THE IMPACT OF EXTERNAL FACTORS ON THE SENSITIVITY OF THE MAIN MONETARY POLICY INDICATORS. EVIDENCE FROM VAR ANALYSIS.

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Introduction. The literature about small open economies shows that their aggregate supply, aggregate demand, and therefore economic activity and price movements mainly depend on the dynamics of large economies [Krznar I. et al., 2010]. As a small open economy, Armenia is also exposed to global shocks directly, or indirectly through the impact of those shocks on its major trading partners. From the descriptive statistics of the time series of inflation and output gap in Armenia, it becomes clear that both indicators have volatile behavior in the short run [Levonyan, 2022]. In order to reveal the causes of this fluctuations, the impulses of inflation, exchange rate and output gap to the shocks of external factors were analyzed in this article, and revealed the transmission mechanisms, through which these shocks are transmitted to domestic economy.

Methodology. To assess the impact of external shocks on the main monetary policy indicators of Armenia, 3 vector autoregressive models were constructed, which represent the impact of the macroeconomic shocks of Russia, Eurozone countries and USA. The data is collected from IMF and Armenian CB statistics. Observations include quarterly data from 2003 to 2021. The variables included in the models are:

$$Y_t = \begin{bmatrix} D(\log(oilprice))_t \\ US\_output\_gap_t \\ D(US\_inflation)_t \\ US\_rates_t \\ D(\log(ReerUSD))_t \\ output\_gap_t \\ y\_y\_core\_inflation_t \\ d(\log(reer))_t \end{bmatrix}, Y_t = \begin{bmatrix} D(\log(oilprice))_t \\ EU\_output\_gap_t \\ D(EU\_inflation)_t \\ EU\_rates_t \\ D(\log(ReerEUR))_t \\ output\_gap_t \\ y\_y\_core\_inflation_t \\ d(\log(reer))_t \end{bmatrix}, Y_t = \begin{bmatrix} D(\log(oilprice))_t \\ RUS\_output\_gap_t \\ D(RUS\_inflation)_t \\ RUS\_rates_t \\ D(\log(ReerRUB))_t \\ output\_gap_t \\ y\_y\_core\_inflation_t \\ d(\log(reer))_t \end{bmatrix} \quad (1)$$

where: $oilprice$ is the world oil prices,

US_output_gap, EU_output_gap, RUS_output_gap are the output gaps of the USA, Euro zone countries and the Russian Federation respectively.

$US\_inflation$, $EU\_inflation$, $RUS\_inflation$ are the inflation of the USA, Eurozone countries and the Russian Federation.

US_rates, EU_rates, RUS_rates are the interest rates of the US Federal Reserve, European Central Bank, Russian Central Bank,

$ReerUSD$, $ReerEUR$, $ReerRUB$ are real effective exchange rate of dollar, euro, ruble, $output\_gap$- Armenia's output gap, $y\_y\_core\_inflation$ core inflation in Armenia,

$reer$ - is the real effective exchange rate of the dram.

To ensure the stationarity, the time series of real effective exchange rate, world oil prices are represented in logarithmic differences, the series of the partner countries' inflation is presented in the form of the first difference. The rest series are stationary. Since internal factors of Armenia cannot have any impact on external factors, therefore, for the correct identification of the model, the principle of block exogeneity was added, as proposed by Cushman and Zha [Cushman D., Zha T., 1997], the meaning of which is that 0 restrictions are placed in both the simultaneous and the lagged relationship matrices, which excludes the inverse impact of internal factors on external block. The model is recursive, and the identification scheme corresponds to the Cholesky decomposition, for which the matrix of variables' simultaneous relationship has the following form.

$$AY_t = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ A_{31} & A_{32} & 1 & 0 & 0 & 0 & 0 & 0 \\ A_{41} & A_{51} & A_{43} & 1 & 0 & 0 & 0 & 0 \\ A_{51} & A_{52} & A_{53} & A_{54} & 1 & 0 & 0 & 0 \\ A_{61} & A_{62} & A_{63} & A_{64} & A_{65} & 1 & 0 & 0 \\ A_{71} & A_{72} & A_{73} & A_{74} & A_{75} & A_{76} & 1 & 0 \\ A_{81} & A_{82} & A_{83} & A_{84} & A_{85} & A_{86} & A_{87} & 1 \end{pmatrix} \begin{pmatrix} D(\log(Crudeoil)) \\ US\_output\_gap_{\ t} \\ US\_inflation_t \\ US\_rates_t \\ D(log(ReerUSD)_t \\ output\_gap_t \\ y\_y\_core\_inflation_t \\ d(log(reer))_t \end{pmatrix} \quad (2)$$

Literature review. The literature concerned to identifying the sources of macroeconomic fluctuations in developing countries, seeking to differentiate the respective contributions of internal and external shocks to business cycles point out that external shocks often play a greater role than internal ones. The latter are usually considered as global output shocks, terms of trade (or world commodity prices) and global interest rates shocks, and, in some cases, other exogenous shocks such as natural disasters or changes in investors' risk expectations changes [Barrot et al., 2018]. In such analyses, two blocks are distinguished in the model: exogenous (external variables) and endogenous (internal variables), and a restriction is introduced in the model such that internal variables can not affect the external block. This approach was used in many analyses: [Kim & Roubini, 2000], [Dungey & Pagan, 2000], [Zaidi et al., 2010]. Taking into account the global economy's growing level of integration, it is a primary importance to analyze the impact of international developments on small open economies. In order to conduct an effective policy in such countries, it is also important to analyze the transmission mechanisms through which the impacts of these developments can be transmitted to domestic economy [Belhedi M. et al., 2015]. Dependence on external

shocks for small open economies can be explained by several circumstances. Developing countries have weaker "shock absorbers", which can be distinguished as financial markets to diversify macroeconomic risk and stabilization policies to counter aggregate shocks [Loayza et al., 2007]. Another channel for counteractting macroeconomic volatility, particularly inflation volatility, is trade openness. According to Romer, there is a negative relationship between trade openness and inflation. Countries with greater trade openness correspond to a lower level of inflation and in these countries the Phillips curve is steeper [Romer, 1993]. Moreover, based on this hypothesis, empirical analyzes show that there is also a negative relationship between trade openness and inflation volatility [Bowdler & Malik, 2017].

Scientific novelty. Based on estimation of vector autoregressive models (VAR), the main external factors affecting inflation, output gap and exchange rate volatility in Armenia were identified. Analysis revealed that the domestic variables are highly sensitive to external shocks. Domestic variables are affected not only by global supply and demand shocks, but also by counterpart countries' real effective exchange rate and interest rate shocks. The possible transmission mechanisms of the above-mentioned shocks on the Armenian economy have been formed.

Analysis. To examine the results of the VAR analysis, the impulse-response functions of 3 internal variables, namely output gap, core inflation, and exchange rate to a standard deviation shock of external factors are considered. The response functions of VAR models are combined for better illustrating the difference in shocks transmitted from partner countries. Figure 1 shows the response of domestic variables to a shock to world oil prices. As can be seen from the obtained results, the responses of internal variables in 3 estimated models are similar, which can be considered as a measure of the model's quality.

Figure 1. Response of Domestic Variables to oil price shock
a) Output response

b) Inflation response

c) Exchange rate response
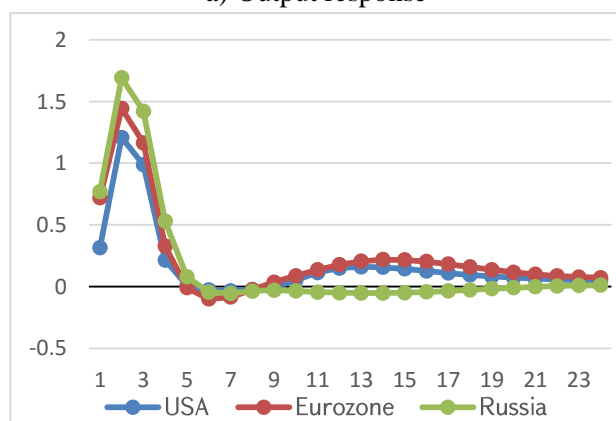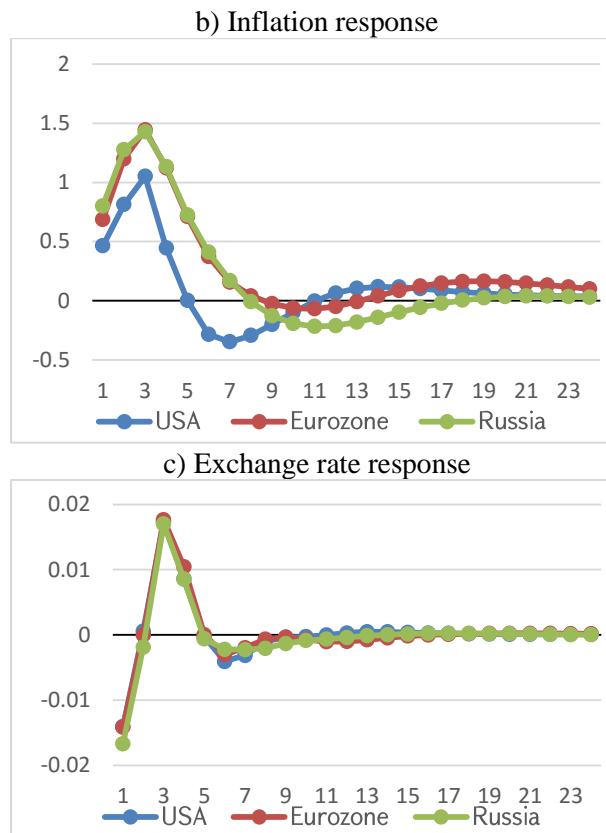
Source: author's calculations

Results show that one-unit standard deviation shock to the oil price leads to acceleration of both inflation and output. Since Armenia is an oil importing country, the output response may seem contradictory, but this reaction may have several explanations. The first is that the positive shock of oil prices leads to a sharp increase in output of the Russian Federation, and the Russian Federation is the main trading partner of Armenia, the increase in the gross income of which can be transmitted to the Armenian domestic output with several channels, namely through increase in exports, in remittances, the state debt and other ways. The second explanation is that ores and metals have huge share in Armenia's exports, the prices of which have a positive correlation with oil prices. To clarify the above-mentioned thesis, a linear regression model was estimated, which shows the positive relationship between the price of oil and non-oil commodities[1].

$$Commodity_t = \alpha_1 + \alpha_2 Oil_t + \varepsilon_t, \qquad t = \overline{2006Q1, 2021Q4}, \qquad (3)$$

[1] Data collected from Federal reserve's statistics https://fred.stlouisfed.org/series/PNFUELINDEXQ

Table 1. Results of the estimated model

Dependent Variable: D(LOG(COMMODITY))				
Method: Least Squares				
Sample (adjusted): 2006Q1 2021Q4				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(OIL))	0.256516	0.031322	8.189757	0.0000
C	0.009954	0.005382	1.849418	0.0392
R-squared	0.519648	Mean dependent var		0.011245
Adjusted R-squared	0.511901	S.D. dependent var		0.061607
S.E. of regression	0.043041	Akaike info criterion		-3.422568
Sum squared resid	0.114858	Schwarz criterion		-3.355103
Log likelihood	111.5222	Hannan-Quinn criter.		-3.395990
F-statistic	67.07211	Durbin-Watson stat		1.798914
Prob(F-statistic)	0.000000			

Source: author's calculations

The obtained results show that there is a clear positive relationship between varia-bles, due to which the positive shock of oil prices leads to an increase in prices of Armenia's mining export, which in turn leads to the positive response of output. Since oil-based products are an important component of CPI, the first-stage effect of higher oil prices is a sudden increase in prices due to rising production costs. [Galesi & Marco, 2009]. A positive oil price shock in Armenia leads to a significant accelerative response of inflation, which reaches its maximum growth in the 3rd quarter, after which the stabilization process begins. The exchange rate falls sharply because of the oil price shock, which is explained by the fact that in case of higher oil prices, it is necessary to buy a larger amount of foreign currency, which leads to an increase in the demand for it and, therefore, dram depreciation. However, starting from the 2nd quarter, dram starts to appreciate, due to the fact that oil prices and real effective exchange rate of dollar have a negative relationship, due to which dram can appreciate against the dollar.

Figure 2. The response of domestic variables to a shock of output gap of partner countries
a) Output response

b) Inflation response


c) Exchange rate response
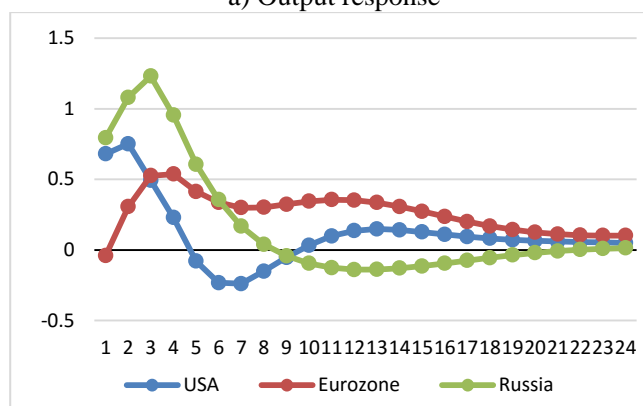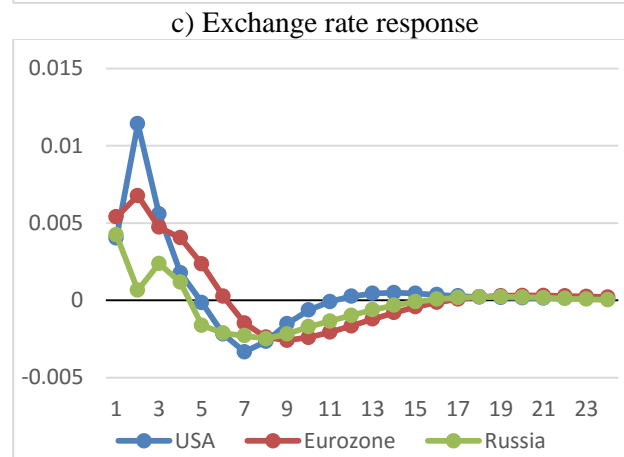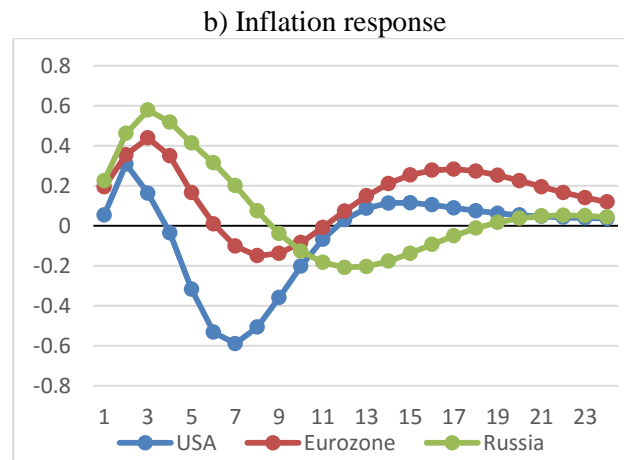
Source: author's calculations

As it becomes clear from the obtained results, all domestic variables are sensitive to the output shocks of partner countries. The response of inflation, output and exchange rate is positive, but the magnitude and duration of the impact are different depending on the considered country's shock. The positive output shock of the Russian Federation leads to a positive reaction of output gap and inflation in Armenia, which has the greatest impact on the domestic variables compared to the observed countries. As a result of the shock, both output and inflation reach their maximum in the 3rd quarter, after which the stabilization process begins, and the positive shock vanishes from the 9th quarter. In case of Europe and USA, these effects are also significant and lead to the acceleration of inflation and output gap in Armenia.

The exchange rate starts to appreciate because of the observed shocks, which can be explained by the fact that output growth in the partner country through the increase of imports, remittances, foreign direct investments, tourism leads to the stimulation of demand for the national currency, which leads to the appreciation of dram.

Figure 3. The relationship between remittances and exports with the output growth of RF
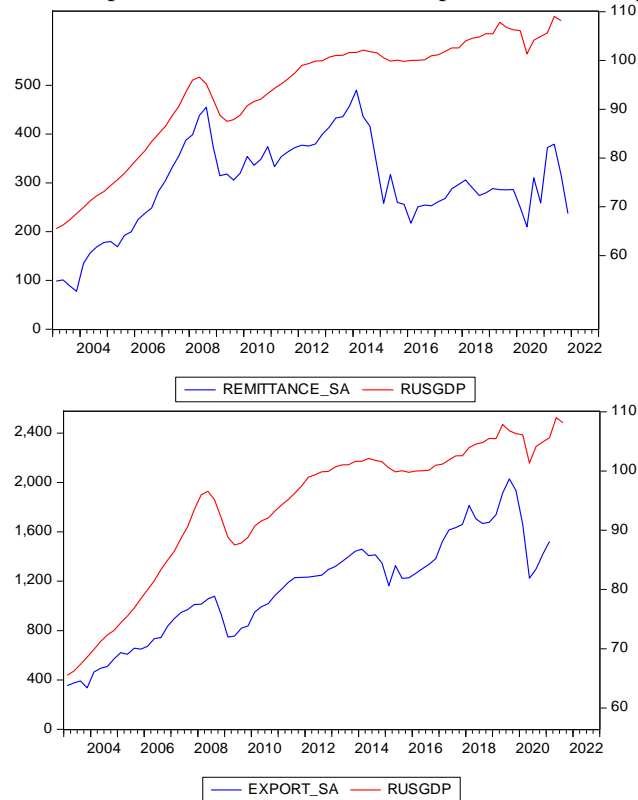

Source: author's calculations based on data of Statistical Committee of RA and IMF

As an example, in figure 3 is shown the relationship between RF's output growth and the volume of exports and remittances of Armenia. It is noticeable that remittances and export volumes in Armenia have a positive correlation with the real output growth of Russia, due to which the positive shock of Russian output gap is positively transmitted to the Armenian economy.

a) Output response

b) Inflation response

c) Exchange rate response
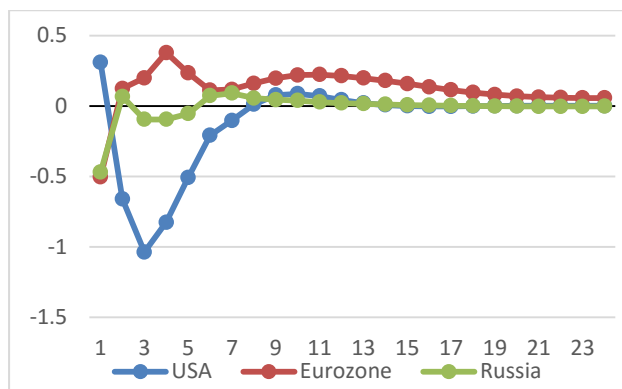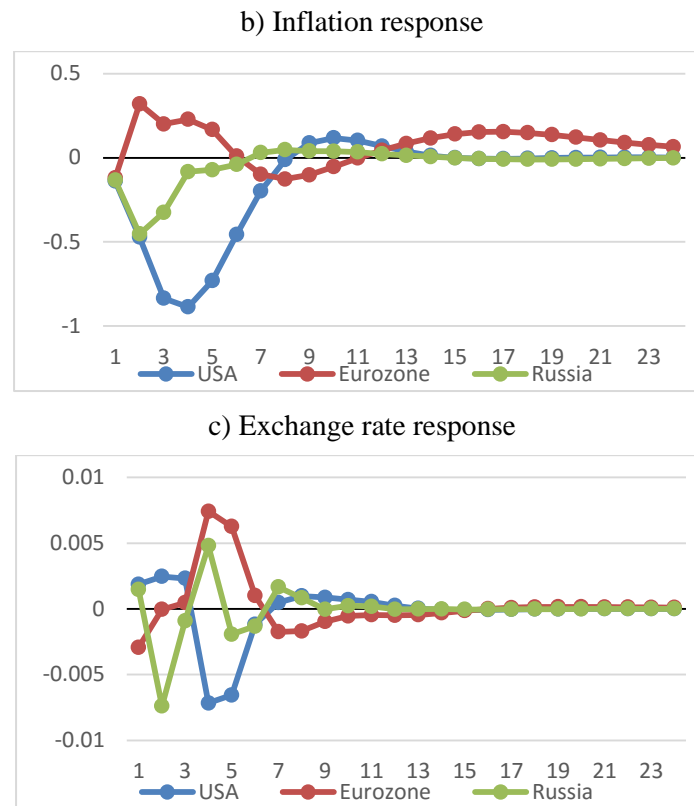
Source: author's calculations

Figure 4 shows the response of domestic variables to a unit standard deviation shock of the real effective exchange rates of the dollar, euro, and ruble. The response functions seem quite different from each other. Figure 4. Response of Domestic Variables to a shock in the Real Effective Exchange Rate of Partner Countries. Even though GDP has a negative response to ruble appreciation, the shock almost completely fades after first quarter. The appreciation of the dollar leads to a decline in output and inflation rates. This interaction can be explained by the income effect [Druck M.P., Magud M.N., 2015]. As the dollar appreciates, prices for commodities tend to fall, and weaker commodity prices suppress domestic demand by reducing real incomes. The empirical analysis also supports this view, since it is noticeable that along with the appreciation of the dollar, the oil prices decrease, the decrease of which has a negative effect on the output and inflation rates of the Republic of Armenia. It is noticeable that starting from the 3rd quarter, the euro shock leads to dram appreciation, and the dollar shock leads to depreciation. In both cases, the shocks fade in the 7th quarter. The main reason for this interaction is that dollar and euro have a negative linear relationship, which means that appreciation of dollar is accompanied by depreciation of euro and vice versa. The results of the correlation analysis document that the positive effect of the euro's shock on output

and inflation is due to euro's depreciation is a cause or a consequence of the appreciation of the dollar, which has significant impact on the Armenian economy.

Table 2. The correlation between dollar and euro real effective exchange rates

Covariance Analysis: Ordinary
Sample: 2003Q1 2021Q4
Included observations: 76

Correlation		
Probability	REER_EUR	REER_US
REER_EUR	1.000000	

REER_US	-0.288167	1.000000
	(0.0116)	-----

Source: author's calculations

Figure 6. The responses of domestic variables to a shock in partner countries' interest rates

a) Output response

b) Inflation response

c) Exchange rate response
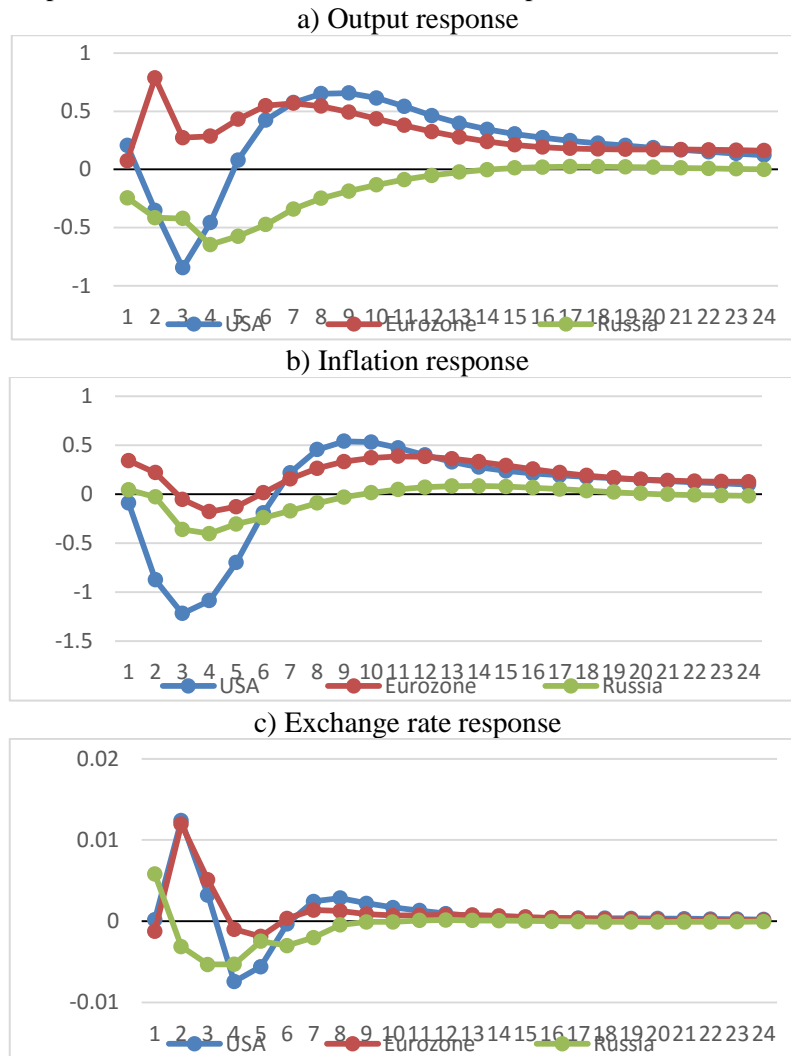
Source: author's calculations

Figure 6 shows the response of domestic variables to the monetary policy (interest rate) shock of partner countries. Domestic output is negatively affected by the monetary policy shocks of the Russian Federation and the USA, and inflation is mostly affected by the increase in the interest rate of the US Federal Reserve.

Some analyzes document the important role of US monetary policy for developing countries. According to the analysis of the International Monetary Fund [Arora & Cerisola, 2000], US interest rates lead to a decrease in real GDP and domestic demand among developing countries. There is a significant difference in the macroeconomic impact between countries with a negative and positive trade balance, with countries with a negative trade balance experiencing a much greater negative impact. A reduction in capital inflows, an increase in the cost of servicing the dollar public debt, as well as the risk of taking new, more expensive debt contribute to such effect [Calvo G. et al., 2001].

Conclusions. Summarizing the results obtained from the empirical analysis, the following conclusions can be drawn.

- global shocks have a major contribution of the small open economies' macroeconomic volatility. In most cases, inflation and output volatility is much more sensitive to external shocks, rather than internal.

- world oil price shocks have strongest impact on volatility of domestic macro-economic performance. Higher oil prices lead to higher output and inflation. The main channels through which these effects transmit to Armenian economy is the increase of main trading partners' income and increase in Armenian mining export prices.

- As a result of a positive shock of the partner countries' (group of countries) output gap, domestic variables react positively. The strongest impact on output and inflation is Russian output shock. This effect is mainly transferred to the Armenian economy by increasing the volume of remittances and exports.

- Dollar appreciation leads to a reduction of output and inflation rates. This interaction can be explained by the income effect. As the dollar appreciates, world commodity prices tend to fall, which in turn suppress domestic demand through lower real incomes.

- Dram's real effective exchange rate response analysis show that starting from the 3rd quarter, the euro shock leads to dram appreciation, and the dollar shock leads to depreciation. In both cases, the shocks fade in the 7th quarter. The main reason for this interaction is that the dollar and the euro have a negative correlation, which means that an appreciation of the dollar is accompanied by a depreciation of the euro and vice versa.

- Empirical analyzes show that US interest rates lead to Armenian output and inflation slowdown, which is in accordance with the literature related to the US monetary policy shocks to developing countries. It is noticeable, that among considered

trading countries, US monetary policy shock have the most significant impact on domestic macroeconomic stability.

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Anahit MKRTCHYAN, Suren LEVONYAN
The impact of external factors on the sensitivity of the main monetary indicators. Evidence from var analysis
Keywords: monetary policy, external factors, shock, inflation, output gap

The macroeconomic instability of a small open economy creates impediments for effective policy making and stabile economic growth of the country. Armenia also suffer from a problem of macroeconomic volatility. The article aims to analyze the causes of this fluctuations, for which three vector autoregressive models were constructed and estimated, which show the impact of partner countries' macroeconomic shocks to inflation, output, and real effective exchange rate of Armenia. The article also refers to the possible channels through which these shocks can be transmitted to the domestic economy. The results show that the macroeconomic fluctuations of Armenia is more sensitive to the shocks of the Russian world oil prices, Federation's output, the interest rate of the US Federal Reserve and dollar's real effective exchange rate.