NATIONAL BANK OF KAZAKHSTAN

A CROSS-BORDER DYNAMICS OF INFLATIONARY PROCESSES IN THE EURASIAN ECONOMIC UNION (EAEU): AN EMPIRICAL ASSESSMENT

Research and Statistics Department
Working Paper No.2017-5

Tuleuov Olzhas

The Working Paper and Analytical Note series of the National Bank of Kazakhstan (the "NBK") are designed to disseminate the results of the NBK's studies as well as other scientific and research works of the NBK staff. The results of research activity are disseminated with a view to encourage discussions. The views expressed are those of the authors and do not necessarily reflect the official views of the NBK.

A Cross-Border Dynamics of Inflationary Processes in the Eurasian Economic Union (EAEU): an Empirical Assessment

June 2017

NBRK – WP – 2017 – 5

The author expresses his gratitude to participants of the 14th Annual Seminar "Monetary Policy Spillovers" conducted jointly with National Banks of Poland and Switzerland in May 2017 for their valuable comments to this study.

A Cross-Border Dynamics of Inflationary Processes in the Eurasian Economic Union (EAEU): an Empirical Assessment

Tuleuov Olzhas[1]

Abstract

The Eurasian Economic Union (the EAEU) is an actual example of how close economic and trade relations develop at the regional level. The absence of trade barriers among the Customs Union member countries increases, among other, the secondary cross-border effects of interrelation of inflationary processes in the EAEU member countries. This, in turn, questions the effectiveness of independent monetary policy implemented in each member country that is aimed to stabilize the behavior of domestic consumer prices, in the first instance. Hence, it is important to study and determine those regularities and factors governing the behavior of domestic inflation in the EAEU member countries which stem from the impact of the cyclical or shock change in consumer prices in other member countries.

Thus, the purpose of this paper is to provide an empirical assessment of regularities and phenomena in the cross-border dynamics of inflationary processes in the EAEU based on SVAR models (structural vector autoregression).

Key words: *Eurasian Economic Union, cross-border inflation dynamics, inflationary processes, prices of traded goods, secondary cross-border effects, international trade, SVAR-modeling, Kazakhstan, Russia, Belarus, Armenia, Kyrgyzstan.*

JEL Classification: *C32; C53; E31; F15.*

[1] Tuleuov Olzhas is a leading analyst in the Division of Macroeconomic Forecasting and Monitoring, Research and Statistics Department, National Bank of Kazakhstan. E-mail: Olzhas.Tuleuov@nationalbank.kz

Contents

Introduction…… 3
Literature Review…..…….. 4
Practical Aspects of the EAEU……...……..... 5
Methodology and Data Description…….…….... 10
Discussion of Results…….…….…… 17
Conclusion……...…. 20
References…… 21
Appendix…….. 22

1. Introduction

At present, such phenomena as the international globalization and integration of national economies, the growth of free capital movements and labor resources among the countries still represent some of the main global trends.

In doing so, such processes have both positive and negative implications for the countries. Positive effects include the output growth, mitigation of trade barriers, and the household welfare. In turn, negative implications include the growth of secondary international spillovers of globalization and integration processes for the member countries that are expressed in the increasing cross-border transfer of economic and financial shocks.

In terms of the monetary policy, the transmission of secondary international spillovers into the consumer price behavior is crucial.

In this context, the key question is whether central banks can still control inflation on their own, especially in a small open economy, given the increasingly close economic relations with other economies.

The Eurasian Economic Union (the "EAEU") is an actual example of how close economic and trade relations develop at the regional level. The absence of trade barriers among the Customs Union member countries increases, among other, secondary cross-border effects of interrelation of inflationary processes in the EAEU member countries. This, in turn, questions the effectiveness of independent monetary policy implemented in each member country and aimed to stabilize the behavior of domestic consumer prices, in the first instance. Hence, it is important to study and determine those regularities and factors governing the behavior of domestic inflation in the EAEU member countries which stem from the impact of the cyclical or shock change in consumer prices in other member countries.

Thus, the purpose of this paper is to provide an empirical assessment of regularities and phenomena in the cross-border dynamics of inflationary processes in the EAEU based on SVAR models (structural vector autoregression). It should be noted that the main advantage of these models is the ability to impose structural limitations on the linear interdependencies of the analyzed multidimensional time series, proceeding from the economic logics of the process being studied.

The further structure of this paper is presented by: a review of the literature, consideration of practical aspects of the EAEU functioning, description of the research methodology and the data used, and discussion of the results obtained.

2. Literature Review

The study of the influence of various external factors including globalization and integration on the inflation rate, the assessment of cross-border behavior of consumer prices is a relatively new area in the applied economic studies. In particular, Ciccarelli and Mojon (2010) analyze the relationship between the world's inflation rates and consumer price indices in the countries of the Organization for Economic Cooperation and Development. Based on the time

series data, the authors argue that the country-specific inflation rates are basically a global phenomenon, that is, individual countries tend to take on the global inflationary pressure. Moreover, global inflation will reflect global trends, such as changes in the prices of food and manufactured goods or the pattern of business cycles.

In this regard, some studies focus on studying the impact of specific global inflation factors on price changes in specific countries. So, Borio and Filardo (2007) in their study make the conclusion that the global production deficit is the key determinant of domestic inflation. However, according to the theoretical model designed by Woodford (2007), the capabilities of national central banks to control inflation will not be jeopardized by the increasing global integration of markets. At the same time, it is important that exchange rates adapt to changes in economic conditions in a flexible way. Nevertheless, as the author points out, the behavior of the economy is also affected by its degree of openness, which must be taken into account when implementing the monetary policy.

These results also correspond to observations made by Mishkin (2009) and Bernanke (2007). However, Rey (2015) focuses on how much international capital flows affect the ability of central banks to pursue an independent monetary policy. The author believes that an independent monetary policy in small economies with free capital movement faces a "dilemma" instead of the traditional "trilemma" (Mundell, 1963). So, even with flexible exchange rates, capital flows and the monetary conditions of these countries are significantly affected by the global financial cycle, which is largely determined by the monetary policy of large economies.

Neely and Rapach (2011) assess the links in the cross-border Inflation dynamic through a model with unobservable variables that explains the rates of change in consumer prices in 64 countries by global, regional and individual factors. Based on the results of the authors' assessment, it was determined that global and regional factors account for 35% and 16% of the annual inflation rate, respectively, on average across countries, that is, the total international influence explains more than half of the variability of internal country inflation. At the same time, the importance of global and regional factors of domestic inflation became more significant for a number of countries in the North and Latin America, Asia and Europe only after the 1980s.

3. Practical Aspects of the EAEU

The first prerequisites for the establishment of modern EAEU appeared almost immediately after the collapse of the USSR. In 1995, Belarus, Kazakhstan and Russia entered into their first agreements. Russia had signed the first agreements about a future establishment of the Customs Union that were later acceded to by Kyrgyzstan and Tajikistan. Later in 2000, these documents became the basis for the creation of the first major official integration association within

the CIS territory - the Eurasian Economic Community (Table 1 of the Supplement), or the EurAsEC, with Russia, Kazakhstan, Belarus, Uzbekistan, Kyrgyzstan and Tajikistan participating.

The next step towards a closer economic cooperation between the current EAEU member countries, namely Russia, Belarus and Kazakhstan, was the signing of an agreement in 2007 regarding the creation of a common customs territory and the Commission of the Customs Union as a common standing governing body of the Customs Union.

In fact, the Eurasian Customs Union, or the Customs Union of Kazakhstan, Belarus and Russia officially began functioning in 2010. It is important to note that the Customs Union was launched as a first step towards the establishment of a broader type of economic union of former Soviet republics, similar to the European Union. At the same time, the creation of the Customs Union should help reducing trade barriers between the member countries, being an integral part of the formation of the future common market.

From 2011, the supranational regulatory body - the Eurasian Economic Commission (the “EEC”) started to function with a view to strengthen closer economic ties for creation of the EAEU by 2015. A year later, in 2012, the same three states established the Common Economic Space (the “CES”) to promote a further economic integration. All three countries have ratified the basic package of 17 agreements governing the launch of the CES.

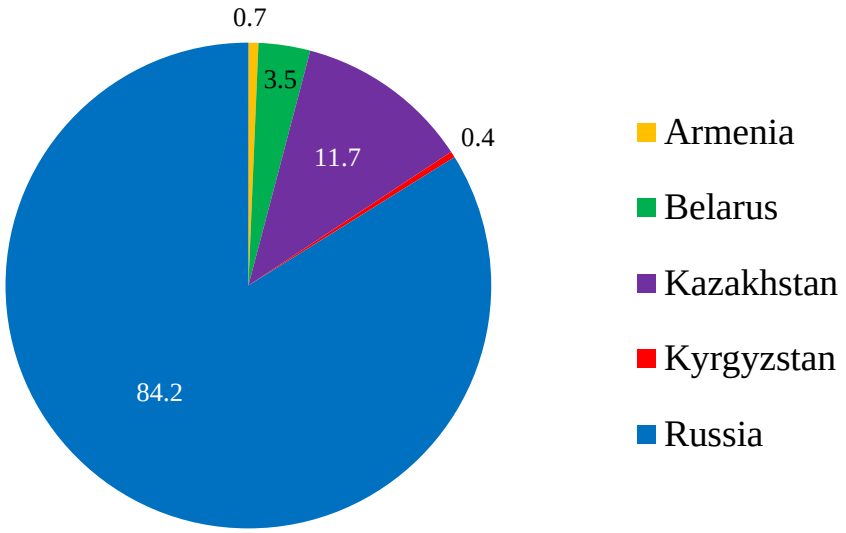
From January 1, 2015, the EAEU, whose creation was initiated by the treaty was signed in 2014, began to function and included Russia, Belarus and Kazakhstan. From January 2, 2015, Armenia became the EAEU member. In August of the same year, Kyrgyzstan joined the EAEU as its new member.

According to the EEC data, the total population of the EAEU member countries is currently 182.7 million people. According to the author's derivations, based on performance in 2015, the total GDP of the EAEU member countries amounted to USD 1 581 billion. At the same time, the shared distribution between them is characterized by a significant predominance of the relative share of Russia’s GDP (see Fig.1). In the total trade turnover between the countries of the union, which, based on performance in 2015-2016, amounted to USD 45.6 billion and USD 42.5 billion, respectively, there is also a significant predominance in the share of Russia (63%) (see Fig.2).

As mentioned above, from the point of view of the monetary policy of each of the EAEU member countries, it is very important to analyze and assess the mutual interstate influence of price level changes, or inflation, within the Union arising as a consequence of the existence and continuous development of close trade links in the absence of customs barriers. In other words, within the EAEU, the Inflation dynamic in each member country can be subject to a different degree of inflationary impact from another member country, which is one of the channels of "contagion" with possible macroeconomic shocks, the source of which is the economy of another country, its inflationary processes in particular. In this case, in

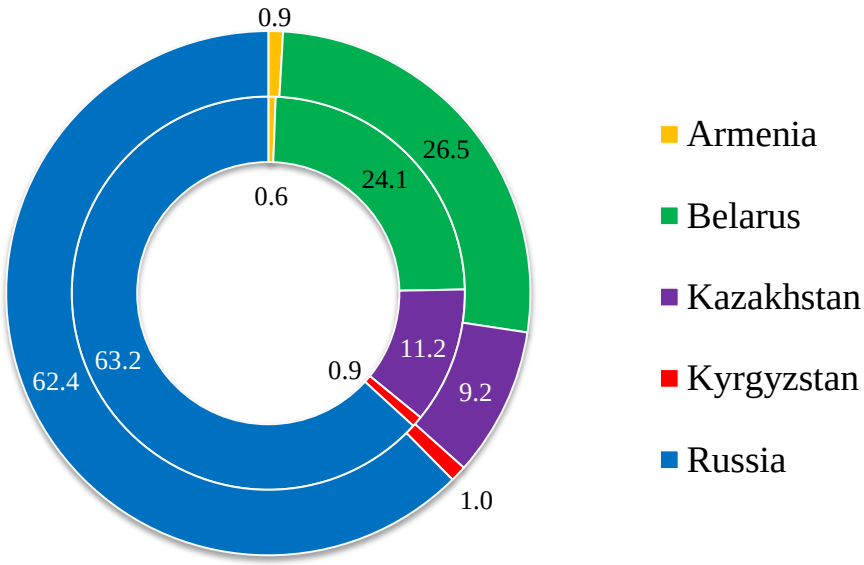
each EAEU member country the price stability may be exposed to risk, and the effectiveness of the implemented national monetary policy may be diminished.

Figure 1. The relative share of the EAEU member countries in the total volume of nominal GDP in the US Dollar equivalent at the end of 2015, %



Source: the author's derivations based on the data from Trading Economics

Figure 2. The relative share of the EAEU member countries in the total volume of trade turnover in the US Dollar equivalent, % (the inner circle -2015, outer circle - 2016)



Source: compiled by the author based on the data from the EEC

The current and historical pattern of inflationary processes in each of the EAEU member countries have both general trends caused by global economic factors and individual characteristics determined by differences in the internal structure of each economy. Figure 3 shows the annual Inflation dynamic in the EAEU countries since 2006. It may be noticed that in 2007-2008 and in 2010-2013 there is a strong positive correlation between the change in the price level in the analyzed countries, which is explained by the increase in world food prices in 2007 and in prices of energy resources – in 2010.

At the same time, inflation in Belarus in 2011-2012 demonstrated a pattern that differs significantly from the indicators of price level changes in other member countries. So, based on performance in 2011, the annual inflation rate in Belarus reached 108.7% as a result of the financial crisis caused by a many-year trade deficit, by side effects of the administrative command system in the economy and two devaluations of the Belarusian ruble that occurred during 2011.

Starting from the second half of 2014, which is characterized as a period of active decline in world oil prices, inflation processes in the EAEU countries began to show divergent pattern. In net oil importers (Belarus, Armenia and Kyrgyzstan) inflation started to go down, including deflationary processes which started to evolve in Armenia и Kyrgyzstan from 2016. However, Russia and Kazakhstan as net exporters of hydrocarbon raw materials, following the fall in world oil prices, were forced at different times to shift to a free float of their domestic currencies as part of implementation of the inflation targeting policy; this resulted in a significant depreciation of the Russian ruble and the Kazakh tenge against world currencies. In turn, the increased effect of the exchange rate pass-through caused a sharp acceleration of inflationary processes in these countries. With the adaptation of Russian and Kazakh economies to new conditions and stabilization of the exchange rate of the ruble and tenge, the inflationary processes in these countries also stabilized.

Thus, based on performance in 2016, the annual inflation in Russia and Kazakhstan accounted for 5.4% and 8.5%, respectively, in Belarus – for 10.6%, and in Armenia and Kyrgyzstan deflation was 1.13% and 0.5%.

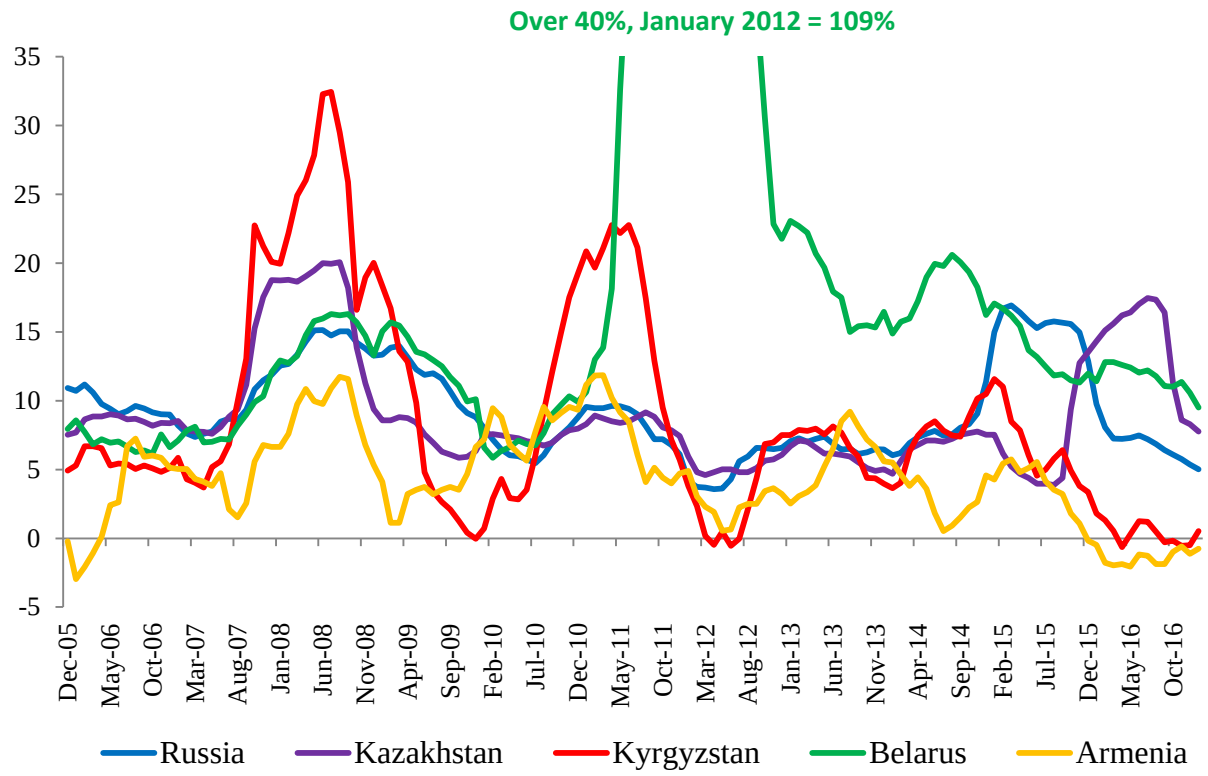
Further, in order to get an initial idea of the main channel through which the cross-border impact on the Inflation dynamic within the EAEU can be made and what typical common factors can be observed in the course of this process, it is necessary to consider and analyze the structure of imports of consumer goods in each member country that are imported from other EAEU member countries.

Figures 4 and 5 show structures of food imports and non-food imports of each EAEU member country from other member countries during 2015-2016 on average. The author used the Trade Map[2] statistical data on the bilateral trade of respective countries. In turn, data on the bilateral trade presented according to the international commodity description and coding system HS6[3] was aggregated

[2] http://www.trademap.org/
[3] Harmonized Commodity Description and Coding Systems

based on the author's expert judgments into the consumer goods under the following codes: foodstuffs – from 2 to 25, and non-food products – 30, 33, 34, 42-44, 47-71, 85, 92, 95, 97.

Figure 3. Inflation dynamic in the EAEU member countries, YoY, %



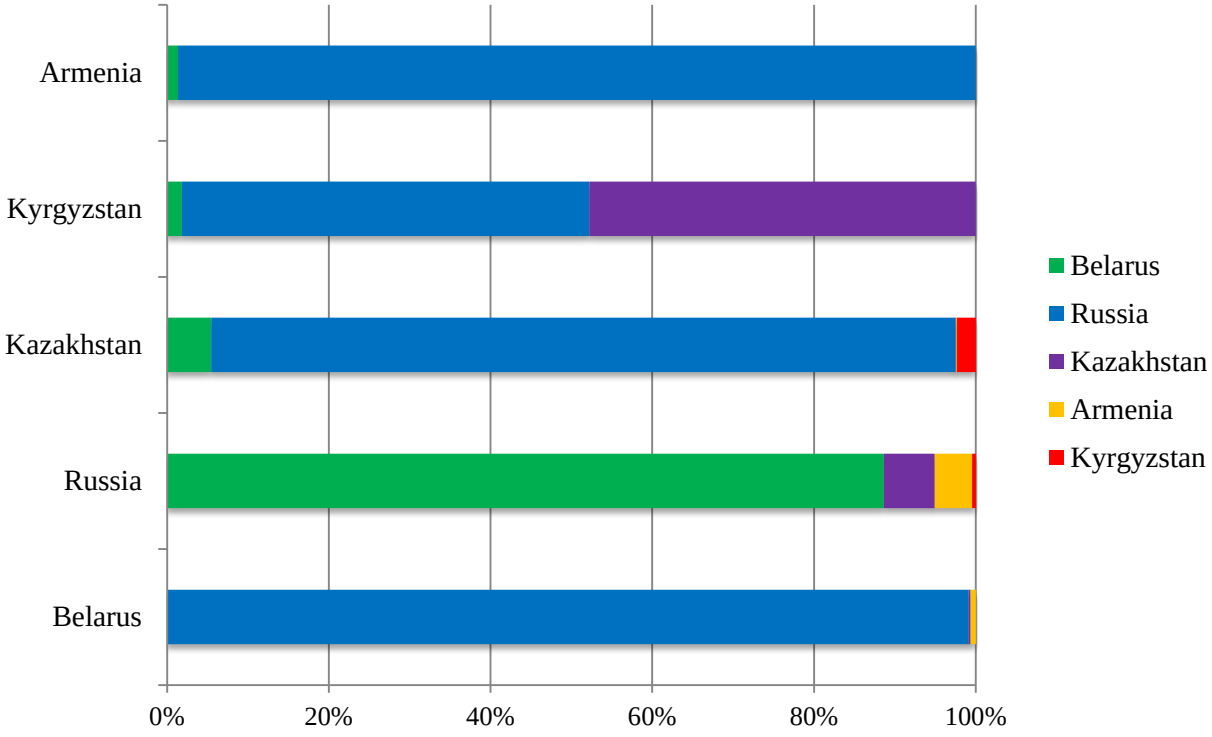
Source: compiled by the author based on the data from national statistical authorities and Thompson Reuters

According to Figures 4 and 5, the main share of consumer imports in the EAEU member countries falls on Russian goods. At the same time, the share of food and non-food products from Belarus is substantially dominant in the structure of Russia's imports of consumer goods which are imported from other member countries.

At the same time, the share of non-food products from Belarus is predominant in the structure of Armenia's and Kyrgyzstan's consumer imports. The main importers of the total volume of Kazakhstani consumer goods are Kyrgyzstan and Russia. However, goods from Kyrgyzstan compared to other EAEU countries are mostly represented in the import structure of Kazakhstan. Also, Armenian consumer goods are mostly represented in the Russian import of food products.

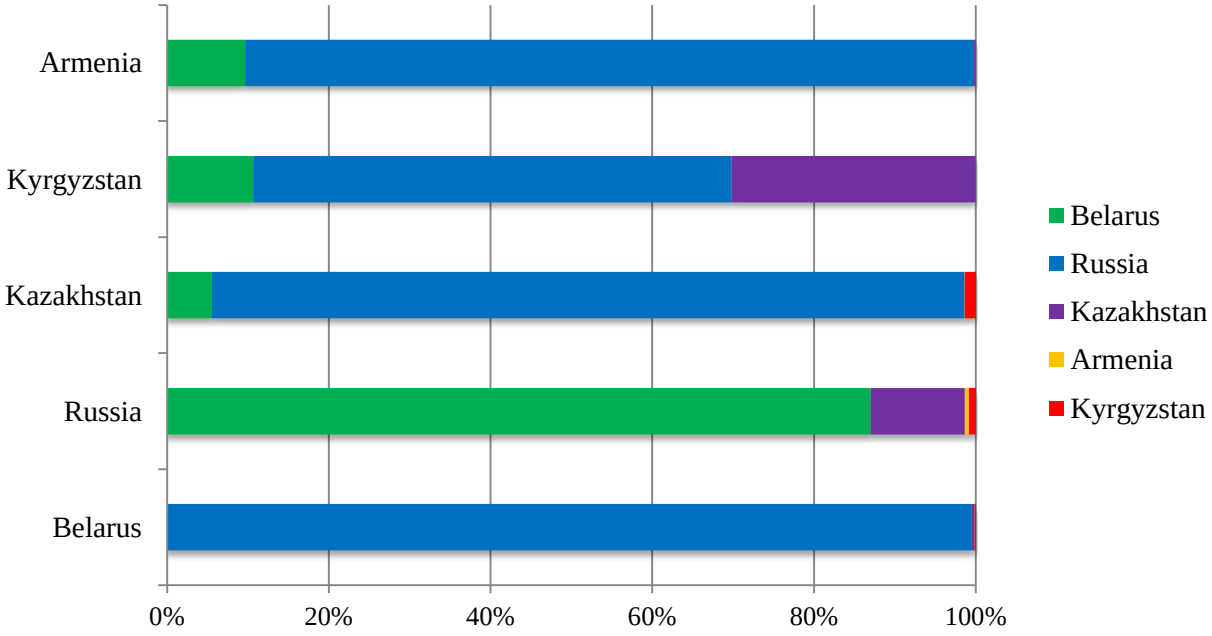
Thus, analysis of the structure of consumer imports of the EAEU member countries demonstrates that trade plays a key role in the cross-border Inflation dynamic between the member countries, and is the main channel of mutual influence of consumer prices in the analyzed countries.

Figure 4. The structure of food imports of each EAEU member country out of the rest union countries, average for 2015-2016, %



Source: the author's derivations based on the data from Trade Map

Figure 5. The structure of non-food imports of each EAEU member country out of the rest union countries, average for 2015-2016, %



Source: the author's derivations based on the data from Trade Map

4. Methodology and Data Description

To implement the research goals, structural vector autoregression models (SVAR) were used in the study. The main advantage of these models is the ability to impose structural limitations on the linear interdependencies of the analyzed multidimensional time series, proceeding from the economic logics of the studied process.

In order to get a broader theoretical understanding of SVAR modeling, the theoretical aspects of vector autoregressive models (VAR) need to be considered. VAR models, on the one hand, are a generalization of autoregressive models for the multidimensional time series. On the other hand, the vector autoregression model is a special case of a system of simultaneous equations. Variables whose behavior over time is subject to modeling in the framework of vector autoregression form a multidimensional time series. It is assumed that the multidimensional time series comprising the vector of variables generate some stochastic process. Thus, the vector autoregression model should describe the joint evolution of variables over time, based on information which the time series contain themselves (Suslov, 2008).

The simplest definition that can be given to the vector autoregression model is the following: an econometric model that simultaneously describes the behavior of several jointly dependent variables through a change in their own previous values and the values of other jointly dependent variables.

Let's take the simplest case of vector autoregression as an example. Let's consider the behavior of two variables. The model will take into account autoregression of the first order. Denote the jointly studied dependent variables as X_t and Y_t, where t is the time index. Given our assumptions, the model will include two equations. The equation for each of the two jointly dependent variables, both for X_t and Y_t, includes the first-order auto-regression components X_{t-1} and Y_{t-1}. Thus, we will have the following system of simultaneous equations, which, in our case, we may call vector autoregression of the first order:

$$X_t = \alpha_1 + \beta_{11}X_{t-1} + \beta_{12}Y_{t-1} + \varepsilon_{1t} \quad (1.1)$$
$$Y_t = \alpha_2 + \beta_{21}X_{t-1} + \beta_{22}Y_{t-1} + \varepsilon_{2t}, \quad (1.2)$$

where α_1, β_{11}, β_{12}, α_2, β_{21}, β_{22} – are parameters. The first index for the parameters points to the equation, the second index – to the variable. Thus, the indices at β_{12} say that the parameter is a part of the first equation and is at the previous values of the dependent variable Y_{t-1}. The perturbations of the model for the first and second equations are denoted as ε_{1t} and ε_{2t}, respectively, and represent white noise with the corresponding distribution parameters:

$$E[\varepsilon_{1t}] = 0, \text{var}[\varepsilon_{1t}] = \sigma^2 \quad (1.3)$$
$$E[\varepsilon_{2t}] = 0, \text{var}[\varepsilon_{2t}] = \sigma^2, \quad (1.4)$$

We assume that ε_{1t} and ε_{2t} do not correlate with each other regardless of the behavior of Xt and Yt, although, in the general case, the processes ε_{1t} and ε_{2t} can correlate. The perturbation distribution of ε_{1t} and ε_{2t} does not depend on the distribution of the studied dependent variables X_t and Y_t.

Interpretation of vector autoregression parameters is determined by the structure of the equations. Thus, the non-zero value of β_{11} parameter indicates the existence of autocorrelation processes in X_t, and the non-zero value of β_{12} parameter means that the previous values of Y_{t-1} have a significant impact on the process of building the variable X_t. A similar interpretation with respect to the process represented in Y_t has parameters β_{21} and β_2 in the second equation; α_1 and α_2 are constants.

Let's write the system of equations (1.1) - (1.2) as a matrix. We introduce the notation. Suppose,

$$Y_t = \begin{pmatrix} X_t \\ Y_t \end{pmatrix}, \alpha = \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix}, B_1 = \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix}, Y_{t-1} = \begin{pmatrix} X_{t-1} \\ Y_{t-1} \end{pmatrix}, \varepsilon = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}, \quad (1.5)$$

then, given (1.5), the system is written as:

$$Y_t = \alpha + B_1 Y_{t-1} + \varepsilon_t, \quad (1.6)$$

which we will further denote as VAR(1).

The interpolated notations enable to easily generalize the matrix representation of the first-order VAR autoregression model (1) with two jointly dependent variables to the case of autoregression of a higher order and dimension. Let's assume that p is the order of autoregression, k – the number of jointly dependent variables, k determines the dimension of the vector Y_t, then the vector of the jointly dependent variables will include k of jointly dependent variables:

$$Y_t = (Y_{1t}, Y_{2t}, \ldots, Y_{kt})^T.$$

In addition, we interpolate the vectors of the lag of the jointly dependent variables Y_{t-1}, Y_{t-2},…, Y_{t-p}, respectively, with the time lag of 1, 2, ..., p; the dimension of vectors Y_{t-1}, Y_{t-2},…, Y_{t-p} is equal to k. We denote the vector of the parameters of the free terms of the equations of k dimension by α; B_1, B_2, B_3, …, B_p are matrices of dimension parameters of k × k corresponding to the vectors of lagged values of the variables Y_{t-1}, Y_{t-2},…, Y_{t-p} p, therefore:

$$B_1 = \begin{pmatrix} B_{11}^{(1)} & B_{12}^{(1)} & \ldots & B_{1k}^{(1)} \\ B_{21}^{(1)} & B_{22}^{(1)} & \ldots & B_{1k}^{(1)} \\ \ldots & \ldots & \ldots & \ldots \\ B_{k1}^{(1)} & B_{k2}^{(1)} & \ldots & B_{kk}^{(1)} \end{pmatrix}; \ldots; B_p = \begin{pmatrix} B_{11}^{(p)} & B_{12}^{(p)} & \ldots & B_{1k}^{(p)} \\ B_{21}^{(p)} & B_{22}^{(p)} & \ldots & B_{1k}^{(p)} \\ \ldots & \ldots & \ldots & \ldots \\ B_{k1}^{(p)} & B_{k2}^{(p)} & \ldots & B_{kk}^{(p)} \end{pmatrix}.$$

The perturbation vector ε_t will also have a dimension equal to k:

$$\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots, \varepsilon_{kt})^T.$$

The distribution of the terms of the vector t is characterized as white noise:

$$E[\varepsilon_{jt}] = 0, \text{ var}[\varepsilon_{jt}] = \sigma^2_j, j = 1, 2, \ldots k.$$

The covariance matrix ε_{1t}, ε_{2t}, …, ε_{kt} for any time t is denoted as $\sum$, the dimension of the matrix is k × k. Under the assumption that the perturbations are uncorrelated, the matrix $\sum$ has the diagonal form with the elements σ^2_1, σ^2_2, …, σ^2_k located on the main diagonal.

Then the vector autoregression model of order p, which is usually denoted as VAR (p), will be written as:

$$Y_t = \alpha + B_1 Y_{t-1} + B_2 Y_{t-2} + B_3 Y_{t-3} + \ldots + B_p Y_{t-p} + \varepsilon_t, \quad (1.7)$$

As known, systems of equations are presented in a structural and reduced form. The writing of vector autoregression in the form (1.1) - (1.2) or in (1.7) can be regarded as an analogue of the reduced form of writing the simultaneous equation systems, since jointly dependent variables are not used on the right side in equations as explanatory variables. Parameters α, B_1, B_2, …, B_p в (1.7) are reduced parameters. Drawing other parallels with the simultaneous equation systems, we note that all variables in the model Y_{1t}, Y_{2t}, …, Y_{kt} that characterize the current state of processes, play the role of jointly dependent variables. Lagged variables Y_{t-1}, Y_{t-2}, …, Y_{t-p} act as predefined and take on the function of explaining the behavior of dependent variables. Note that in the vector autoregression, all variables are defined within the system, that is, they are endogenous. At the same time, the presence of variables with the lag of Y_{t-1}, Y_{t-2}, …, Y_{t-p} allows us to characterize the model (1.7) as a dynamic model.

The structural form of the notation can be obtained on the basis of the reduced form as follows:

$$\Theta Y_t = \gamma + \Psi_1 Y_{t-1} + \Psi_2 Y_{t-2} + \ldots + \Psi_p Y_{t-p} + w_t, \quad (1.8)$$

where Θ is the dimension matrix k×k with the elements in the main diagonal equal to one. The off-diagonal elements of the matrix Θ in (1.8), provided that the jointly dependent variables Y_{1t}, Y_{2t}, …, Y_{kt} are not explanatory, are equal to zero. But if in the model of vector autoregression the current values of the dependent variables Y_{1t}, Y_{2t}, …, Y_{kt} act as explanatory ones, then non-zero off-diagonal elements may appear in the matrix Θ. The matrices Ψ_1, Ψ_2, …, Ψ_p have a dimension of k × k. The dimension of the vector γ is k. The w_t vector includes perturbations at this moment in time t and has a dimension equal to k. The structural and reduced parameters are linked by the following relations:

$$B_j = \Theta^{-1}\Psi_j; \ \alpha = \Theta^{-1}\gamma,$$

covariance matrices of errors in the model in the structural and reduced form, Ω and Σ, respectively, are related as:

$$\sum = \Theta^{-1}\Omega(\Theta^{T})^{-1}.$$

Thus, the vector autoregression model written in a structural form is a structural vector autoregressive model, or SVAR.

Note that the first studies using SVAR were presented by Sims (1980). Later, SVAR was used to study the impact of money on output (Sims, Zha, 2005), to assess the importance of how supply and demand shocks affect the business cycles (Blanchard, Quah, 1989), to determine the consequences of fiscal policy (Blanchard and Perotti, 2002), and to study the connection between technological shocks and productivity (Galí, 1999), etc.

As has already been mentioned above, in order to realize the research objectives, models of structural vector autoregressions (SVAR) were used in the work. The main advantage of these models is the ability to impose structural limitations on the linear interdependencies of the analyzed multidimensional time series, proceeding from the economic logics of the studied process.

The time series of a monthly consumer Inflation dynamic in the EAEU countries were used as input endogenous variables of SVAR models. But due to the fact that trade was defined as the main channel of the cross-border transmission of inflation processes within the EAEU, the author decided to use not the general index of the consumer price index (the "CPI") in modeling but just its seasonally adjusted[4] traded components: food and non-food CPI. At the same time, it was concluded that, initially, the components of consumer price indices in the analyzed countries are "nominal" indicators, i.e., they reflect the change in the average price level in the respective country, for the calculation of which the value of goods in the local currency of the country is applied. In this regard, "nominal" price indices, in addition to cross-border effects, include the effect of changes in the exchange rate of the local currency, or the effect of the exchange rate pass-through. In order to neutralize this effect and calculate the "real" price index for traded goods in the EAEU countries, the "nominal" price indices were adjusted for the lagged monthly indices of the nominal effective exchange rate (NEER) of the local currencies of the respective countries. So, the maximum number of lags of the effect of NEER's changes on the corresponding CPI components for each analyzed country was determined based on the values of the Akaike information criterion (AIC) in the "Lag length criteria" test (see Tables 1 and 2). In turn, the zero lag was defined as the minimum lag of the effect of changes in the NEER on the CPI components in the analyzed countries.

Thus, resulting from calculation of the "real" price indices for traded goods in the EAEU countries expressed in the clean up of the effect of the exchange rate pass-through onto the consumer price behavior, the comparison and joint modeling

[4] Deseasonalization of time series used in modeling was carried out in line with the Census X-12-ARIMA method

of the food and non-food CPIs of the analyzed countries with the aim of determining "net" cross-border inflation effects became possible.

Thus, in this study, in finite estimated SVAR models, endogenous factors will be represented by "real" food and non-food price indices in each EAEU country.

To explain the changes in the behavior of endogenous factors ("real" price indices for traded goods) caused not by cross-border effects but by the impact of global phenomena, exogenous variables characterizing the change in world prices of such basic food and industrial products as crude oil, potash fertilizers and gold were defined.

It should be noted that actual and estimated monthly observations of endogenous and exogenous variables for the period from January 2005 to December 2016, or 144 observations have been used in the simulation.

Table 3 shows notations and sources of statistical observations of the input variables of the estimated models as well as the results of the augmented Dickey-Fuller test for the presence of a unit root, demonstrating that all model variables are stationary.

Due to the fact that price indices of food and non-food products were chosen as price indices of traded goods, the author estimated two SVAR-1 and SVAR-2 models describing cross-border communications separately between food prices and non-food prices, respectively, within the EAEU. At the same time, based on the analysis of the structure of food and non-food imports of each EAEU country from other member countries (Figures 1 and 2 of the Supplement), the author determined the appropriate restriction matrices Θ_1 и Θ_2 for each of the SVAR models.

Table 1. Akaike Information Criteria (AIC) for determining the maximum lag of NEER's impact on the food CPI in the EAEU countries

Lag (months)	Russia	Kazakhstan	Kyrgyzstan	Belarus	Armenia
0	7.563398	7.686076	8.530657	10.284760	7.716421
1	6.657329	**6.887319***	8.299970	9.395922	**7.598073***
2	6.536458	6.923662	8.302688	9.381942	7.651100
3	**6.516737***	6.963971	8.340048	9.164934	7.699765
4	6.558117	6.992712	8.282573	9.200202	7.753147
5	6.601629	7.019520	**8.252442***	**9.161561***	7.775275
6	6.650391	7.051797	8.273485	9.165938	7.815883
7	6.605402	7.100859	8.321973	9.170374	7.867654
8	6.651560	7.104138	8.337767	9.202087	7.913993
9	6.680604	7.131768	8.386754	9.238247	7.940664
10	6.725407	7.132811	8.405366	9.248606	7.953305
11	6.694107	7.164998	8.450953	9.294593	7.949190
12	6.715610	7.188905	8.427531	9.331210	7.957083

Note: the * sign corresponds to the value of the Akaike information criterion at the maximum lag of the analyzed relationship

Table 2. Akaike Information Criteria (AIC) for determining the maximum lag of NEER's impact on the non-food CPI in the EAEU countries

Lag (months)	Russia	Kazakhstan	Kyrgyzstan	Belarus	Armenia
0	6.106102	7.832216	6.523337	10.253620	6.582627
1	4.696334	7.117241	6.529588	9.528547	6.096197
2	4.636255	**6.983930***	6.530848	9.480266	6.129918
3	4.572453	7.033360	6.539262	9.432392	**6.063819***
4	**4.566633***	7.061846	**6.503787***	9.439325	6.120895
5	4.584501	7.055514	6.530469	9.306632	6.157461
6	4.635360	7.069263	6.586161	9.261042	6.200921
7	4.643688	7.128745	6.592485	**9.241957***	6.240511
8	4.679405	7.158399	6.598511	9.288747	6.238437
9	4.640631	7.175048	6.639179	9.291832	6.257998
10	4.635971	7.223281	6.683298	9.335093	6.282669
11	4.629353	7.255373	6.723437	9.387584	6.300920
12	4.673814	7.287765	6.742508	9.428158	6.262830

Note: the * sign corresponds to the value of the Akaike information criterion at the maximum lag of the analyzed relationship

Restraint Matrix Θ_1 for the SVAR-1 Model (food prices)

$$\begin{pmatrix} u^{ARMENIA} \\ u^{BELARUS} \\ u^{KYRGYZSTAN} \\ u^{KAZAKHSTAN} \\ u^{RUSSIA} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & a_5 \\ 0 & 1 & 0 & 0 & b_5 \\ 0 & 0 & 1 & c_4 & c_5 \\ 0 & d_2 & d_3 & 1 & d_5 \\ f_1 & f_2 & 0 & f_4 & 1 \end{pmatrix} \times \begin{pmatrix} e^{ARMENIA} \\ e^{BELARUS} \\ e^{KYRGYZSTAN} \\ e^{KAZAKHSTAN} \\ e^{RUSSIA} \end{pmatrix}$$

Restraint Matrix Θ_2 for the SVAR-2 Model (non-food prices)

$$\begin{pmatrix} u^{ARMENIA} \\ u^{BELARUS} \\ u^{KYRGYZSTAN} \\ u^{KAZAKHSTAN} \\ u^{RUSSIA} \end{pmatrix} = \begin{pmatrix} 1 & a_2 & 0 & 0 & a_5 \\ 0 & 1 & 0 & 0 & b_5 \\ 0 & c_2 & 1 & c_4 & c_5 \\ 0 & d_2 & 0 & 1 & d_5 \\ 0 & f_2 & 0 & f_4 & 1 \end{pmatrix} \times \begin{pmatrix} e^{ARMENIA} \\ e^{BELARUS} \\ e^{KYRGYZSTAN} \\ e^{KAZAKHSTAN} \\ e^{RUSSIA} \end{pmatrix},$$

where u – are structural shocks, and e – statistical shocks.

Thus, based on the estimated SVAR-1 and SVAR-2 models, the impulse response functions were obtained, whose graphs are presented in Figures 1 and 2 of the Supplement.

Table 3. Endogenous and Exogenous Variables in SVAR-1, SVAR-2 Models and the Result of the ADF-Test

Variable	Notation	Source of Statistical Data	The value of the t-statistics of the ADF-test (null hypothesis: the variable has a unit root)
Seasonally adjusted "real" food CPI of Armenia, versus the previous month	ARM_RCPI_F	The author's derivations based on the Bloomberg terminal and the official website of the Central Bank of Armenia (www.cba.am)	-7.42***
Seasonally adjusted "real" food CPI of Belarus, versus the previous month	BE_RCPI_F	The author's derivations based on the Bloomberg terminal and the official website of the National Bank of Belarus (www.nbrb.by)	-5.55***
Seasonally adjusted "real" food CPI of Kyrgyzstan, versus the previous month	KR_RCPI_F	The author's derivations based on the data from official sites of the National Statistics Committee (www.stat.kg) and the National Bank of the Kyrgyz Republic (www.stat.kg)	-7.58***
Seasonally adjusted "real" food CPI of Kazakhstan, versus the previous month	KZ_RCPI_F	The author's derivations based on the data from official sites of the Committee on Statistics (www.stat.gov.kz) and the National Bank of Kazakhstan (www.nationalbank.kz)	-4.75***
Seasonally adjusted "real" food CPI of Russia, versus the previous month	RU_RCPI_F	The author's derivations based on the data from official sites of the Federal State Statistics Service (http://www.gks.ru) and the Central Bank of Russia (www.cbr.ru)	-8.48***
Seasonally adjusted "real" non-food CPI of Armenia, versus the previous month	ARM_RCPI_NF	The author's derivations based on the Bloomberg terminal and the official website of the Central Bank of Armenia (www.cba.am)	-5.56***
Seasonally adjusted "real" non-food CPI of Belarus, versus the previous month	BE_RCPI_NF	The author's derivations based on the Bloomberg terminal and the official website of the National Bank of Belarus (www.nbrb.by)	-5.66***
Seasonally adjusted "real" non-food CPI of Kyrgyzstan, versus the previous month	KR_RCPI_NF	The author's derivations based on the data from official sites of the National Statistics Committee (www.stat.kg) and the National Bank of the Kyrgyz Republic (www.stat.kg)	-5.37***
Seasonally adjusted "real" non-food CPI of Kazakhstan, versus previous month	KZ_RCPI_NF	The author's derivations based on the data from official sites of the Committee on Statistics (www.stat.gov.kz) and the National Bank of Kazakhstan (www.nationalbank.kz)	-5.34***
Seasonally adjusted "real" non-food CPI of Russia, versus the previous month	RU_RCPI_NF	The author's derivations based on the data from official sites of the Federal State Statistics Service (http://www.gks.ru) and the Central Bank of Russia (www.cbr.ru)	-7.74***
Monthly increase in the price of crude oil (Brent)	BRENT	Bloomberg Terminal	-8.74***
Monthly increase in the price of gold	GOLD	Bloomberg Terminal	-5.13***
Monthly increase in the FAO Cereals Price Index	FAO_CER	Official site of the UN Food and Agriculture Organization (http://www.fao.org)	-7.61***
Monthly increase in the price of potash fertilizers	KCI	Economic and financial statistical data site (http://www.indexmundi.com)	-6.88***

Note: ***, ** and * show statistical significance of coefficients at the levels of 1%, 5% and 10%, respectively

5. Discussion of Results

Based on the impulse responses of SVAR-1 models (food prices) and SVAR-2 models (non-food prices), whose graphs are presented in Figures 1 and 2 of the Supplement, the regularities and phenomena typical for the cross-border dynamic of inflationary processes in the EAEU were determined. Thus, the analysis of reaction of the traded prices in the EAEU countries to the shocks of the food and non-food CPI in other member countries is presented below. *It should be noted that among the results obtained, **the results in the form of the negative impact** of a positive inflation shock in some EAEU countries on other member countries are basically interpreted by the author to summarize the findings as the absence of any mutual influence between the analyzed indicators in the context of the selected restricted specification of SVAR models.*

Armenia

The price shock for traded goods in Armenia generally does not have a significant positive impact on other countries within the EAEU. At the same time, with a more detailed and thorough analysis of the impulse response graphs, one can note that there is a very weak impact of Armenia's food inflation shock on Kyrgyzstan within 2-3 months after the onset of the shock; and a very weak impact of the shock of Armenia's non-food inflation on Russia within 1-2 months. It should be noted that pharmaceutical products, gems and semiprecious stones and their products make the basis of the consumer imports of Russia from Armenia in the group of non-food products. At the same time, the main group of food products imported from Armenia into Kyrgyzstan is represented by non-alcoholic and alcoholic beverages. It is possible that the reason for the slight increase in the reaction of the inflationary inflation of Russia and Kyrgyzstan to the shock of Armenian prices is a significant transport and logistics costs in the absence of common state borders with Armenia.

Belarus

According to the results of the study, it was determined that within the EAEU, shocks in the prices of traded goods in Belarus given relatively significant volumes of consumer goods exports have the greatest cross-border effect on food prices in Kazakhstan and Kyrgyzstan. Thus, a 1% shock of food inflation in Belarus causes the acceleration of similar price indices in Kazakhstan and Kyrgyzstan by 0.5 percentage points for each country in total within three months of the onset of shock. Also, in terms of non-food inflation, there is an insignificant effect of a 1% shock of Belarusian prices on prices in Kyrgyzstan in the total range of 0.1-0.2 percentage points within five months of the onset of the shock. Belarus exports mainly dairy products, food products of animal origin, meat, and seafood to Kazakhstan. In turn, Kyrgyzstan imports from Belarus such food products as sugar and confectionery products, mill industry products (malt, starches, inulin, wheat gluten), and non-food products such as metal, furs, wood, ceramics,

machinery and electrical equipment. The reason for the increased impact of the shock of Belarusian consumer prices on prices in Kazakhstan and Kyrgyzstan is the effect of two factors: a wide range and a significant volume of imported goods as well as transport costs due to the absence of common borders and the remoteness of the reviewed countries from Belarus.

Along with this, despite a significant volume of exports of goods from Belarus to Russia and the presence of a developed transport and logistics infrastructure between these countries, according to results of the model, the shocks of Belarusian consumer prices do not affect the prices of Russian food and non-food products. The reason for this is probably the establishment of trade relations between Belarus and Russia on the basis of government arrangements according to which the process of pricing can be regulated and thereby can deviate from the market conditions.

Kyrgyzstan

Food price shocks in Kyrgyzstan have a greater and longer influence among the EAEU countries on food prices in Kazakhstan and Belarus. Thus, a 1% shock of Kyrgyzstan's food inflation leads to a gradual acceleration of the monthly price index for food products in Kazakhstan and Belarus cumulatively by 0.5-0.7 percentage points within 4-6 months from the onset of a corresponding shock. At the same time, such influence of Kyrgyz prices on prices in Kazakhstan is determined by the presence of common state borders, and by the proximity of industrially developed regions of Kyrgyzstan to the most densely populated regions and cities of Kazakhstan. It should also be noted that Kazakhstan imports such consumer goods produced in Kyrgyzstan as dairy products, eggs, vegetables, animal products.

In turn, the reaction of food prices in Belarus to the shocks of similar prices in Kyrgyzstan may be due to the impact of re-exports of Kyrgyz goods to Belarus via Kazakhstan and Russia and a possible lack of direct supplies from primary Kyrgyz producers to final Belarusian consumers, which increases costs and final prices of goods further. At the same time, the Kyrgyz export of food products to Belarus consists of vegetables and animal products.

Kazakhstan

The shock of food inflation in Kazakhstan significantly affects the prices of food products in Armenia, Kyrgyzstan and Belarus. So, a 1% shock of food inflation in Kazakhstan leads to an increase in the monthly food inflation in Armenia cumulatively by 0.6-0.7 percentage points within 3-4 months after the shock and in Kyrgyzstan and Belarus - cumulatively by 0.5 percentage points within 2-3 months after shock. Throughout the reviewed period, Kazakhstan was the largest supplier of wheat and cereal products to Armenia and also exported flour products, wheat, vegetable oils, animal fats, tobacco products, etc. to Kyrgyzstan in large quantities; and it exported cooking salt, animal products, sugar to Belarus.

The trend in reaction of the prices of non-food products in Armenia, Belarus and Kyrgyzstan to the shock of non-food inflation in Kazakhstan is quite similar to the reaction to the shock of food inflation, both in terms of quantity and duration of influence. At the same time, Kazakhstan exports mainly products made of metal, cotton, as well as refined products to these countries.

In case of Kyrgyzstan, the reaction of prices to shocks in Kazakhstan is explained by the presence of common borders, which allows increasing the volume of trade between the countries and enables the price shocks to flow more quickly and massively. In its turn, the revealed nature of the response of prices in Armenia and Belarus to the price shocks of Kazakhstan is presumably associated with a large component of transport and logistics costs in the final cost of goods.

Russia

Despite the fact that, based on comparative economic indicators, Russia is regarded as a "big economy" within the EAEU, the results of the evaluation of impulse response functions in the framework of this study did not confirm this assumption. The model results showed that the shock of the traded prices in Russia affects only the behavior of Kazakhstan's inflation in a significant way but not all the EAEU member countries. So, a 1% shock of food prices in Russia leads to the acceleration of similar prices in Kazakhstan cumulatively by 1-1.5 percentage points within three months of the onset of shock. In turn, a similar shock in the prices of Russian non-food products leads to a cumulative growth of the non-food inflation in Kazakhstan in monthly terms by 2 percentage points within 3 months from the onset of shock.

This reaction of changes in consumer prices in Kazakhstan to price shocks in Russia is the largest in quantitative terms as compared to other results identified in this study. At the same time, such a connection in the form of a large inertia of the influence of Russian prices on Kazakhstan is explained by the fact that Russia is the largest importer of a wide range of food and non-food products for Kazakhstan, not only within the EAEU but also in comparison with the rest of the world. In addition, it should be noted that the Russian-Kazakhstan border is the longest land border in the world and has a well-developed transport and logistics infrastructure linking large cities and regions of both countries.

6. Conclusion

Based on the results of this study, the author formulated the conclusion that the cross-border dynamic of inflation processes within the EAEU can evolve and intensify for two reasons:

- a large trade turnover given the common state borders and the development of transport and logistics infrastructure (the effect of Russia's prices on Kazakhstan, the mutual impact of prices in Kazakhstan and Kyrgyzstan),
- a high transport and transit costs because of the absence of common state borders (the effect of prices in Kazakhstan and Kyrgyzstan on prices in Armenia and Belarus, the impact of prices in Belarus on Kazakhstan and Kyrgyzstan).

Further strengthening of the cross-border dynamic of inflationary processes in the EAEU may limit effectiveness and create additional external risks for the actions of monetary authorities. This, in turn, will complicate the objectives of the independent monetary policy implemented in the EAEU countries to ensure the price stability.

Despite the fact that certain results have been obtained in this work, it is worth noting that there is still a potential for further research aimed at studying the cross-border Inflation dynamic in the EAEU by developing the methodological approaches and model tools presented here.

References

1. Sims C. (1980). Macroeconomics and Reality. *Econometrica 48, 1-48.*
2. Blanchard O., Quah D. (1989). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review 79, 655-673.*
3. Galí J. (1999). Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations? *American Economic Review 89, 249-271*.
4. Blanchard O., Perotti R. (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *Quarterly Journal of Economics 117, 1329-1368*
5. Sims C. and Zha T. (2005). Does Monetary Policy Generate Recessions? Macroeconomic Dynamics, forthcoming.
6. Bernanke B. (2007). Globalization and Monetary Policy. *Speech at Fourth Economic Summit, Stanford Institute for Economic Policy Research, March.*
7. Borio C., Filardo A. (2007). Globalisation and Inflation: New Cross-Country Evidence on the Global Determinants of Domestic Inflation. *BIS Working Paper, No. 227.*
8. Mishkin F. (2009) Globalization, Macroeconomic Performance, and Monetary policy. *Journal of Money, Credit and Banking, vol. 41, no. s1, pp. 187-196.*
9. Ciccarelli M., Mojon B. (2010). Global Inflation. *The Review of Economics and Statistics, vol. 92, no. 3, pp. 524-535.*
10. Neely C., Rapach D. (2011). International Comovements in Inflation Rates and Country Characteristics. *Journal of International Money and Finance, vol. 30, pp. 1471-1490.*
11. Rey H. (2015). Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. *NBER Working Paper Series, No. 21162.*
12. Suslov V.I. Lecture course. Econometrics-3. // Suslov V.I., Lapo V.F., Talysheva L.P., Ibragimov N.M. - Krasnoyarsk: SFU, 2008. - p.193.
13. Tuleuov O. (2017). Analysis and Empirical Assessment of the Cross-Border Impact of the Unconventional Monetary Policy of Central Banks of Developed Countries on Developing Markets. *Research and Statistics Department, National Bank of Kazakhstan, Economic Study No.2017-2. NBRK - WP - 2017* - 2. *February.*
14. http://www.eurasiancommission.org/ - the official web-site of the Eurasian Economic Commission.

APPENDIX

Table 1. Establishment and Development of the Eurasian Economic Union

<table>
<tr><td>Year of Establishment</td><td>2000</td><td>2007</td><td>2007 and 2011</td><td>2014</td></tr>
<tr><td>Year of Accession</td><td>2001</td><td>2010</td><td>2012</td><td>2015</td></tr>
<tr><td>Document</td><td>Treaty on the Establishment of the Eurasian Economic Community</td><td>Treaty on the Establishment of the Common Customs Territory and Creation of the Customs Union</td><td>Declaration of the Eurasian Economic Integration</td><td>Treaty on the Eurasian Economic Union</td></tr>
<tr><td rowspan="3">Integration Association, Member Countries</td><td colspan="2" rowspan="2"></td><td>Common Economic Space (CES): Kazakhstan, Belarus, Russia, Armenia (from 2014), Kyrgyzstan (from 2015)</td><td rowspan="3">Eurasian Economic Union (EAEU): Kazakhstan, Belarus, Russia, Armenia, Kyrgyzstan (from August 2015)</td></tr>
<tr><td colspan="2">Customs Union (CU): Kazakhstan, Belarus, Russia, Armenia (from 2014), Kyrgyzstan (c 2015)</td></tr>
<tr><td colspan="3">Eurasian Economic Community (EurAsEC): Kazakhstan, Kyrgyzstan, Belarus, Russia, Tajikistan, Uzbekistan</td></tr>
</table>

Figure 1. Cumulative Impulse Responses to a 1% Shock of Food Inflation in the EAEU

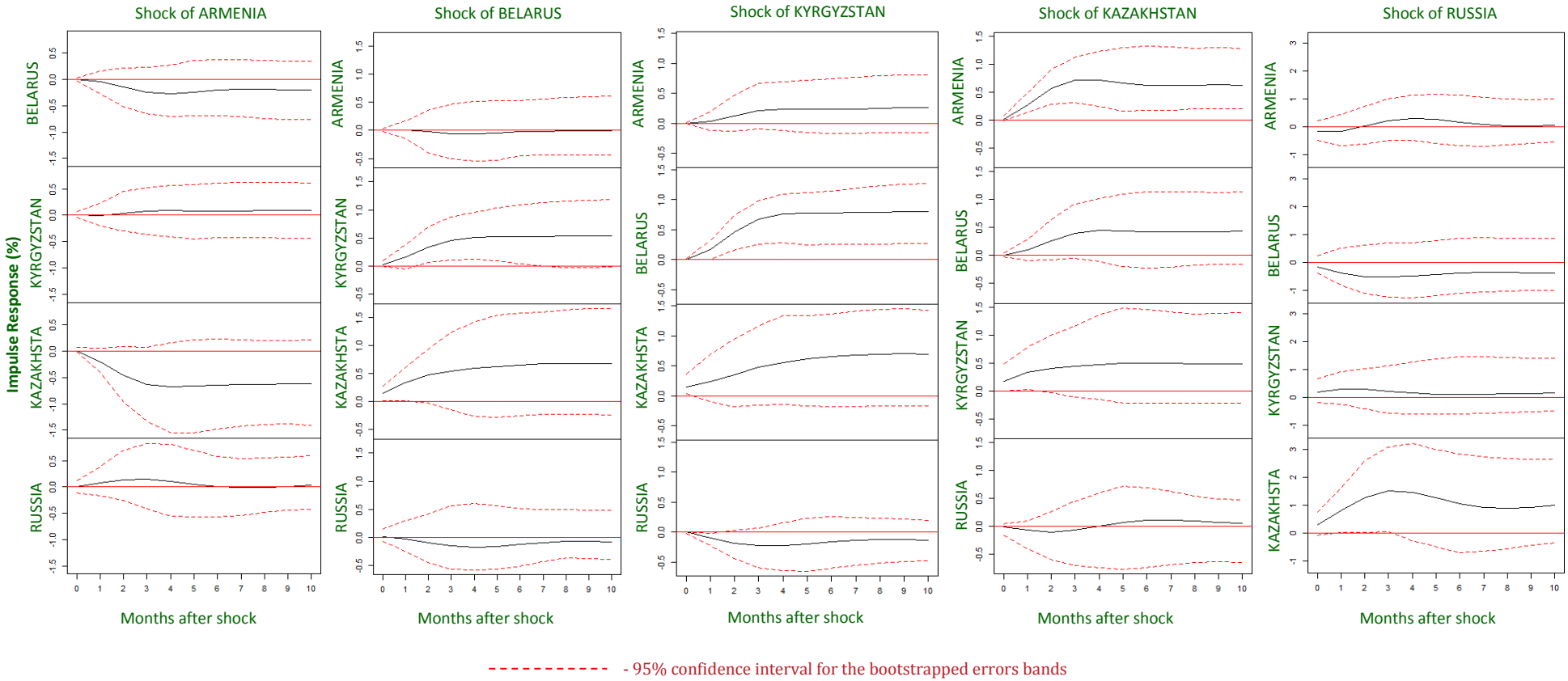


Figure 2. Cumulative Impulse Responses to a 1% Shock of Non-Food Inflation in the EAEU