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THE EFFECTS OF MONETARY POLICY SHOCK: EVIDENCE FROM SYSTEMICALLY IMPORTANT ECONOMIES

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ABSTRACT

In the paper, we explore the effects of monetary policy shock on the economic growth in systemically important countries such as the US, the Euro Area and China and their impact on Ukraine. Thus, the war in Ukraine and the rise of key policy rates by central banks to curb inflation have had a significant negative impact on economic activity. There has been both a significant decrease in trade activity and a slowdown in the services sector growth, which was the main engine of global economic growth at the beginning of 2023. Based on the vector autoregression model results, we demonstrated a slight initial decline of GDP growth with following stabilization in response to the rise of key policy rates in the US. In China, this decline is much bigger and constitutes 11% after the shock. In the Euro Area, we also observe a similar pattern as in the US with an initial decline up to 2% and a further return to equilibrium. Analyzing the results of the forecast error variance decomposition, we should note that GDP fluctuations in systemically significant economies are mainly explained by their own fluctuations. The key policy rate's contribution ranges from 1% in the US to 11% in China. At the same time, economic growth in China is less vulnerable to inflation fluctuations, in the Eurozone we observe the most sustained one among the considered economies. In addition, the study shows that the key policy rate in the United States has a positive effect on the one in Ukraine.

Keywords: monetary policy, monetary policy shock, economic growth, key policy rate, cross-country income differences, war in Ukraine, VAR model

JEL Classification: E47, E52, C54

INTRODUCTION

Nowadays monetary policy is considered to be one of the crucial elements of the economic policy to influence any economy. The primary goals of monetary policy typically include targeting inflation, maintaining price stability, and supporting economic growth and employment. Nevertheless, in the modern economy, the main monetary policy goal should be price stability which includes keeping up the low and stable inflation rate (Nocoń, 2023). For these purposes, central banks use various tools among which are interest rates, open market operations, reserve requirements, and forward guidance. However, the effectiveness of monetary policy can be various depending on economic conditions, global factors, and other policies, such as fiscal policy. Furthermore, excessive use of its instruments could provoke negative consequences for the economy.

Due to the financial crisis, pandemic and war in Ukraine there have been economic changes caused by such factors as geopolitical developments, trade disruptions, energy markets, global economic sentiment, etc. The central banks have faced enormous challenges, that is why monetary policy has altered significantly. For instance, the degree of the economic decline, market volatility and uncertainty regarding the pandemic's influence caused "a central bank reaction that was unprecedented in terms of its speed, scope, and size" (English etc., 2021) as short-term interest rates fell rapidly in both advanced economies and emerging markets reaching almost zero levels (English et al., 2021). Such changes in systemically important economies significantly influenced the global economy (Bazhenova, 2015).

The purpose of this article is to shed light on the impact of monetary policy shock on economic growth for such systemically important economies as the US, the Euro Area and China.

The paper is structured as follows. The introduction covers the topicality of the research. In the Literature Review chapter, we present a short overview of the literature on the empirical studies of the effects of monetary policy on economic growth that helps to outline a methodological foundation for our study. The goals of the study constitute the Aims and Objectives chapter. The methods chapter describes the methodology used by the authors. In the Results chapter we outline the theoretical foundations and some analytics on the monetary policy effects on the real economy as well as information on construction, estimation and results of models to define the effects of monetary policy. The discussion chapter highlights the main results of the study. Finally, the Conclusions chapter incorporates some conclusions remarks and directions for further research.

LITERATURE REVIEW

Empirical studies and econometric models play a crucial role in understanding the effects of monetary policy. These studies often aim to estimate the impact of monetary policy actions on various economic variables, evaluate policy rules, and provide insights into the functioning of the economy. In other words, monetary policy modelling involves creating frameworks or models to understand how changes in interest rates, money supply, and other central bank tools impact the economy.

There are various approaches and models used by economists and policymakers to simulate, evaluate, and predict the effects of monetary policy decisions. However, most empirical studies of monetary policy employ such instruments as vector autoregression (VAR) models and DSGE (dynamic stochastic general equilibrium) models.

Vector autoregression (VAR) models and their modifications are widely used in empirical studies to examine the effects of monetary policy shocks. They do not rely on explicit economic theory but rather capture the statistical relationships and dynamic responses of variables to shocks, including monetary policy changes. In other words, they analyze the joint dynamics of multiple time series variables, such as output, inflation, interest rates, money supply, etc. Structural VARs (SVARs) help to identify and interpret the structural nature of these shocks. For example, Ramaswamy and Sloek (Ramaswamy and Sloek, 1997) constructed a vector autoregression (VAR) model (includes such variables as output level, price level, and short-term interest rate) to find the quantitative difference in the impact of monetary policy on the economies of the EU. Carlino and DeFina (Carlino and DeFina, 1998) used a structural VAR model to examine reasons for the different impacts of monetary policy on regions in the United States. The model included such indicators as the growth rate of real money income, relative energy prices, and monetary factors. The impulse response functions showed that most regions have a response to monetary policy shocks that is close to the US average. Svensson (Svensson, 2012) examined the impact of monetary policy on employment in 21 Swedish regions using a structural VAR model with exogenous external variables. To check the monetary policy effect on macroeconomic and labour market indicators in the US Evgenidis and Fasianos (Evgenidis and Fasianos, 2023) applied the Bayesian vector autoregression (BVAR) model concluding that expansionary monetary policy has long-run effects on labour market variables under Covid-19 conditions. In the paper (Lastauskas and Nguyen, 2023) authors modelled the global impacts of the volatility of the US monetary policy shocks by employing a global vector autoregressive (GVAR) model with time-varying variances of local structural shocks. The results of this study proved that shocks spill over to other economies they are connected with. Thus, the uncertainty in the US interest rate leads to decreases in output, inflation, and the interest rate in other countries connected with the US. Similar research (Chen et al., 2023) showed the spillover effects of China's monetary policy shocks in 26 countries along the Belt and Road (B&R) using the large BVAR model with sign restrictions. Based on the research, authors came to the conclusion that monetary tightening in China provokes an increase in the short-term interest rate spread, a decrease of the equity price, nominal and real depreciations of local currencies against the RMB, and an improvement in the trade balance in the 26 countries along the B&R. Also, a time-varying parameter vector autoregression (TVP-VAR) model has been used to explore the China's monetary policy impact on financial stability (Wang et al., 2022) allowing to demonstrate that after crisis quantitative monetary policy is the most efficient toolkit to support financial stability in the short run in China. Kavanagh (Kavanagh et al., 2022) also uses TVP-VAR to model the impacts of monetary policy on inflation and economic growth as well as the trade-offs between inflation and economic growth of the Bank of England and the monetary policy transmission in the UK.

Studies using panel data techniques analyze data across multiple entities (such as countries or regions) over time. These approaches allow to investigate the heterogeneity across different economies in response to monetary policy. For example, Bayesian panel VAR models are used to estimate the responses of monetary policy to supply shocks in emerging economies

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(Ocampo and Ojeda-Joya, 2022). Also, a panel VAR model has been applied to examine the impact of monetary policy shocks on indicators of bubbles in the stock markets in G7 countries (Caraiani et al., 2023). The results of the study proved that in G7 countries monetary policy both impacts the bubble indicators and responds to them.

Moreover, various time-series econometric techniques, such as co-integration analysis, Granger causality tests, and impulse response functions, are used to understand the relationships between different economic variables and their responses to monetary policy shocks. For instance, in the paper (Golpe, Sánchez-Fuentes, and Vides, 2023) to investigate the ultimate causal flows between monetary policy indicators, fiscal sustainability and economic growth and finally to determine «causality path» multivariate Granger causality has been used suggesting that monetary policy variables have a crucial role for the economic system.

Dynamic Stochastic General Equilibrium (DSGE) models provide a theoretical framework for analyzing the effects of monetary policy. These models are based on microeconomic principles and aim to capture the interactions of various economic agents (households, firms, government etc.) over time incorporating stochastic elements to account for uncertainty in the economy. A number of DSGE models are "a variant of the benchmark medium-scale New Keynesian DSGE model" (Hirakata et al., 2019). For instance, DSGE models have been used to study the impact of monetary policy effects during the COVID-19 pandemic. For this purpose, Melina and Villa (Melina and Villa, 2023) constructed the DSGE model for the Euro Area and the US and concluded that monetary policy shocks positively affect output and inflation during and after the COVID-19 crisis. DSGE model used has incorporated such agents as households, labour unions, retailers, final and intermediate good firms, capital producers, financial intermediaries, the policymaker, etc. The results of the research by Brzoza-Brzezina and others (Brzoza-Brzezina et al., 2022) using the DSGE framework demonstrated the role of monetary policy in the trade-off between stabilization of the economy and containing the pandemic. It was proved that in the absence of any restrictions monetary policy should be contractionary. Otherwise, in the case of restrictions' introduction, it should be expansionary to stabilize the economy. Furthermore, we would like to emphasize that many of the studies devoted to the monetary policy effects employ the New Keynesian framework (an introduction to this framework and its application to monetary policy was provided by Galí (Galí, 2015)). For instance, the study of monetary policy's transmission mechanism with the help of the New Keynesian model's modifications in (Xin Xu, Xiaoguang Xu, 2023) demonstrated the dependence of exogenous shocks' transmission on the agents' behaviour and macroeconomic indicators. A simple New Keynesian model with the assumption of the Taylor rule with error applied by the central bank is used in (Bachmann et al., 2022). Calstrom (Calstrom et al., 2015) simulated the effect of interest rates on outcomes based on the Dynamic New Keynesian model. Lepetit and Fuentes-Albero (Lepetit and Fuentes-Albero, 2022) used a New Keynesian model to analyze the impact of monetary policy during a pandemic and demonstrated that accommodative monetary policy leads to large increases in inflation while having small effects on real economic activity.

Eventually, central banks widely use the Quarterly Projection Model (QPM) which is considered to be a semi-structural, New-Keynesian model. It represents «a reduced-form representation of structural DSGE models, expanded with data-driven extensions», and is used, for example, by the National Bank of Ukraine (Grui and Vdovychenko, 2019), Czech National Bank (Beneš et al., 2003), for India (Beneš et al., 2017), and Japan (Hirakata et al., 2019). The last modification of the Bank of Japan's large-scale macroeconomic model (the Quarterly Japanese Economic Model), for instance, is used in (Kawamoto et al., 2023) to find the macroeconomic effects of the Bank of Japan's expansionary monetary policies since the introduction of Quantitative and Qualitative Monetary Easing.

These models and techniques are employed to estimate the effects of monetary policy actions on key macroeconomic variables like output, inflation, interest rates, and asset prices. They help policymakers and researchers assess the consequences of different policy strategies, understand the transmission mechanisms, and guide decision-making.

To sum up, each model has its strengths and limitations, and policymakers often use a combination of models to gain a comprehensive understanding of how different policies might affect the economy. The choice of the model often depends on the specific research issue, data availability, and the preferences of policymakers or researchers.

In this study, we propose to assess the impact of monetary policy shock on economic growth in systemically important economies by employing the vector autoregression model's toolkit and computing both impulse response functions with the confidence intervals and forecast error variance decomposition for gross domestic products of these economies.

AIMS AND OBJECTIVES

The aim of the study is to examine the impact of monetary policy shocks on economic growth in systemically important economies and explore their influence on Ukraine's policy rate. Besides this, we have shaped the following specific objectives:

1. A brief review of macroeconomic tendencies worldwide after the beginning of the war in Ukraine, peculiarities of monetary policy transmission mechanisms and authorities' responses.
2. An empirical investigation of the key policy rate influence on the economic growth rates in such systemically important economies as the US, the Euro Area and China.
3. An empirical exploration of the interplay of key policy rates in Ukraine and in the systemically important economies.

METHODS

To achieve the study's aim and objectives mentioned, we have employed such methods:

- to examine the effect of monetary policy shock on economic growth in systemically important economies we constructed three vector autoregression models for the US, the Euro Area and China;
- to explore the dependence of key policy rates in Ukraine on the dynamics of ones in systemically important economies we have also employed a vector autoregression model toolkit;
- to determine the responses of economic growth in the US, the Euro Area and China to shocks in key policy rates the impulse response functions have been used;
- forecast error variance decomposition has allowed to demonstrate how much information each variable in the vector autoregression models contributes to the economic growth in systemically important economies.

The data analysis and all simulations have been performed by using a cross-platform software package for econometric analysis Gretl 2022b.

RESULTS

Backgrounds

Since the beginning of the war, the Ukrainian economy has lost about 30-50% of its production capacity, which was located in eastern Ukraine. Not only large factories and plants were destroyed, but also the entire urban infrastructure that ensures the livelihood of the cities. Moreover, the war in Ukraine has affected the global economy, especially the European one as most countries in Europe depending on russian energy resources refused to use them which has greatly impacted their economies. In Ukraine the losses of the economy are really shocking – for instance, in 2022 we had almost a 30% decline of GDP (Figure 1).

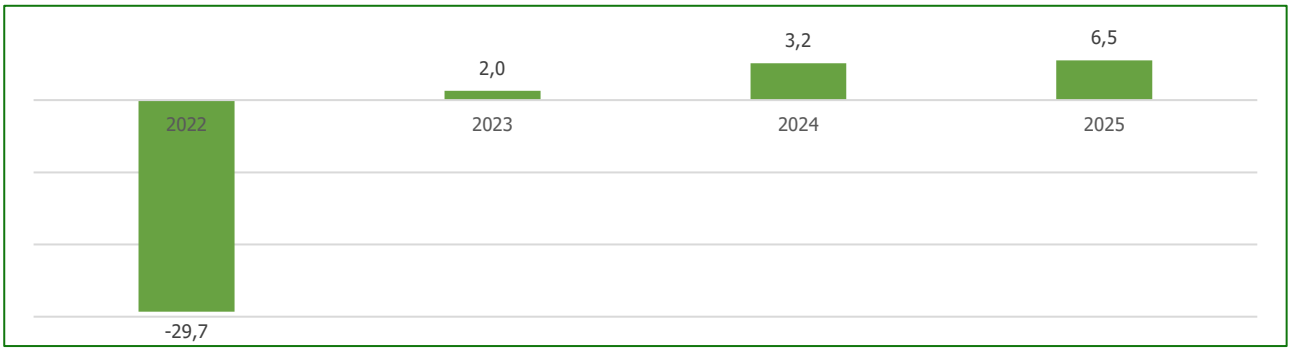

Figure 1. Dynamics of GDP growth in Ukraine for 2022-2025, percent change. Note: estimates for 2023-2025. *(Source: International Monetary Fund (IMF, 2023))*

Thus, the war in Ukraine and the rise of key policy rates by central banks to curb inflation have had a significant negative impact on economic activity. There has been both a significant decrease in trade activity and a slowdown in the services sector growth, which was the main engine of global economic growth at the beginning of 2023.

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Sanctions introduced by the majority of European countries and the US with the aim of curbing the financing of russia's military aggression also had a negative impact on the economic growth of the EU countries mainly due to their significant dependence on russian energy supplies.

At the same time, Asian countries, most of which ignored the introduction of sanctions against the aggressor country and continued to purchase russian oil and gas at prices significantly lower than market ones, have remained the key driver of economic growth worldwide. In addition, higher growth rates were supported by higher private demand and softer monetary conditions in service-oriented economies. In particular, according to the IMF forecast (IMF, 2023), economic growth in India in 2023 at the level of 6.3% is one of the largest in the world. So, in particular, in China and Turkey, growth rates in 2023 are forecasted at the levels of 5% and 4%, respectively. In 2024, the IMF predicts (IMF, 2023) an economic slowdown of 4.2% and 3%, respectively, due to the introduction of tighter monetary conditions, which will negatively affect demand that is sensitive to these interest rates.

Moreover, in 2023 the IMF predicts (IMF, 2023) a slowdown in the economic growth of Ukraine's MTPs. These growth rates are going to be the following: Germany (-0.5%), Poland (0.6%), and Romania (2.2%). However, in 2024, the revitalization of these economies is predicted due to the weakening of inflationary pressure, provided that the stability of the labour market is preserved and energy prices decrease. But, in our opinion, there is a risk of higher energy prices as a result of recent events in the Middle East.

Barring new shocks, the global economy is expected to slow down at least until mid-2024 due to the war in Ukraine, tighter monetary conditions and high inflation. Against the background of the increasingly unsettled flywheel of tight monetary policy, global economic growth is forecasted to fall from 3.5% in 2022 to 3.0% in 2023, and 2.9% in 2024.

All these trends are going to have a negative impact on the growth and recovery of Ukraine.

Due to higher interest rates, and lower food and energy prices, inflation gradually decreased in the first half of 2023, but core inflation is still higher than the central banks' targets. However, it is predicted that due to the improvement of logistics, prices of goods are going to decrease, but the recovery of the services market will not allow inflation to decrease too rapidly.

Core inflation is significantly influenced by discount rates, therefore, to reduce it (approach the target), it is urgent to ensure the rigidity of monetary conditions at a sufficient level. However, there might be a risk that inflation will turn out to be more persistent than expected, implying the need for further increases in key policy rates.

Monetary policy remains quite tight at the moment. It is predicted that it will remain the same at least until the end of 2023. After the simultaneous increase in the key rates of the central banks worldwide, there is now a certain branching due to different rates of inflation in the countries. In developing economies, there is a tendency towards some softening of monetary policy. A significant softening of the monetary policy of emerging market countries is expected at the end of 2023 - the beginning of 2024.

At the same time, the central banks of advanced economies maintain a strict monetary policy, keeping key policy rates at a high level and reducing the amount of securities in circulation. The rise of key policy rates in advanced countries entails certain risks for developing economies. The probability of devaluation of national currencies is increasing. In addition, debt servicing in US dollars or euros becomes more expensive.

In 2023 the IMF predicts a significant decline in inflation in the MTPs of Ukraine (IMF, 2023). In particular, inflation is forecasted to fall from 16.6% in 2022 to 7.4% in 2023 in Poland, from 16.4% to 7.8% in Romania, from 1.8% to 0.9% in China, and finally in Germany - from 9.8% to 4.1%. However, in Turkey, the inflation rate is going to remain unchanged at the level of almost 64%. In 2024 the downward trend of inflationary processes is going to continue (China is the exception with a forecast of inflation’s rise to 1.9%).

Thus, in our opinion, the tendency of lowering of the inflation in Ukraine's MTPs is going to slow down the inflationary processes in Ukraine due to its significant dependence on these countries and the import of inflation from systemically important economies.

In this regard, we are going to explore the peculiarities of monetary policy transmission and its impact on cross-country income differences.

It is worth noting that monetary policy transmission is considered to be the mechanism by which changes in key policy rates or other monetary policy tools could affect diverse macroeconomic variables such as inflation, output, employment, etc. The channels through which monetary policy activities shape the real economy provide a framework for understanding

how changes in key policy rates impact different sectors and economic agents. It is worth identifying the major transmission channels through which the monetary policy affects the real economy.

Cross-country income differences could be explained through the interest rate channel. Due to the economic structures of the countries and, therefore, the sensitivity of sectors to interest rates, the effects of monetary policy shocks on investment activities are dissimilar. For example, economies with a higher share of sectors sensitive to interest rates are more vulnerable to contractionary monetary policy. Moreover, changes in monetary policy have a greater impact on the production sector as it is more dependent on borrowing than services (Jansen et al., 2013), Carlino and DeFina (1998).

The credit channel of the transmission mechanism helps to explain cross-country differences as well. Variations in the small companies' locations could cause different responses to monetary policy changes. As small businesses have access to more sources of financing than larger ones, they are more vulnerable to changes in interest rates. Therefore, given the tightening of the monetary policy, countries with a domination of small businesses will probably undergo a higher crowding-out effect. Moreover, the credit channel is "stronger in countries with lower levels of financial development, in line with financial accelerator logic" (Choi, 2022).

The exchange rate channel of the monetary policy transmission stipulates those economies with larger export-oriented sectors are more sensitive to monetary policy shocks. Besides this, small open economies are more vulnerable to such shocks and, therefore, they react with a larger decrease in output compared with countries that have lower dependency on export-oriented sectors (Ca'Zorzi et al., 2020).

In addition, such monetary policy transmission channels as asset price channel, expectations channel, and global spillover channel may be identified. Here, it is worth noting the importance of forward guidance when central banks use communication tools to impact expectations about future interest rates and inflation.

Finally, the effectiveness of monetary policy highly depends on the economic environment, the responsiveness of economic agents to interest rate changes, and the presence of other factors influencing the economy.

In our study, we are going to consider a key policy rate as an instrument of monetary policy to examine the monetary policy shocks on economic development in systemically important economies and explore their influence on Ukraine's key policy rate.

Data

Thus, in this paper, we are making an attempt to investigate the effect of monetary policy on the real economy by constructing three VAR models for the US, the Euro Area and China, respectively. For this purpose, we use such data: seasonally adjusted Gross Domestic Product in domestic currencies, consumer price index (all items, 2010=100), and a Central Bank Policy Rate in per cent per annum. The quarterly data used covers the period from 2016:1 to 2023:4 and is extracted from the International Financial Statistics database of the International Monetary Fund (IFS), FRED Economic Data of the Federal Bank of St. Louis and the statistics of the National Bank of Ukraine.

The description of all variables used in the models is given in Table 1.

Table 1. Variables included in the models.

Variable	Description	Country	Unit of measure
gdp_ust	Gross Domestic Product, real, seasonally adjusted	United States	Domestic currency
cpi_ust	Consumer Price Index, all items	United States	Index, 2010=100
r_ust	Central Bank Policy Rate	United States	Percent per Annum
gdp_eut	Gross Domestic Product, real, seasonally adjusted	Euro area	Domestic currency
cpi_eut	Consumer Price Index, all items	Euro area	Index, 2010=100
r_eut	Central Bank Policy Rate	Euro area	Percent per Annum
gdp_cht	Gross Domestic Product, real, seasonally adjusted	China	Domestic currency
cpi_cht	Consumer Price Index, all items	China	Index, 2010=100
r_cht	Central Bank Policy Rate	China	Per cent per Annum
gdp_ukrt	Gross Domestic Product, real, seasonally adjusted	Ukraine	Domestic currency
cpi_ukrt	Consumer Price Index, all items	Ukraine	Index, 2010=100
r_ukrt	Central Bank Policy Rate	Ukraine	Percent per Annum
dt	Indicates periods of pandemic and military aggression in Ukraine	Common for countries and country group	A dummy variable (1 – for periods when pandemic and war occur, 0 – otherwise)

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Results of the Unit Root testing of variables in levels, 1st differences and growth rates by employing the Augmented Dickey-Fuller test are given in Table 2.

Table 2. Unit Root test results. Note: [1] - the values of tau-statistics; [2] - *p-values* are in brackets.

Variable	Level	1st Dif.	Growth rate
gdp_ust	-3.62276[1] (0.02788)[2]	-	-7.20919 (8.897e-11)
cpi_ust	-1.23323 (0.9028)	-3.02639 (0.03252)	-3.00439 (0.0345)
r_ust	-3.69745 (0.004172)	-	-3.60963 (0.005608)
gdp_eut	-3.11514 (0.1026)	-7.05655 (2.326e-10)	-7.32507 (4.251e-11)
cpi_eut	-4.04226 (0.007575)	-	-3.41184 (0.0106)
r_eut	-0.791459 (0.821)	-3.9217 (0.001888)	-5.47556 (1.966e-06)
gdp_cht	-3.23645 (0.05732)	-	-3.1525 (0.0242)
cpi_cht	-2.18229 (0.499)	-5.85469 (2.658e-07)	-5.80223 (3.53e-07)
r_cht	-1.93961 (0.3142)	-5.97716 (1.359e-07)	-5.58024 (1.145e-06)
gdp_ukrt	-2.83114 (0.1859)	-6.81504 (1.034e-09)	-6.92591 (4.064e-09)
cpi_ukrt	-4.86303 (0.00033)	-	-4.35618 (0.0154)
r_ukrt	-2.54746 (0.1043)	-4.04648 (0.001188)	-3.586 (0.03096)

Models' estimation

As most of the variables are the first order integrated, in models we used the growth rates of the variables mentioned. So, to determine the impact of key policy rates on economic growth in the US, the Euro Area and China, three vector auto-regression models were constructed:

$$Y_t = A_0 + A_1 Y_{t-1} + d_t + \varepsilon_t \quad (1)$$

where $Y_t = (pc\_gdp_{\_us_t}, pc\_cpi_{\_us_t}, pc\_r_{\_us_t}, d_t)$ *is a vector of endogenous variables* ($t = \overline{1,T}$), d_t *– exogenous variable,* A_0 *– a vector of intercepts,* A_1 *– coefficients matrix, and* ε_t *– disturbances;*

$$Z_t = B_0 + B_1 Z_{t-1} + d_t + \vartheta_t \quad (2)$$

where $Z_t = (pc\_gdp_{\_ch_t}, pc\_cpi_{\_ch_t}, pc\_r_{\_ch_t}, d_t)$ *is a vector of endogenous variables* ($t = \overline{1,T}$), d_t *– exogenous variable,* B_0 *– a vector of intercepts,* B_1 *– coefficients matrix, and* ϑ_t *– disturbances;*

$$H_t = C_0 + \sum_{i=1}^{4} C_i H_{t-i} + d_t + \theta_t \quad (3)$$

where $H_t = (pc\_gdp_{\_eu_t}, pc\_cpi_{\_eu_t}, pc\_r_{\_eu_t}, d_t)$ *is a vector of endogenous variables* ($t = \overline{1,T}$), d_t *– exogenous variable,* C_0 *– vector of intercepts,* C_i *– coefficients matrices* ($i = \overline{1,4}$), *and* θ_t *– disturbances.*

The number of lags (the order of a vector autoregression model) is determined based on the information criteria (Table 3).

Table 3. Results of the lag length selection. Note: * - denotes the lag selected.

Lags	Akaike Information Criterion	Bayesian information criterion	Hannan-Quinn information criterion
Model 1			
1	30.34	30.91*	30.51*
2	30.33	31.34	30.63
3	30.23	31.67	30.66
4	30.12*	31.99	30.67
Model 2			
1	28.20*	28.50*	28.28*
2	28.35	28.84	28.48
3	28.55	29.24	28.73
4	28.59	29.47	28.82

(continued on next page)

Table 3. Continued

Lags	Akaike Information Criterion	Bayesian information criterion	Hannan-Quinn information criterion
Model 3			
1	75.98	76.57	76.13
2	60.03	61.07	60.29
3	60.33	61.81	60.70
4	58.88*	60.80*	59.36*

In addition, inverse roots of the characteristic polynomials for models confirmed their stationarity. Based on VAR models we explore the reaction of economic growth in the US, Euro Area and China to shocks in key policy rates by computing the impulse response functions (Figure 2).

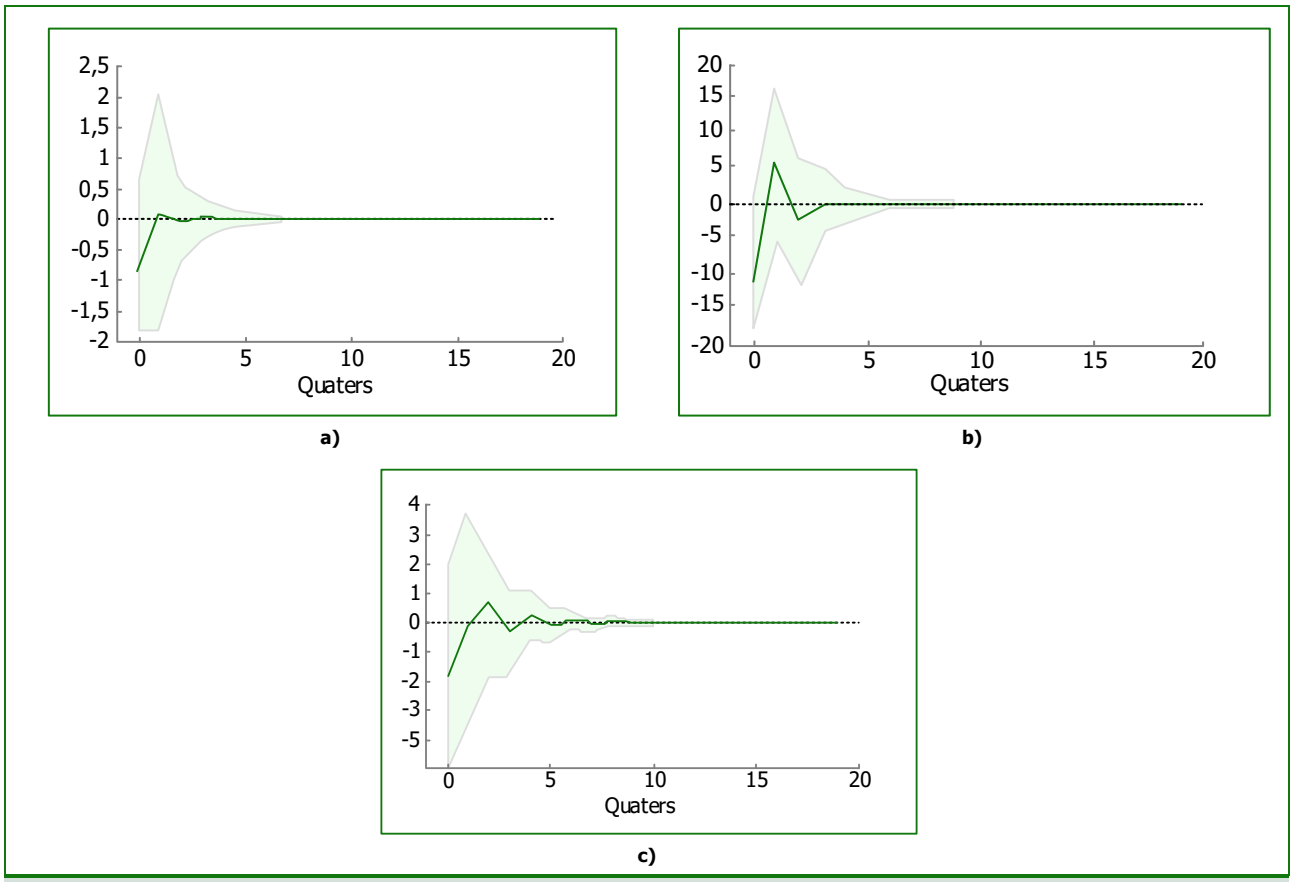

Figure 2. Impulse response functions of real GDP to shock in key policy rates in the US, Euro Area and China. Note: **a)** Impulse response function of pc_gdp_us to shock in pc_r_us; **b)** Impulse response function of pc_gdp_ch to shock in pc_r_ch; **c)** Impulse response function of pc_gdp_eu to shock in pc_r_eu.

As to the impulse response functions, we could observe a slight decline in GDP growth (-0,85%) in the first quarter in response to the rise of the key policy rate in the US and a stabilization within four quarters after the shock. In China, this decline is much bigger and constitutes up to 11% in the first quarter. Stabilization takes place only within five quarters. In the Euro Area, we also observe a similar pattern as in the US with an initial decline up to 2% and a further return to equilibrium.

Forecast error variance decomposition of GDP growth in the US demonstrates that only nearly 1% of its variance is caused by fluctuations in the key policy rate. Nevertheless, nearly 22% of GDP fluctuations are due to inflation (Table 4). We might explain this by the influence of key policy rates on GDP via inflation.

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Table 4. Forecast error variance decomposition of economic growth in the US.

Period	pc_gdp_us	pc_cpi_us	pc_r_us
1	77.61	21.28	1.11
2	76.42	22.58	1.01
3	76.56	22.44	1.00
4	76.52	22.48	1.00
5	76.52	22.48	1.00
6	76.52	22.48	1.00

However, we obtained another result for China (Table 5). In this case, GDP is more sensitive to changes in key policy rates but less vulnerable to fluctuations in inflation. Additionally, we should admit that GDP growth in China is more sustained than that of the US.

Table 5. Forecast error variance decomposition of economic growth in China.

Period	pc_gdp_ch	pc_cpi_ch	pc_r_ch
1	77.39	10.94	11.67
2	81.36	9.67	8.97
3	81.36	9.95	8.70
4	81.34	9.98	8.68
5	81.34	9.98	8.68

In the Euro Area fluctuations of key policy rate and inflation make up only nearly 8% of GDP growth variance. Moreover, in this case, we have the most sustained economic growth among the three economies analyzed (Table 6).

Table 6. Forecast error variance decomposition of economic growth in the Euro Area.

Period	pc_gdp_eu	pc_cpi_eu	pc_r_eu
1	96.13	1.75	2.12
2	92.62	5.52	1.86
3	92.14	5.79	2.08
4	91.83	6.06	2.11
5	91.80	6.07	2.14
6	91.78	6.08	2.14

Finally, we are going to investigate the dependence of key policy rates in Ukraine on the dynamics of ones in systemically important economies mentioned in the paper. For this purpose, we also used a vector autoregression model with four endogenous variables (*pc_r_us, pc_r_ch, pc_r_eu, pc_r_ukr*) and one lag. Due to the model's results key policy rate in Ukraine reacts positively to the rise of the central bank's policy rate in the US during the first five quarters after the shock (Figure 3). In addition, fluctuations in the central bank's policy rate in Ukraine are explained mainly by fluctuations in the US key policy rate.

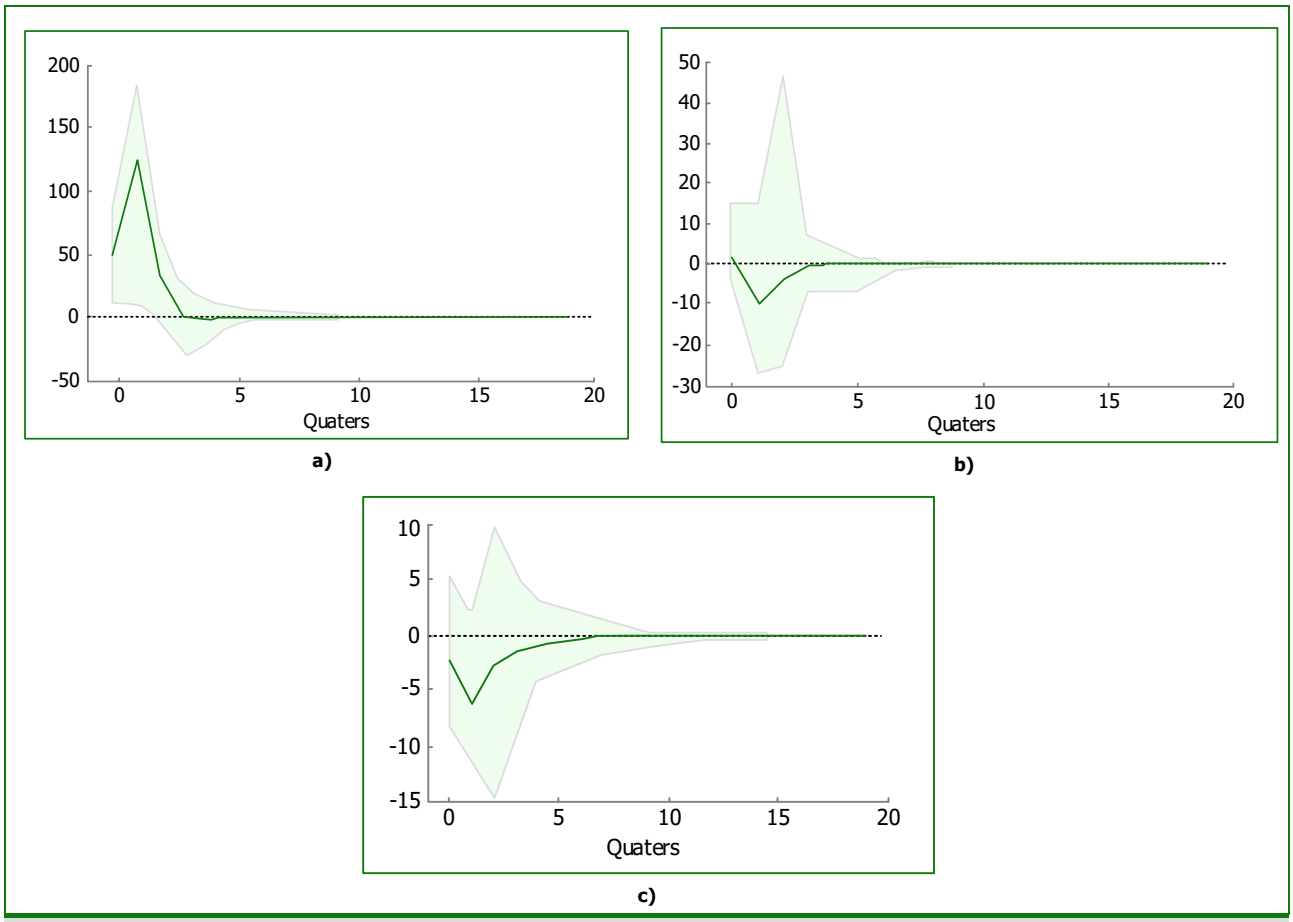

Figure 3. Impulse response functions of real GDP to shock in key policy rates in the US, the Euro Area and China. Note: **a)** The impulse response function of pc_r_ukr to shock in pc_r_us; **b)** The impulse response function of pc_r_ukr to shock in pc_r_ch; **c)** The impulse response function of pc_r_ukr to shock in pc_r_eu.

DISCUSSION

Thus, in the study, we have attempted to examine the effects of monetary policy on economic growth in systemically important economies. For this purpose, we used key policy rates as a major instrument of monetary policy. As to the results of the study we have observed a decline in GDP growth in response to the rise of key policy rates in all economies we mentioned. It is worth noting that the decline of China's gross domestic product due to a shock in key policy rates is the biggest one among systemically important economies. So, in the US we see a slight initial decline in GDP growth with following stabilization. In the Euro Area, we also observe a similar pattern with a decline of up to 2% and a further return to equilibrium.

To explore the causes of economic growth fluctuations due to the models' inputs we used the forecast error variance decomposition based on the VAR models. The results of the decompositions showed us the similar behaviour of the variables. For instance, in the US fluctuations of GDP growth are caused mainly by ones of consumer price index. At the same time, fluctuations in key policy rates contributed only 1% to GDP growth. It is empirically explained by the influence of key policy rates on the consumer price index, and then transmitting to GDP. Analyzing the forecast error variance decomposition of China's GDP, it should be noted that it is more sensitive to the changes in key policy rates, comparing with patterns of other systemically important economies. However, in the eurozone, we might observe the most sustained economic growth.

Moreover, by using the VAR model's toolkit we concluded that the central bank's policy rate in the US has a positive impact on key policy rates in Ukraine. Besides, its fluctuations are mainly due to the changes in key policy rates in the US. In addition, taking into account the influence of key policy rates on economic growth in systemically important economies, we might assume the transmission of these effects to economic growth in Ukraine that corresponds to some conclusions on economic growth impact in (Bazhenova, 2015), (Kavanagh et al., 2022) and (Lastauskas and Nguyen, 2023).

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Finally, compared to the results of empirical studies mentioned in the Literature review chapter, we showed the influence of monetary shock not only on economic growth in systemically important economies but also on key policy rates in Ukraine as one of the small open economies (particularly, in (Lastauskas and Nguyen, 2023) and (Chen et al., 2023)). We demonstrated that the impact of the US's key policy rate on Ukraine's one was proved to be the most significant among the systemically important economies mentioned in the paper. Moreover, as demonstrated the spillover effects of China's and Euro Area's monetary policy shocks do not have a crucial influence on Ukraine's key policy rate, comparing with the study (Chen et al., 2023). Thus, we might conclude the leading role of China's economy only among countries along the Belt and Road and probably in the Asia-Pacific region.

CONCLUSIONS

A country's response to fluctuations in key policy rates could depend on various economic factors and policy considerations. Here we are introducing several aspects Ukraine might consider when reacting to key policy rate changes in the US. First of all, it should be taken into account the impact of the US key policy rate on exchange rates causing the fluctuations of value of the US dollar. As a result, Ukraine, being an exporting economy, has to monitor how exchange rate movements affect its trade balance. Secondly, as known, the interest rate differential between the US and Ukraine also could influence capital flows. In addition, as changes in the US key policy rate are affecting both global commodity prices and inflation, Ukraine as a small open economy has to keep track of its impact on domestic inflation dynamics and economic growth and, consequently, adjust its monetary policy if needed. Furthermore, due to significant external debt denominated in foreign currencies, it should be carefully managed the external debt portfolio and considered potential impacts on debt sustainability. In response to changes in the US key policy rate, Ukraine should keep an eye on coordinating its own monetary and fiscal policies that could help maintain domestic stability and support economic growth. Finally, Ukraine has to maintain flexibility in its monetary policy tools to respond effectively to changes in the global economic environment. This includes being ready to adjust interest rates, use unconventional policy tools if necessary, and implement macroprudential measures.

Additionally, it is important to note that the specific response will depend on the unique economic conditions in Ukraine, its economic objectives, and the prevailing global economic environment. Consultations with international financial institutions and close monitoring of global economic developments can support Ukraine's response to changes in the US key policy rate.

Concerning further directions of the research, we find it necessary to construct the DSGE Model for Ukraine to analyze the macroeconomic effects of monetary policy during the war based on microeconomic fundamentals incorporating interactions of such economic agents as households, firms, public institutions, and taking into account possible uncertainties in the economy.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

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Validation: *Olena Bazhenova*
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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ЕФЕКТИ ШОКУ МОНЕТАРНОЇ ПОЛІТИКИ: КЕЙСИ СИСТЕМНО ЗНАЧУЩИХ ЕКОНОМІК

Автори досліджують питання впливу монетарної політики на економічне зростання в таких системно значущих економіках, як США, єврозона та Китай. Крім того, приділено увагу дослідженню їхнього впливу на Україну. Унаслідок війни в Україні та підвищення центральними банками облікових ставок для стримування інфляції відбулося падіння економічної активності. Причому спостерігалося й значне зниження торговельної активності, і вповільнення зростання сектора послуг, який був основним двигуном глобального економічного зростання на початку 2023 року. У дослідженні на основі побудови векторних моделей авторегресії для США, єврозони та Китаю доведено незначне початкове зниження ВВП у відповідь на підвищення облікової ставки в США з наступною стабілізацією, у єврозоні простежено схожу ситуацію, як і в США, з початковим падінням до 2% і подальшим поверненням до рівноваги, у Китаї ж спостерігається набагато більший спад – до 11%. Аналізуючи результати декомпозиції похибки прогнозу, зазначимо, що коливання ВВП в системно значущих економіках пояснюються в основному власними коливаннями. На облікову ставку припадає від 1% в США до 11% у Китаї. Водночас, економічне зростання в Китаї є менш вразливим до коливань інфляції, у єврозоні – найбільш стійким серед розглянутих економік. Крім того, у дослідженні показано, що облікова ставка в Сполучених Штатах позитивно впливає на облікову ставку в Україні.

Ключові слова: монетарна політика, шок монетарної політики, економічне зростання, облікова ставка, різниця в доходах між країнами, війна в Україні, VAR-модель

JEL Класифікація: E47, E52, C54