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Economic and Mathematical Modeling of the Shocks Impact on the Russian Economy Stability

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ABSTRACT

The identification and analysis of structural trends and the close monitoring of macroeconomic and financial vulnerabilities can improve economic resilience to shocks. This research modeled the effects of exogenous and endogenous economic shocks on the stability of the Russian Federation's economic system. Granger test results uncovered that the key internal, external, and global economic shocks affecting Russia's economic stability are productive, monetary, and budget policy shocks, foreign exchange shocks, and oil price shocks. A spectral analysis confirmed the absence of structural changes in the Russian economy from 2000 to 2018, which was regarded as the basis of representativeness of the chosen study period. Vector autoregression models were used to determine specific shock effects on the aforementioned stability, and elasticity indicators were calculated to characterize the response of the Russian economy to economic impulses (shocks). The calculation enabled us to classify types of shock by priority. The results can serve as reference in developing domestic and foreign economic policies intended to prevent or minimize the impact of external negative shocks on the economy of Russia. They can also be adopted as guidelines in formulating measures of Russian economic growth stimulation.

INTRODUCTION

Economic shocks are the basic factors contributing to economic instability in a country (Jiang et al., 2019; Yang, 2019; Bonciani and van Roye, 2016). These occurrences result in long economic recessions in systemically important countries and partner nations, and they diminish the activities of traditional export economies or cause uncertainty in these dealings (Bonciani and van Roye, 2016; Ong and Sato, 2018). In the context of emerging globalization, the effects of shocks are substantially exacerbated given the gradual elimination of borders among national economies. Shock events occur unexpectedly and are therefore extremely difficult or even impossible to predict (Ong and Sato, 2018); clearly identifying a given shock itself is unattainable. The unsystematic character of economic shocks makes it impossible for an economic system to definitively pinpoint their consequences as the extent and the scope of the process depend on specific conditions. In general, any type of economic shock can take on a wide range of values (Jiang et al., 2019; Yang, 2019). A specific category of shocks are macroeconomic ones, which are probabilistic, as recognized by numerous economists (Kornstad, Nymoen and Skjerpen, 2012; Schiaffino, Crespo and Heymann, 2017), including O.J. Blanchard. The author indicated that the causes of shocks include changes in consumer sentiment, a decline in investment demand, a decrease in monetary demand, lost productivity, and oil price collapse (Blanchard and Milesi-Ferretti, 2011; Blanchard and Summers, 2017).

Similar to most economies in the world, Russia is substantially influenced by systemically important countries, whose economic changes affect the global economy in general and Russian economic stability in particular. Among these nations, the main trade partners of Russia are as follows:

- China – Russia's main strategic partner (The trade turnover is 15.74% of Russia's total foreign trade turnover, according to the references of 2018)
- Germany – 8.66% of Russia's total foreign trade turnover
- Netherlands – 6.85% Russia's total foreign trade turnover
- Belarus – 4.94% Russia's total foreign trade turnover

Russia also entered into trade partnerships with member states of the European Union (EU) (42.7% of foreign trade turnover) and the Asia-Pacific Economic Cooperation (APEC) (31.0%) in 2018 and 2019, respectively. According to US news and world reports, the Russian economy is likewise affected by the most influential countries in the world, namely, the US, the UK, France, Japan, Israel, Saudi Arabia, and South Korea (The World's 25 Most Powerful Countries Official Rating, 2019). Issues worth highlighting are the fact that the Russian economy is typified by a developing market and that a remarkable share of raw material exports are less resistant to external shocks than are the exports of developed economies (Abegunde and Stanciole, 2008; Bouwmeester and Oosterhaven, 2017). Russia is characterized by an economic structure and a financial market that are less diversified and less developed than those of other nations, respectively (Ankudinov, Ibragimov and Lebedev, 2017; Ono, 2017). To begin with, external shocks affect the country's commodity sector, budget revenues, and foreign currency liquidity (Korotin et al., 2019). As reported by the International Monetary Fund (IMF), the annual negative effect of sanctions on the growth of the Russian GDP from 2014 to 2018 averaged 0.2 percentage points. The greatest damage to economic growth was caused by a drop in oil prices, which averaged at 0.65 percentage points. Russia's annual GDP growth averaged at 0.5%. Had it not been for economic shocks, the average annual growth in the country could have reached 1.7% (Russian Federation, 2019, 2019). These developments reflect the need to examine the influence of external shocks using not only classical approaches to economic policy implementation but also fundamentally new techniques. A country can fortify its resilience to shocks by strengthening policy that deals with long-term problems and vulnerabilities that can cause expensive shocks. It can also develop economic measures designed to offset shock factors and accelerate recovery.

In consideration of the above-mentioned issues, this study modeled the effects of exogenous and endogenous economic shocks on the stability of the Russian economic system. The research substantiated the reliability and completeness of an exogenous and endogenous shock sample used to trace the development of the Russian economy. The characteristics of shock effects were determined, and indicators that embody the response of the Russian economy to economic impulses (shocks) were introduced. The rest of the paper is structured as follows: Section 2 presents a review of the literature, and Section 3 outlines the factors explored in this work, the hypotheses formulated, and the research methodology. Section 4 describes the data collection, and Section 5 presents the data analysis and discusses the results. Section 6 provides the conclusions, and Section 7 consists of recommendations.

1. LITERATURE REVIEW

Nowadays, in terms of studies of economic cycles, one approach is widely used to determine the results of a random impact on the economic system, the so-called impulses, or shocks, which destabilize the economy and cause response effects (Mishchenko, 2014). The types of economic shocks are divided into:

- Internal, shocks that occurred within the country;
- External, shocks that are correlated to the economic development of foreign countries and groups, as well as to the financial market (Almansouretal, 2015; Andrade and Zachariadis, 2016; Civcir and Varoglu, 2019);
- Global, shocks formed in global markets (Andrade and Zachariadis, 2016; Civcir and Varoglu, 2019).

There is a wide range of economic shocks that influence the sustainability of economic development, namely, shocks that involve the real and financial sectors of the economy, labor, external and global factors (Ankudinov, Ibragimov and Lebedev, 2017; Ono, 2017).

The ambiguity of shock phenomena justifies the dialectical approach to formulate the essence of shocks. Shocks must be regarded as a form of influence from an external factor that influences economic integrity in both negative and positive ways (Minsky, 1982; Carriero, Galvao and Marcellino, 2017). H. Minsky declared that a positive aspect is the clear advantages of the exogenous push for the macroeconomic system. The magnitude of external influence can improve economic prospects for at least one sector of the economy (Minsky, 1982). This helps to catalyze economic growth, as in the example of Japanese economic leadership, the “East Asian miracle,” and the “New American Economy” (Minsky, 1982). However, the dual nature of the shocks impact on economic sustainability should be noted. Thus, in Russia the signs of a “Dutch disease” have been observed. The negative effect of positive shocks comes out in national currency strengthening. This leads to the prioritizing of the commodity sector at the expense of the manufacturing sector. For example, the constant increase in oil prices at the beginning of the century contributed to the dependence of the national economy on oil exports (Pönkä and Zheng, 2019). Moreover, in this period, despite the Russian GDP growth, the quality of economic growth was not improving. Thus, the short-term positive effects of economic shocks do not contribute to positive results over the longer term (Carriero, Galvao and Marcellino, 2017). The duality and uncertainty of economic shocks impact economic stability. Therefore, it is a necessity to study their assessment and identification.

There is some ambiguity in the literature about the definition. Some researchers use the term *shock* to mean *innovation* (i.e. the residuals from a Vector Autoregression Model (VAR)) or *instrument*. Sims (1980) regarded *innovations* as macroeconomic *shocks*, despite claiming to be atheoretical. Other researchers used the word *shock* to mean *instrument* (e.g. Cochrane, 2004). In this work, we regard *shocks*, *VARinnovations*, and *instruments* as different concepts, although their identification may equate them in many cases. Shocks are most closely related to the structural

disturbances in a system of simultaneous equations. We accept the concept of shocks as developed by such researchers as O. Blanchard and M. Watson (1986), and B. Bernanke (1986).

The research of large-scale econometric and single - equation models, conducted from 1940 to 1970, determined fiscal and monetary policy shocks (Ramey, 2015). In the 1980s, there were two important innovations observed that fundamentally changed the essence of the research. First, Sims's work "Macroeconomics and Reality" (1980) revolutionized the study of systems controlled by random pulses by introducing vector autoregression (VAR). Sims's VARs connected the innovations to a linear system and macroeconomic shocks. This method made it easier to identify assumptions and impulse response functions, as well as to do innovation accounting using the decomposition of forecast error. A second important innovation was the extension beyond political shocks to accommodate important non-political shocks, such as technological ones (Kydland and Prescott, 1982). These innovations contributed to a number of studies of shocks and their consequences.

There are a lot of other approaches. It is worth noting the SVAR model with restrictions on the signs of the vectors of impulse response, namely sign restricted SVAR (hereinafter SR-SVAR). Some researchers devoted their works to the influence of monetary policy and demand shocks on various macroeconomic indicators using SR-SVAR (Uhlig, 2005; Mountford and Uhlig, 2009; Enders, Müller and Scholl, 2011; Vargas-Silva, 2008; Mallick and Sousa (2013). The shock of monetary policy and the changes of financial conditions in the eurozone are analyzed in the framework of SR-SVAR. The analysis results indicate the important role of financial shocks in the dynamics of real variables. The same authors conducted a similar study on the role of monetary policy in developing countries, including Russia (Mallick and Sousa, 2012). They came to the conclusion that tough policies can stabilize inflation, although its basic effect is a decreased output.

Another significant study was conducted by Sanchez (Sanchez, 2007). He highlights premium shock risk. In his work, Sanchez comes to controversial conclusion: external shocks do not affect developing economies as much as internal ones. He explains that the methodology of the model deals with unexpected shocks, bit not just changes. The features of the impact of shocks on the stability of the economy are considered in this study on the example of Russia, as a country with a developing market, commodity economy, and a narrow differentiation of production.

2. METHODS AND MATERIALS

The methodological basis of the study was a vector autoregression model implemented with a time series reduced to stationarity according to the results of the cause-effect relationship determination. The use of the vector autoregression model is caused by the necessity to take into account autocorrelation and time lag of variables. To verify the stationarity of the time series, the advanced Dickey-Fuller method was used in the EViews 10.0 software package. Stationarity of the time series provides the use of VAR for analyzing the shock effect on the stability of Russian economy. The Granger causality test was used to determine the cause-effect relationship between the indicators and their statistical significance. According to the calculations and the selected structure of shocks (internal, external, and global) that impact the economic stability of Russia, the VAR is developed:

$$\begin{cases} (Y_k)_t = A_0 + A_1(Y_k)_{t-l} + A_2(X_i\_C)_{t-l} + \varepsilon_t & (1) \\ (Y_k)_t = A_0 + A_1(Y_k)_{t-l} + A_2(X_i\_C_j)_{t-l} + \varepsilon_t & (2) \\ (Y_k)_t = A_0 + A_1(Y_k)_{t-l} + A_2(Z_i)_{t-l} + \varepsilon_t & (3) \end{cases}$$

Where:

$(Y_k)_t$ - - dependent variable vector that characterizes the economic stability of Russia. Vector of the composite indicator of function (1) takes on value of functions (2)-(3) - Y_C, X_i_C;

A_0 – vector of constants;
A_1 – matrix coefficient for lag values of the composite;
A_2 – matrix of coefficients for lag values of variables describing the shock effect on the stability of the economy;
$(X_i\_C)_t$, $(X_i\_C_j)_t$, $(Z_i)_t$ – vector of variables describing the shocks effect on the stability of the economy;
ε_t – model error;
$t - l$ – time lag, $l = \overline{1,2}$.

The presented functions form a decomposition of the model of the internal shocks (X_i_C) impact on the economic stability of Russia - function (1); decomposition of the model of the external shocks ($X_i\_C_j$) impact on the economic stability of Russia - function (2); decomposition of the model of the global shocks (Z_i) impact on the economic stability of Russia - function (3).

According to the factors studied, the vector of endogenous model variables is formed like the following: $(X_i\_C)_t$ is vector of the time series values of internal *i* pulse variables in Russia, $i = \overline{1,7}$; $(X_i\_C_j)_t$ isvector of the time series values of external *i*pulse variables in other countries C_j, $i = \overline{1,7}$, $j = \overline{1,11}$; $(Z_i)_t$ is vector of the time series values of global *i*pulse variables, $i = \overline{1,2}$.

In function system (1)-(3) vector of variables are used: *b, c* = $\left[(Y_k)_t, (X_i\_C)_t, (X_i\_C_j)_t, (Z_i)_t\right]$, that satisfy the conditions: $b_t = \alpha_0 + \sum \alpha_j \cdot b_{t-l} + \sum \beta_j \cdot c_{t-l} + \varepsilon_t$, for$\beta_j \neq 0$. Where*b*, *c* are dependent and independent variables respectively; α_0, α_j, β_j are regression coefficient; ε_t is an error.

3. DATA

To describe the impact of external economic shocks on the stability of the Russian economy, the index of the real GDP of Russia in millions of US dollars (Y) was used as the resultant indicator for 2000-2018 with quarterly detailing of indicators. The use of a real variable adjusted for the deflator made it possible to offset the growth of GDP due to an increase in the price level. The variable calculated using the indicator values in millions of US dollars allowed taking the devaluation / revaluation factor of the national currency into account . The use of relative indicator (index) made it possible to commensurate the data and improve the reliability of the results. Besides, the use of the index values allowed us to level the seasonal component, which appears in quarter study, by finding indices (growth rates) of the indicator relative to the same period (quarter) of the previous year.

The industrial production index in millions of US dollars (X1) was used for the analysis of the production shock impact on the Russian economy. For the analysis of the impact of the monetary market and the corresponding shock, the authors used the weighted average interest rate of loans that were revealed by credit institutions to non-financial organizations in the national currency, % (X2). The consumer price index (X3) was used for the analysis of the price shock impact. For the analysis of the impact of the internal shocks on economic sustainability, the authors used the following indicators of fiscal policy: the unemployment rate for citizens aged 15 and older, % (X4) and the ratio of external debt to GDP in millions of US dollars (X5).

The impact of a foreign trade shock was estimated through the ratio of the current account of the balance of payments to the GDP in millions of US dollars (X6). A decrease in this indicator will lead to a further decrease in GDP due to a decrease in exports. The effect of the exchange rate and the effects of the currency shock are reflected in the national currency to US dollar index (X7). The representativeness of the indicators list (X1-X7) for the period from 2000 to 2018 for the analysis of the shocks impact is confirmed with the multivariate factor analysis. The factorization proportion

was 86.4%, which means that the introduced scorecard is meaningful (a sufficient level of 80%) (Menke, 2018).

Sanctions against Russia were regarded by the IMF for the period from 2014 to 2018 as one of the most influential shocks (the IMF decomposed Russia's economic growth into external shocks, 2019). However, the authors did not consider them in the study, since their influence is reflected in indicators X1-X7. The indicators X1-X7 for the period from 2000 to 2018 for the countries of the greatest impact on Russian economy development are characterized with a high coefficient of variation due to the difference in levels and pace of economic development (61-88% for the EU, EAEU, BRICS, CIS, and 73-92% for APEC). This contributes to the heterogeneity of the sample. Therefore, the indicators X1-X7 of external shocks that impact the stability of the Russian economy were used for the following countries: China (C1), Germany (C2), Netherlands (C3), Belarus (C4), the United Kingdom (C5), France (C6), Japan (C7), Israel (C8), Saudi Arabia (C9), South Korea (C10); for the USA (C11) were used indicators X1-X6.

In addition to external shocks, the global economy is also influencing the Russian economy, namely: the oil prices shock (the Brent crude oil price index, calculated in US dollars (Z1)) and gas prices shock (the world index for natural gas prices, calculated in US dollars (Z2)). The application of these global factors is based on the fuel and energy specialization of Russia in world markets and this sector dominance in domestic economy. All the indicators (Y, X1-X7, Z1-Z2) are presented by relative variables. It provides the commensurability of the indicators and the adequacy of the modeling results. The time period of the study is from 2000 to 2018. The indicators of external and global factors for these years were applied in the research.

4. RESULTS

To identify structural changes in the Russian economy for the period from 2000 to 2018, which affects the selection of research methodology, the dynamics of the real GDP index (y) is analyzed and a spectral analysis is carried out. During this period, the Russian economy has a distinct decline from the 1st quarter of 2000 to the 3rd quarter of 2001 (Figure 1a) and stable values during the subsequent period. The results are confirmed by the polynomial trend line of the 6th degree, which does not distinguish periods of index recession and growth from the 3rd quarter of 2002. The dynamics of the real GDP index is reflected in the trend line and is confirmed by the approximation coefficient of 0.8776, which is higher than the boundary value of 0.75.

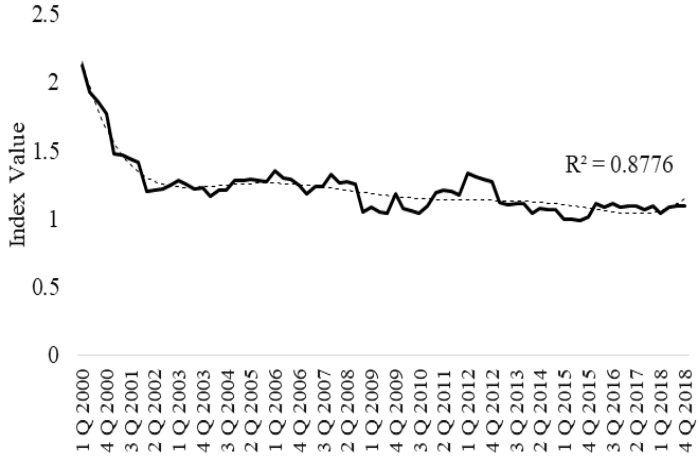

Figure 1a. The dynamics of the Russian real GDP index

	Spectral analysis No. of cases: 76						
	Frequency	Period	Cosine Coeffs	Sine Coeffs	Periodogram	Density	Hamming Weights
0	0.000		0.000	0.000	0.000	0.144	0.036
1	0.013	76.00	0.069	-0.051	0.277	0.191	0.241
2	0.026	38.00	0.062	-0.014	0.154	0.271	0.446
3	0.039	25.33	0.121	-0.004	0.561	0.305	0.241
4	0.053	19.00	0.012	0.009	0.008	0.186	0.036
5	0.066	15.20	0.043	0.050	0.166	0.108	
6	0.079	12.67	0.028	0.015	0.038	0.079	
7	0.092	10.87	0.032	0.034	0.081	0.069	
8	0.105	9.50	0.019	0.039	0.072	0.056	
9	0.118	8.444	0.017	-0.006	0.012	0.029	

Figure 1b. Spectral analysis of the dynamics of the Russian real GDP index

Spectral analysis results confirm the absence of cycles in the indicator development. A period with statistically significant indicator "Periodogram" (Periodogram Values) has not been identified (Figure 1b). The absence of cycles in the Russian economy development and the distinct tendency to decline or rise at certain time intervals indicates the absence of structural changes. This fact made it possible to use the indicated period (2000-2018) as the modeling period for the study.

Table 1 introduces the results of the analysis of the data series for stationarity using the extended Dickey-Fuller test. The table shows significant statistics at p = 0.05 for the indicators Y, X1-X7, and Z1-Z2.

Table 1. Extended Dickey-Fuller test of the data series for stationarity

Indicator	*C*	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	*C8*	*C9*	*C10*	*C11*	*W*
y	0.023 * (I, 1)**	0.008 (I, 2)	0.039 (I, 0)	0.008 (I, 0)	0.040 (I, 1)	0.000 (I, 0)	0.025 (I, 1)	0.004 (I, 0)	0.000 (I, 1)	0.002 (I, 0)	0.038 (I, 1)	0.019 (I, 2)	-
X1	0.026 (I, 0)	0.009 (I, 0)	0.028 (I, 1)	0.019 (I, 0)	0.008 (I, 1)	0.019 (I, 0)	0.031 (I, 0)	0.002 (I, 1)	0.019 (I, 0)	0.034 (I, 0)	0.002 (I, 1)	0.009 (I, 1)	-
X2	0.009 (I, 0)	0.008 (I, 1)	0.034 (I, 0)	0.034 (I, 0)	0.004 (I, 1)	0.013 (I, 0)	0.024 (I, 0)	0.011 (I, 0)	0.027 (I, 0)	0.025 (I, 0)	0.006 (I, 0)	0.004 (I, 1)	-
X3	0.037 (I, 0)	0.005 (I, 0)	0.008 (I, 0)	0.006 (I, 0)	0.011 (I, 1)	0.029 (I, 0)	0.005 (I, 1)	0.022 (I, 0)	0.005 (I, 0)	0.018 (I, 0)	0.014 (I, 0)	0.041 (I, 1)	-
X4	0.007 (I, 0)	0.013 (I, 1)	0.001 (I, 0)	0.008 (I, 1)	0.019 (I, 1)	0.007 (I, 1)	0.004 (I, 1)	0.008 (I, 1)	0.011 (I, 0)	0.019 (I, 0)	0.018 (I, 0)	0.022 (I, 1)	-
X5	0.012 (I, 0)	0.007 (I, 1)	0.013 (I, 0)	0.008 (I, 0)	0.007 (I, 1)	0.001 (I, 1)	0.007 (I, 0)	0.004 (I, 0)	0.009 (I, 0)	0.008 (I, 0)	0.020 (I, 0)	0.037 (I, 1)	-
X6	0.029 (I, 1)	0.001 (I, 1)	0.000 (I, 1)	0.014 (I, 0)	0.004 (I, 1)	0.006 (I, 0)	0.001 (I, 0)	0.016 (I, 0)	0.004 (I, 0)	0.015 (I, 0)	0.005 (I, 0)	0.027 (I, 1)	-
X7	0.037 (I, 2)	0.006 (I, 1)	0.009 (I, 1)	0.024 (I, 1)	0.029 (I, 2)	0.033 (I, 1)	0.031 (I, 1)	0.011 (I, 1)	0.016 (I, 1)	0.023 (I, 1)	0.034 (I, 1)	-	-
Z1	-	-	-	-	-	-	-	-	-	-	-	-	0.018 (I, 2)
Z2	-	-	-	-	-	-	-	-	-	-	-	-	0.029 (I, 2)

Explanation of Symbols:
* - the probability of accepting the null hypothesis that the time series is not stationary;
** - specification for time series stationarity;

I – Intersep – time series specification relative to a constant;
0 – level; 1 – the 1st; 2 – the 2ndrow difference;
C - Russia, C1 - China, C2 - Germany, C3 - Netherlands, C4 - Belarus, C5 – the Great Britain, C6 - France, C7 - Japan, C8 - Israel, C9 - Saudi Arabia, C10 - South Korea, C11 – the USA, W – World

The t-Statistic values indicate the stationarity of the following time series:

- Originaltimeseries (Y forthecountries C2-C3, C5, C7, and C9; X2 forthecountries C2-C3, C5-C7, and C9-C10; X1 forthecountries C, C1, C3, C5-C6, and C8-C9; X2 for C, C2-C3, and C5-C10; X3 for C, C1-C3, C5, and C7-C10; X4 for C, C2, and C8-C10; X5 for C, C2-C3, and C6-C10; X6 for C3, and C5-C10) .
- Integratedfirst-orderseries (Y for C, C4, C6, C8, and C10; X1 for C2, C4, C7, and C10-C11; X2 for C1, C4, and C11; X3 for C4, C6, and C11; X4 for C1, C3-C7, and C11; X5 for C1, C4-C5, and C11; X6 for C, C1-C2, C4, and C11; X7 for C1-C3, and C5-C10) .
- Second-order series (Y for C2 and C11; X7 for C and C4; Z1 and Z2).

Thus, these indicators can be applied in the study of the shocks' impact on the economic stability of Russia. The Granger causality test was conducted to identify causal relations between shock factors that impact the stability of the Russian economy. The lag selection (L = 1, … 4) is determined by the use of quarterly data in the study. Table 2 introduces statistics that are significant at p = 0.05, which indicate the influence of factors (external and global) on the economic stability of Russia.

Table 2. The Granger causality test, reflecting the impact of world economic shocks on the economic stability of Russia

Causal Direction	Influencing Country			Causal Direction	Influencing Country		
	C	*C1*	*C11*		*C*	*C1*	*W*
X1[1] → y[2]	0.033, L=1	0.028[3], L=2[4]	-	X6 → y	0.035, L=1	-	-
X1 → X1	-	0.011, L=2	-	X7 → y	0.038, L=1	0.020, L=2	-
X1 → X5	-	0.020, L=2	-	X7 → X1	-	0.030, L=2	-
X1 → X6	-	0.011, L=2	-	X7 → X5	-	0.021, L=2	-
X1 → X7	-	0.009, L=2	-	X7 → X6	-	0.020, L=2	-
X2 → y	0.038, L=1	-	0.031, L=2	X7 → X7	-	0.029, L=2	-
X2 → X1	-	-	0.017, L=2	Z1 → y	-	-	0.009, L=1
X2 → X5	-	-	0.011, L=2	Z1 → X1	-	-	0.013, L=1
X2 → X6	-	-	0.017, L=2	Z1 → X5	-	-	0.001, L=2
X2 → X7	-	-	0.014, L=2	Z1 → X6	-	-	0.011, L=1
X5 → y	0.049, L=1	-	-	Z1 → X7	-	-	0.005, L=1

Explanation of Symbols:
1 – indicator for countries C1-C11, influencing the economic stability of Russia;
2 – indicator for Russia, which is influenced by external and global factors;
3 - the minimal (significant) probability of accepting the hypothesis that a causal relationship is insignificant with the lags under consideration;
4 - time lag providing the indicated probability

Table 2 introduces the cause-and-effect relations that are statistically significant with a confidence interval of 95%. They reflect the impact of internal, external and global shocks on the economic stability of Russia. The analysis showed that the Russian economy is most vulnerable to

production, monetary and credit shocks, budget policy shocks, foreign trade, foreign exchange and oil prices shocks. The Granger test revealed statistically significant impact of these shocks on Russia's economic stability. Currently, the impact of price and unemployment shocks is not significant. This is caused by more significant influence of world prices for goods, services and currency than domestic prices, and by a significant share of unreported employment. According to the geopolitical criterion, the stability of the Russian economy is most significantly influenced by global shocks - Z1, for which the probability of accepting the hypothesis on the cause-effect relation insignificance comprises (0.001-0.013). The probability of a hypothesis rejection by external shocks is (0.009-0.031). The highest probability (0.033-0.049) suggests that there is a less significant impact of internal shocks on the stability of the Russian economy. Russian economy is most influenced by China (production and currency shocks) and the United States (monetary shock). The impact of other factors on the economic stability of Russia is not so statistically insignificant at p = 0.05. All external shocks introduced in the Table 2, demonstrate the impact on the economic stability of Russia with a lag of 2 quarters. A faster reaction is observed to the changes in internal and global factors and comprises 1 quarter. Figure 2 shows the impulse responses of the Russian real GDP index (Y_C) to internal economic shocks and the elasticity values (E) of changes in the real GDP index influenced by shocks, calculated with VAR models. Elasticity is shown in Fig. 2-5, calculated as the change in the resulting indicator, expressed in%, caused by an increase in the pulse value by 1%. Elasticity (Figures 2-5) is calculated as the change in the resultant indicator, expressed in%, and caused by an increase in the pulse value by 1%.

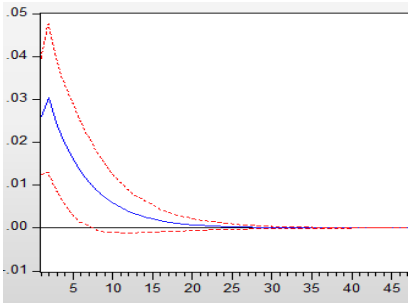

Figure 2a. The response of Y_C to the pulse X1_C, E = 0.07.

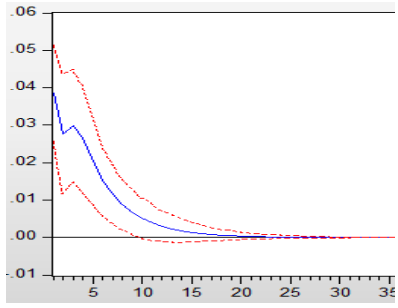

Figure 2b. The response of Y_C to the pulse X2_C, E = 0.04.

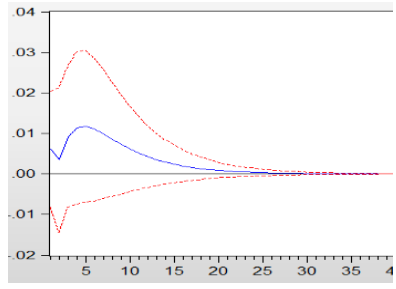

Figure 2c. The response of Y_C to the pulse X5_C, E = -0.05.

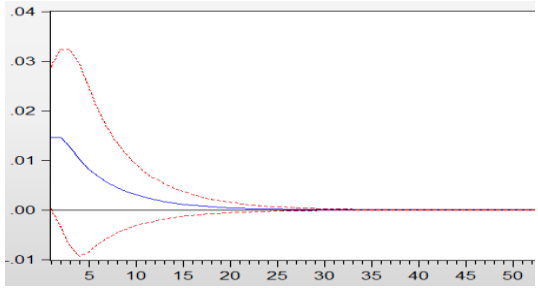

Figure 2d. The response of Y_C to the pulse X6_C, E = 0.07.

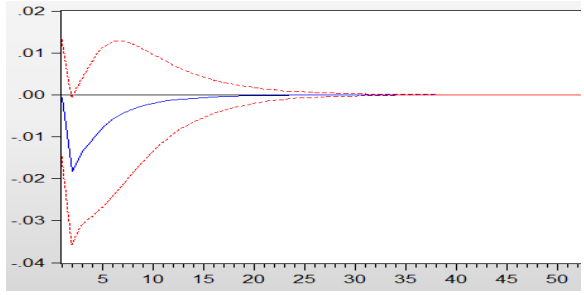

Figure 2e. The response of Y_C to the pulse X7_C, E = -0.04.

Figure 2. The response of the Russian of real GDP index (Y_S) to internal impulses

The calculated elasticity indicators reveal a positive impact on economic stability and the dynamics of the real GDP of Russia of the following internal impulses: as an increase in the industrial production index, an increase in the money market rate, an increase in the ratio of the current balance of payments to GDP and a negative effect of the increase in the ratio of external debt to GDP, ruble devaluation. The transmission mechanism of the influence of the Chinese economy on the

Russian economy is realized through production (indicator X1) and currency (indicator X7) shocks (Figure 3).

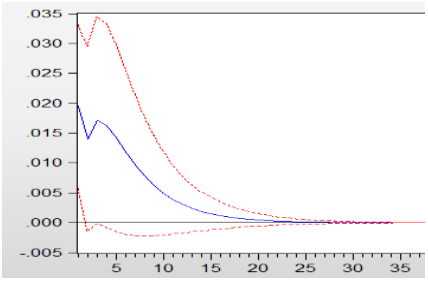

Figure 3a. The response of У_C to the pulse X1_C1, E = 0.14

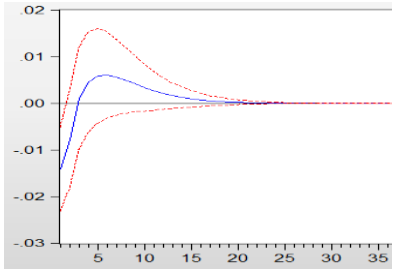

Figure 3b. The response of X1_C, to the pulse X1_C1, E = 0.11

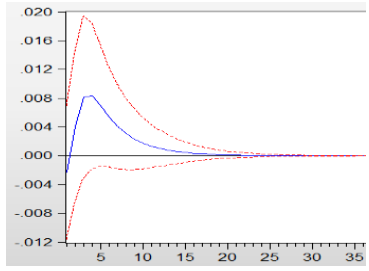

Figure 3c. The response of X5_C to the pulse X1_C1, E=-0.29

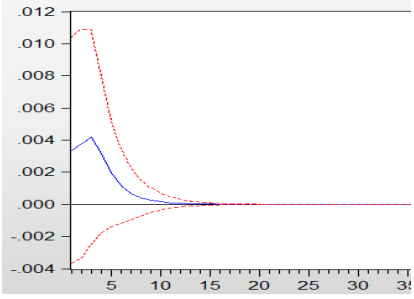

Figure 3d. The response of X6_C to the pulse X1_C1, E=0.32

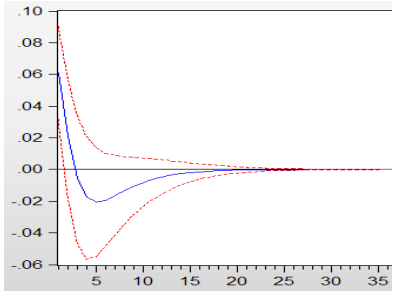

Figure 3e. The response of X7_C to the pulse X1_C1, E=-0.08

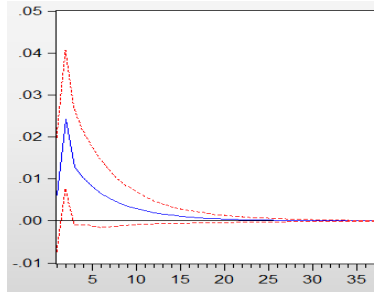

Figure 3f. The response У_C to the pulse X7_C1, E=-0.13

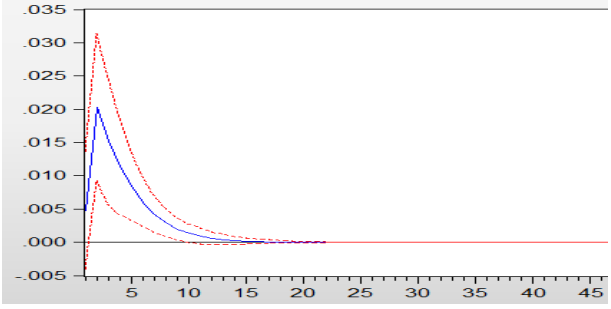

Figure 3g. The response of X1_C to the pulse X7_C1, E=-0.10

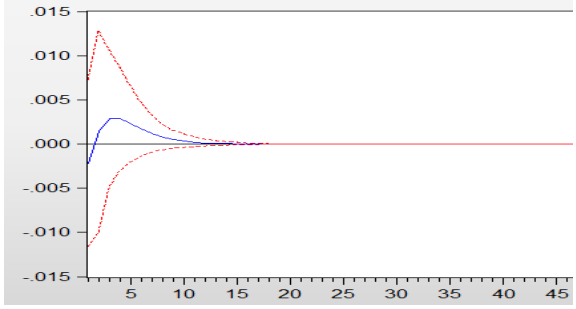

Figure 3h. The response of X5_C to the pulse X7_C1, E=0.25

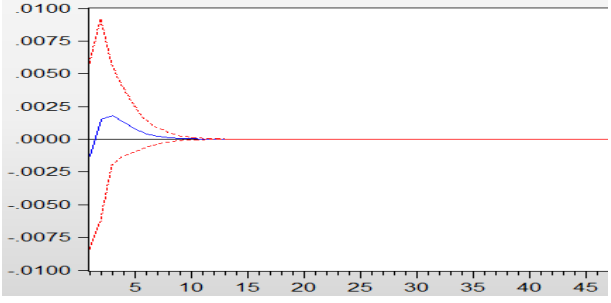

Figure 3i. The response of X6_C to the pulse X7_C1, E=-0.44

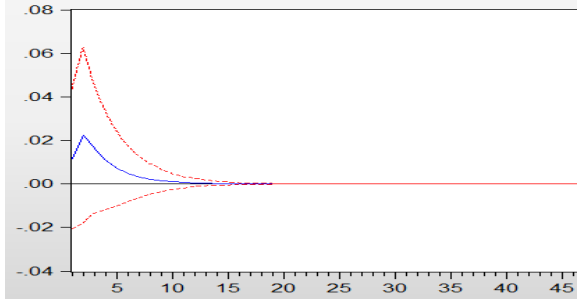

Figure 3j. The response of the X7_C to the pulse X7_C1, E=0.10

Figure 3. The response of indicators of economic stability of Russia (У _S, X1_C, X5_C, X6_C, X7_C) to external impulses of the Chinese economy

The reaction of the Russian economy to the production shock is expressed through the trade channel, by means of the changes in the external consumption of energy resources. Decrease in China's industrial production (X1_C) contributes to:

- A decrease in demand for Russian oil products.
- A decrease in the current account balance of payments caused by a decrease in exports (X6_C).
- Production decline (X1_C).
- Reduction of the filling of the budget revenues, which causes the increase of debt burden (X5_C).
- Devaluation of the ruble exchange rate (X7_C) caused by reduction of the dollar supply.
- A decrease in China's industrial production index by 1% contributes to:
- A decrease in Russia's industrial production index by 0.11%.
- An increase in the ratio of the external debt to GDP by 0.29%.
- A decrease in the ratio of current account balance of payments by 0.32%.
- Ruble devaluation by 0.08% percentage points
- The total decline in the real GDP index was estimated as 0.14%.

Currency shock, i.e. a Yuan rate change, using the example of devaluation, contributes to appreciation of imports. As a result, China is trying to reduce its volume. Reducing importation of goods and services reduces Russia's export earnings, balance of payments, production, and GDP. Besides, it leads to an increase in the ratio of external debt to GDP. As a result of modeling, it was found that Yuan devaluation by 1% contributes to a decrease in the production index of Russia by 0.10%, an increase in the ratio of external debt to GDP by 0.25%, a decrease in the ratio of current account balance of payments by 0.44%, and ruble devaluation by 0.10%. The total decline in the real GDP index was estimated as 0.13%. The US impact on Russian economy stability is significantly determined by a monetary shock (Figure 4).

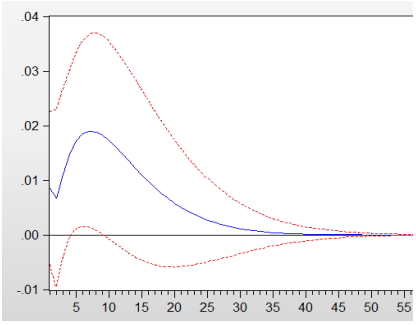

Figure 4a. The response of Y_C to the pulse X2_C11, E = -0.11

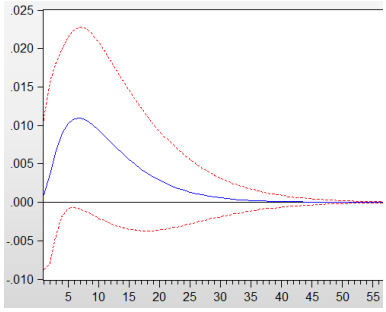

Figure 4b. The response of X1_C to the pulse X2_C11, E=-0.09

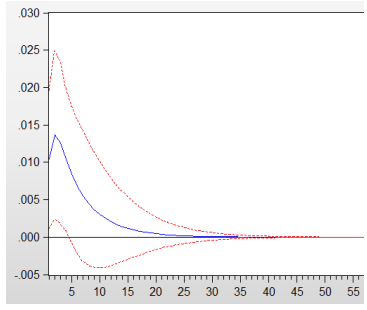

Figure 4c. The response of X5_C to the pulse X2_C11, E=0.12

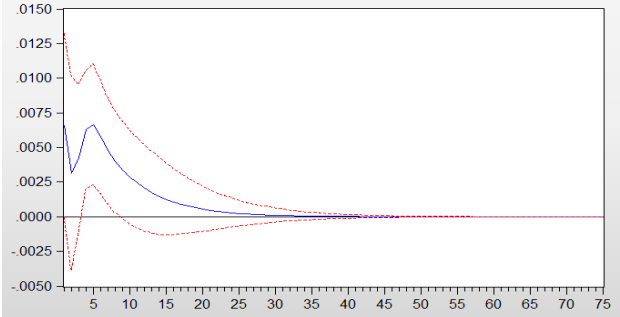

Figure 4d. The response of X6_C to the pulse X2_C11, E=-0.11

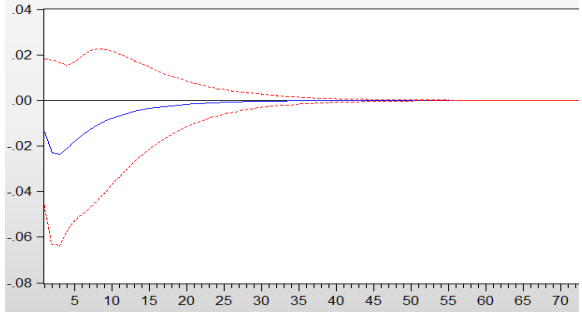

Figure 4e. The response of X7_C to the pulse X2_C11, E=0.08

Figure 4. The response of indicators of Russian economy stability to external impulses from the United States

An increase in the US money market rate leads to a revaluation of the dollar and lower oil prices, which affects the Russian economy. The US increase in the average weighted interest rate on loans by 1% contributes to:

- A decrease in Russia's production index by 0.09%;
- An increase in the ratio of external debt to GDP by 0.12%;
- A decrease in the ratio of current transactions of the balance of payments by 0.11%;
- Ruble devaluation by 0.08%;
- A decrease in the real GDP index by 0.11%.

The study showed the most significant impact on the Russian economy by the oil prices shock, determined by the world prices for Brent oil (Z1). This factor is based on the systemic function of the fuel and energy complex for the Russian economy, in particular, for the oil market (Figure 5).

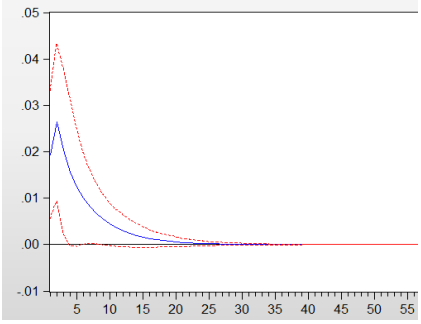

Figure 5a. The response of Y_C to the pulse Z1, E=0.21

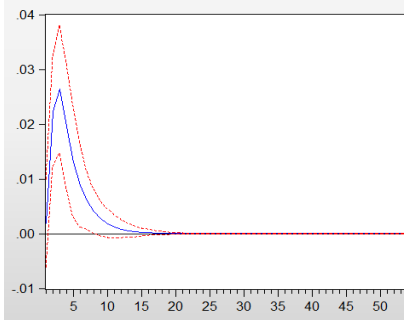

Figure 5b. The response of X1_C to the pulse Z1, E=0.16

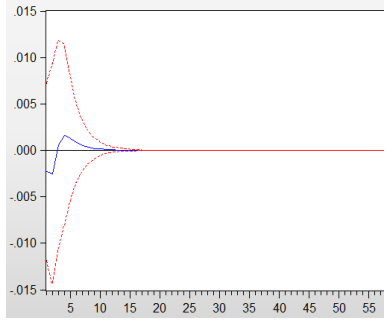

Figure 5c. The response of X5_C to the pulse Z1, E=-0.42

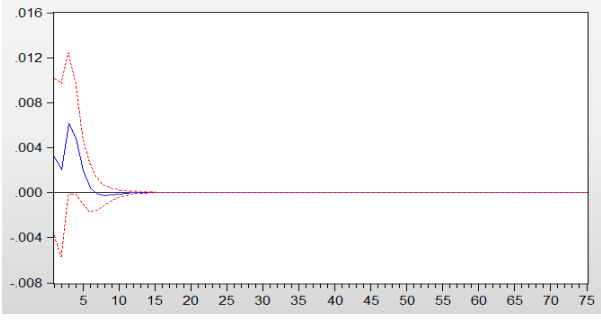

Figure 5d. The response of X6_C to the pulse Z1, E=0.60

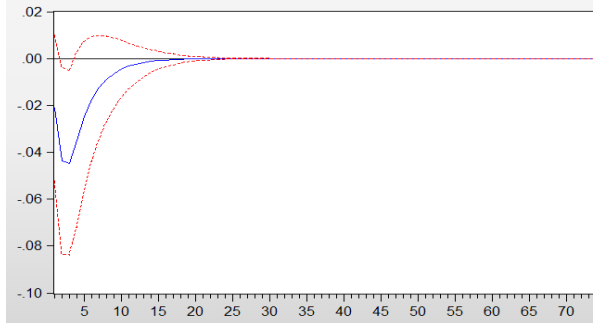

Figure 5e. The response of X7_C to the pulse Z1, E=-0.11

Figure 5. The response of indicators of Russian economy stability to global impulses

A decrease in world prices by 1% affects the following aspects:

- Oil exports and GDP (a decrease of 0.21%) due to exports decrease;
- Current account of the balance of payments (decrease of X6 by 0.6%);
- Production (decrease of X1 by 0.16%);
- Reduces the filling of the budget revenues, that leads to debt burden increase (an increase of X5 by 0.42%);
- Ruble devaluation (by 0.11%) due to the prolongation of the dollar decline.

The calculated indicators of elasticity for global shocks modulo exceed the values of the corresponding indicators for internal and external shocks. This indicates the greatest degree of dependence of the Russian economy stability on world oil prices. The smallest impact on the real GDP index is performed by internal shocks. The change in the real GDP index influenced by the internal

shocks is in the range 0.04-0.07, index influenced by the external shocks is in the range 0.11-0.14, and indexes influenced by global shocks comprise 0.21%.

5. DISCUSSION

The study was based on the development of a vector autoregressive model. As a result, it was possible to determine the character and priority of the shock's impact on the stability of Russian economy. In addition, the authors analyzed the features of the shocks' impact on the countries whose economic development significantly influences the global economy and whose external positions, if deviated in conditions of perfect competition and unstable price regulation, bring risks for the global economy. The applied approach to assessing the shocks' impact on economic stability has some key differences from well-known studies on this issue (Cochrane, 2004; Watson, 2012). Firstly, the time frame of the study is from 2000 to 2018. Thus, it includes the period of the first reaction of the Russian economy to the sanctions, and the succeeding quarters. Therefore, two crises were covered (the crisis of 2008–2009 and the crisis after 2013–2014). Since the period of crisis is characterized by the most significant shocks, we got the opportunity to conduct a natural experiment, resulting in more accurate estimates of the impact. Secondly, the sample of the external and internal shocks' influence on the Russian economy met the following characteristics:

- It should be exogenous in relation to the other current and lagged endogenous variables in the model.
- It should not correlate with other exogenous shocks.
- It must represent either unforeseen movements in exogenous variables or forecast future movements in exogenous variables.

The study conducted by the authors is significantly different to the current research (Mallick and Sousa, 2012; Mountford and Uhlig, 2009). Thus, it was possible to estimate the empirical components of the shocks and identify the causal relations of exogenous shocks.

It is worth highlighting that the presented approach to the assessment of macroeconomic impulses' impact on the economic stability made it possible to refute the theory that external shocks do not influence developing economies as much as the internal ones (Sanchez, 2007). The authors used the Granger causality test to prove empirically that a high probability (0.033-0.049) confirms that there is a less significant impact of internal shocks on the stability of the Russian economy. The results of the study proved the fact that the Russian economy is the most vulnerable to global shock – namely, world oil prices. This confirms the hypothesis that price fluctuations of raw materials are becoming one of the main sources of macroeconomic volatility in resource countries (Pönkä and Zheng, 2019).

The results of the study can be useful for the prevention of serious recessions and crises, and should be an integral part of the strategy of the Russian Federation to improve economic stability. The presented approach for the assessment of the economic shocks' impact is complemented with other monitoring tools and in-depth assessments that provide a holistic view of risks to the country. Countries without significant domestic or external imbalances can also be influenced by external shocks through spillovers and distribution via trade, financial and confidence channels. Nevertheless, the aim of the study is to identify the character and priority of the shocks' impact on the stability of a particular country. Therefore, due to the limited sampling, the results cannot be implemented into the economic practice of other countries. In addition, the dual long-term character of the shocks' impact on the economic stability has not been investigated. It will be the purpose of the further scientific research.

CONCLUSION

The results of the empirical study provided the conclusions and recommendations that can be useful to reduce dependence on global markets fluctuations and for the development of preventive measures for the Russian economy. The dynamics of exogenous external and global shocks predetermines a significant proportion of fluctuations in key indicators of the Russian economy. The change in the real GDP index influenced by the internal shocks is in the range from 0.04% to 0.07%, influenced by external shocks is in the range from 0.11% to 0.14%, and influenced by global shocks comprises 0.21%. The most significant dependence of the Russian economy is observed in relation to the shocks of the global raw materials and financial markets. In addition, the Russian economy is influenced by trading partners such as the United States and China. It is necessary to provide distinct economic policy and structural reforms that would reduce the dependence of the Russian economy on foreign markets. Structural reforms will contribute to the diversification of the Russian economy. This will protect the exchange rate and the balance of payments from fluctuations in the global oil market.

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