



Publisher

<http://jssidoi.org/esc/home>



CHANGES IN REAL INCOME OF HOUSEHOLDS IN THE CZECH REPUBLIC DUE TO THE RUSSIAN INVASION OF UKRAINE

Marek Vochozka ¹, Stanislav Škapa ², Yelyzaveta Apanovych ³

¹ DTI University, Sládkovičova 533/20, 018 41 Dubnica nad Váhom, Slovakia

² Faculty of Business and Management, Brno University of Technology, Antonínská 548/1, 601 90, Brno, Czech Republic

^{1,3} Institute of Technology and Business in České Budějovice, Okružní 517/10, 370 01 České Budějovice, Czech Republic

E-mails: ¹ vochozka@mail.vstecb.cz; ² skapa2730@gmail.com; ³ apanovych@mail.vstecb.cz

Received 15 July 2023; accepted 15 October 2023; published 30 December 2023

Abstract. The objective of the paper was to assess the impact of the invasion of Ukraine by the Russian Federation on real household income in the Czech Republic. The research methods used in the study include content analysis, seasonal modification of SARIMA, and discounting method, specifically NPV. Data were collected from publicly available sources of the Czech Statistical Office. Based on a content analysis of the macroeconomic indicators under study, inflation and gross monthly household income were selected to examine further development of real household income in the Czech Republic. Based on historical data, the SARIMA model made statistically relevant forecasts of the selected variables for the "pre-war" year 2022. Comparing real and forecast data, it was confirmed that the Russian invasion of Ukraine (from 24th February 2022 onwards) has shown how vulnerable the European financial system is to external shocks, which can be observed in significant inflationary changes. The ability of the SARIMA model to handle a larger range of data and accurately determined seasonality was demonstrated in forecasting the development of real household income. The identified economic consequences of deviations of the real and forecast figures in the "pre-war" period showed new realities in turbulent economic conditions. In order to further expand the research, combining the applied method with other analytical tools can be recommended. Moreover, it is advisable to include new relevant variables in the model. This would allow understanding better and forecasting the development of real household income in the context of current economic events.

Keywords: prediction; inflation; household income; invasion; Ukraine

Reference to this paper should be made as follows: Vochozka, M., Škapa, S., Apanovych, Y. 2023. Changes in real income of households in the Czech Republic due to the Russian invasion of Ukraine. *Entrepreneurship and Sustainability Issues*, 11(2), 37-53. [http://doi.org/10.9770/jesi.2023.11.2\(3\)](http://doi.org/10.9770/jesi.2023.11.2(3))

JEL Classifications: M21, E31, E61

1. Introduction

The financial crisis of 2008 brought into question the characteristics of previously observed standard economic theories (Boyer, 2018). Thus, the Great Recession caused an apparent contradiction between empirical findings and macroeconomic models based on rational expectations (Mauersberger et al., 2020). Traditional economic theory failed to explain, let alone predict, the imminent collapse of the financial system and its long-term effects on the global economy of European countries (Soltes & Gavurova, 2014, 2015; Battiston et al., 2016). The subsequent occurrence of the crisis triggered reactions conditioned by the specificities of each country worldwide (Santos et al., 2019). Terms such as tipping points, contagion and resilience have entered the financial and regulatory lexicon (Battiston et al., 2016).

Even nowadays, economists monitor and forecast economic sequences due to the impact of the 2007/2008 economic crisis. Determining the current and future state of the business economic cycle is a timely and extensive topic both in the past and the present (Vochozka et al., 2020; Gavurova et al. 2022).

Supporting the recovery from the global economic crisis brought temporary economic equilibrium, which was subsequently replaced by the crisis caused by the COVID-19 pandemic. The pandemic hit the world at a time when the effects of the global financial crisis and the subsequent Great Recession were still affecting the market economy (Moosa, 2022). The new nature of the economic and social crisis due to the spread of COVID-19 caused a spiral of shocks between supply and demand. It turned out that inflation comes when a stochastic shock hits the economy, which can be influenced by lowering the unemployment rate (Della Posta, 2022). The COVID-19 disease halted almost half the world, disrupting a quarter of financial market wealth. Global markets went into free fall, particularly in the later stages of the contagion (Ali, 2020). The complications that the COVID-19 crisis revealed are public deficits and a downturn in the business cycle (Ashta, 2021). The pandemic highlighted the growing gaps and inequalities, access and facilities in financial digitalisation (Vasile et al., 2022; Androniceanu, 2023; Androniceanu & Georgescu, 2023a).

The COVID-19 crisis proved to be a curse for financial markets, with unexpected levels of uncertainty and high volatility. Prediction hints that markets will increasingly panic as the disease moves from an epidemic to a pandemic. The global spread crossed geographical and continental boundaries (Ali, 2020).

Certain global signs of economic recovery and optimism during late 2021 were hampered by the impact of inflation and the Russian Federation's invasion of Ukraine. The global economy continues to deal with inflation, which is exacerbated by the energy crisis due to the emergency (Arner et al., 2022). The current state of inflation, combined with global factors, is unpredictable. Uncertainty about the crisis trajectory is real (Gavurova et al. 2017; Braunerhjelm, 2021).

It cannot be named or predicted, but the options are, for instance, to respond, identify and find ways to work with the crisis (Bloom, 2014). Observing hypothetical changes and fluctuations in the financial market is one of the options for adapting to macroeconomic changes and then reacting to these changes (Al-Zoubi et al., 2018; Gavurova et al. 2020). The long-term goal of realising the current economic situation formulates steps to achieve a sustainable post-war order (Gresova, et al., 2021; Androniceanu & Sabie, 2022).

The objective of this paper is to assess the impact of the invasion of Ukraine by the Russian Federation on real household income in the Czech Republic.

Since an emergency causes the crisis, there are likely to be turning points in the business cycle development that are identified by estimating macroeconomic data (Belas et al. 2019; Cavallari, 2022; Radchenko et al., 2023).

In order to meet the objective, it is necessary to first determine development of macroeconomic indicators, hence the first research question (RQ1) is as follows:

RQ1: What was the development of inflation and gross household income in the Czech Republic before the RF invasion?

National business is moving towards adapting to a transforming economy that is changing due to a diversity of threats. The consequences are fluctuations in macroeconomic indicators (Demchenko, 2018). As for the global economy, the war poses a threat, not only in the form of fluctuations, but it also brings a new challenge in the efforts of businesses and society to recover from the war (Lytvynova et al., 2022).

The formulation of the second research question (RQ2) and the third research question (RQ3) is aimed at determining the extent of the impact of the invasion on changes in the living conditions of households in the Czech Republic based on established indicators.

RQ2: What is the forecast for inflation and gross household income in the Czech Republic for 2022 based on historical data?

RQ3: What will be the deviation of the forecast and real inflation and gross household income in the year 2022?

During the invasion of Ukraine, there has been a deep decline in economic activity as well as the introduction of a number of changes to mitigate the shock in society and the economy (Irtyshcheva et al., 2022). The last, i.e. the fourth research question (RQ4), will focus on real household income, as this reflects the amount of goods and services households can afford (Yang et al., 2020).

RQ4: What will be the impact of identified economic consequences of the deviations on the development of real household income in the Czech Republic until 2025?

2. Theoretical background

According to Musil et al. (2019), changes in the interpretation of regional indicators affect price level development. Subsequently, these changes reflect the development of market microstructures and their economic equilibrium or vice versa. The financial downturn in 2008-2009 and the Greek crisis in 2011 showed that the economic systems of each country are interconnected and mutually influenced. Each crisis period is characterised by the specific nature of the economic crisis. However, one rarity remains constant: the sharp increase in prices in individual areas (Zubikova and Smolak, 2022).

During the global financial crisis of 2007-2008, banking systems were under stress (Haq, Tripe and Seth, 2022). According to Godechot et al. (2022), increased capital requirements and a cap on national spending led to a significant asymmetry in restructuring. As Shen et al. (2018) claimed, the global financial crisis of 2007-2009 revealed the need to measure and monitor the transmission of extreme market risk.

In 2019, the COVID-19 pandemic caused an economic slowdown in the Czech Republic and worldwide. At that time, the price dynamics on the market were characterised by an inflexible and insufficient supply of new properties, due to which it was mostly demand-driven. The property market was influenced by monetary and fiscal policies (Godechot et al., 2022). Cermakova et al. (2022) found that finance intentionally invested in all economic sectors to limit the negative effects of pandemic measures led to a sharp rise in property prices, particularly in wealthier areas with minimal unemployment rates.

Given the financial turmoil over the last 10 years, financial institutions have been the point of economic reaction. The problems that occurred in the financial system since the pandemic have not vanished but are now being exacerbated by the price level changes caused by the invasion of Ukraine by the Russian Federation (Arner et al., 2022). Ukraine and Russia are important players in the energy market, and this has been confirmed. According to Osicka and Cernoch (2022), the European energy transition is coming (Androniceanu & Georgescu, 2023b). The current existence of an unstable economy brings lessons from the past, which, from a financial viewpoint, has been experienced by every citizen not only in the Czech Republic, but also in Europe.

The disruption of international trade and its activities has affected EU countries. The ongoing war in Ukraine has had a devastating effect on human lives, infrastructure and global inflation. According to Aliu et al. (2022), the Russian invasion of Ukraine (from 24th February 2022) has shown that the European financial system is fragile to external shocks. Given the Eurozone's dependence on Ukrainian and Russian resources, the immediate food security problem became apparent.

In response to Russia's request in June 2022, gas payments were made in rubles, further complicating the current situation and strengthening the value of the ruble, which, in the view of Aliu et al. (2022) is not a hard currency. The empirical research study by Liang et al. (2022) showed that import and export trading are major factors affecting economic growth. James, Menzies and Chin (2022) followed concerns about the current stagflationary economic environment. Based on multivariate time series and observing external indicators, they identified the most anomalous historical periods most similar to current market dynamics. According to Vrbka et al. (2018), a powerful model for solving a number of economic classifications can be artificial neural networks which allow making of time series forecasts. Based on their content analysis of capital markets and by determining the magnitude and variability of the impact of the invasion by the Russian Federation, Serrano and Angosto-Fernandez (2022) applied a system of uncorrelated regressions to daily index returns that were affected by energy and economic factors.

According to Astrov et al. (2022), Western financial support seriously impacts the financial sector of every country engaged in it. As a result of the war, the whole of Europe was already affected by high inflation and sharp rises in the price level. Also, cost-burdened real incomes, real household incomes and a reduction in economic growth will not be left out.

Using sets of annual time series on the growth rate of macroeconomic indicators provides a picture of the development of economic indicators and the subsequent determining of their causal relationships, which is one of the objectives of this study. To assess differences in regional price levels, Kocourek et al. (2017) applied the method of estimating regional price levels in individual districts of the Czech Republic, based on which they arrived at a tool for a more accurate and realistic comparison of household living standards. The used data taken from the Czech Statistical Office, the Eurostat International Comparison Programme and the OECD showed differences in market prices that affected household needs at the regional level.

Geltner et al. (2022) examined the effect of NPV indicator on real purchasing power of a certain municipality. Their study was related to finding evidence of a positive correlation between two financial indicators that compared the market value of a company's assets with their replacement cost. Finally, the study examined whether NPV can be used to forecast real-world price increases and how NPV affects the purchasing decisions of investors and consumers.

Following on from the aforementioned study, the used beta-convergence framework was taken into account by Lichner et al. (2022) who then focused on observing differences in nominal and discretionary household incomes before the economic recession and during the crisis from January 2004 to December 2012. Their results supported the hypothesis that in assessing economic imbalance, income and consumption should be assessed together.

Arjunan (2022) came up with a fresh view where a new method for estimating NPV and IRR of an investment project was introduced. The method was different from the traditional discounted cash flow (DCF) approach that was replaced by the capital amortisation schedule (CAS) method. According to CAS, the interest rate at which the present value of the closing balance in CAS equals zero appeared equivalent to the internal rate of return.

Liang et al. (2022) applied a combination of linear and nonlinear models to forecast exchange rate fluctuations. The aim of obtaining the forecast was to enhance the ability of companies to avoid exchange rate risks. Using the ARIMA model, dynamic exchange rate fluctuations were analysed. The model's application allowed us to capture better the factors affecting exchange rates, including non-linear interactions between different variables. The analysis results showed that the mechanism of influencing economic growth is dependent on extraordinary situations, which can affect exchange rate fluctuations.

In terms of the comparative method, Shahriar et al. (2021) examined performance of hybrid models using Autoregressive Integrated Moving Average (ARIMA) and Artificial Neural Networks (ANN). According to the authors, the ARIMA method demonstrated the ability to work with a larger range of data and accurately determined seasonality, which corresponds to the research objective of this paper.

On formulating the forecast of dissolved gas concentration in transformer oil, Liu et al. (2022) also used the ARIMA model, or the seasonal modification of SARIMA, where the accuracy and stability of performance were demonstrated. Equally positive results in modelling river runoff forecast were achieved in the study by Zhang et al. (2022), where SARIMA allowed to use historical data and further analyse time series with seasonal variations.

In order to provide a comprehensive overview of the impact of emergency situations, it is important to take into account changes in household consumption behaviour, which, as claimed by Tran (2022), is considered a key measure of a country's economic growth or decline.

As regards this paper, the content analysis method will be used to collect and subsequently analyse data in relation to the above research questions. The development of inflation and gross household income will be shown based on identified variables' fluctuations over the specified period. The ARIMA model, or the seasonal modification of SARIMA, and the discounting method, specifically NPV, will be used to address the second research question. Descriptive statistics will be used to determine deviations of the forecast and real figures of the selected variables in the year 2022. The seasonal modification of SARIMA will also be applied to answer the fourth research question, which is to forecast real household income until 2025, as its use is relevant and demonstrable.

3. Research objective and methodology

Data on the development of the aforementioned variables for the period under review (2000-2022) are available on the website of the Czech Statistical Office, specifically in the database of time series of inflation and consumer prices and in the sections on social security, wages and labour costs (ČSÚ, 2022).

Another criterion that will be addressed is the development over time and the possible scenario of the development of the variables in 2022. In relation to the second research question (RQ2), particular time series in the form of quarterly frequency will be defined from 2000 to 2021. Data on the variables (inflation, gross monthly income increased by average income) will be taken from the public database of the Czech Statistical Office, specifically from the sections on social security, prices and inflation, wages and labour costs. Furthermore, in order to deepen the RQ2, the discount factor will be determined on the basis of historical data on price level adjusted for inflation for the period from December 2020 to December 2022. The elaboration of the third research question will follow on from the data obtained from the previous question. Finding the future development of real income will be finalised with the use of data on gross monthly income increased by average income. The data will

be drawn from the public database of the Czech Statistical Office, specifically from the sections on social security, wages and labour costs.

The time series analysis of the period under review serves to answer the first research question. The first step in creating a model of development of the variables will involve data collection related to this period. Using data published by the Czech Statistical Office, changes in the relevant data of a particular variable will be shown. The statistical software R will be used to make the collected data more transparent (Androniceanu, 2021). This step is preceded by data cleansing and also their quality control. Subsequently, the data will be implemented by means of graphical representations, which will be available in the Results section and enable the formulating of a conclusion based on the results obtained.

The SARIMA model will be applied to forecast inflation and average monthly income increased by average income. The seasonal modification of the SARIMA model, as proposed by Clarke and Clarke (2018), will be expressed using the following formula:

$$\overline{\phi_p(B)\Phi_p(B^s)(1-B)^d(1-B^s)^D Y_t = \theta_q(B)\Theta_q(B^s)\varepsilon_t.}$$

The establishment of the model will be carried out in the statistical software R. Using data with quarterly frequency in the specified period, the forecast of the variables under study for the period of 2022 will be completed. Here, the purpose is to find out what the economic situation in 2022 might look like. Based on the observance of the previous period's trends and without the influence of the emergency situation, which was the Russian invasion of Ukraine, the second research question (RQ2) will be answered.

Moreover, in order to deepen the RQ2, an inflation-adjusted discounting of the price level for the years 2021 and 2022 will be performed. An inflation rate for each month of a particular year will be identified and then the numerical figure of this indicator will be removed from the nominal value of the price level. Also, the NPV method will be used to take into account the real value of money for 2021 and 2022, and the results will then be compared with each other. This method will be displayed with the use of a month-on-month inflation index considering the monthly price level always in relation to the previous month. Using the real discount factor in monetary terms of CZK 1 000, calculations will be made in the statistical software R in order to determine the impact of the aforementioned invasion on the inflation-adjusted price level development. The final step will be to compare the results of the real discount factor. The calculation formula will be as follows:

$$RPH = \frac{PH}{(1+i)^n}$$

where:

PH is the nominal value of the price level;

i is the inflation rate;

RPH is the inflation-adjusted price (i.e. the price level adjusted for inflation).

In the third stage, there will be a comparison of the forecast and real inflation and monthly income increased by average income for the year 2022. The comparison will be made in the statistical software R, into which the data related to the period under review will be installed.

In the final stage of solving the research problem, the SARIMA model will be applied. This will answer the fourth research question, i.e. forecasting future development of real household income in the Czech Republic until 2025.

Depending on the methods and data sources, research outputs will take the form of graphs and figures. The anticipated results should show how inflation developed over time. What could be the development of the selected variables in response to the invasion. What are the forecast deviations, real inflation, and gross household income in 2022. The real income development in the Czech Republic until 2025 should then be presented in the final part.

3. Results

Development of inflation and gross household income in the Czech Republic before the RF invasion.

During the period under review, the observed variables went through different stages, which is evidenced by the baseline result in the following graphs:

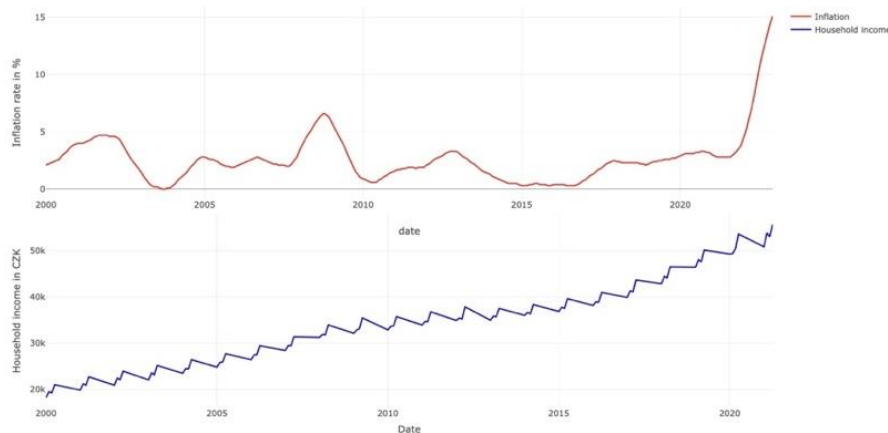


Figure 1. Development of inflation and gross monthly household income (ČSÚ, 2022)

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2022)

The above Figure 1 shows the development of inflation and gross household income from 2000 to 2022. When considering the first (top) curve related to inflation, it can be stated that the crises that hit the Czech economy have left their mark on the development of the given variable. Inflation was relatively high at the beginning of the year 2000, inflationary pressures gradually decreased, and from 2004 inflation stabilised at relatively low rates. Between 2004 and 2008, inflation in the Czech Republic was relatively stable and hovered mainly around 2-3%. In 2008, however, inflation increased significantly due to rising oil and food prices in world markets. This increase was temporary, and inflationary pressures eased in 2009. Then, inflation gradually increased from 2013 to 2017, reaching around 2%. The 2017 – 2021 period is noteworthy since the variable showed a largely stable trend. Subsequently, in 2021 and 2022, there was a significant increase in inflation due to the Covid-19 pandemic, disruption of foreign trade and, last but not least, the impact of the RF invasion of Ukraine.

The second (bottom) curve indicates a certain stability and consistency in the development of the other variable. Despite occasional fluctuations, it can return to its normal trends in a shorter time horizon.

Forecast of inflation and gross household income in the Czech Republic for the year 2022 based on historical data.

The inflation forecast is made using the SARIMA model in the statistical software R. The answer to the second research question can be found in the following graph, where the forecast development of the inflation variable for 2022 can be observed:

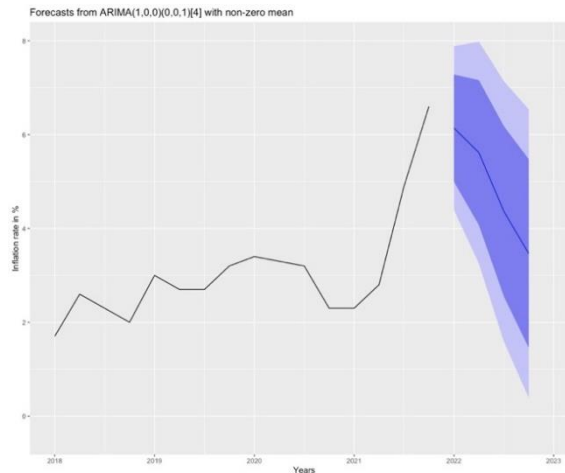


Figure 2. Forecast of inflation for the year 2022

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

The above graph in Figure 2 can be divided into two parts. The first part depicts the quarterly development of inflation from 2018 to 2021. Based on publicly available information, the following trends in the development of the variable can be established. In 2018, there was a fluctuating trend ranging from 1.70% to 2.60%. 2019 inflation started at 2.0% and gradually increased to 3.4%. In 2020, inflation was impacted by the COVID-19 pandemic due to reduced demand, reduced energy costs and other factors, and by the end of that year, the variable reached its minimum (2.30%). Then, there was an upward trend, significantly increasing to 6.6%.

The second part includes inflation forecasts for 2022. The projected trend in the first quarter of 2022 is expected to be 6.14%, whilst a decrease to 5.60% is expected in the second quarter of 2022. In the third quarter of 2022, inflation is expected to further fall to 4.40%. In the fourth quarter of 2022, it is expected to fall again (3.50%).

The specific forecasts of inflation development depend on the input data used to train the forecast model, and the resulting model's specification. For clarity, Table 1 with point forecasts is available in the list of appendices. In order to ensure the statistical significance of the forecasting, p-values of the inflation forecast for 2022 are provided in the following part.

z test of coefficients:

	Estimate	Std. Error	z value	Pr(> z)
ar1	0.912067	0.049391	18.4662	< 2.2e-16 ***
sma1	-0.477338	0.102407	-4.6612	3.144e-06 ***
intercept	2.663529	0.546074	4.8776	1.074e-06 ***

Signif. codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.' 0.1 ' ' 1

Figure 3. P-values of inflation

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

In order to meet the second research objective, differences are first identified in the real value of money between 2022 and the previous year. From the discounting output performed in the statistical software R, it is found that the sample amount lost CZK 61.78 in 2021 due to inflation. Moreover, in the period when Russia launched its invasion of Ukraine, the results show an almost two-fold change. The price level decline in the Czech Republic is

CZK 136.75 lower given the sample value of CZK 1 000. As opposed to the year 2021, the difference is CZK 75.025 in monetary terms.

The following part involves forecasting of the variable of gross monthly income increased by average income for the year 2022.

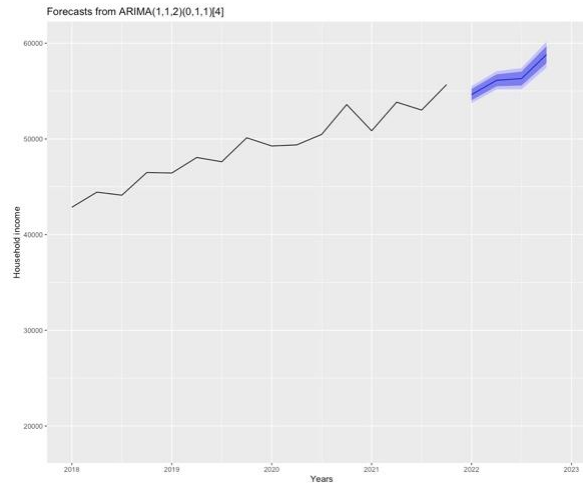


Figure 4. Forecast of monthly income for the year 2022

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

The above graph in Figure 4 of the quarterly development of monthly income from 2018 to 2021 can be divided into two parts. A gradual increase in the income was observed in 2018 and 2019. However, in 2020 and 2021, there was a decrease due to the COVID-19 pandemic. Then, it can be seen on the basis of the available information that the income gradually recovered and started to increase again towards the end of 2021.

The forecasts indicate a gradual increase in monthly income over the period under review. In the first quarter of 2022, the income is projected to reach 54 633. In the second quarter of that year, a slight increase in the income is expected, eventually amounting to 56 127. During the third quarter, further moderate growth is projected to reach 56 308, and the last quarter is characterised by an increase in income to 58 814.

For clarity, Table 2 with point forecasts is available in the list of appendices. Thus, given its input parameters, the resulting forecast of the variable of gross monthly income increased by average income is completed for the year 2022. However, in order to ensure the statistical significance of the forecasting, p-values are provided in the following part.

	Estimate	Std. Error	z value	Pr(> z)	
ar1	0.858483	0.078053	10.9987	< 2.2e-16 ***	
ma1	-1.494075	0.109896	-13.5953	< 2.2e-16 ***	
ma2	0.828968	0.129165	6.4179	1.382e-10 ***	
sma1	-0.925538	0.153999	-6.0100	1.855e-09 ***	

Signif. codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' ' 1

Figure 5. P-values of monthly income

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

Deviation of forecast and real inflation and gross household income in the year 2022.

Inflation rate in %		
Date	Real	Prediction
I-22	12,70	6,14
II-22	17,20	5,60
III-22	18,00	4,40
IV-22	15,80	3,50

Figure 6. Real and forecast inflation

Source: Own processing based on data from the Czech Statistical Office (2000–2021)

As regards the above data in Figure 6, several differences between the real and forecast inflation can be observed. In the first quarter, there is a statistically significant difference between the real rate (12.70%) and the forecast rate (6.14%). This difference suggests that the inflation rate exceeded expectations in the given period. In the second quarter, there is an even more pronounced difference between the real rate (17.20%) and the forecast rate (5.60%). This deviation indicates that the inflation rate was above expectations as well as being significantly higher. The third quarter is also characterised by a difference between the real (18.00%) and the forecast (4.40%) inflation. As in the previous case, the real inflation rate exceeded expectations. In the final quarter, the difference between the real (15.80%) and forecast (3.50%) rates is not as significant as in the previous quarters.

Household income in CZK		
Date	Real	Prediction
I-22	54228,00	54633,00
II-22	57392,00	56127,00
III-22	57913,00	56308,00
IV-22	61473,00	58814,00

Figure 7. Real and forecast monthly income

Source: Own processing based on data from the Czech Statistical Office (2000–2021)

The above comparison of the baseline data in Figure 7 shows several trends in the relationship between the real and forecast monthly income. In the first quarter, the real income (54 228) was slightly lower than the forecast income (54 633), with the difference between them being relatively small. This suggests that the income forecast was generally accurate, although the reality differed slightly from expectations. The second quarter saw an increase in the real income (57 392) compared to the forecast income (56 127). This difference indicates that the income was actually higher than originally expected. The third quarter again showed an increase in the real income (57 913) as opposed to the forecast income (56 308). This difference indicates that the income was again higher than expected. The fourth quarter again sees an increase in the real income (61 473) compared to the forecast income (58 814).

Development of real household income in the Czech Republic to the year 2025.

When considering the real household income as such, Figure 8 below illustrates forecasting of its future development in the Czech Republic until 2025. The forecasting is made with the use of a modified SARIMA model with quarterly data.

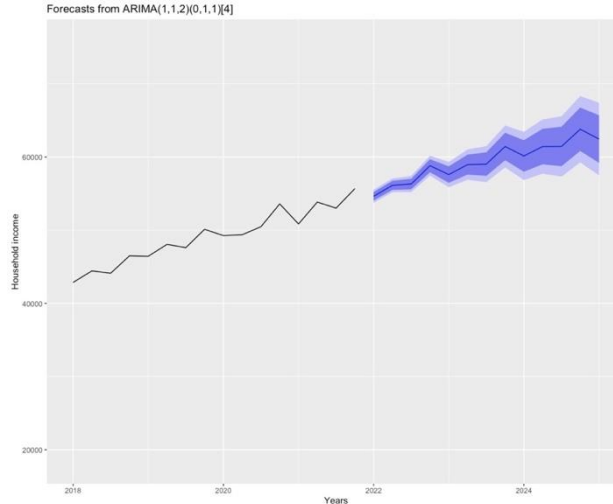


Figure 8. Forecast of real household income in the Czech Republic until 2025

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2022)

On the basis of the forecasting by the selected model, a slight increase in real household income in the Czech Republic is observed from 2022 onwards. The income rises during 2023, but falls towards the end of that year. A favourable development is expected during 2024, suggesting a gradual improvement in economic conditions. Then, the income is forecast to reach its peak in 2025, but is expected to decline again towards the end of the forecast period. The baseline forecast indicates that real household income has a trend of fluctuation and moderate variability.

Discussion

Based on the results achieved, all four research questions (RQ1, RQ2, RQ3, RQ4) can be answered.

RQ1: What was the development of inflation and gross household income in the Czech Republic before the RF invasion?

In the context of monitoring variables in the Czech Republic before the invasion by the Russian Federation, different development stages can be identified. Overall, it can be concluded that the development of inflation in the Czech Republic was characterised by considerable fluctuations, including periods of low and high inflation. The resulting instability reflects the impact on the internal factors of the Czech economy and the global economy.

The other variable under study, i.e., gross monthly household income, is characterised by a certain stability and consistency. Despite occasional fluctuations, the variable is able to return to its normal trends in the short term. This implies that household incomes maintained a particular degree of stability and were able to recover from occasional adverse fluctuations. This income stability is significant as it affects the living standards of the population and their consumption behaviour.

Determining the current and future state of the business cycle is a timely and extensive topic, as argued by Vochozka et al. (2020). Taking account of the development of both variables was a beneficial step towards a comprehensive grasp of the development of inflation and monthly household income.

RQ2: What is the forecast for inflation and gross household income in the Czech Republic for the year 2022 based on historical data?

Based on the historical data analysis, forecasts of inflation and gross household income in the Czech Republic for the year 2022 were made. The results of the selected SARIMA model were relatively accurate and, importantly, statistically relevant as well. The forecasts of the development of inflation and gross monthly income for 2022 outlined what the economic situation might look like if the trend of the previous periods was to be maintained. Applying the SARIMA model allowed to obtain relevant forecast results despite the dynamic and unexpected final figures. The results were comparable to the study by Shahriar et al. (2021), where the model's ability to handle a larger data range and determined seasonality was demonstrated.

In order to provide a comprehensive overview of the impact of emergency situations, the financial circumstances of households were taken into account. The assertion made by Osicka and Cernoch (2022) that the prevailing economic instability has been experienced by every citizen was confirmed in the results of the obtained real value of the price level. It turned out that during the period when the Russian Federation attacked Ukraine, there was a significant change in the price level compared to the previous period.

RQ3: What will be the deviation of the forecast and real inflation and gross household income in the year 2022?

In relation to answering the third research question, data from the previous research question were used. On the basis of the previous analysis, possible future inflation and gross household income were estimated for the "pre-war" year 2022. Comparing the real and forecast data confirmed that the Russian invasion of Ukraine (from 24 February 2022 onwards) has shown that the European financial system is vulnerable to external shocks, which can be easily observed in significant inflationary changes. The analysis of the real and forecast figures indicated that with regard to inflation, the real figures showed frequent deviations from those anticipated.

Considering the first quarter of gross monthly income, the real figures were lower than expected, whereas in other cases, they were higher.

RQ4: What will be the impact of identified economic consequences of the deviations on the development of real household income in the Czech Republic until the year 2025?

Using the selected SARIMA model, the development of real household income in the Czech Republic was found to be slightly fluctuating. The ability of the SARIMA model to handle a larger range of data and accurately determined seasonality, as claimed by Shahriar et al. (2021), was confirmed. The use of historical data, as in the study by Zhang et al. (2022), contributed to the careful analysis of the time series and the identification of potential fluctuations that may occur when modelling future estimates. Similar findings were also confirmed in the study by Liu et al. (2022), which focused on maintenance and safety. The SARIMA model proved to be a helpful tool for better forecasting of data with significant seasonality.

The identified economic consequences of the deviations resulted in the following development of real household income in the Czech Republic until 2025. The moderate growth of the income in 2022 suggests a certain stability. However, a decrease was expected towards the end of 2023, which could to some extent be due to changing economic conditions. The favourable development in 2024 indicated improving economic conditions, which could contribute to the real income growth. Towards the end of the forecast period in 2025, the income was expected to decrease again, which could signal volatility and uncertainty in the economy.

Conclusions

The objective of the research was to assess the extent to which the invasion of Ukraine by the Russian Federation has affected the real income of households in the Czech Republic. Regarding the information obtained, it can be concluded that the objective was met. The research fulfilled its objective and provided valuable insights into the relationship between the invasion of Ukraine by the Russian Federation and the aforementioned income in the Czech Republic.

Monitoring gross monthly household income in relation to inflation represents the development of key indicators of economic stability and living standards of the population in the Czech Republic. The analysis of the development of these variables in the period from 2000 to 2022 allows to identify long-term trends, cyclical fluctuations and possible deviations caused by economic events.

Modelling forecasts of inflation and gross household income for the pre-war year 2022 in the Czech Republic provides an opportunity to examine and analyse historical trends and new realities in turbulent economic conditions. The real inflation often deviated from the anticipated one, suggesting that it is a complex phenomenon. Accurate forecasting in a turbulent environment is challenging and difficult. In terms of gross monthly household income, it was important to regard household consumption behaviour. Although in this case the real income exceeded the forecast income, this situation could be seen as positive, but the significant and sharp rise in inflation must be taken into account. Given this inflationary growth, the slight increase in the monthly income cannot be considered positive.

The identified economic consequences of the deviations point to the importance of analysing external factors that may affect the development of real household income. Studying the variables of inflation and gross monthly household income brings a deeper understanding of the economic environment in the Czech Republic. These analyses provide valuable information for formulating policies related to social security and pension system.

When interpreting the above forecasts, it is important to bear in mind that the forecasting models were based on historical data and assume that the future will follow the same trends and patterns. Comparing the real figures with the forecast figures enabled us to assess not only the accuracy and reliability of the models used but also how crisis situations can affect the behaviour of economic indicators.

Due to the instability and rapidly changing nature of the issues under study, there are certain limitations and specified shortcomings within the presented framework. In order to further expand the research, combining the applied method with other analytical tools, such as neural networks is recommended. Moreover, it is advisable to include other relevant variables in the model. This would allow us to understand better and forecast the development of real household income in the context of current economic events.

References

- Al-Zoubi, H. A., O'Sullivan, J. A., & Alwathnani, A. M. (2018). Business Cycles, Financial Cycles and Capital Structure. *Annals of Finance*, 14(1), 105-123. <https://doi.org/10.1007/s10436-017-0306-z>
- Ali, M., Alam, N., & Rizvi, S. A. R. (2020). Coronavirus (COVID-19) - An Epidemic or Pandemic for Financial Markets. *Journal of Behavioral and Experimental Finance*, 27, 100341. <https://doi.org/10.1016/j.jbef.2020.100341>
- Aliu, F., Hašková, S., & Bajra, U. Q. (2022). Consequences of Russian invasion on Ukraine: evidence from foreign exchange rates. *The Journal of Risk Finance*, 40–58. <https://doi.org/10.1108/JRF-05-2022-0127>
- Androniceanu, A. (2023). The new trends of digital transformation and artificial intelligence in public administration. *Administratie si Management Public*, 40, 147-155. <https://doi.org/10.24818/amp/2023.40-09>
- Androniceanu, A., & Georgescu, I. (2023a). Public administration digitalisation and government effectiveness in EU countries. *Central European Public Administration Review*, 21(1), 7-30. <https://doi.org/10.17573/cepar.2023.1.01>

- Androniceanu, A., & Georgescu, I. (2023b). The impact of CO2 emissions and energy consumption on economic growth: a panel data analysis. *Energies*, 16(3), 1342; <https://doi.org/10.3390/en16031342>
- Androniceanu, A., & Sabie, O.M. (2022). Overview of green energy as a real strategic option for sustainable development. *Energies*, 15(22), 8573. <https://doi.org/10.3390/en15228573>
- Androniceanu, A. (2021). Transparency in public administration as a challenge for a good democratic governance. *Administratie si Management Public*, 36, 149-164. <https://doi.org/10.24818/amp/2021.36-09>
- Arjunan, K. (2022). A New Method to Estimate NPV and IRR from the Capital Amortization Schedule and the Advantages of the New Method. *Australasian Accounting Business and Finance Journal*, 16(6), 23-44.
- Arner, D. W., Aygouleas, E., & Gibson, E. C. (n.d.). COVID-19, Macroeconomic and Sustainability Shocks, Moral Hazard and Resolution of Systemic Banking Crises: Designing Appropriate Systems of Public Support. *European Business Organization Law Review*. <https://doi.org/10.1007/s40804-022-00255-1>
- Ashta, A. (2021). Towards a New Form of Undemocratic Capitalism: Introducing Macro-Equity to Finance Development Post COVID-19 Crisis. *Journal of Risk and Financial Management*, 14(3), 116. <https://doi.org/10.3390/jrfm14030116>
- Astrov, V., Ghodsi, M., Grieveson, R., Holzner, M., Kochnev, A., Landesmann, M., Pindyuk, O., Stehrer, R., Tverdostup, M., & Bykova, A. (2022). Russia's Invasion of Ukraine: Assessment of the Humanitarian, Economic, and Financial Impact in the Short and Medium Term. *International Economics and Economic Policy*, 19(2), 331-381. <https://doi.org/10.1007/s10368-022-00546-5>
- Babecky, J., Franta, M., & Rysanek, J. (2018). Fiscal Policy within the DSGE-VAR Framework. *Economic Modelling*, 75, 23-37. <https://doi.org/10.1016/j.econmod.2018.06.005>
- Battiston, S., Farmer, J. D., Flache, A., Garlaschelli, D., Haldane, A. G., Heesterbeek, H., Hommes, C., Jaeger, C., May, R., & Scheffer, M. (2016). COMPLEX SYSTEMS Complexity Theory and Financial Regulation. *Science*, 351(6275), 818-819. <https://doi.org/10.1126/science.aad0299>
- Belas, J., Strnad, Z., Gavurova, B., Cepel, M. (2019). Business environment quality factors research – SME management's platform. *Polish Journal of Management Studies*, 20(1), 64-77. <https://doi.org/10.17512/pjms.2019.20.1.06>
- Bloom, N. (2014). Fluctuations in Uncertainty. *Journal of Economic Perspectives*, 28(2), 153-175. <https://doi.org/10.1257/jep.28.2.153>
- Boyer, R. (2018). Marx's Legacy, Regulation Theory and Contemporary Capitalism. *Review of Political Economy*, 30(3), 284-316. <https://doi.org/10.1080/09538259.2018.1449480>
- Braunerhjelm, P. (2022). Rethinking Stabilization Policies; Including Supply-Side Measures and Entrepreneurial Processes. *Small Business Economics*, 58(2), 963-983. <https://doi.org/10.1007/s11187-021-00520-6>
- Cavallari, L. (2022). The International Real Business Cycle When Demand Matters. *Journal of Macroeconomics*, 73, 103445. <https://doi.org/10.1016/j.jmacro.2022.103445>
- Čermáková, K., Hromada, E., & Machová, V. (2022). Comparison of Property Price Development in Regions Affected by Mining with Other Regions of the CR. *Acta Montanistica Slovaca*, 27(2), 491-504. <https://doi.org/10.46544/AMS.v27i2.16>
- Della Posta, P., & Morroni, M. (2022). The Credibility of Monetary Policy and the Fiscal Response to the Pandemic in the Eurozone. *Evolutionary and Institutional Economics Review*, 19(1), 77-96. <https://doi.org/10.1007/s40844-021-00226-0>
- Demchenko, I., & Iatsukh, O. (2018). The Problem of Unprofitable Activity of Enterprises in Ukraine. *Baltic Journal of Economic Studies*, 4(2), 64-69. <https://doi.org/10.30525/2256-0742/2018-4-2-64-69>
- Egrioglu, E., Bas, E., Cansu, T., & Kara, M. A. (n.d.). A New Nonlinear Causality Test Based on Single Multiplicative Neuron Model Artificial Neural Network: A Case Study for Turkey. *Neural Computing and Applications*. <https://doi.org/10.1007/s00521-023-06679-6>
- James, N., Menzies, M., & Chin, K. (2022). Economic State Classification and Portfolio Optimisation with Application to Stagflationary Environments. *Chaos, Solitons & Fractals*, 164, 112664. <https://doi.org/10.1016/j.chaos.2022.112664>

- Ferrández Serrano, V., & Angosto-Fernández, P. L. (2022). A Russian Carol: Impact and Dependence on Global Equity Markets during the Ukraine Invasion. *Journal of Economic Studies*. <https://doi.org/10.1108/JES-06-2022-0364>
- Gavurova, B., Belas, J., Bilan, Y., & Horak, J. (2020). Study of legislative and administrative obstacles to SMEs business in the Czech Republic and Slovakia. *Oeconomia Copernicana*, 11(4), 689-719. <https://doi.org/10.24136/oc.2020.028>
- Gavurova, B., Soltes, M., & Kovac, V. (2017). Application of cluster analysis in process of competitiveness modelling of Slovak Republic regions. *Transformations in Business & Economics*, 16(3).
- Gavurova, B., Schonfeld, J., Bilan, Y., & Dudas, T. (2022). Study of the Differences in the Perception of the Use of the Principles of Corporate Social Responsibility in Micro, Small and Medium-Sized Enterprises in the V4 Countries. *Journal of Competitiveness*, 14(2), 23-40. <https://doi.org/10.7441/joc.2022.02.02>
- Geltner, D., Kumar, A., & Van de Minne, A. M. (2023). Is There Super-Normal Profit in Real Estate Development? *Journal of Real Estate Research*. <https://doi.org/10.1080/08965803.2022.2069331>
- Godehot, O., Neumann, N., Apascariței, P., Boza, I., Hallsten, M., Henriksen, L., Hermansen, A., et al. (2022). Ups and Downs in Finance, Ups without Downs in Inequality. *Socio-Economic Review*. <https://doi.org/10.1093/ser/mwac036>
- Gresova, E., & Svetlik, J. (2021). Simulation Modeling of the Czech Republic Economy with Development Forecasting. *Mm Science Journal*, 2021, 4463-4467. https://doi.org/10.17973/MMSJ.2021_6_2021047
- Haq, M., Tripe, D., & Seth, R. (2022). Do Traditional Off-Balance Sheet Exposures Increase Bank Risk? *Journal of International Financial Markets, Institutions & Money*, 80, 101627. <https://doi.org/10.1016/j.intfin.2022.101627>
- Chin, K.-H. (2022). Inflation Persistence and Monetary Policy: DSGE-VAR Approach. *Manchester School*, 90(6), 715-729. <https://doi.org/10.1111/manc.12420>
- Irtysheva, I., Kramarenko, I., & Sirenko, I. (2022). The Economy of War and Postwar Economic Development: World and Ukrainian Realities. *Baltic Journal of Economic Studies*, 8(2), 78-82. <https://doi.org/10.30525/2256-0742/2022-8-2-78-82>
- Johannesson, J., & Clowes, D. (2022). Energy Resources and Markets - Perspectives on the Russia-Ukraine War. *European Review*, 30(1), 4-23. <https://doi.org/10.1017/S1062798720001040>
- Jondeau, E., & Rockinger, M. (2019). Predicting Long-Term Financial Returns: VAR versus DSGE Model - A Horse Race. *Journal of Money, Credit and Banking*, 51(8), 2239-2291. <https://doi.org/10.1111/jmcb.12586>
- Karel, T., & Hebak, P. (2018). Forecasting Czech GDP Using Bayesian Dynamic Model Averaging. *International Journal of Economic Sciences*, 7(1), 65-81. <https://doi.org/10.20472/ES.2018.7.1.004>
- Kocourek, A., Simanova, J., & Smida, J. (2016). Estimation of Regional Price Levels in the Districts of the Czech Republic. *Statistika-Statistics and Economy Journal*, 96(4), 56-70.
- Krkoskova, R. (2019). Modelling Macroeconomic Aggregates of the Czech and Slovak Economies Using VAR Models. *Politická Ekonomie*, 67(6), 593-610. <https://doi.org/10.18267/j.polek.1262>
- Liang, F., Zhang, H., & Fang, Y. (2022). The Analysis of Global RMB Exchange Rate Forecasting and Risk Early Warning Using ARIMA and CNN Model. *Journal of Organizational and End User Computing*, 34(8). <https://doi.org/10.4018/JOEUC.300762>
- Lichner, I., Lyocsa, S., & Vyrostova, E. (2022). Nominal and Discretionary Household Income Convergence: The Effect of a Crisis in a Small Open Economy. *Structural Change and Economic Dynamics*, 61, 18-31. <https://doi.org/10.1016/j.strueco.2022.02.004>
- iu, J., Zhao, Z., Zhong, Y., Zhao, C., & Zhang, G. (2022). Prediction of the Dissolved Gas Concentration in Power Transformer Oil Based on SARIMA Model. *Energy Reports*, 8, 1360-1367. <https://doi.org/10.1016/j.egy.2022.03.020>
- Lu, B., Yang, M., Cumming, R. G., & Stanaway, F. F. (2020). Falls and Impact on Disability and Healthy Life Expectancy in China: Evidence from the China Health and Retirement Longitudinal Survey (CHARLS). *China Economic Review*, 61, 101426. <https://doi.org/10.1016/j.chieco.2020.101426>

- Lytvynova, I., Ignatyuk, A., Knir, M., & Liubkina, O. (2022). The Impact of the War with Russia on the Export/Import of Ukraine and Possible Tools to Restore the Ukrainian Economy. *Amazonia Investiga*, 11(53), 16-25. <https://doi.org/10.34069/AI/2022.53.05.2>
- Martin-Rios, C., & Pasamar, S. (2018). Service Innovation in Times of Economic Crisis: The Strategic Adaptation Activities of the Top EU Service Firms. *R&D Management*, 48(2), 195-209. <https://doi.org/10.1111/radm.12276>
- Mauersberger, F., Nagel, R., & Buehren, C. (2020). Bounded Rationality in Keynesian Beauty Contests: A Lesson for Central Bankers? *Economics-The Open Access Open-Assessment E-Journal*, 14. <https://doi.org/10.5018/economics-ejournal.ja.2020-16>
- Moosa, I. A., & Merza, E. (2022). The Effect of COVID-19 on Foreign Direct Investment Inflows: Stylised Facts and Some Explanations. *Future Business Journal*, 8(1), 20. <https://doi.org/10.1186/s43093-022-00129-5>
- Musil, P., & Kramulova, J. (2019). Development of Regional Price Levels in the Czech Republic. In M. Boda, V. Mendelova, & M. Gausova (Eds.), *Proceedings of the 22nd International Scientific Conference on Applications of Mathematics and Statistics in Economics (Amse 2019)*. Paris: Atlantis Press, 30-38. <https://www.webofscience.com/wos/woscc/full-record/WOS:000558637800004>
- Osicka, J., & Cernoch, F. (2022). European Energy Politics after Ukraine: The Road Ahead. *Energy Research & Social Science*, 91, 102757. <https://doi.org/10.1016/j.erss.2022.102757>
- Radchenko, O., Tulush, L., & Leontovych, S. (2023). Financial instruments for ensuring national security: experience of Ukraine in military conditions. *Insights into Regional Development*, 5(1), 10-25. [https://doi.org/10.9770/IRD.2023.5.1\(1\)](https://doi.org/10.9770/IRD.2023.5.1(1))
- Santos, A. D., Silva, N. T., & Castela, G. (2019). A Costatis Approach to Business Sustainability in Turbulent Environments from 2008 to 2014. *International Journal for Quality Research*, 13(4), 887-900. <https://doi.org/10.24874/IJQR13.04-10>
- Shen, Y., Shi, X., & Padinjare Variam, H. M. (2018). Risk Transmission Mechanism between Energy Markets: A VAR for VaR Approach. *Energy Economics*, 75, 377-388. <https://doi.org/10.1016/j.eneco.2018.08.027>
- Shkurupii, O., Pedchenko, N., Shymanovska-Dianych, L., Yakhno, T., & Franko, L. (2021). Macroeconomic Effect of Corporate Social Responsibility: Ukraine's International Status. *Financial and Credit Activity-Problems of Theory and Practice*, 6(41), 318-328. <https://doi.org/10.18371/fcaptop.v6i41.251464>
- Soltes, V., & Gavurova, B. (2014). Innovation policy as the main accelerator of increasing the competitiveness of small and medium-sized enterprises in Slovakia. *International Conference on Emerging Markets Queries in Finance and Business*, Oct. 24-27, 2013. *Emerging Markets Queries in Finance and Business (EMQ 2013)*. Edited by: Stefan, D; Comes, CA; Munteanu, A; Nistor, P; Stefan, AB. *Procedia Economics and Finance*, 15, 1478-1485. [https://doi.org/10.1016/s2212-5671\(14\)00614-5](https://doi.org/10.1016/s2212-5671(14)00614-5)
- Soltes, V., & Gavurova, B. (2015). Modification of Performance Measurement System in the Intentions of Globalization Trends. *Polish Journal of Management Studies*, 11(2), 160-170.
- Teplova, T., & Ruzanov, D. P. (2019). One Approach for Backtesting VaR Specifications in the Russian Stock Market. *Inžinerinē Ekonomika-Engineering Economics*, 30(1), 32-40. <https://doi.org/10.5755/j01.ee.30.1.17795>
- Tevdovski, D., Petrevski, G., & Bogoev, J. (2019). The Effects of Macroeconomic Policies under Fixed Exchange Rates: A Bayesian VAR Analysis. *Economic Research-Ekonomska Istraživanja*, 32(1), 2138-2160. <https://doi.org/10.1080/1331677X.2019.1579661>
- Tran, N. V. (2022). Understanding Household Consumption Behaviour: What Do We Learn from a Developing Country? *B E Journal of Economic Analysis & Policy*, 22(4), 801-858. <https://doi.org/10.1515/bejeap-2022-0036>
- Vasile, V., Panait, M., & Apostu, S. A. (2021). Financial Inclusion Paradigm Shift in the Postpandemic Period. Digital-Divide and Gender Gap. *International Journal of Environmental Research and Public Health*, 18(20), 10938. <https://doi.org/10.3390/ijerph182010938>
- Vochozka, M., Horak, J., & Krulicky, T. (2020). Innovations in Management Forecast: Time Development of Stock Prices with Neural Networks. *Marketing and Management of Innovations*, 2, 324-339. <https://doi.org/10.21272/mmi.2020.2-24>
- Vrbka, J., Machova, V., & Turkova, M. (2018). Evaluation of the stock prices of a concrete company. In *9th International Scientific Conference "Company Diagnostics, Controlling and Logistic"*.
- Westerhout, E., Meijdam, L., Ponds, E., & Bonenkamp, J. (2022). Should We Revive PAYG? On the Optimal Pension System in View of Current Economic Trends. *European Economic Review*, 148, 104227. <https://doi.org/10.1016/j.euroecorev.2022.104227>

Zhang, X., Wu, X., Zhu, G., Lu, X., & Wang, K. (2022). A Seasonal ARIMA Model Based on the Gravitational Search Algorithm (GSA) for Runoff Prediction. *Water Supply*, 22(8), 6959-6977. <https://doi.org/10.2166/ws.2022.263>

Zubikova, A., & Smolak, P. (2022). Macroeconomic Impacts of the Covid-19 Pandemic in the Czech Republic in the Period of 2020-2021. *International Journal of Economic Sciences*, 11(1), 117-145. <https://doi.org/10.52950/ES.2022.11.1.008>

Author Contributions: The authors contributed equally; they have read and agreed to the published version of the manuscript.

Marek VOCHOZKA is a senior researcher and professor of Research department of economics and natural resources management at Institute of Technology and Business in České Budějovice and professor of DTI University. He is interested in business economics, corporate finance, theory of production factors and capital and financial markets.

ORCID ID: <https://orcid.org/0000-0001-9923-7814>

Stanislav SKAPA is a member of the Scientific Board and professor at the Faculty of Business and Management at the Brno University of Technology. He is interested in business economics, environmental sciences, the mathematical aspects of engineering, relationship between economics and ecological aspects of the economy.

ORCID ID: <https://orcid.org/0000-0002-9681-0061>

Yelyzaveta APANOVYCH is a junior researcher at Research department of economics and natural resources management at Institute of Technology and Business in České Budějovice. She is interested in business economics and corporate finance.

ORCID ID: <https://orcid.org/0000-0001-5921-9793>

Copyright © 2023 by author(s) and VSI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>

