 5779 ha, gradually decreasing in the following years. Tubers and onion vegetables saw the most significant increase in the uncovered cultivated land of all vegetable groups. The other two groups that reported an increase were Fruit, vegetables and Strawberries. The rest of the groups shrank their harvested areas during the analyzed period.

The uncovered cultivated areas with strawberries for the period 2013-2014 were in the range between 633 ha and 756 ha. In 2013, the areas with strawberries were the smallest – 633 ha. In the following years, an increase was observed. At the end of the period, the areas were 731 ha, which is 98 ha more compared to the beginning of the research period (2013), or they are 115.48% in comparison to 2013.

The total uncovered cultivated areas of vegetable crops for the period 2013-2020 are in the range between 30,000 ha and 60,000 ha. If we compare the end of the period (2020) with the beginning (2013), we can see that the cultivated areas are 86.29% or the trend is decreasing. The year with the largest size of the areas was 2016 – 58069 ha, and the smallest size was reported in 2014 – 30131 ha.

Table 4

Average yields of main vegetable crops by year (kg/ha)

| Year/Crop | Tomatoes | Peppers | Cucumbers | Onions | Cabbage | Potatoes |
|---|---|---|---|---|---|---|
| 2007 | 19 710 | 14 400 | 16 220 | 8 400 | 22 060 | 13 320 |
| 2013 | 23 871 | 14 734 | 13 914 | 10 407 | 23 694 | 14 610 |
| 2014 | 26 603 | 16 340 | 19 661 | 11 920 | 21 779 | 12 999 |
| 2015 | 26 635 | 16 936 | 13 689 | 8 311 | 22 668 | 14 965 |
| 2016 | 25 555 | 19 050 | 10 668 | 10 931 | 26 265 | 15 150 |
| 2017 | 23 434 | 16 031 | 16 220 | 11 298 | 24 715 | 17 782 |
| 2018 | 21 815 | 17 083 | 15 353 | 11 374 | 24 090 | 18 558 |
| 2019 | 20 568 | 18 726 | 18 809 | 11 953 | 26 242 | 21 244 |
| 2020 | 26 881 | 18 221 | 17 045 | 10 856 | 21 959 | 19 338 |
| Change 2020:2007, % | 136.4 | 126.5 | 105.1 | 129.2 | 99.5 | 145.2 |
| Change 2020:2013, % | 112.6 | 123.7 | 122.5 | 104.3 | 92.7 | 132.4 |

*Source: Agrarian reports Ministry of Agriculture "Agrostatistics".*

Table 4 represents the average yields for the main vegetable crops by year for the period 2013-2020. The selected vegetables are traditionally consumed in the country and their production is important for the national food supply. A comparison was made between the last analyzed year (2020), the first year of Bulgaria's membership in the EU (2007), and the initial year of the study (2013) in terms of average vegetable yields. The change for all main

vegetables is positive compared to 2007, with the exception of cabbage, where an insignificant decrease of 101 kg/ha is reported. The biggest change is recorded for the average yields of potatoes – 145.2% or 19338 kg/ha in 2020 compared to 13320 kg/ha in 2007. In second place is the average yield for tomatoes – 136.4% or 26881 kg/ha for 2020 compared to 19710 kg/ha for 2007, followed by onions – 129.2%, pepper – 126.5% and cucumbers – 105.1%.

The change reported of average yields for all main vegetables, compared to 2007 and 2013, is positive, with the exception again of cabbage, where a decrease of 1735 kg/ha was observed. The largest change in the average yields was reported for potatoe crops – 132.4% or 19338 kg/ha in 2020 compared to 14610 kg/ha in 2013. In second place is the average yield of pepper with a change of 123.7% or 18221 kg/ha for 2020 compared to 14734 kg/ha in 2013, followed by cucumbers – 122.5%, tomatoes – 112.6% and onions – 104.3%.

The average yield for the tomatoe crops for the studied period increased until 2015 (26635 kg/ha), in the following years, the trend decreased. In 2020, the value of the indicator increased by about 6000 kg/ha compared to 2019. In all analyzed years, the average yield of tomatoes ranged from 20000 kg/ha to 27000 kg/ha.

The average yield for peppers at the beginning of the period was 14734 kg/ha and increased every year up to and including 2016 (19050 kg/ha), which was also the year with the highest yields for the crop. In 2017, there was a decrease of 3019 kg/ha compared to the previous year, however, the average yield gradually increased in the following years by over 1000 kg/ha per year. For the last year of the analyzed period, an insignificant decrease in the average yield of pepper was reported at 18221 kg/ha.

The average yield for cucumbers for the period 2013-2020 was in the range of 10000 kg/ha to 20000 kg/ha, sharp changes in the values of the indicator are observed every year. In 2014, an increase of over 5,000 kg/ha compared to 2013 was reported, and in the following year, 2015, yields fell again and reached those from the beginning of the period. The decrease continued in 2016, but in 2017 a significant increase was reported and average yields reached 16220 kg/ha. In 2018, there was another decrease (15353 kg/ha), and in 2019 – an increase (18809 kg/ha). In the last year of the period, the average yield for cucumbers decreased again to 17045 kg/ha.

The average yield for onions during the studied period did not change significantly. The values were preserved in all years and ranged from 10400 kg/ha to 11960 kg/ha, except for 2015, when they sharply decreased and reached the lowest value for the analyzed period – 8311 kg/ha. The highest yield was reported in 2014 and 2019 (11920 kg/ha and 11953 kg/ha, respectively).

The average yield for cabbage was the highest in 2016 and 2019, 26265 kg/ha and 26242kg/ha respectively. The values are the lowest in 2014 and 2020, 1779 kg/ha and 21959 kg/ha, respectively. Cabbage and tomatoes had the highest average yields of all the selected for the research vegetable crops. The values of the indicator varied between 21000 kg/ha and 26500 kg/ha for the period 2013-2020.

The average yield for potatoes for the analyzed period was in the range between 12000 kg/ha and 21300 kg/ha. At the beginning of the period, a decrease was recorded and in 2014, the

yield shrank to 12999 kg/ha, which is the lowest value for all the years considered in the research. After 2014 the trend was positive; yields gradually increased up until 2019, when they reached 21244 kg/ha, which is the highest value of the indicator for the period 2013-2020. In 2020, the average yield for potatoes decreased by 1906 kg/ha compared to 2019 and reached 19338 kg/ha.

Table 5

Dynamics of total vegetable production from uncovered areas by selected vegetable crops by year (thousand tons)

| Year | Total Vegetables | Tomatoes | Peppers | Cucumbers | Onions | Cabbage | Potatoes |
|---|---|---|---|---|---|---|---|
| 2013 | 547 280 | 77 390 | 59 452 | 8 237 | 12 748 | 45 090 | 186 499 |
| 2014 | 431 545 | 80 448 | 46 994 | 6 783 | 13 327 | 42 316 | 132 594 |
| 2015 | 516 164 | 71 541 | 65 039 | 4 230 | 8 926 | 42 411 | 164 866 |
| 2016 | 699 151 | 92 330 | 68 143 | 2 635 | 14 921 | 75 512 | 126 897 |
| 2017 | 685 836 | 102 548 | 52 455 | 4 574 | 23 499 | 41 817 | 227 713 |
| 2018 | 710 172 | 85 232 | 48 755 | 7 216 | 41 798 | 47 240 | 261 594 |
| 2019 | 651 308 | 95 722 | 57 263 | 26 502 | 31 376 | 46 449 | 197 382 |
| 2020 | 559 030 | 69 515 | 47 319 | 8 352 | 28 443 | 32 060 | 192 331 |
| Change 2020:2013, % | 102.1 | 89.8 | 79.6 | 101.4 | 223.1 | 71.1 | 103.1 |

*Source: Agrarian reports Ministry of Agriculture "Agrostatistics".*

Table 5 represents the dynamics of the total vegetable production as well as the produce from uncovered cultivated land of selected vegetable crops for the period 2013-2020. The data shows that the total vegetable production at the end of the period has increased compared to the beginning, the change from 2013 to 2020 was 102.1%, or 11,750 tons. 2018 was the year with the largest volume of vegetable production – 710,172 tons. The lowest values of the indicator were reported in 2014 – 431545t. A decrease was observed until 2014, after which the total production of vegetables gradually increased for four consecutive years and reached its maximum in 2018. By the end of the analyzed period, the trend was decreasing and in the last year (2020), the production amounted to 559,030 tons.

Changes in open area production of selected vegetable crops for the period 2013-2020 showed that onions reported the largest growth – 223.1%, meaning that the production area for onions more than doubled in 2020 compared to 2013, the difference nearing 15695t. Cucumbers and potatoes also recorded a positive trend in the last year compared to the beginning of the research period. The change in the production from open areas with potatoes was 103.1% or 5832 tons more in 2020 compared to 2013. The production of cucumbers increased insignificantly in 2020 compared to 2013 – 101.4% or 115 tons more. The production from open areas of vegetable crops: tomatoes, pepper and cabbage for 2020 had a negative change compared to 2013. For tomatoes, the change was 89.8% or 7875 tons less in 2020 compared to 2013. The values of the indicator for pepper were 59452 tons in 2013 and 47319 tons in 2020, the change is 79.6% or 12133 tons less. In the production of cabbage from open areas, the most significant decrease was reported in 2020 compared to 2013, the change was 71.1% or 13030 tons less cabbage produced.

Potatoes have the highest production from uncovered cultivated areas in all the years analyzed in the research. At the beginning of the period, there was a drop to 132,594 tons

(2014), and in 2015, there was an increase in production by about 30,000 tons. The next year (2016), the value of the indicator significantly decreased and reached 126,897 tons, but in 2017 the largest increase for the period was reported at 100,816 tons and production from open areas reached 227,713 tons. The increasing trend was maintained in 2018 to a lesser degree, in the last two years, a gradual decrease was reported, and in 2020, the production of potatoes reached 192331 tons.

The quantities of tomatoes produced from open areas for the period 2013-2020 are in the range between 69,000 tons and 103,000 tons, the most produce was reported in 2017 – 102,548 tons, and the smallest amount was in the last year of the study (2020) – 69,515 tons. From the beginning of the period to 2017, an increase in the produced quantities was reported, with the exception of 2015, when the production fell to 71541 tons. In the second half of the studied period, the trend was negative, the produced quantities of tomatoes from open areas decreased, and in 2020 the smallest volume for the period was recorded.

The produced quantities of pepper from open areas for the period 2013-2020 were between 46000 tons and 69000 tons. The largest quantities were in 2016 – 68143 tons, and in 2014 the lowest values of the indicator for the period were recorded at 46994 tons. The trend at the beginning of the studied period was upward and continued until 2016, with the exception of 2014, when the volume of production was the lowest. After 2016, a decrease was observed, which continued until the end of the period, and in 2019, a momentary increase of pepper production of 8,508 tons was recorded, compared to the previous 2018 year. For 2020, the production of pepper amounted to 47,319 tons.

During the analyzed period, the amount of cabbage produced from open areas was about 40,000 tons, but in 2016, a significant increase in production by 33,101 tons was observed. 2016 was also the year with the highest value of the indicator for the period – 75512 tons. A sharp decline in the volume of cabbage produced followed, and the negative trend continued until the end of the researched period when the produced quantities of cabbage from open areas amounted to 32,060 tons, the lowest value for the reviewed years.

The volume of cucumbers produced from open areas for 2013-2020 decreased by about 2000 tons every year from the beginning of the period until 2016, when the volume of production reached its lowest value at 2635 tons. Since 2017, the trend has been in a positive direction and the volume grew, and in 2019, it reached 26502 tons. However, in 2020 the production of cucumbers shrunk to 8352 tons.

The volume of onions produced from open areas for the period 2013-2020 was in the range between 8000 tons and 42000 tons, the most produce was harvested in 2018 – 41798 tons, and the least in 2015 – 8,926 items. From the beginning of the period to 2018, an increase in the onions produce was reported, with the exception of 2015, when production fell by 4,401 units compared to the previous year, 2013. In the last two years of the research period, the trend was negative, the volume of onions produced from open areas was decreasing and in 2020, it amounted to 28443 tons.

## 3. Conclusion

Bulgaria is a traditional producer and exporter of vegetables, but over the past thirty years, vegetable production has constantly been shrinking in volume and becoming uncompetitive both on the European and world markets. In the case of vegetable crops, negative trends are forming. Cultivated land and production are decreasing, and in individual planning areas, some types of vegetables are no longer being produced. The acreage and production curve is extremely steep and such a trend continuing into the future would lead to further shrinking of production to economically insignificant volumes, onions and leafy greens could disappear as cultivated crops. These trends do not correspond to the potential opportunities and traditions in vegetable production in Bulgaria, they are not a reflection of the world and European markets, which increase in vegetable production.

Vegetable production in Bulgaria has a decreasing role in the gross production of the agricultural sector, in the structure of the total agricultural export, and in the satisfaction of the national market. Vegetable production lags behind consumer demand and the result is an ever-increasing need for imported vegetables. The negative trend is also exacerbated by the rising import prices, which means that more expensive vegetables are offered on the domestic market and the Bulgarian consumer has to spend more from their budget in order to buy the same amount of vegetables. Rising imports are a stark indicator of the depth of the problems in this sector of Bulgarian agriculture.

The supply of vegetables on the domestic market is determined by the level of production. The drastic contraction of basic traditional produce such as tomatoes, pepper and onions, which for decades were the main export for the county, to the extent that they cannot satisfy even half of the consumer demand in the domestic market, shows that the Bulgarian vegetable industry has deep structural and strategic problems that cannot be solved by means of foreign trade policy.

Many factors of production have seen a steep decline, those include: aging of the population in vegetable-producing areas; low degree of organization and specialization of production; predominance of numerous small vegetable producers; destruction of hydro-melioration fund (expensive water, insufficient irrigation equipment); lack of financial means for technological modernization in the sector. The most significant problem which affects vegetable production is the inability of small producers to agree on higher purchase prices. Keeping prices at a very low level makes production loss-making.

The main guidelines for the improvement and sustainable development of vegetable production in Bulgaria are:

- accelerated creation of producers' organizations and their transformation into a key factor for consolidating production;
- increasing labour productivity and competitiveness of the sector;
- increasing the average yields of vegetables. They are lower both compared to the average yields obtained in the main vegetable-producing countries in the EU and to the levels

reached for the country in past periods. Low average yields result in high unit production costs and low competitiveness;

- reduction of production costs, by optimizing the production structure, regionalization and specialization, technological renewal and innovative production;
- increasing the quality of finished products and restoring the traditional flavours of Bulgarian vegetables;
- redirection of unused financial resources from less attractive measures to measures that can be applied in vegetable production;
- more targeted use of financial resources at the regional and municipal levels.

Vegetable production occupies an important place and plays a key role in the development of Bulgarian agriculture. It is defined by the fact that vegetables are produced using the country's natural and production potential, some of which are used as raw material for the processing industry and for consumption by the population. The exposed and substantiated problems in this sector of Bulgarian agriculture lead to significant consequences: a decrease in the produced quantities, the emergence of imbalances in relation to the produced and required quantities, strengthening the role of vegetable imports to cover their shortage, disrupting the balance between supply and demand and the impact on the country's food security level. Vegetables occupy an important part in people's diet, which is why they are also important from the point of view of achieving food security in feeding the country's population.

Guidelines for the improvement and sustainable development of vegetable production can be derived in terms of: accelerated creation of producers' organizations and their transformation into a key factor for consolidating production, increasing labour productivity and the competitiveness of the sector; increasing the average yields of vegetables, which are lower not only than the main vegetable-producing countries in the EU, but also lower than the levels maintained by the country in past periods. Low average yields result in high unit production costs and low competitiveness. Solutions could include reduction of production costs, through optimization of the production structure, regionalization and specialization, technological renewal and innovative production; quality improvement, restoring the traditional tastes of Bulgarian vegetables; redirection of unused financial resources from less attractive measures to measures that can be applied in vegetable production; more targeted use of financial resources at the regional and municipal level.

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ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# SUSTAINABILITY OF PRODUCTION AND EXPORT OF MAIN CEREAL AND OIL CROPS FROM BULGARIA[3]

*Bulgaria is one of the leading exporters of agricultural crops in Southeast Europe. Though smaller than their neighbours, Bulgarian farmers have a long tradition of growing all main cereals and oil crops, including wheat, maize, sunflower (in 2020 Bulgaria was the seventh largest exporter in the world), rape seed, barley and others. The main objective of the current study is to determine the nature of the considered processes for the production and export of main cereals and oil crops from Bulgaria and to study their sustainability. This is achieved by calculating the coefficients of sustainability of the specific indicators characterizing the processes. Determined is also whether the distribution of the main countries – trading partners is specific. Based on the obtained results, conclusions are drawn about the sustainability of the production and the export of main cereals and oil crops from Bulgaria.*
*Keywords: cereals; oil crops; agriculture; sustainability; export*
*JEL: F14; Q10; Q17; Q18*

## Introduction

Food and agricultural systems are fundamental to the successful and fulfilling development of humanity. As for food security, these systems are necessary not only to ensure safe and healthy food, but also the livelihood and income of a large number of farmers (Ruscheva, Grozdanova, 2021; Kirova, 2020). These systems are integral to rural and economic development (Kotseva-Tikova, 2018). At the core of food security is the production of cereals and oil crops worldwide to meet the growing needs for food, animal feed and biofuels.

The objective of the current analysis is to establish the sustainability of the production and export processes of main cereals and oil crops from Bulgaria. The subject is the production and the export as processes. The object is the sustainability of the production and export processes of main cereals and oil crops from Bulgaria.

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Examined are cereal and oil crops that are in the top 100 of Bulgaria's export list (based on. Combined Nomenclature) They include the following 5 crops:

- Wheat and meslin;
- Sunflower seeds, whether or not broken;
- Maize or corn;
- Rape or colza seeds, whether or not broken;
- Barley.

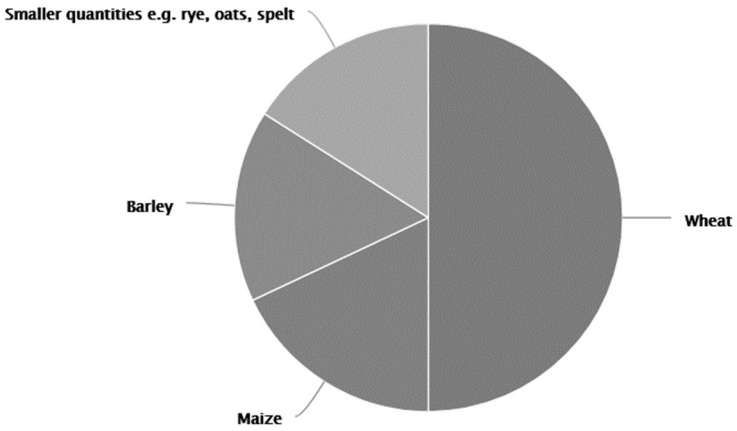
The study period is the last 6 economic years – from 2016 to 2021. For some of the indicators, data for 2021 are not yet available. In these cases, data are used to the available extent.

## 1. General characteristics of the main cereal and oil crops

Wheat, maize and rice have the main share of the cereal production in the world. In the EU countries, the situation is more or less identical – 50% of the production is wheat, about 17% – barley, about 17% – maize, and about 16% – all other cereals.

Figure 1

Structure of production of main cereals in the EU

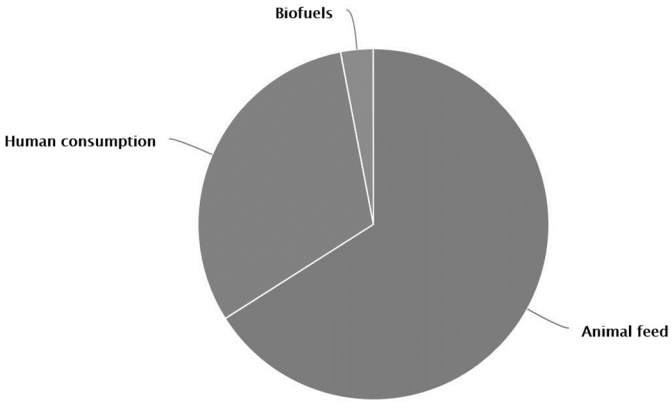



*Source: European Commission.*

Cereals in the EU are used mainly for animal feed (almost 2/3), 1/3 is intended for human consumption and 3% is used for biofuels (EC, 2022).

Figure 2

Structure of consumption of main cereals in EU




*Source: European Commission.*

Another significant part of plant species forms the production of oilseed crops in the EU. Oilseeds are used for food, feed, fuel and industrial purposes. They are grown to produce seeds with high-fat content. The oils and meals extracted from them are used in the food industry or for the production of biodiesel, and the meals are an important component for feed.

In the EU, oilseeds are rape seed (59%), sunflower seed and soybean seed. There are no specific measures to support oilseed production. 2/3 of Europe's consumption each year is produced in the member state. However, there remains a significant share of about 1/2 of the oilseeds used annually for animal feed in the EU from non-EU sources, with zero import duties.

Concerning economic importance, the agricultural sector is very important for Bulgaria. According to preliminary data, in 2021, the gross added value (GVA), created in the agricultural sector, amounts to 4950 million BGN, forming 4.3% of the total GVA of the country's economy. In real terms, it marks a growth of 6.1% compared to the previous year (Ministry of Agriculture, Food and Forestry, 2021).

The most significant for Bulgaria is the production of cereal and oil crops. (Dimitrova, 2020) Of the cerels, the main production is wheat and maize. Barley, rye, triticale, oats, millet, sorghum are produced to a smaller extent, and the other crops have rather local importance for a certain region in which they are distributed.

In Bulgaria, traditionally, are produced significantly more quantities of cereal and oil crops than are necessary to meet the needs of the country's consumption. This allows a large export to be realized annually. In 2021, the harvested wheat production increased by 51% on annual

basis to a record of 7.1 million tons. There is also a significant increase in the production of rape seed (34%) and barley (25%), and more moderately – in that of maize for grain and sunflower (by about 14% and 16%, respectively).

The export of maize is one of the most important in the field of food products, and for some countries in the world the import of wheat is vitally important. That is why the development of the cereals and the corresponding amount of harvest in the countries in the world, which are large producers and exporters of wheat, are so carefully followed. Wheat has the largest share in the export of cereal crops, but maize, rape seed, soy and barley are also exported in large quantities.

Russia is one of the biggest exporters of cereals in the world. Together with the USA, Australia, Canada and Ukraine, in the previous agricultural year (July 2020 – June 2021), these 5 countries realized a total of over 58% of the world exports.

The total value of agricultural goods exported from Bulgaria in 2021 is slightly over 6 billion EUR – 25.8% more than in 2020. With a smaller increase in imports (by 10.5%), the traditionally positive balance for Bulgaria in the agricultural trade grows double on an annual basis, reaching nearly 1.6 billion EUR. The leading groups of products in the structure of the agrarian exports in 2021 are cereals and oilseed plants, followed by fats of vegetable or animal origin, residues of the food industry and prepared animal feed, food products based on cereal plants, cocoa products, soft drinks, etc.

As one of the largest producers and traders of cereals in the world, the EU supports farmers with income support, market measures and trade policy under the Common Agricultural Policy (CAP) (Harizanova-Bartos, Stoyanova, Harizanova-Metodieva, 2020). The support has distanced from the principle of what and how much is produced and has become completely disconnected from production (when payments are no longer linked to the produced quantity) (Doitchinova, Miteva, Zaimova, 2019).

Cultivated areas for arable crops are currently integrated into the single common organization of the market and the policy of the EU is limited to two main areas (Kirechev, 2021):

- Intervention by the European Commission and aid for private storage – initially, the measure is introduced to protect farmers against low market prices, the purchase of cereals and rice for storage in public warehouses; now it is used only in emergency situations, providing a safety net for farmers.
- Trade measures – a number of fixed import tariff quotas are introduced with lower or zero duties.

## 2. Methodology

The main indicators characterizing the production of main cereals and oil crops are:

- Harvested areas;
- Production;

- Producer price.

On the other hand, the indicators characterizing the exports are:

- Exported quantities;
- Unit price;
- Export value;
- Share in the world exports;
- Main trading partners.

The sustainability of the process is examined in order to determine the nature of the studied production and export processes. This is done by calculating the sustainability coefficients of the specific indicators characterizing the processes.

To study the sustainability of an economic process, Nestorov (2021) suggests the following definition: "sustainable is an economic process that changes rectilinearly". Since, in economic practice, completely rectilinearly changing processes are rarely found, Nestorov proposes the statement that "a given economic process is more sustainable the closer its change is to the rectilinear change" (Nestorov, 2021). He also suggests a coefficient for measuring the sustainability of a process, representing the coefficient of correlation between the actual values of the studied time series and its values smoothed by the method of least squares for a linear function (can be shown by a straight line in a figure):

$$Y=a_0+a_1t \tag{1}$$

where:

$Y$ is estimated values of the variable;

$a_0$ and $a_1$ – regression coefficients.

The coefficient of economic sustainability has the following mathematical record:

$$CS = \sqrt{1-\frac{\sum(Y_t-\hat{Y}_t)^2}{\sum(Y_t-\bar{Y})^2}} \tag{2}$$

where:

CS is the coefficient of economic sustainability.

The higher the coefficient (closer to 1), the closer the process fluctuations are to a rectilinear function, and this indicates a more sustainable process. Similarly, low levels of correlation dependence indicate a fluctuation far from the rectilinear function, which is a manifestation of the unsustainability of the studied process.

Table 1

Interpretation of CS values

| CS value | Interpretation |
|---|---|
| 0.8 – 1.0 | Very high sustainability |
| 0.6 – 0.8 | High sustainability |
| 0.4 – 0.6 | Average sustainability |
| 0.2 – 0.4 | Low sustainability |
| 0.0 – 0.2 | Absence of sustainability |

*Source: Nestorov, 2021.*

Since the distribution of the main countries – trading partners is specific, the analysis should take into account and include their sustainability over time. Galabova and Nestorov (2018) suggest a specific coefficient – the Geographic Sustainability Rate (GSr) of export/import – to measure its sustainability. The mathematical record is expressed by the following formula:

$$GSr = \frac{\sum_{1}^{5} \frac{C}{m}}{5} \quad (3)$$

where:

GSr is Geographic Sustainability rate of export/import;

C – number of times the partner country has been on the top five places of the geographic structure by different periods;

m – number of studied periods.

"Its values change from 0 to 1. The lower the value, the lower the sustainability of the partner countries in export/import, in other words, the geographic structure is dynamic. On the contrary, the higher the value of the rate, the higher the geographic concentration – during a certain period, the partner countries remain for a longer time" (Galabova, Nestorov, 2018).

Interpretation of the GSr values is presented on Table 2.

Table 2

Interpretation of GSr values

| GSr value | Interpretation |
|---|---|
| 0.0 – 0.2 | Highly dynamic geographic structure |
| 0.2 – 0.4 | Dynamic geographic structure |
| 0.4 – 0.6 | Balanced geographic structure |
| 0.6 – 0.8 | Sustainable geographic structure |
| 0.8 – 1.0 | Highly sustainable geographic structure |

*Source: Galabova, Nestorov, 2018.*

As "an expression of the external sector of an economy, the foreign trade of goods is indicative of its openness, its participation in the international division of labour, its international trade specialization and competitiveness" (Marinov, 2017). That is why, when

analyzing such a topic, it is important to monitor the state and dynamics of the country's exports. Particularly the geographic structure, which shows the direction of trade relations, has an important place.

## 3. Analysis and Results

### *3.1 Wheat and meslin*

Wheat is the most-grown cereal crop in Bulgaria. The main data for its production are presented on Table 3.

Table 3

Main indicators for the production of ***"Wheat"*** in Bulgaria in the period 2016-2020

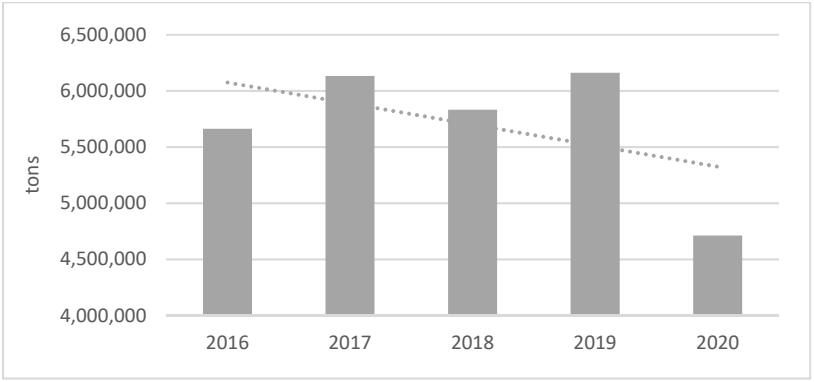
| ***Wheat*** | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Harvested areas (ha) | 1 192 589 | 1 144 519 | 1 212 012 | 1 198 682 | 1 200 175 |
| Production (ton) | 5 662 721 | 6 132 671 | 5 832 449 | 6 161 997 | 4 710 993 |
| Average yields (ton per ha) | 4.75 | 5.36 | 4.81 | 5.14 | 3.93 |

*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

About 1.2 million hectares of land are sown with "Wheat" each year. Production by years is presented on Figure 3.

Figure 3

Production of "Wheat" in Bulgaria in the period 2016-2020 (tons)




*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

Production of "Wheat" in Bulgaria in the period 2016-2020 varied from 4.71 to 6.16 million tons during the individual years of the studied period. The applied sustainability coefficient CS is 0.50, which indicates average sustainability of the process.

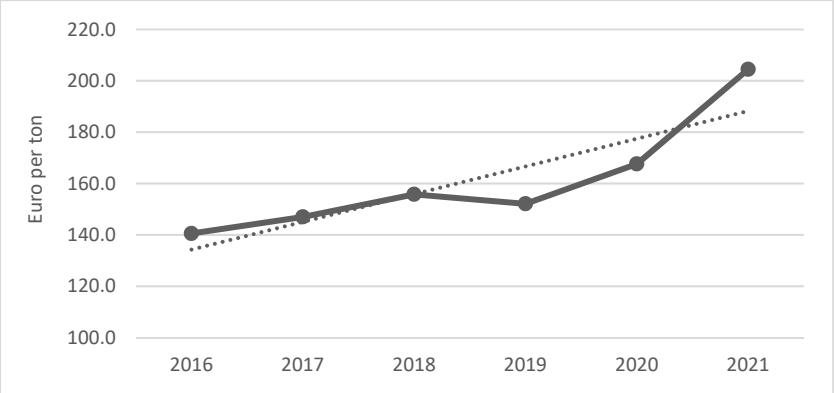
On the other hand, the average yield varies over the years between 3.93 and 5.36 tons per hectare of land. The yield was the highest in 2017, and the lowest in 2020. According to the Ministry of Agriculture, this is due to the bad impact of the main agrometeorological factors

on the development and yields of wheat in the country in 2020. Its sustainability for the period is 0.54 – average sustainability.

The data on the producer price of "Wheat" in Bulgaria in the period 2016-2021 are presented on Figure 4.

Figure 4

Producer price of "Wheat" in Bulgaria in the period 2016-2021 (euro per ton)




*Source: according to NSI data.*

Producer price increases during almost the entire period. In 2016 it was 140 euros and in 2015 it reached 295 euros. The coefficient of sustainability, in relation to the price, is 0.61. The value can be interpreted as very high sustainability.

By 2021 Bulgaria ranks 11th in the world in terms of "Wheat and meslin[4]" exports. Exports during the year reach 5 122 009 tons, forming a market share of 2.4% of the world trade.

By 2021 wheat ranks 2nd in Bulgaria's export list. Its share during the entire period is about 3% of the country's total commodity exports.

Exported quantities vary between 3 and 5 million tons per year. The coefficient of sustainability CS for the quantities is 0.05 – an absence of sustainability.

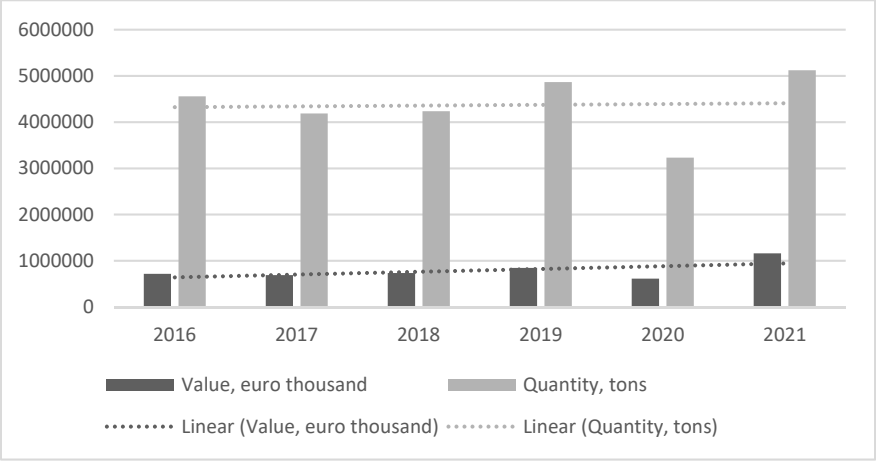
In the period 2016-2020, exports vary between 600 and 800 million euros. 2021 is an atypical year, when exports jump to over 116 million euros. The sustainability of the value is 0.58 – average sustainability.

The annual average unit value of one exported ton is presented on Figure 6.

[4] According to the Combined Nomenclature, wheat and meslin are grouped together under a 4-digit code. They are presented together in this section.

Figure 5

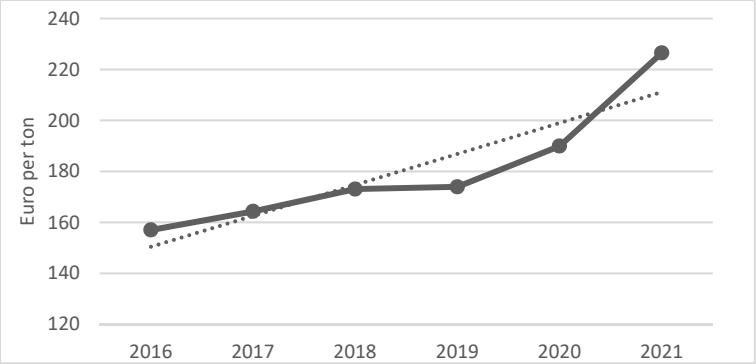
Quantities and values of the export of "Wheat and meslin" from Bulgaria in the period 2016-2021 (tons and thousand euros)




*Source: according to data of International Trade Centre.*

Figure 6

Annual average unit value of the export of "Wheat and meslin" from Bulgaria in the period 2016-2021 (euro per ton)




*Source: own calculations with data of International Trade Centre.*

The annual average unit value of one exported ton steadily increases during the studied period – from around 160 to over 220 euros per ton. The coefficient of sustainability is 0.91 – very high sustainability.

The geographic distribution of the export transactions is presented on Table 4.

The share of the top five partner countries in the export of wheat varies between 52 and 69% of all exports. This is an indicator of a concentrated geographic structure of exports. It can be considered a prerequisite for the influence of the economic situation of these countries on the Bulgarian economy (Tassev, 2012).

Table 4

Top five partner countries of Bulgaria in the export of "Wheat and meslin" in the period 2016-2021 and their annual relative shares

| Rank in export | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| 1 | Spain 23 | Spain 40 | Spain 31 | Spain 22 | Spain 19 | Spain 14 |
| 2 | Italy 15 | Greece 11 | Italy 14 | Greece 11 | Greece 15 | Greece 13 |
| 3 | Romania 11 | Italy 9 | Romania 9 | Romania 8 | Romania 11 | Romania 9 |
| 4 | Greece 10 | Romania 8 | Greece 8 | Philippines 7 | Philippines 8 | Tunisia 8 |
| 5 | Vietnam 8 | Libya 6 | Germany 7 | Italy 5 | Libya 7 | Korea 8 |
| Total top 5 | 67% | 74% | 69% | 53% | 60% | 52% |

*Source: own calculations with data of International Trade Centre*

Concerning geographic sustainability, GSr is 0.77. This is the "sustainable geographic structure" of Wheat exports.

### *3.2. Sunflower seeds, whether or not broken*

Sunflower is the second most grown crop in Bulgaria. The main data on its production are presented on Table 5.

Table 5

Main indicators for the production of ***"Sunflower seeds"*** in Bulgaria in the period 2016-2020

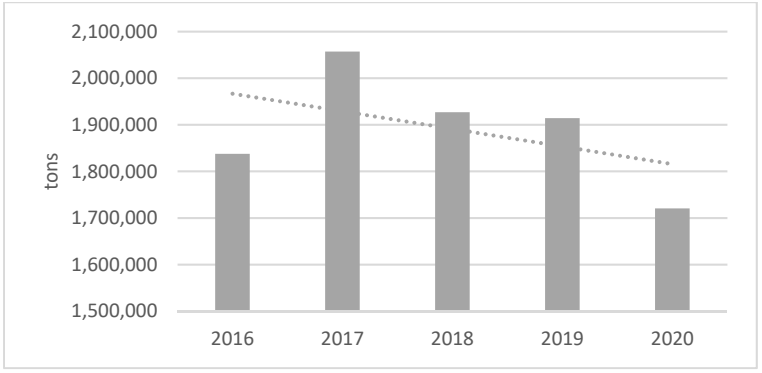
| ***Sunflower seeds*** | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Harvested areas (ha) | 817 511 | 898 844 | 788 656 | 815 561 | 821 922 |
| Production (ton) | 1 837 677 | 2 056 987 | 1 927 040 | 1 914 072 | 1 720 299 |
| Average yields (ton per ha) | 2.25 | 2.29 | 2.44 | 2.35 | 2.09 |

*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

About 830 000 hectares of land are sown with sunflower each year. Production by years is presented on Figure 7.

Figure 7

Production of "Sunflower seeds" in Bulgaria in the period 2016-2020 (tons)




*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

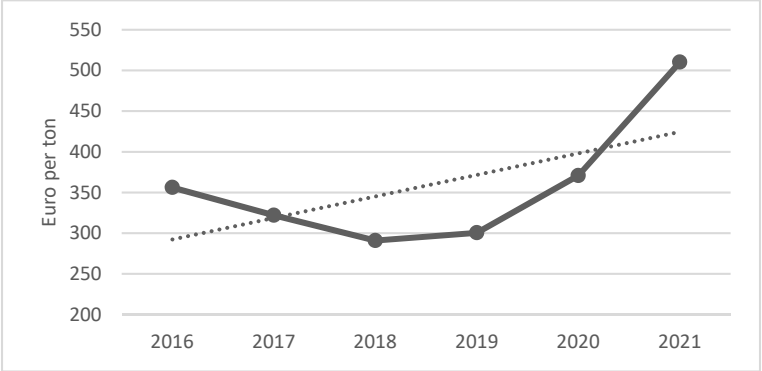
Production of Sunflower seeds in Bulgaria in the period 2016-2020 varies between 1.7 and 2 million tons during the individual years of the studied period. The applied coefficient of sustainability CS is 0.48, which indicates average sustainability of the process.

On the other hand, the average yield varies over the years between 2.09 and 2.44 tons per hectare of land. The yield is the highest in 2018, and the lowest in 2020. According to the Ministry of Agriculture, this is due to the bad impact of the main agrometeorological factors on the development and yields of sunflower in the country in 2020. Its sustainability for the period is 0.31 – low sustainability.

Data for producer price of "Sunflower seeds, whether or not broken" in Bulgaria in the period 2016-2021 are presented on Figure 8.

Figure 8

Producer price of "Sunflower seeds" in Bulgaria in the period 2016-2021 (euro per ton)




*Source: according to NSI data.*

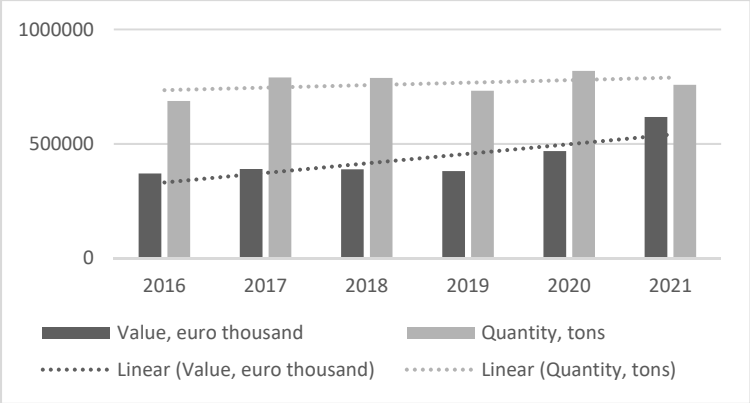
Producer prices in the period up to 2018 dropped from nearly 360 to 290 euros per ton. Since 2019, the price has started to increase and reaches 500 euros per ton in 2021. The coefficient of sustainability, in relation to the price, is 0.61. The value can be interpreted as high sustainability.

By 2021 Bulgaria is on 2nd place in the world in the export of "Sunflower seeds, whether or not broken". Exports during the year reach 757 451 tons, forming a market share of 15.4% of the world trade.

By 2021 Sunflower seeds is 2nd in Bulgaria's export list. Its relative share during the entire period is about 1.5% of the country's total commodity exports.

Figure 9

Quantities and values of the export of "Sunflower seeds, whether or not broken" from Bulgaria in the period 2016-2021 (tons and thousand euros)




*Source: according to data of International Trade Centre.*

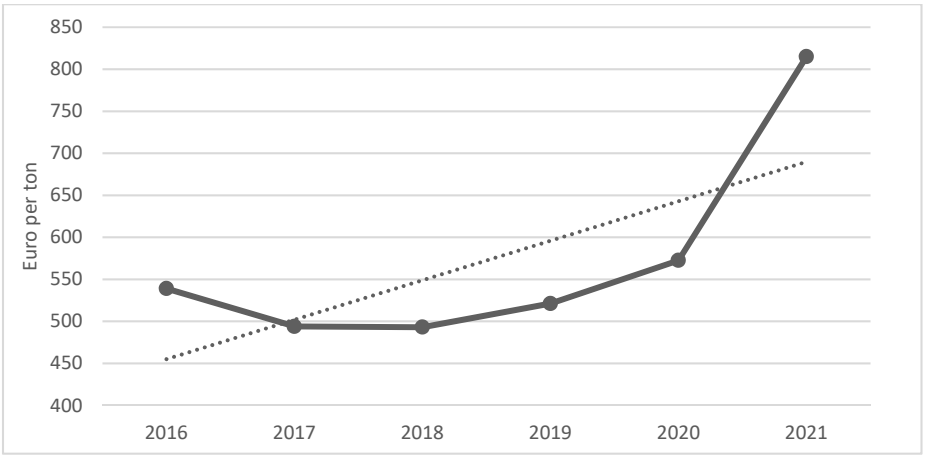
The exported quantities vary between 670 and 820 thousand tons per year. The coefficient of sustainability CS for the quantities is 0.43 – average sustainability.

In the period 2016-2019 exports vary between 370 and 390 million euros. In 2020 and 2021, exports increased to over 610 million euros. The sustainability of the value is 0.82 – very high sustainability.

The annual average unit value of one exported ton is presented on Figure 10.

Figure 10

Annual average unit value of the export of "Sunflower seeds, whether or not broken" from Bulgaria in the period 2016-2021 (euro per ton)




*Source: own calculations according to data of International Trade Centre.*

Annual average unit value of one exported ton drops till 2018. Since 2019 the price starts to increase and reaches over 800 euros per ton in 2021. The coefficient of sustainability, in relation to the price, is 0.72. The value can be interpreted as high sustainability.

The geographic distribution of the export transactions of sunflower from Bulgaria is presented on Table 6.

Table 6

Top five partner countries of Bulgaria in the export of "Sunflower seeds, whether or not broken" in the period 2016-2021 and their annual relative shares

| Rank in export | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| 1 | Netherlands 17 | Germany 16 | Netherlands 26 | Germany 16 | Germany 15 | Germany 14 |
| 2 | Germany 16 | Netherlands 14 | Germany 15 | Netherlands 13 | Netherlands 15 | Turkiye 14 |
| 3 | France 9 | Turkiye 12 | UK 8 | UK 9 | USA 12 | USA 9 |
| 4 | UK 7 | UK 8 | Romania 7 | USA 8 | Turkiye 8 | UK 9 |
| 5 | Turkiye 6 | France 6 | Turkiye 6 | Turkiye 8 | UK 8 | Netherlands 8 |
| Total top 5 | 55% | 56% | 62% | 54% | 58% | 54% |

*Source: own calculations with data from International Trade Centre.*

The share of the top five partner countries in the export of Sunflower varies between 54 and 62% of the total export. This is an indicator of a balanced geographic structure of exports. It is a prerequisite for a high influence of the economic situation of these countries on the Bulgarian one.

Concerning the geographic sustainability, GSr is 0.90. This corresponds to a highly stable geographic structure.

### *3.3. Maize or corn*

Maize or corn is the third most-grown cereal crop in Bulgaria. The main data on its production are presented on Table 7.

Table 7

Main indicators for the production of ***"Maize"*** in Bulgaria in the period 2016-2020

| ***Maize*** | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Harvested areas (ha) | 406 942 | 398 152 | 444 623 | 560 911 | 581 532 |
| Production (ton) | 2 226 094 | 2 562 569 | 3 478 013 | 3 990 190 | 2 969 210 |
| Average yields (ton per ha) | 5.47 | 6.44 | 7.82 | 7.11 | 5.11 |

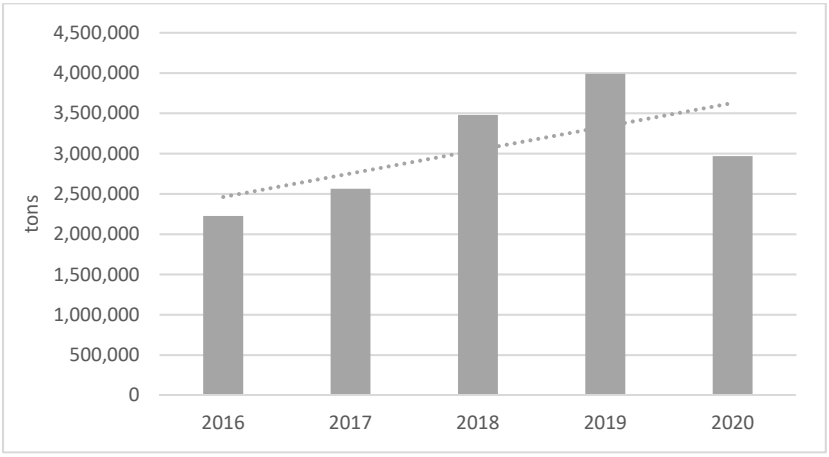
*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

About 480 000 hectares of land are sown with "Maize" every year. Production by years is presented on Figure 11.

Production of "Maize" in Bulgaria in the period 2016-2020 varies between 2.2 and 4 million tons in the individual years of the studied period. The applied coefficient of sustainability CS is 0.65, which indicates high sustainability of the process.

Figure 11

Production of "Maize" in Bulgaria in the period 2016-2020 (tons)



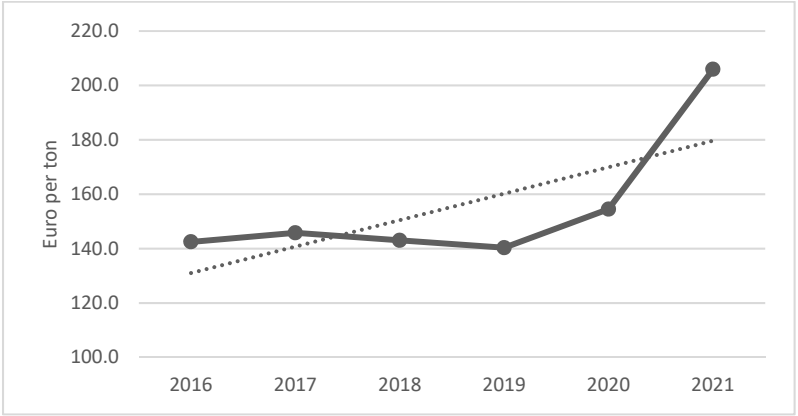

*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

On the other hand, the average yield varies over the years between 5.1 and 7.8 tons per hectare of land. The yield is the highest in 2018, and the lowest in 2020. According to the Ministry of Agriculture, this is due to the bad impact of the main agrometeorological factors on the development and yields of maize in the country in 2020. The coefficient CS in the period is 0.01 – an absence of sustainability.

The data on the producer price of "Maize or corn" in Bulgaria in the period 2016-2021 are presented on Figure 12.

Figure 12

Producer price of "Maize or corn" in Bulgaria in the period 2016-2021 (euro per ton)

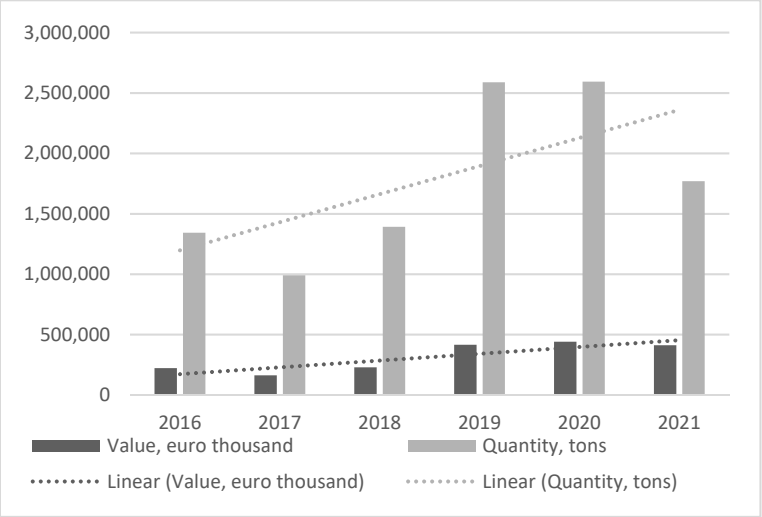



*Source: according to NSI data.*

Producer price in the period up to 2019 varies around 140 euros per ton. In 2020 and 2021, it increases, reaching over 200 euros per ton. The coefficient of sustainability, in relation to the price, is 0.72. The value can be interpreted as high sustainability.

Figure 13

Quantities and values of the export of "Maize or corn" from Bulgaria in the period 2016-2021 (tons and thousand euros)




*Source: according to data of International Trade Centre.*

By 2021 Bulgaria ranks 16th in the world in terms of "Maize or corn" exports. Exports during the year reach 1 769 736 tons, forming a market share of 1.3% of the world trade.

By 2021, Maize ranks 15th in Bulgaria's export list. Its relative share during the entire period is about 1.1% of the country's total commodity exports.

Exported quantities vary between 1 and 2.5 million tons per year. The coefficient of sustainability CS for the quantities is 0.64 – high sustainability of the process.

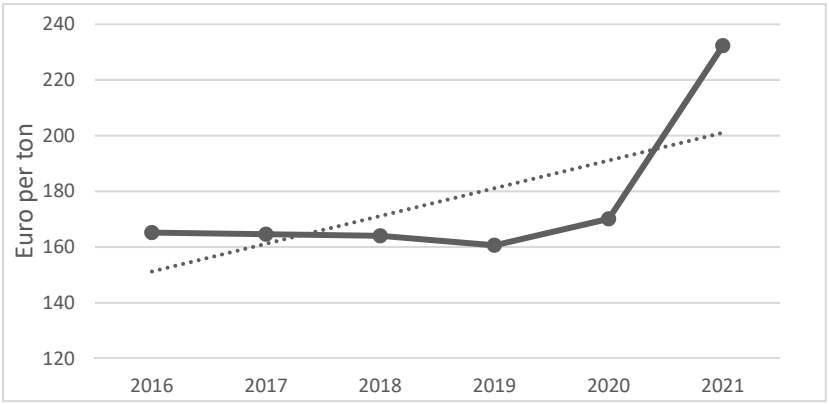
In the period 2016-2021, exports vary from 160 to 440 million euros. The sustainability of the value is 0.86 – very high sustainability.

Annual average unit value of one exported ton is presented on Figure 14.

Annual average unit value of one exported ton varies around 160 euros until 2019. Then it increases – from around 160 to over 230 euros per ton. The coefficient of sustainability is 0.67 – high sustainability.

Geographic distribution of the export transactions with Maize or corn in the period 2016-2021 is presented on Table 8.

Figure 14
Annual average unit value of the export of "Maize or corn" from Bulgaria in the period 2016-2021 (euro per ton)




*Source: own calculations according to data of International Trade Centre.*

Table 8
Top five partner countries of Bulgaria in the export of "Maize or corn" in the period 2016-2021 and their annual relative shares

| Rank in export | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| 1 | Greece 16 | Greece 29 | Greece 32 | Greece 25 | Greece 20 | Greece 23 |
| 2 | Romania 14 | France 13 | Romania 20 | Romania 17 | Romania 15 | Romania 19 |
| 3 | Portugal 10 | Netherlands 8 | Korea 10 | Spain 10 | Iran 12 | Spain 14 |
| 4 | Spain 10 | Spain 8 | Italy 9 | Turkiye 6 | Netherlands 8 | Korea 13 |
| 5 | Italy 8 | UK 7 | Cyprus 4 | Spain 5 | Spain 8 | China 10 |
| Total top 5 | 58% | 65% | 75% | 63% | 63% | 79% |

*Source: calculations with data of International Trade Centre.*

The share of the leading five countries – trade partners in the export of Maize or corn varies between 63 and 79% of all exports. This is an indicator of a concentrated geographic structure of exports. Such a significant concentration is a prerequisite for a strong influence of the economic situation of these countries on the Bulgarian economy.

Concerning geographic sustainability, GSr is 0.63. This corresponds to a "sustainable geographic structure" of Maize or corn exports.

### *3.4 Rape or colza seeds, whether or not broken*

Rape seed is the fifth most-grown crop in Bulgaria. The main data on its production are presented on Table 9.

Table 9

Main indicators for the production of ***"Rape"*** in Bulgaria in the period 2016-2020

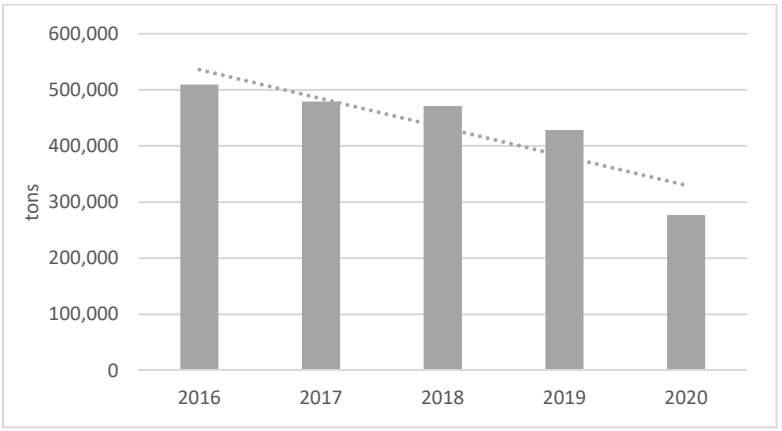
| ***Rape*** | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Harvested areas (ha) | 171 511 | 160 650 | 182 619 | 151 174 | 119 137 |
| Production (ton) | 509 251 | 478 987 | 471 035 | 428 256 | 276 846 |
| Average yields (ton per ha) | 2.97 | 2.98 | 2.58 | 2.83 | 2.32 |

*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

About 160 000 hectares of land are sown with "Rape" every year. Production by year is presented on Figure 15.

Figure 15

Production of "Rape" in Bulgaria in the period 2016-2020 (tons)




*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

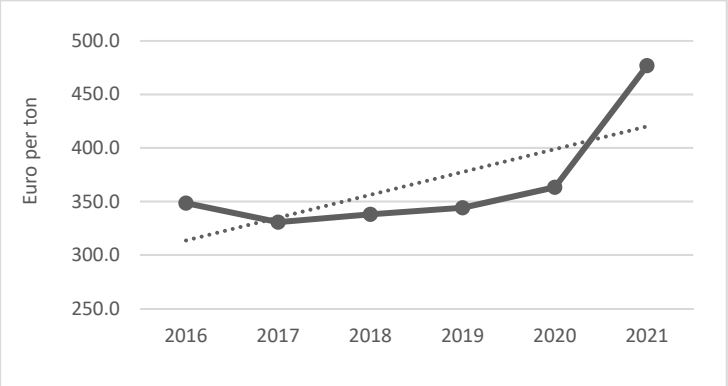
Production of "Rape" in Bulgaria in the period 2016-2020 varies between 277 and 509 thousand tons in the individual years of the studied period. The applied coefficient of sustainability CS is 0.89, which indicates the very high sustainability of the process.

On the other hand, the average yield varies over the years between 2.3 and 3 tons per hectare of land. The yield was the highest in 2017, and the lowest in 2020. According to the Ministry of Agriculture, this is due to the bad impact of the main agrometeorological factors on the development and yields of rapeseed in the country in 2020. Its sustainability for the period is high – 0.81.

Data on the producer price of "Rape or colza seeds" in Bulgaria in the period 2016-2021 are presented on Figure 16.

Producer price in the period till 2020 varies from around 350 euros per ton. In 2021, it increases and reaches over 470 euros per ton. The coefficient of sustainability in terms of price is 0.73. The value can be interpreted as high sustainability.

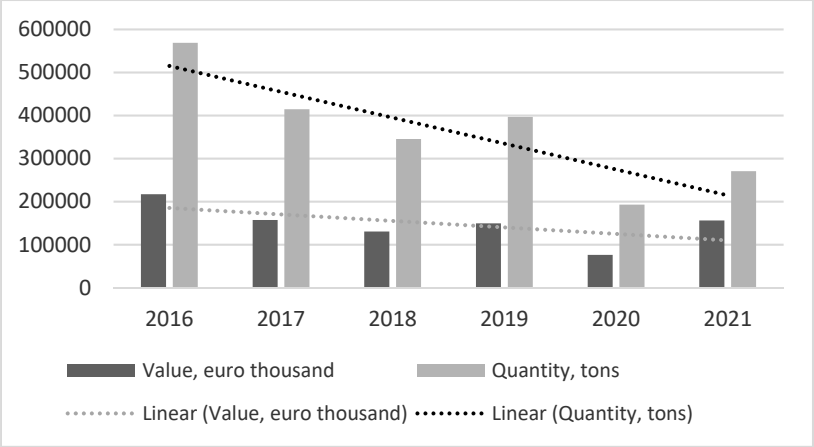
Figure 16
Producer price of "Rape or colza seeds" in Bulgaria in the period 2016-2021 (euro per ton)




*Source: according to NSI data.*

By 2021 Bulgaria is 14th in the world in terms of export of "Rape or colza seeds". Exports during the year reach 270 653 tons, forming a market share of 1.3% of the world trade.

Figure 17
Quantities and values of the export of "Rape or colza seeds" from Bulgaria in the period 2016-2021 (tons and thousand euros)




*Source: according to data of International Trade Centre.*

By 2021 Rapeseed is on 56th place in Bulgaria's export list. Its relative share during the entire period is about 0.5% of the country's total commodity exports.

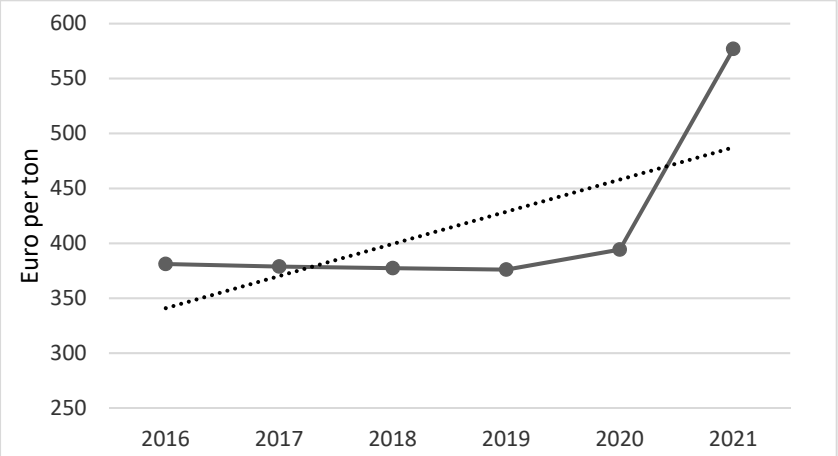
The exported quantities vary between 570 and 192 thousand tons per year. The coefficient of sustainability CS for the quantities is 0.87 – very high sustainability.

In the period 2016-2021 exports vary between 75 and 216 thousand euros. The coefficient CS is 0.62 – high sustainability.

Annual average unit value of one exported ton is presented on Figure 18.

Figure 18

Annual average unit value of the export of "Rape or colza seeds" from Bulgaria in the period 2016-2021 (euro per ton)




*Source: own calculations with data of International Trade Centre.*

Annual average unit value of one exported ton steadily increases in the studied period – from around 370 to over 580 euros per ton. The coefficient of sustainability is 0.68 – high sustainability.

The geographic distribution of the export transactions is presented on Table 10.

Table 10

Top five partner countries of Bulgaria in the export of "Rape or colza seeds" in the period 2016-2021 and their annual relative shares

| Rank in export | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| 1 | Belgium 42 | Belgium 46 | Belgium 51 | Netherlands 43 | Netherlands 45 | Netherlands 55 |
| 2 | Germany 20 | Netherlands 29 | Netherlands 39 | Belgium 36 | Belgium 43 | Belgium 17 |
| 3 | France 13 | France 12 | Turkiye 5 | Germany 14 | Romania 9 | France 11 |
| 4 | Netherlands 10 | Portugal 6 | Romania 4 | Romania 5 | Greece 2 | Portugal 7 |
| 5 | Turkiye 8 | South Africa 5 | France 1 | Greece 1 | France 1 | Hungary 4 |
| Total top 5 | 93% | 98% | 100% | 99% | 100% | 94% |

*Source: own calculations with data of International Trade Centre.*

The share of the top five trading partner countries in the export of rape seed varies between 93 and 100% of all exports. This is an indicator of a highly concentrated geographic structure of exports. It is practically a prerequisite for a high influence of the economic situation of these countries on the Bulgarian economy. Zlatinov and Atanasov (2021) study the relationship between economic crises and convergence between countries.

Concerning geographic sustainability, GSr is 0.67. This corresponds to a "sustainable geographic structure" of exports.

### *3.5 Barley*

Barley is the fourth most-grown cereal crop in Bulgaria. The main data on its production are presented on Table 11.

Table 11

Main indicators for the production of ***"Barley"*** in Bulgaria in the period 2016-2020

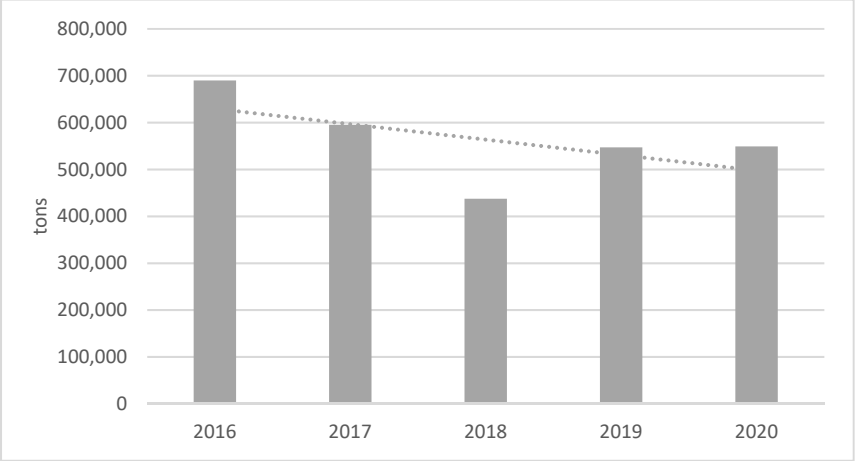
| ***Barley*** | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Harvested areas (ha) | 159 830 | 128 365 | 103 570 | 112 029 | 130 757 |
| Production (ton) | 689 850 | 595 237 | 437 507 | 547 244 | 549 079 |
| Average yields (ton per ha) | 4.3 | 4.6 | 4.2 | 4.9 | 4.2 |

*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

About 125 000 hectares of land are sown with "Barley" annual average for the period. Production by year is presented on Figure 19.

Figure 19

Production of "Barley" in Bulgaria in the period 2016-2020 (tons)




*Source: Ministry of Agriculture, Food and Forestry – Department "Agrostatistics".*

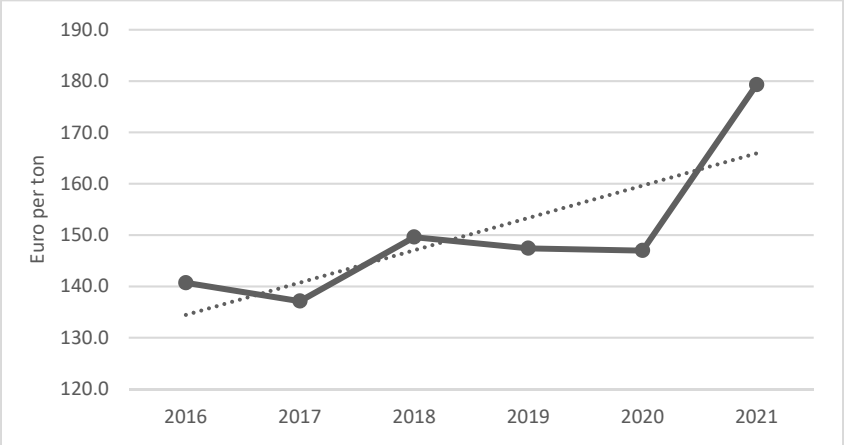
Production of "Barley" in Bulgaria in the period 2016-2020 varies between 437 and 690 thousand tons during the individual years of the studied period. The applied coefficient of sustainability CS is 0.57, which indicates average sustainability of the process.

On the other hand, the average yield varies over the years between 4.2 and 4.9 tons per hectare of land. The yield is the highest in 2019, and the lowest in 2018 and in 2020. According to the Ministry of Agriculture, this is due to the bad impact of the main agrometeorological factors on the development and yields of barley in the country in 2020. The coefficient CS is 0 – an absence of sustainability.

The data on the producer price of "Barley" in Bulgaria in the period 2016-2021 are presented on Figure 20.

Figure 20

Producer price of "Barley" in Bulgaria in the period 2016-2021 (euro per ton)



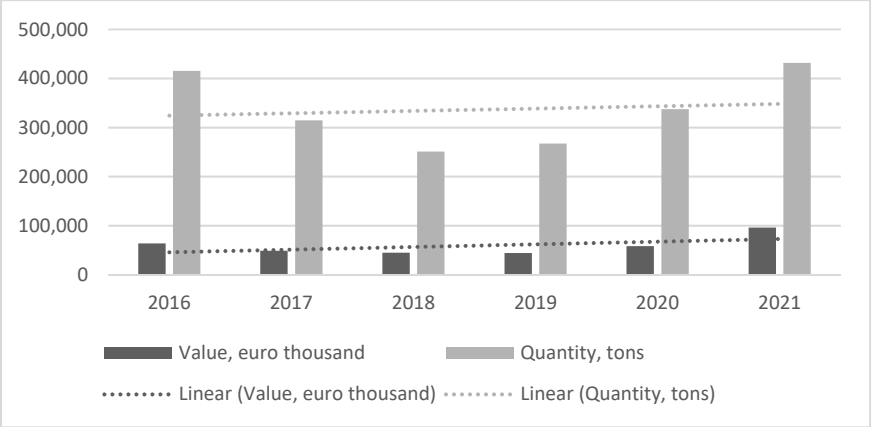

*Source: according to NSI data.*

Producer price in the period until 2020 varies between 137 and 150 euros per ton. Since 2021, the price marks a serious increase and reaches 180 euros per ton. The coefficient of sustainability, in relation to the price, is 0.78. The value can be interpreted as high sustainability.

By 2021, Bulgaria is 15$^{th}$ in the world in terms of exports of "Barley". Exports during the year reach 431 761 tons, forming a market share of 1% of the world trade.

By 2021 Barley is 85$^{th}$ in Bulgaria's export list. Its relative share during the entire period is about 0.2% of the country's total commodity exports.

Figure 21
Quantities and values of the export of "Barley" from Bulgaria in the period 2016-2021 (tons and thousand euros)



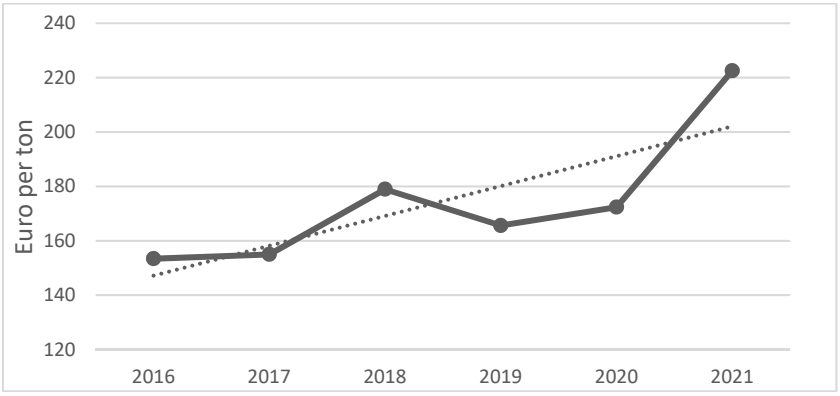

*Source: according to data of International Trade Centre.*

The exported quantities vary between 250 and 430 thousand tons per year. The coefficient of sustainability CS for the quantities is 0.12 – an absence of sustainability.

In the period 2016-2020, exports vary from 44 to 63 million euros. 2021 is an atypical year, when exports reach over 96 million euros. The coefficient of sustainability of the value is 0.52, corresponding to average sustainability.

Annual average unit value of one exported ton is presented on Figure 22.

Figure 22
Annual average unit value of the export of "Barley" from Bulgaria in the period 2016-2021 (euro per ton)




*Source: own calculations with data of International Trade Centre.*

Annual average unit value of one exported ton increases with slight fluctuations during the studied period – from around 150 to over 220 euros per ton. The coefficient CS has a value of 0.81 – high sustainability.

The geographic distribution of the export transactions is presented on Table 12.

Table 12

Top five partner countries of Bulgaria in exports of "Barley" in the period 2016-2021 and their annual relative shares

| Rank in export | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|
| 1 | Libya 41 | Spain 42 | Libya 33 | Saudi Arabia 24 | Libya 30 | Greece 30 |
| 2 | Greece 26 | Greece 28 | Greece 20 | Libya 23 | Morocco 16 | Spain 15 |
| 3 | Spain 15 | Libya 9 | Tunisia 16 | Greece 20 | Tunisia 15 | Cyprus 13 |
| 4 | Cyprus 11 | Cyprus 8 | Algeria 10 | Spain 12 | Greece 15 | Libya 13 |
| 5 | Romania 2 | Syrian Arab Republic 5 | Turkiye 6 | Israel 9 | Romania 14 | Israel 12 |
| Total top 5 | 95% | 92% | 85% | 88% | 90% | 83% |

*Source: own calculations with data of International Trade Centre.*

The share of the top five partner countries in Barley exports varies between 83 and 95% of all exports. This is an indicator of a highly concentrated geographic structure of exports. A prerequisite has been formed for a high influence of the economic situation of these countries on the Bulgarian one.

Concerning geographic sustainability, the GSr coefficient is 0.63. This corresponds to a "sustainable geographical structure" of Barley exports.

## 4. Summary of the Results

The results of the study of the sustainability of the production and the export of the studied main cereals and oil crops are summarized on Table 13.

Table 13

Summary of the results of the study of the sustainability of the production and the export of main cereals and oil crops from Bulgaria

| Summary on sustainability | Production | Average yield | Producer price | Exported quantities | Average price | Value of export | Geographic structure |
|---|---|---|---|---|---|---|---|
| Wheat and meslin | 0.50 | 0.54 | 0.61 | 0.58 | 0.91 | 0.58 | 0.77 |
| Sunflower seeds, whether or not broken | 0.48 | 0.31 | 0.61 | 0.43 | 0.72 | 0.82 | 0.90 |
| Maize or corn | 0.65 | 0.01 | 0.72 | 0.64 | 0.67 | 0.86 | 0.63 |
| Rape or colza seeds, whether or not broken | 0.89 | 0.81 | 0.73 | 0.87 | 0.68 | 0.62 | 0.67 |
| Barley | 0.57 | 0.00 | 0.78 | 0.12 | 0.81 | 0.52 | 0.63 |

*Source: own calculations.*

For the studied period 2016-2021. for the established sustainability of the processes, it can be concluded that in terms of production and export of the main cereals and oil crops from Bulgaria:

- *The sustainability of the production* of main cereal and oil crops is generally high, with the highest sustainability for Rape or colza seeds (0.89) and the lowest for Sunflower seeds (0.48).
- Concerning *average yield*, the coefficient of sustainability varies within wider limits. The sustainability is highest for Rape or colza seeds (0.81), and lowest for Maize or corn (0.01) and Barley (0.00).
- Concerning *producer prices*, sustainability is observed across all crops, with the coefficient ranging from 0.61 to 0.78.
- Concerning *exported quantities*, the sustainability of Rape or colza seeds is highest (0.87), and the one of Barley is lowest (0.12).
- The analysis of the *average annual export prices* shows that all studied crops demonstrate sustainability. Wheat and meslin (0.91) and Barley (0.81) have the highest sustainability.
- High sustainability of the *export value* is demonstrated by Maize or corn (0.86), followed by Sunflower seeds (0.82). Barley has the lowest sustainability value (0.52).
- Concerning the *geographic structure*, all commodities show sustainability. Only Sunflower seeds show very high sustainability – 0.90.

As a whole, the highest sustainability on most indicators is observed for Rape or colza seeds, followed by Wheat and meslin, Sunflower seeds. Maize or corn and Barley have lower sustainability.

## Conclusion

Agriculture continues to be one of the most dynamic sectors in Bulgaria. Provoked by many factors, farmers are constantly looking for ways to increase their yields or improve their production.

Based on the results presented here, namely that three of the five studied crops have high sustainability of the production and export processes, the following comments and recommendations can be made:

- Production of cereals and oil crops is sustainable and will continue to occupy a main part of the arable land in Bulgaria.
- Production is relatively sustainable and with improving competitiveness in the international market.
- The current sustainable functioning of the cereal and oil crops is also supported by the good potential for production growth based on the growth of average yields. More

sustainable yields for maize can be achieved by introducing irrigation practices and technologies, and according to experts, average yields can increase by at least 50%.

- The export of the five crops from Bulgaria will remain stable and in the medium term, a significant contribution is expected to the formation of a positive foreign trade balance from agricultural goods in Bulgaria.
- The main challenges in the short and medium term for Bulgarian grain producers are controlling the costs and increasing the yields, which is a strategy against price fluctuations.
- Direct payments in Bulgarian agriculture are an important buffer for meeting a drop in income in grain production. Apart from them, other risk management tools (production, technological and insurance) are not sufficiently widespread. This threatens these producers, both from unfavourable natural conditions (as it is in 2020 for three of the studied crops), and from price upheavals.
- Cereal and oilseed production should be considered a good opportunity for the development of new economic cycles and value chains (processing and energy, for example), as well as a basis for providing the necessary feed at competitive prices for animal husbandry.

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Annex 1

List of codes of the main cereals according to the Combined Nomenclature

| *Code* | *Name* |
|---|---|
| 1001 | Wheat and meslin |
| 1206 | Sunflower seeds, whether or not broken |
| 1005 | Maize or corn |
| 1205 | Rape or colza seeds, whether or not broken |
| 1003 | Barley |

ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
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# THE GRAIN MARKET OF UKRAINE: ACTUAL STATE, CURRENT PROBLEMS, AND DEVELOPMENT PROSPECTS[6]

*The article is devoted to the current problems occurring in the grain industry as a result of Russia's armed aggression and active hostilities in a large area of Ukraine. The purpose of the article is operational monitoring of the current state of the grain market in Ukraine and the calculation of forecast parameters of its stabilization and further development in the conditions of military aggression.*

*The research used the information database of the Ministry of Agrarian Policy and Food of Ukraine, the State Statistics Service of Ukraine, and the information and analytical materials of the NSC Institute of Agrarian Economics regarding the forecast indicators of the production of agricultural products in Ukraine in 2022 year. The production forecast is made taking into account losses of cultivated areas, damage to crops, violations of production technologies and a decrease in the yield of grain crops.*

*The total production of grain crops in 2022 is forecast to be 53.6 million tons, which is almost 40% lower than in 2021. The area under harvest is expected to decrease by 4.7 million hectares (from 15.9 to 12.3 million hectares). The actual losses of products of the grain market of Ukraine in the current 2022 are estimated at 204 billion UAH, or almost 7 billion EUR. The biggest losses will be experienced by the production of corn – EUR 3 billion, wheat – EUR 2.7 billion, barley – EUR 0.9 billion.*

*To determine the extent of destructive shifts occurring in the grain market of Ukraine, the actual (for 2020 and 2021) and forecast for 2022 balances of grain products were made. The main factors that will affect the functioning and further stabilization of the grain market in Ukraine have been established.*

*Keywords: grain market; production forecast; losses of sown areas; crop losses; production balance; domestic consumption; total demand; total supply*
*JEL: Q11; Q18; C53*

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## 1. Introduction

The grain industry is the flagship of the domestic agricultural market and the entire economy of Ukraine. The level of development of grain production and the stable and efficient functioning of the grain market has acquired the importance of priority levers for solving the problem of food and the national security of the state in modern conditions.

The Ukrainian grain market meets the needs not only of domestic consumption but also of many countries around the world. Ukraine annually increases the volume of production and export of grain crops and is among the main players in the international market.

The tendency to increase the volume of grain production remained quite stable for a lengthy period, however, Russia's armed aggression and the conduct of active hostilities in a significant territory of Ukraine caused several large-scale problems that had a destructive effect on the current state and prospects for the further functioning of the grain market.

The number of cultivated areas is declining, the technological discipline of cultivation is unobserved, the yield levels of grain crops are decreasing, the export of grain products has fallen catastrophically, transport logistics have been extensively injured, and many agricultural and processing enterprises have been destroyed or significantly damaged.

Problems and prospects for the development of the Ukrainian grain market remained a priority for N. Golomsha (2017), V. Lagodienko et al. (2019), V. Mesel-Veselyak (2018) and M. Ilchuk et al. (2019). The result of the scientific research of the scientists obtains a statement of the need to stabilize the domestic grain market, as well as the priority of the state in these regulatory processes.

A. Hyrka, V. Kompaniets, and A. Kulyk (2019) are engaged in improving the processes of standardizing production costs and forecasting indicators of winter wheat cultivation efficiency. The authors emphasize the importance and necessity of the further development of grain farming, in particular, the producing of high-quality food grains of winter wheat. Simultaneously, scientists focus their research on the development of differentiated norms of monetary, material, labour, and energy costs for the production of wheat grain, the analysis of technological aspects of the formation of costs by articles, and periods of fieldwork.

The problems of scientific and technological modelling of increasing the efficiency of grain production were considered in the works of V. Cherchel, M. Shevchenko (2020), V. Kolodiychuk (2016). O. Skrypnyk, N. Klymenko, K. Tuzhuk (2021), S. Zaika, R. Romanova (2018) and others are engaged in substantiating the prospects of sustainable development of grain production in Ukraine. N. Kovalenko, V. Kovalenko, T. Hutsol (2021) devoted their scientific works to evaluating the efficiency of growing grain crops and developing road maps for making management decisions when planning a production program.

Actual problems of increasing the efficiency of grain production in Ukraine are outlined by Y. Grynchuk, E. Tkachenko, A. Dragan (2018), I. Solovey (2017). Y. Dolgikh (2019) evaluated the dynamics of changes in the net technical efficiency of the production of grain and leguminous crops in Ukraine using the DEA method.

Problems of increasing the economic efficiency of the production of grain industry products in the conditions of European integration were investigated by O. Kotykova, T. Oliynyk, and D. Kichuk. (2018). Methodical aspects of determining the efficiency of grain production in modern conditions were studied by T. Lositska (2019). R. Miroshnyk and I. Baglay (2022) are engaged in researching the problems of the grain market in Ukraine in modern conditions of armed aggression.

Among foreign scientists, the following authors made a significant contribution to the study of the problems of increasing the economic efficiency of grain production and the development of the grain market.

O. Zhaltyrova (2019) considered the practical mechanisms of improving competitiveness and increasing the export potential of the grain market. Youzhu Zhao, Qiuxiang Jiang, and Zilong Wang (2019) studied the dependence of grain production in conditions of limited water and land resources. Luiz Gustavo Garbelini, Henrique Debiasi, Alvadi Antônio BalbinotJunior studied the influence of crop rotation diversification on increasing yield and economic efficiency of grain production (2022).

Preeti Kapuria and Roshan Saha (2020) worked on the development of parameters for ensuring the food security of the grain market. K. Tireuov. S. Mizanbekova, B. Kalykova (2018) investigated the effect of increasing the efficiency of the grain industry on the level of food security and sustainable development of the country's economy. John Baffes and Peter Nagle (2022) are engaged in studies of global problems of reducing the risks of the impact of the war in Ukraine on world commodity markets.

However, the peculiarities of the functioning of the Ukrainian grain market in the conditions of Russia's armed aggression and the world crisis require further analysis and research for the successful development of effective organizational and economic measures to stabilize and increase efficiency.

The purpose of the article is to conduct an operational monitoring of the current state of the grain market in Ukraine and the calculation of forecast parameters for its stabilization and further development in the conditions of armed aggression.

## 2. Research Methodology

We will present a step-by-step algorithm for determining the forecast parameters of the grain market in Ukraine under conditions of military aggression by Russia.

1. The forecast of grain production was determined by the formula:

$$\Pr = \sum_{i=1}^{n} S_i \times Y_i * K_i \quad (1)$$

where:

Pr is the aggregate forecast production of grain crops, taking into account losses of cultivated areas, damage to crops, violations of production technologies, and a decrease in the yield of grain crops by region of Ukraine, thousands of tons;

S – sown areas of grain crops in **i** region of Ukraine, thousands of hectares;

Y – yield of grain crops in **i** region of Ukraine, t/he;

K – approximate coefficient of loss of cultivated area in another region of Ukraine;

N – the number of regions in Ukraine.

2. Losses of grain crops are determined by the formula:

$$Lsabs = \sum_{i=1}^{n} S_{i\,2022} - S_{i\,2021} \quad (2)$$

$$Lsrel = \sum_{i=1}^{n} \left( S_{i\,2022} / S_{i\,2021} \right) * 100 \ \% \quad (3)$$

where:

Liabs is the absolute loss of grain crops, thousands of hectares;

Lirel – the relative losses of grain crops, %;

$S_{i2022}$ – the area of grain crops in **i** region of Ukraine in 2022, thousands of hectares;

$S_{i2021}$ – the sown area of grain crops in **i** region of Ukraine in 2021, thousands of hectares;

3. Crop yield losses are determined by the formula:

$$Lprabs = \sum_{i=1}^{n} \mathrm{Pr}_{i\,2022} - \mathrm{Pr}_{i\,2021} \quad (4)$$

$$Lprrel = \sum_{i=1}^{n} \left( \mathrm{Pr}_{i\,2022} / \mathrm{Pr}_{i\,2021} \right) * 100 \ \% \quad (5)$$

where:

Lprabs is the absolute loss of grain crops, thousands of tons;

Lprrel – relative loss of crop yield, %;

Pr – production of grain crops in another region of Ukraine in 2021-2022, thousand tons.

Similarly, forecast indicators of production, losses of cultivated areas and harvest separately for wheat, corn, and barley were calculated.

4. The calculation of the gross output of the grain market of Ukraine for 2022 is determined by the formula:

$$GP = \sum_{j=1}^{n} \mathrm{Pr}_{j} \times FP_{j} \quad (6)$$

where:

GP is the total forecasted volume of gross production of the grain market, UAH million;

Pr – the predicted production of the **j** type of grain crop in Ukraine in 2022, thousand tons;

FP – the constant price of 2016 of the j type of grain crop, UAH/ton;

N – the number of types of grain crops grown in Ukraine.

5. The calculation of actual losses of products of the grain market of Ukraine in 2022 is calculated according to the formula:

$$AL = \sum_{j=1}^{n} \mathrm{Pr}_{j\,2021} \times P_{j\,2021} - \sum_{j=1}^{n} \mathrm{Pr}_{j} \times P_{j\,2021} \quad (7)$$

where:

AL is the expected amount of actual losses of grain market products, million UAH/ million EUR;

$Pr_{j2021}$ – the actual production of the j type of grain crop in 2021, million tons;

$P_{j2021}$ – the average price of the j type of grain crop in 2021, UAH /ton.

6. Determining the parameters of grain market product balances were carried out according to the following formulas:

$$TS_j = \mathrm{Pr}_j + \mathrm{Im}_j \quad (8)$$

$$TD_j = Dd_j + Ex_j \quad (9)$$

where:

TS is the total offer on the market of the **j** type of grain crop, thousands of tons;

TD – the total market demand of the **j** type of grain crop, thousand tons;

Dd – the aggregate domestic demand on the market of the **j** type of grain crop, thousands of tons;

Im – the import of the **j** type of grain crop, thousands of tons;

Ex – export of the **j** type of grain crop, thousands of tons.

$$Dd_j = Ip_j + Cf_j + Sf_j + Af_j \quad (10)$$

where:

Ip is the volume of industrial processing of the **j** type of grain crop, thousands of tons;

Cf – consumption fund of the **j** type of grain crop, thousand tons;

Sf – costs of seeds for sowing the **j** type of grain crop, thousands of tons;

Af – use of the **j** type of grain crop for animal feed, thousand tons.

$$Sch_j = TD_j - TS_j \quad (11)$$

$$\mathrm{Pr}\,P_j = \frac{\mathrm{Pr}_j}{Pop} \quad (12)$$

where:

$Sch_j$ is the index of changes in stocks of the **j** type of grain crop, thousands of tons;

Pop – the population of Ukraine, millions of people.

## 3. The Research Results

The economy of Ukraine in 2022 suffered catastrophic destruction and losses. Russia has seized territories, is ruining cities and villages, destroying enterprises, roads, bridges, stealing and taking away machinery, equipment, and grain from elevators. All components of the country's economy suffered colossal losses, including the agricultural sector.

After Russia invades Ukraine, almost the entire agricultural sector of the country is in the zone of total risk, and the issues of the sowing campaign in 2022 have become the most problematic. According to the Ministry of Agrarian Policy and Food of Ukraine, this year only 75% of Ukraine's acreage was sown. Accordingly, a significant decrease in the level of production of grain yields is expected compared to 2021.

As a result of hostilities, Chernihiv, Sumy, Kyiv, Kharkiv, Luhansk, Donetsk, Zaporizhzhya, Kherson, and Mykolaiv regions turned dangerous regions for the sowing campaign, and Zhytomyr, Poltava, and Dnipropetrovsk regions became high-risk regions. Taking into account the military danger, agro-climatic influence, and long-term dynamics of the yield of agricultural crops in the regions, the forecast of the production of farmed products in Ukraine in 2022 (June 2022) developed by specialists of the NSC "Institute of Agrarian Economy" (Lupenko, Nechiporenko et al., 2022), predictive conclusions were made regarding the future harvest of grain crops (wheat, corn, and barley) by regions of the country and the general state of the grain market of Ukraine in wartime conditions.

Data on the actual production and sown areas of grain crops for 2015-2021 were used to carry out forecast calculations. The percentages of losses of the sown area under grain crops by regions of warlike operations and those affected by occupation were predicted (Table 1).

The production forecast is made by taking into account losses of cultivated areas, damage to crops, violations of production technologies, and a decrease in the yield of grain crops.

A significant share (more than 40%) of the production of grain crops in Ukraine is formed by winter crops of wheat, barley, and rye, formed before the war.

Over the past 3 years, in the structure of grain crops, winter crops occupied an average of 51%, and their area ranged from 7.6 to 8.2 million hectares. For the 2022 harvest, 7.6 million hectares were sown with winter grains, which is 7% lower than the figure for 2021 (8.2 million hectares) and practically the same as the area in 2020 (Kupchenko, 2022).

The region under winter wheat in 2022 is 6.5 million hectares (-5% compared to the indicator of 2021), under winter barley – 969.0 thousand hectares (-15%), and under rye – 108.5 thousand hectares (-39%). However, the armed actions in Ukraine will most likely lead to a significant reduction in the areas available for harvesting. A leading part of the land was beyond the limit of the physical possibility of its cultivation. Foremost, these are the territories of Kherson, Donetsk, Luhansk, Zaporizhzhia, Mykolaiv, Kharkiv, Sumy, Chernihiv, and Kyiv regions.

Table 1

Approximate losses of cultivated areas and harvest of grain crops by regions of Ukraine in 2022 (%)

| Regions of military operations | | Regions affected by the occupation | |
|---|---|---|---|
| Region | Losses of sown areas and production of grain crops, % | Region | Losses of sown areas and production of grain crops, % |
| Donetsk | 80 | Kyiv | 5 |
| Zaporizhzhya | 80 | Sumy | 10 |
| Luhansk | 100 | Chernihiv | 10 |
| Mikolayiv | 30 | | |
| Kharkiv | 50 | | |
| Kherson | 80 | | |
| Other regions of the country | | | |
| Vinnytsya | 0 | Odesa | 20 |
| Volyn | +20 | Poltava | +5 |
| Dnipropetrovsk | 5 | Rivne | 0 |
| Zhytomyr | 1 | Ternopil | 0 |
| Zakarpattya | 7 | Khmelnytskiy | 0 |
| Ivano-Frankivsk | 1 | Cherkasy | 0 |
| Kirovohrad | 5 | Chernivtsi | +7 |
| Lviv | 3 | | |

*Source: The result of the authors' research.*

The total production of grain crops in 2022 is forecast to be 53.6 million tons, which is almost 40% lower than in 2021. The area under harvest is expected to decrease by 4.7 million hectares (from 15.9 to 12.3 million hectares). The most massive losses of area and harvest of grain crops are expected in Luhansk, Donetsk, Zaporizhzhia, Kherson, Kharkiv, and Mykolaiv regions (Table 2).

A more detailed regional analysis of the distribution of the land area under the main crops shows that almost 51% of the total acreage of the yield has been sown with winter wheat for the 2022 harvest in the currently most dangerous regions. Therefore, the projected losses of areas under winter crops are significant. According to the results of spring wheat sowing in the previous season, the total share of crops in dangerous parts is estimated at 30%.

Accordingly, there are prospects for expanding the area under spring wheat in relatively safe regions. First of all, this applies to Zhytomyr, Ternopil, and Vinnytsia regions (Table 3).

The forecast reduction in the area of wheat crops is set at 2 million hectares (or 28.4%), a yield loss of 12.7 million tons, or 39.5% less than the level of 2021. An analysis of the distribution of corn crops according to the data for 2021 shows that in the areas that became dangerous as a result of the war in 2022, 36% more area was planted with corn. The most critical are the Chernihiv, Sumy, and Kyiv regions, where more than 25% of corn crops have been planted. Obvious that these regions will not be leaders in corn production this year. And taking into account the low market incentives and the high-energy intensity of the production of this crop in relatively safe areas, there will be no expansion of crops to compensate for areas unavailable for cultivation.

Table 2

Forecast of production and crop loss by regions of Ukraine, 2022

| Regions of Ukraine | Grain area, thsd.ha | | Grain production, thsd. t | | Losses of cultivated areas, compared to 2021 | | Crop yield losses compared to 2021 | |
|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | 2021 | 2022 (forecast) | thsd.ha | % | thsd. t | % |
| Vinnytsya | 890,3 | 890,3 | 6535,5 | 5031,8 | 0,0 | 0,0 | -1503,7 | 23,0 |
| Volyn | 327,1 | 396,8 | 1509,3 | 1426,8 | 0 | 0 | -82,5 | 5,5 |
| Dnipropetrovsk | 1150,2 | 1095,8 | 4948,8 | 3534,0 | -54,4 | 4,7 | -1414,8 | 28,6 |
| Donetsk | 596,3 | 120,3 | 2227,6 | 346,8 | -476,0 | 79,8 | -1880,8 | 84,4 |
| Zhytomyr | 552,0 | 544,3 | 3356,7 | 2581,3 | -7,7 | 1,4 | -775,4 | 23,1 |
| Zakarpattya | 83,2 | 77,7 | 362,8 | 254,1 | -5,5 | 6,6 | -108,7 | 30,0 |
| Zaporizhzhya | 1013,8 | 197,2 | 3838,0 | 590,6 | -816,6 | 80,5 | -3247,4 | 84,6 |
| Ivano-Frankivsk | 154,7 | 152,6 | 1009,5 | 776,1 | -2,1 | 1,4 | -233,4 | 23,1 |
| Kyiv | 676,0 | 632,5 | 4567,4 | 3206,8 | -43,5 | 6,4 | -1360,6 | 29,8 |
| Kirovohrad | 899,6 | 855,4 | 4981,1 | 3743,7 | -44,2 | 4,9 | -1237,4 | 24,8 |
| Luhansk | 392,0 | 0,0 | 1391,1 | 0,0 | -392,0 | 100 | -1391,1 | 100,0 |
| Lviv | 315,3 | 306,4 | 1827,9 | 1403,9 | -8,9 | 2,8 | -424,0 | 23,2 |
| Mikolayiv | 950,5 | 616,5 | 3925,5 | 2011,4 | -334,0 | 35,1 | -1914,1 | 48,8 |
| Odesa | 1238,1 | 951,5 | 5105,4 | 3096,9 | -286,6 | 23,1 | -2008,5 | 39,3 |
| Poltava | 1010,7 | 1058,1 | 5979,6 | 4917,2 | 0 | 0 | -1062,4 | 17,8 |
| Rivne | 318,9 | 318,9 | 1727,0 | 1345,7 | 0,0 | 0,0 | -381,3 | 22,1 |
| Sumy | 722,1 | 641,2 | 4260,7 | 2913,2 | -80,9 | 11,2 | -1347,5 | 31,6 |
| Ternopil | 487,1 | 487,0 | 3303,7 | 2542,4 | -0,1 | 0,0 | -761,3 | 23,0 |
| Kharkiv | 1061,3 | 508,9 | 4936,9 | 1822,1 | -552,4 | 52,0 | -3114,8 | 63,1 |
| Kherson | 813,8 | 155,4 | 3528,8 | 485,6 | -658,4 | 80,9 | -3043,2 | 86,2 |
| Khmelnytskiy | 626,1 | 626,1 | 4830,8 | 3770,1 | 0,0 | 0,0 | -1060,7 | 22,0 |
| Cherkasy | 708,1 | 706,1 | 5150,3 | 3850,0 | -2,0 | 0,3 | -1300,3 | 25,2 |
| Chernivtsi | 120,5 | 129,1 | 728,9 | 609,2 | 0 | 0 | -119,7 | 16,4 |
| Chernihiv | 840,7 | 803,1 | 5977,1 | 3351,2 | -37,6 | 4,5 | -2625,9 | 43,9 |
| **Ukraine** | **15948,4** | **12271,2** | **86010,4** | **53610,9** | **-3677,2** | **23,1** | **-32399,5** | **37,7** |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.*

Table 3

Forecast of wheat production and crop losses by regions of Ukraine, 2022

| Regions of Ukraine | Wheat area, thsd. ha | | Wheat production, thsd. t | | Losses of cultivated areas, compared to 2021 | | Wheat harvest losses compared to 2021 | |
|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | 2021 | 2022 (forecast) | thsd.ha | % | thsd. t | % |
| Vinnytsya | 317,4 | 351,5 | 1767,2 | 1431,0 | 34,1 | +10,7 | -336,2 | 19,0 |
| Volyn | 165,4 | 181,3 | 718,0 | 726,9 | 15,9 | +9,6 | 8,9 | -1,2 |
| Dnipropetrovsk | 561,1 | 561,1 | 2468,9 | 2222,0 | 0,0 | 0,0 | -246,9 | 10,0 |
| Donetsk | 380,8 | 70,6 | 1548,6 | 228,0 | -310,2 | 81,5 | -1320,6 | 85,3 |
| Zhytomyr | 162,1 | 162,1 | 754,0 | 650,0 | 0,0 | 0,0 | -104,0 | 13,8 |
| Zakarpattya | 24,2 | 28,9 | 81,5 | 92,4 | 4,7 | +19,4 | 10,9 | -13,4 |
| Zaporizhzhya | 706,7 | 133,6 | 2716,6 | 481,0 | -573,1 | 81,1 | -2235,6 | 82,3 |
| Ivano-Frankivsk | 47,4 | 70,3 | 235,8 | 282,6 | 22,9 | +48,3 | 46,8 | -19,8 |
| Kyiv | 208,3 | 181,2 | 1053,9 | 793,7 | -27,1 | 13,0 | -260,2 | 24,7 |
| Kirovohrad | 383,6 | 383,6 | 1868,9 | 1503,7 | 0,0 | 0,0 | -365,2 | 19,5 |
| Luhansk | 281,5 | 0,0 | 1080,7 | 0,0 | -281,5 | 100,0 | -1080,7 | 100,0 |
| Lviv | 167,1 | 180,6 | 824,4 | 756,7 | 13,5 | +8,1 | -67,7 | 8,2 |
| Mikolayiv | 480,3 | 343,3 | 2029,9 | 1253,0 | -137,0 | 28,5 | -776,9 | 38,3 |

| Regions of Ukraine | Wheat area, thsd. ha | | Wheat production, thsd. t | | Losses of cultivated areas, compared to 2021 | | Wheat harvest losses compared to 2021 | |
|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | 2021 | 2022 (forecast) | thsd.ha | % | thsd. t | % |
| Odesa | 678,5 | 547,6 | 2642,8 | 1796,1 | -130,9 | 19,3 | -846,7 | 32,0 |
| Poltava | 249,5 | 260,5 | 1203,9 | 932,6 | 11,0 | +4,4 | -271,3 | 22,5 |
| Rivne | 114,6 | 114,6 | 539,2 | 467,6 | 0,0 | 0,0 | -71,6 | 13,3 |
| Sumy | 195,5 | 187,7 | 928,9 | 756,4 | -7,8 | 4,0 | -172,5 | 18,6 |
| Ternopil | 205,5 | 229,5 | 1139,4 | 941,0 | 24,0 | +11,7 | -198,5 | 17,4 |
| Kharkiv | 589,4 | 299,3 | 2830,9 | 1062,5 | -290,1 | 49,2 | -1768,4 | 62,5 |
| Kherson | 503,7 | 98,3 | 2073,4 | 333,4 | -405,4 | 80,5 | -1740,0 | 83,9 |
| Khmelnytskiy | 219,3 | 233,9 | 1317,0 | 933,3 | 14,6 | +6,7 | -383,7 | 29,1 |
| Cherkasy | 227,8 | 227,8 | 1228,9 | 945,4 | 0,0 | 0,0 | -283,5 | 23,1 |
| Chernivtsi | 34,6 | 49,6 | 173,9 | 191,5 | 15,0 | +43,4 | 17,6 | -10,1 |
| Chernihiv | 185,9 | 182,2 | 924,3 | 685,0 | -3,7 | 2,0 | -239,3 | 25,9 |
| **Ukraine** | **7090,2** | **5079,1** | **32151,0** | **19465,6** | **-2011,1** | **28,4** | **-12685,4** | **39,5** |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.*

A reduction in the region under corn is predicted in the amount of 0.7 million hectares (by 12%), and crop losses are estimated at 14.4 million tons, which is 34.3% lower than in 2021. (Table 4).

Table 4

Forecast of corn production and loss by region of Ukraine, 2022

| Regions of Ukraine | Corn area, thsd. ha | | Corn production, thsd. t | | Losses of cultivated areas, compared to 2021 | | Corn harvest losses compared to 2021 | |
|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | 2021 | 2022 (forecast) | thsd.ha | % | thsd. t | % |
| Vinnytsya | 456,7 | 449,5 | 4279,4 | 2638,6 | -7,2 | 1,6 | -1640,8 | 38,3 |
| Volyn | 58,2 | 40,7 | 501,1 | 307,7 | -17,5 | 30,1 | -193,4 | 38,6 |
| Dnipropetrovsk | 303,5 | 290,2 | 1574,4 | 1282,6 | -13,3 | 4,4 | -291,8 | 18,5 |
| Donetsk | 56,1 | 11,8 | 238,8 | 41,5 | -44,3 | 79,0 | -197,3 | 82,6 |
| Zhytomyr | 273,9 | 225,8 | 2261,0 | 1655,2 | -48,1 | 17,6 | -605,8 | 26,8 |
| Zakarpattya | 53,0 | 47,3 | 267,6 | 228,5 | -5,7 | 10,8 | -39,1 | 14,6 |
| Zaporizhzhya | 36,9 | 6,7 | 278,5 | 39,2 | -30,2 | 81,8 | -239,3 | 85,9 |
| Ivano-Frankivsk | 70,6 | 48,6 | 635,8 | 361,6 | -22,0 | 31,2 | -274,2 | 43,1 |
| Kyiv | 357,9 | 359,7 | 3104,2 | 2111,2 | 1,8 | -0,5 | -993,0 | 32,0 |
| Kirovohrad | 353,5 | 394,2 | 2483,8 | 1801,5 | 40,7 | -11,5 | -682,3 | 27,5 |
| Luhansk | 55,9 | 0,0 | 161,0 | 0,0 | -55,9 | 100,0 | -161,0 | 100,0 |
| Lviv | 83,4 | 66,4 | 755,0 | 517,9 | -17,0 | 20,4 | -237,1 | 31,4 |
| Mikolayiv | 121,4 | 79,9 | 634,4 | 305,1 | -41,5 | 34,2 | -329,3 | 51,9 |
| Odesa | 137,4 | 125,4 | 838,1 | 584,2 | -12,0 | 8,8 | -253,9 | 30,3 |
| Poltava | 642,8 | 599,4 | 4362,2 | 2925,1 | -43,4 | 6,8 | -1437,1 | 32,9 |
| Rivne | 109,9 | 78,4 | 892,1 | 591,1 | -31,5 | 28,7 | -301,0 | 33,7 |
| Sumy | 459,9 | 441,3 | 3116,3 | 3221,5 | -18,6 | 4,0 | 105,2 | -3,4 |
| Ternopil | 176,0 | 144,0 | 1737,3 | 1061,3 | -32,0 | 18,2 | -676,0 | 38,9 |
| Kharkiv | 286,8 | 167,4 | 1475,0 | 852,1 | -119,4 | 41,6 | -622,9 | 42,2 |
| Kherson | 59,0 | 9,4 | 533,3 | 84,0 | -49,6 | 84,1 | -449,3 | 84,3 |
| Khmelnytskiy | 303,1 | 261,3 | 3117,2 | 1701,3 | -41,8 | 13,8 | -1415,9 | 45,4 |
| Cherkasy | 406,1 | 420,2 | 3634,5 | 2344,6 | 14,1 | -3,5 | -1289,9 | 35,5 |
| Chernivtsi | 64,0 | 56,6 | 477,8 | 357,7 | -7,4 | 11,6 | -120,1 | 25,1 |
| Chernihiv | 555,8 | 499,8 | 4751,1 | 2653,8 | -56,0 | 10,1 | -2097,3 | 44,1 |
| **Ukraine** | **5481,8** | **4823,8** | **42109,9** | **27667,1** | **-658,0** | **12,0** | **-14442,8** | **34,3** |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022.*

As for barley, the situation in this segment is also rather complicated. The distribution between winter and summer crops was formed in the ratio of 45% to 55%, respectively. At the same time, a significant share of both winter and spring crops is located in dangerous areas. Thus, the total share of winter grain crops for the 2022 harvest in dangerous regions is estimated at almost 44% of its total area. The key regions where expansion is possible are Poltava, Ternopil, Vinnytsia, and Khmelnytskyi regions, which traditionally produce sufficiently high yields of spring barley. The reduction in the area under barley is estimated at 0.8 million hectares or 32%, and crop losses will amount to 4.4 million tons, which is almost 50% below the level of 2021 (Table 5).

Table 5

Forecast of production and loss of barley harvest by regions of Ukraine, 2022

| Regions of Ukraine | Barley area, thsd. ha | | Barley production, thsd. t | | Losses of cultivated areas, compared to 2021 | | Barley harvest losses compared to 2021 | |
|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | 2021 | 2022 (forecast) | thsd.ha | % | thsd. t | % |
| Vinnytsya | 93,8 | 88,6 | 433,0 | 275,5 | -5,2 | 5,5 | -157,5 | 36,4 |
| Volyn | 32,8 | 33,4 | 111,6 | 104,2 | 0,6 | +1,8 | -7,4 | 6,6 |
| Dnipropetrovsk | 249,3 | 228,4 | 810,9 | 701,1 | -20,9 | 8,4 | -109,8 | 13,5 |
| Donetsk | 116,6 | 22,7 | 350,4 | 60,2 | -93,9 | 80,5 | -290,2 | 82,8 |
| Zhytomyr | 35,5 | 29,2 | 141,0 | 78,3 | -6,3 | 17,7 | -62,7 | 44,5 |
| Zakarpattya | 1,9 | 2,3 | 5,6 | 6,3 | 0,4 | +21,1 | 0,7 | -12,5 |
| Zaporizhzhya | 194,7 | 39,4 | 684,5 | 124,8 | -155,3 | 79,8 | -559,7 | 81,8 |
| Ivano-Frankivsk | 25,3 | 27,9 | 109,8 | 86,2 | 2,6 | +10,3 | -23,6 | 21,5 |
| Kyiv | 70,4 | 63,0 | 284,7 | 200,9 | -7,4 | 10,5 | -83,8 | 29,4 |
| Kirovohrad | 132,4 | 117,6 | 535,4 | 370,4 | -14,8 | 11,2 | -165,0 | 30,8 |
| Luhansk | 40,7 | 0,0 | 112,8 | 0,0 | -40,7 | 100,0 | -112,8 | 100,0 |
| Lviv | 38,4 | 39,8 | 183,5 | 129,0 | 1,4 | +3,6 | -54,5 | 29,7 |
| Mikolayiv | 307,2 | 179,2 | 1159,3 | 510,8 | -128,0 | 41,7 | -648,5 | 55,9 |
| Odesa | 370,3 | 264,8 | 1498,9 | 683,1 | -105,5 | 28,5 | -815,8 | 54,4 |
| Poltava | 89,5 | 84,9 | 325,9 | 288,7 | -4,6 | 5,1 | -37,2 | 11,4 |
| Rivne | 45,2 | 45,4 | 172,6 | 142,6 | 0,2 | +0,4 | -30,0 | 17,4 |
| Sumy | 32,5 | 35,2 | 127,2 | 107,3 | 2,7 | -8,3 | -19,9 | 15,6 |
| Ternopil | 83,6 | 99,6 | 374,1 | 293,8 | 16,0 | +19,1 | -80,3 | 21,5 |
| Kharkiv | 136,1 | 85,8 | 502,3 | 260,0 | -50,3 | 37,0 | -242,3 | 48,2 |
| Kherson | 209,8 | 33,4 | 813,0 | 107,5 | -176,4 | 84,1 | -705,5 | 86,8 |
| Khmelnytskiy | 71,5 | 69,6 | 319,6 | 209,4 | -1,9 | 2,7 | -110,2 | 34,5 |
| Cherkasy | 54,8 | 45,9 | 228,6 | 140,5 | -8,9 | 16,2 | -88,1 | 38,6 |
| Chernivtsi | 18,3 | 19,4 | 67,3 | 66,6 | 1,1 | +6,0 | -0,7 | 1,0 |
| Chernihiv | 21,5 | 23,5 | 85,0 | 68,6 | 2,0 | +9,2 | -16,4 | 19,3 |
| **Ukraine** | **2472,1** | **1678,9** | **9437,0** | **5015,7** | **-793,2** | **32,1** | **-4421,3** | **46,9** |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022*

According to our calculations, the reduction of the gross output of the grain market in 2022 compared to 2021 is almost 40% (from 271.4 to 169.2 billion UAH). Gross production will decrease the most for such grain crops as millet (by 55%), sorghum (by 54.1%), barley (by 46.9%), rye (by 46.3%), wheat (by 39.5%), corn (by 34.3%) (Table 6).

Table 6

Calculation of the gross output of the grain market of Ukraine for 2022

| Types of grain crops | Production, thsd. t | | | Constant prices of 2016, UAH/t | Cost in constant prices of 2016, UAH million | | | 2022 to 2021, % | 2022 to 2020, % |
|---|---|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | 2022 (forecast) | | 2020 | 2021 | 2022 (forecast) | | |
| Total | **64932,9** | **86010,4** | **53610,9** | **3156,9** | **204984,1** | **271351,1** | **169244,3** | **62,4** | **82,6** |
| wheat | 24877,4 | 32151 | 19465,6 | 3117,2 | 77547,9 | 100221,2 | 60678,2 | 60,5 | 78,2 |
| Rye | 456,8 | 593,2 | 318,7 | 2954,1 | 1349,4 | 1752,2 | 941,5 | 53,7 | 69,8 |
| buckwheat | 97,6 | 105,8 | 84,3 | 12277,5 | 1198,8 | 1298,7 | 1035,0 | 79,7 | 86,3 |
| Corn | 30290,3 | 42109,9 | 27667,1 | 3179,7 | 96314,2 | 133896,7 | 87973,1 | 65,7 | 91,3 |
| barley | 7636,3 | 9437 | 5015,7 | 2966,7 | 22654,7 | 27996,8 | 14880,1 | 53,1 | 65,7 |
| pea | 478,9 | 566,3 | 290,3 | 4891 | 2342,2 | 2769,6 | 1419,9 | 51,3 | 60,6 |
| oat | 510 | 467,9 | 419,5 | 3081,5 | 1571,6 | 1441,8 | 1292,7 | 89,7 | 82,3 |
| millet | 256,1 | 205 | 92,2 | 3196,8 | 818,5 | 655,3 | 294,7 | 45,0 | 36,0 |
| sorghum | 106,6 | 173,2 | 79,4 | 3424 | 364,9 | 592,9 | 271,9 | 45,9 | 74,5 |
| rice | 60,7 | 49,5 | 28,5 | 5936,9 | 360,3 | 293,8 | 169,2 | 57,6 | 47,0 |
| other cereals | 162,2 | 151,8 | 149,6 | 2846 | 461,7 | 432,1 | 425,8 | 98,5 | 92,2 |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Lupenko, Nechiporenko et al., 2022.*

Regarding the forecast estimates of the actual losses of products of the grain market of Ukraine in the current 2022, the decrease will amount to UAH 204 billion, or almost EUR 7 billion. The biggest losses will be experienced by the production of corn – EUR 3 billion, wheat – EUR 2.7 billion, barley – EUR 0.9 billion (Table 7).

Table 7

Calculation of actual losses of products of the grain market of Ukraine in 2022, million UAH/million EUR

| Types of grain crops | Production, thsd. t | | Average prices in 2021, UAH/t | Cost in actual prices of 2021, UAH million | | Market losses, UAH million | Market losses, EUR million |
|---|---|---|---|---|---|---|---|
| | 2021 | 2022 (forecast) | | 2021 | 2022 (forecast) | | |
| Total | **86010,4** | **53610,9** | **6296,1** | **541530,1** | **337539,6** | **-203990,5** | **-6799,7** |
| wheat | 32151 | 19465,6 | 6433,6 | 206846,7 | 125233,9 | -81612,8 | -2720,4 |
| rye | 593,2 | 318,7 | 4470,5 | 2651,9 | 1424,7 | -1227,2 | -40,9 |
| buckwheat | 105,8 | 84,3 | 17909,2 | 1894,8 | 1509,7 | -385,0 | -12,8 |
| corn | 42109,9 | 27667,1 | 6245,5 | 262997,4 | 172794,9 | -90202,5 | -3006,8 |
| barley | 9437 | 5015,7 | 5862,6 | 55325,4 | 29405,0 | -25920,3 | -864,0 |
| pea | 566,3 | 290,3 | 5608,5 | 3176,1 | 1628,1 | -1547,9 | -51,6 |
| oat | 467,9 | 419,5 | 4948,1 | 2315,2 | 2075,7 | -239,5 | -8,0 |
| millet | 205 | 92,2 | 6559 | 1344,6 | 604,7 | -739,9 | -24,7 |
| sorghum | 173,2 | 79,4 | 7018,1 | 1215,5 | 557,2 | -658,3 | -21,9 |
| rice | 49,5 | 28,5 | 9007,7 | 445,9 | 256,7 | -189,2 | -6,3 |
| other cereals | 151,8 | 149,6 | 5622,2 | 853,4 | 841,1 | -12,4 | -0,4 |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Lupenko, Nechiporenko et al., 2022.*

Actual (for 2020 and 2021) and prognostic for 2022 production balances were made to determine the extent of destructive shifts occurring in the grain market of Ukraine (Table 8).

Table 8

Grain market product balances for 2020-2022, thsd. t

| Balance sheet figure | 2020 | | | |
|---|---|---|---|---|
| | Cereal crops | Wheat | Corn | Barley |
| **Total offer** | **65126** | **24986** | **30315** | **7645** |
| Production | 64933 | 24877 | 30290 | 7636 |
| Import | 193 | 109 | 25 | 9,2 |
| **Total demand** | **71395** | **26228** | **35166** | **8332** |
| Domestic demand | 20082 | 8168 | 7220 | 3286 |
| Industrial processing | 1040 | 128 | 632 | 264 |
| Consumption fund | 5379 | 4473 | 156 | 159 |
| Seeds for sowing | 2247 | 1416 | 197 | 527 |
| Using for animal feed | 11416 | 2151 | 6235 | 2336 |
| Export | 51313 | 18060 | 27946 | 5046 |
| Changes of stocks +, - | -6269 | -1242 | -4851 | -686,8 |
| Production per person, kg | 1555,3 | 595,9 | 725,5 | 182,9 |
| | 2021 | | | |
| **Total offer** | **86195** | **32169** | **42129** | **9477** |
| Production | 86010 | 32151 | 42110 | 9437 |
| Import | 185 | 18,1 | 18,8 | 39,7 |
| **Total demand** | **71302** | **28944** | **29634** | **9129** |
| Domestic demand | 20505 | 8873 | 4959 | 3473 |
| Industrial processing | 1456 | 263 | 473 | 501 |
| Consumption fund | 5684 | 5033 | 154 | 69 |
| Seeds for sowing | 2229 | 1082 | 131 | 565 |
| Using for animal feed | 11136 | 2495 | 4201 | 2338 |
| Export | 50797 | 20071 | 24675 | 5656 |
| Changes of stocks +, - | 14893 | 3225 | 12495 | 348 |
| Production per person, kg | 2078,5 | 777,0 | 1017,6 | 228,1 |
| | 2022 (forecast) | | | |
| **Total offer** | **53335** | **19483** | **27688** | **5029** |
| Production | 53210 | 19465,6 | 27667,1 | 5015,7 |
| Import | 125 | 17,5 | 21,1 | 12,8 |
| **Total demand** | **47402** | **19292** | **19026** | **4994** |
| Domestic demand | 17732 | 7567 | 4614 | 2608 |
| Industrial processing | 1264 | 179 | 435 | 275 |
| Consumption fund | 5215 | 4365 | 147 | 87 |
| Seeds for sowing | 2117 | 928 | 125 | 328 |
| Using for animal feed | 9136 | 2095 | 3907 | 1918 |
| Export | 29670 | 11725 | 14412 | 2386 |
| Changes of stocks +, - | 5933 | 191 | 8662 | 35 |
| Production per person, kg | 1404,7 | 513,9 | 730,4 | 132,4 |

*Source: Calculated according to the data of the State Statistics Service of Ukraine, 2022 and Cheremisina, Pedorchenko, 2021.*

Based on balances, the unlimited supply of grain will decrease by almost 33 million tons in 2022, in particular: wheat – by 12.7, corn – by 14.4, barley – by 4.4 million tons. Accordingly, grain production per person will decrease to 1,405 kg (compared to 2,079 kg in 2021). Industrial processing of grain crops will decrease by 13.2% (from 1,456 to 1,264 thousand

tons), the consumption fund will decrease by 8.3% (from 5,684 to 5,215 thousand tons), and animal feed costs by 18% (from 11,136 up to 9136 thousand tons).

The leading factors that will influence the more isolated formation of internal consumption of grain crops currently obtain the following:

- further development of military events on the territory of Ukraine;
- setting up logistics for raw materials and finished products within the country and ensuring export and import in critical segments;
- the current state and level of realization of the capacity potential of grain processing enterprises by the present military situation;
- provision of state support to enterprises in the grain processing industry;
- formation of demand in the livestock industry;
- the present level of risks of damage to objects of the grain storage system;
- the more isolated activity of migration processes in the country. In most cases, there will be no shortage in the grain market in Ukraine.

Accordingly, no significant problems are expected with providing Ukrainians with grain processing products. The available fodder base will be sufficient to support a functioning livestock industry. However, the military risks remain exceptionally considerable, and the situation can change at any moment.

At the same moment, the following negative trends are taking place. Like so, against the background of export problems, the price of wheat in Ukraine on EXW (own delivery) terms for the period from May 23 to June 27 decreased by 31.1% - from 5.9 to 4.5 thousand UA/t. During a similar period, the price of EXW corn decreased from UA 5,750 to UA 4,750/t, or by 17.4%, and barley – from UA 6.4 to 4,500/t, or by 29.7% (Agropravda, 2022).

The current price policy for grain crops in Ukraine is extremely unfavourable for farmers. The costs of growing grain crops have increased and surpassed sales prices. Production is below the profitability limit, and farmers receive significant losses. However, notwithstanding at such minimum prices, it is challenging to sell grain products. Without the unblocking of Ukrainian seaports, the losses of participants in the grain market will be scarcely greater.

The export of grain from Ukraine in the recent marketing season, which begins in July, may reach 30 million tons, provided that the throughput capacity of crossings at the borders of Ukraine is doubled and the ports are unblocked. Without this, Ukraine can count on no more than 12-18 million tons in the 2022/2023 marketing year. As experts note, without the complete unblocking of the ports, the surplus of grain will amount to 55 million tons (LandLord, 2022).

Shipping in the Black Sea ports of Ukraine stays extremely dangerous. The Russian Navy can prevent and capture civilian vessels. Even the release of Island Zmeiny does not ensure the unblocking of the ports, subjected to rocket and artillery fire every day, especially in the

city of Mykolaiv, where the largest logistics facilities are concentrated, and the entrance to the Dnipro-Buzky estuary remains under Russian control.

Turkey is ready to provide 20 vessels for the safe export of grain from Ukraine through "grain corridors." Lithuania, Romania, and other countries are equally making efforts so that Ukraine can transport food by rail. Greece offered its vessels to export Ukrainian grain. British reconnaissance planes can patrol "grain corridors." This will help ensure sea routes for the export of Ukrainian grain.

According to the Ministry of Agrarian Policy and Food, since the beginning of the full-scale war, the invaders have already taken more than 500,000 tons of seed from the occupied territory of Ukraine. The EU's decision to develop markets for Ukraine is a significant gesture of support for the state in wartime conditions.

However, residents of the European Union will also benefit from it. The war in Ukraine caused a global disruption of agricultural supply chains. As a result, prices for this product have risen sharply. Thus, the cost of wheat in European countries has increased by 50% since February. Other crops are also becoming more expensive, and all this will cause other food products to rise in price.

## 4. Conclusions

Because of the above, we state that the functioning and further stabilization of the grain market in Ukraine will depend on the following factors:

- further development of the situation in Ukraine due to Russia's armed aggression;
- conducting active hostilities in the southern, eastern, and northern regions and constantly changing front lines;
- mining of a significant part of territories, including agricultural land;
- the possibility of setting up logistics, the level of road destruction and the shortage of fuel and drivers, as a result of which the delivery of seeds, plant protection products, and fertilizers is significantly complicated;
- financing, as many agricultural commodity producers expected to sell present stocks of grain and oil crops in the spring before the sowing campaign to replenish circulating resources. This issue is extremely acute in regions close to the front line, where trade is significantly slow;
- availability of resources – not having the opportunity to properly prepare for the situation and taking into account logistical problems, farmers will use the limited number of resources available in their regions;
- the terms and scope of solving the problem of unblocking Ukrainian ports and establishing export corridors for the export of grain.

Ukraine has sent the European Union a specific list of the aid it needs to preserve its agricultural sector. The European Commission will coordinate the assistance. First of all, the European Commission proposes creating so-called "solidarity routes" for the export of grain from Ukraine.

Such routes should alleviate the difficulties currently arising at the borders between Ukraine and the EU. On this day, thousands of wagons and trucks expect 16-30 days for permission to span the border. A relatively serious problem is the different way widths of the Ukrainian railway network and the EU, so most of the cargo needs to be transshipped onto trucks or wagons that conform to the standard EU track. This process takes a long time, and there are few transhipment facilities along the borders.

The European Commission offers the following practical solutions:

- to provide other vehicles to Ukraine as EU market participants;
- create a logistics platform on which partners will be sought and special contact points will be appointed;
- to give priority status to Ukrainian grain export flows at transhipment terminals;
- to ensure prompt and urgent movement of mobile grain loaders by market participants to relevant border terminals to speed up grain transportation;
- to ensure the acceleration of customs procedures at checkpoints.

The EU also plans to increase capacity for the temporary storage of Ukrainian grain exports. The construction of temporary elevators in Poland near Ukraine (where the broad tracks from Ukraine end) will facilitate the process of overloading and increase the carrying capacity of vehicles. In the medium and long term, the Commission will also work on extending the throughput and infrastructure development of new export grain corridors.

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# *SUMMARIES*

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## REGIONAL ELECTRICITY TRADE IN SOUTH EAST EUROPE – FINDINGS FROM A PANEL STRUCTURAL GRAVITY MODEL

The paper discusses whether the electricity trade in South East Europe in 1990-2019 is driven by fundamentals or, like other commodities, one could argue for a speculative movement of electricity flows motivated by factors such as prices. We employ a panel structural gravity model on the example of Bulgaria, Romania, Serbia, Republic of North Macedonia, Greece, Turkey, and Hungary to study the dependence between net exports, generation, and consumption of electricity, as well as the regulations in the field of exporting electricity. We find that domestic consumption of electricity is a much stronger factor than the generation when considering foreign trade in electricity. The construction of power capacity in the countries considered is much more oriented towards the domestic market, which results in an underdeveloped interconnection between them. This is a serious obstacle to the liberalization on the electricity market in the region and its integration into pan-European market structures. It also creates conditions for maintaining higher and volatile electricity prices and, consequently, negatively affects economic development.
Keywords: foreign trade in electricity; panel structural gravity model; electricity market regionalization
JEL: Q43; F14; R11

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## ARRANGEMENT OF DIGITAL LEADERSHIP STRATEGY BY CORPORATE STRUCTURES: A REVIEW

An ecosystem model of effective solution of the customer management quality issue based on the platforms' (internal and external) interaction is proposed, which indicates that digital platforms are the main tool of digital corporate transformation and regeneration. The key elements of the digital leadership strategy based on the "business model-ecosystem" interaction were identified, allowing determining the main features of the digital leadership strategy and forming the deployment direction within the corporate structure. The "road map" model of digital leadership strategy formation is introduced, the stages' sequence of digital strategy formation is systematised, and its key elements are outlined.
Keywords: company strategy; strategic vision; digital leadership; digital solutions; digital platform; the business model of a company
JEL: L19; F23

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## INFLATION, INFLATION INSTABILITY AND NOMINAL UNCERTAINTY IN THE BULGARIAN ECONOMY

The main goal of the paper is to assess the relationship between inflation, inflation instability and nominal uncertainty in the Bulgarian economy in January 2000 – May 2022. Employing the ARCH model, GARCH-M model, EGARCH model and Granger Causality Test we find a two-way causal relationship between inflation and inflation instability. Initially, inflation provokes inflation

instability, and inflation instability provokes inflation consequently. Nominal uncertainty is measured by wavelet analysis, which establishes the presence of nominal uncertainty in the Bulgarian economy. Therefore, at certain lags, the inflation instability is transformed into nominal uncertainty. The empirical evidence raises the question of the effectiveness of the Currency Board Arrangements in Bulgaria.
Keywords: inflation; inflation instability; nominal uncertainty
JEL: E31; C22; C52

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## CIVILISATION PRINCIPLES OF TRANSFORMATION OF VALUES OF ECONOMIC AND SOCIETY DEVELOPMENT UNDER THE CONDITIONS OF ARTIFICIAL INTELLIGENCE EXPANSION

The article explores theoretical and methodological issues of defining the essence, functions and role of civilisational principles in the assurance of centripetal processes of restoring key forms of human civilisation activities, highlighting allowable limits of constructive transformation of values of economic and social development. The article pays great attention to economic and philosophic comprehension of principles and forms of the origination of a brand-new reality in the system of social and economic relations under the influence and pressure of the modern technological revolution. It reveals the particularities of methodological approaches to the essence analysis, trends in the development of new forms of human functioning in the context of Revolution 4.0, the digital economy and the active deployment of artificial intelligence.
Keywords: digital economy; artificial intelligence; nanotechnological revolution; human-centred development paradigm; transhumanistic paradigm; development benchmarks; humanitarian constant; framework for ethics principles; identity transformation, labour.
JEL: B40; I3; J08; O1; O3; P10

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## STOCK INDICES AS INDICATORS OF MARKET EFFICIENCY AND INTERACTION

The efficient market hypothesis dominates in the studies on the effectiveness of stock market performance, one illustration of which is the presence of calendar anomalies of different nature. The advent of the Adaptive Market Hypothesis calls into question both the presence of such anomalies and the effectiveness of the stock market. To confirm the effective market hypothesis, the time series behaviour of the rates of return of the most significant global stock indices and a local Ukrainian PFTS Stock Index has been investigated in the work. According to the study results, the efficient market hypothesis has not been confirmed; the results partially confirm the adaptive market hypothesis. To confirm the hypothesis that global stock markets have an impact on local stock exchanges, a pre-selected sample of time series of stock index rates of return was used. The Granger causality test was used for this purpose. To determine whether the time series of the dynamics of the stock index rates of return are stationary, the advanced Dickie-Fuller test was used since it takes into account the possible autocorrelation in residuals. The Phillips-Perron test was used as well.
Keywords: S&P; NIKKEI; DAX; FTSE; PFTS; day-of-the-week; calendar; anomalies; effect
JEL: G10; G15

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## STUDY OF THE SPECIFIC COVID-19 PANDEMIC EFFECTS ON THE BULGARIAN TOURISM LABOUR MARKET

The Covid-19 pandemic has significantly affected tourism in the last two years. The tourism industry forms a big part of the world's GDP and is an important industry in terms of employment. The great leakage of qualified, experienced and motivated tourism workers is severe for the future recovery and development perspectives of the tourism business. Tourism-dependent destinations, such as Bulgaria, are the most affected. Almost 11% of the Bulgarian economy is formed by the tourism industry. Some regions, such as the Black sea coast, are one of the tourism most dependent regions in the country as many people see their livelihood in tourism employment. Moreover, as a tourist destination with traditions, Bulgaria's tourism foundation is contained in the experienced and qualified workers in the industry. The main purpose of the present article is to investigate the Covid-19 impact on the Bulgarian tourism labour market due to reveal the future perspectives for its development.
Keywords: Tourism; Covid-19 pandemic; labour market; resilience; Bulgaria
JEL: J60; J81; L83; Z32

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## VEGETABLE PRODUCTION AS A PART OF BULGARIAN AGRICULTURE

The importance of vegetable production for the agricultural sector of Bulgaria is determined by the year-round presence of vegetable crops in household consumption and the strong traditions in vegetable production. The problems in the sector are significant and timely intervention is needed to solve them in order to ensure the country's food security. The purpose of the report is to outline the place of vegetable production in Bulgarian agriculture and the trends observed in the sector for the period 2013-2020. Data from the agrarian reports of the Ministry of Agriculture were used, FAO, Eurostat.
Keywords: agriculture; vegetable production; trends
JEL: Q10; O13; Q18

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## SUSTAINABILITY OF PRODUCTION AND EXPORT OF MAIN CEREAL AND OIL CROPS FROM BULGARIA

Bulgaria is one of the leading exporters of agricultural crops in Southeast Europe. Though smaller than their neighbours, Bulgarian farmers have a long tradition of growing all main cereals and oil crops, including wheat, maize, sunflower (in 2020 Bulgaria was the seventh largest exporter in the world), rape seed, barley and others. The main objective of the current study is to determine the nature of the considered processes for the production and export of main cereals and oil crops from Bulgaria and to study their sustainability. This is achieved by calculating the coefficients of sustainability of the specific indicators characterizing the processes. Determined is also whether the distribution of the main countries – trading partners is specific. Based on the obtained results, conclusions are drawn about the sustainability of the production and the export of main cereals and oil crops from Bulgaria.
Keywords: cereals; oil crops; agriculture; sustainability; export
JEL: F14; Q10; Q17; Q18

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# THE GRAIN MARKET OF UKRAINE: ACTUAL STATE, CURRENT PROBLEMS, AND DEVELOPMENT PROSPECTS

The article is devoted to the current problems occurring in the grain industry as a result of Russia's armed aggression and active hostilities in a large area of Ukraine. The purpose of the article is operational monitoring of the current state of the grain market in Ukraine and the calculation of forecast parameters of its stabilization and further development in the conditions of military aggression.

The research used the information database of the Ministry of Agrarian Policy and Food of Ukraine, the State Statistics Service of Ukraine, and the information and analytical materials of the NSC Institute of Agrarian Economics regarding the forecast indicators of the production of agricultural products in Ukraine in 2022 year. The production forecast is made taking into account losses of cultivated areas, damage to crops, violations of production technologies and a decrease in the yield of grain crops.

The total production of grain crops in 2022 is forecast to be 53.6 million tons, which is almost 40% lower than in 2021. The area under harvest is expected to decrease by 4.7 million hectares (from 15.9 to 12.3 million hectares). The actual losses of products of the grain market of Ukraine in the current 2022 are estimated at 204 billion UAH, or almost 7 billion EUR. The biggest losses will be experienced by the production of corn – EUR 3 billion, wheat – EUR 2.7 billion, barley – EUR 0.9 billion.

To determine the extent of destructive shifts occurring in the grain market of Ukraine, the actual (for 2020 and 2021) and forecast for 2022 balances of grain products were made. The main factors that will affect the functioning and further stabilization of the grain market in Ukraine have been established.

Keywords: grain market; production forecast; losses of sown areas; crop losses; production balance; domestic consumption; total demand; total supply

JEL: Q11; Q18; C53