VAR Analysis of the monetary transmission mechanism with factor of labor migration: case of Armenia

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ABSTRACT

This contribution develops the VAR model to estimate the monetary transmission for the Armenian economy based on the quarterly data of the past decade consistently following the steps proposed in the paper by Stock and Watson (2001) on vector auto regressions. The results of the estimation indicate existence of the "price puzzle" with the inflation increasing in response to the monetary tightening. To address the issue it is suggested to account for the migration factor in the model given the high rate of migratory flows from Armenia to Russia. To show the significance of accounting for the latter factor when making decisions on the monetary policy implementation, the traditional RBC model of indivisible labor proposed by Hansen is considered with further introduction of labor exports. The model is parameterized in the way to match core features of the Armenian economy. In the framework of the model, foreign component, particularly construction-workers in Russia, is introduced as a part of the labor supply along with the domestic component. As results of the estimation show, positive wage shock on the Russian labor market, as opposed to the productivity shock, has a bigger and a more long-lasting effect on the Armenian economy, which reinstates the necessity of introducing the migration factor into the VAR model.

Rise of oil prices which entails increase in the world commodity prices has, further, been taken into account as the indicator of economic activity in the foreing state . And it is believed that the rapid growth of remittances is mainly due to rising energy prices because the latter has raised incomes and prices in the Russian non-trade sector in which most of the Armenian labor migrants are working. Ultimately, the issue of the price puzzle is overcome by introducing the exogenuos variable of oil prices index and nominal exchange rate into the VAR specification.

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1. INTRODUCTION

Human history is a history of migration; today there are even countries where the migrants make up more than half of the population[1]. Collapse of the USSR and creation of 21 new countries with the economies viable to even slightest external shocks has fuelled the process of migration considerably. The Russian Federation has become by far the most popular destination for the labor migrants from post-Soviet countries due to common language, existence of the diasporas from recipient countries and a big wage differential. The wave of the labor migration from Armenia to Russia has been triggered from the early stage of its independence fuelled also by the war with the neighboring Azerbaijan and two strong earthquakes. Step by step Armenia was getting out of the deep crisis and turning into a new spot for investments especially from Diaspora Armenians who were denied this opportunity during the years of Soviet Occupation. Nevertheless, currently labor migration to Russia has accelerated immensely with the majority of labor migrants employed in the construction sector. And even though the high level of migration and strong dependence on the remittances remain main characteristics of the Armenian Economy, the Central Bank of Armenia still utilize various models of the monetary policy with the assumption of the closed labor market and in no particular way accounts for the factor of migration, thus leading to the distortions in the proposed forecasts. The goal of the contribution is to overcome the distortions and price puzzles entailed by the omission of the migration factor in the models of the monetary policy by exemplifying it through the VAR modeling of the monetary transmission mechanisms. Nevertheless, prior to the consideration of the above-mentioned models the importance of migration factor for the Armenian economy will be shown by pining down the propagation

[1] In Qatar 86,5 %, UAE - 70 %, Kuwait – 68,8 % // http://data.worldbank.org/indicator/SM.POP.TOTL.ZS

mechanism of foreign wages positive shock into the domestic economy by applying RBC model with the indivisible labor and labor exports.

The outline of the thesis will be structured as follows. In Chapter 2, I will conduct an overview of the migratory processes in Armenia and, furthermore, the RBC model with the indivisible labor and labor exports will be introduced. The latter will consist of the 3 subsections: in the 1st subsection, I will review the materials that cover some theoretical aspects of the model (Hansen 1985), (Tlelima, 2009) and discuss the selected economic indicators that are to be matched in the model; in the 2nd subsection, the model for an economy with labor exports is introduced, considered in the aggregate terms and further solved; in the 3rd subsection, the model is calibrated in the way to match selected macroeconomic indicators discussed in the subsection 1; and finally, subsection 4 discusses the results and interpretation of the impulse-response functions to the foreign wage and productivity shocks. In Chapter 3, I will be developing the VAR model to estimate the monetary transmission for the Armenian economy which will be consistent with the paper of Stock and Watson (2001) on vector regressions. And furthermore, having pinned down in the 2nd Chapter how the macroeconomic situation in Armenia is affected by the migration factor, the latter will be accounted for to overcome the distortions and price puzzle.

2. ANALYSIS OF THE MIGRATION FACTOR IN THE FRAMEWORK OF THE REAL BUSINESS CYCLE MODEL: CASE OF ARMENIA

2.1 Overview of the migratory processes in Armenia for the years of 1990-2012

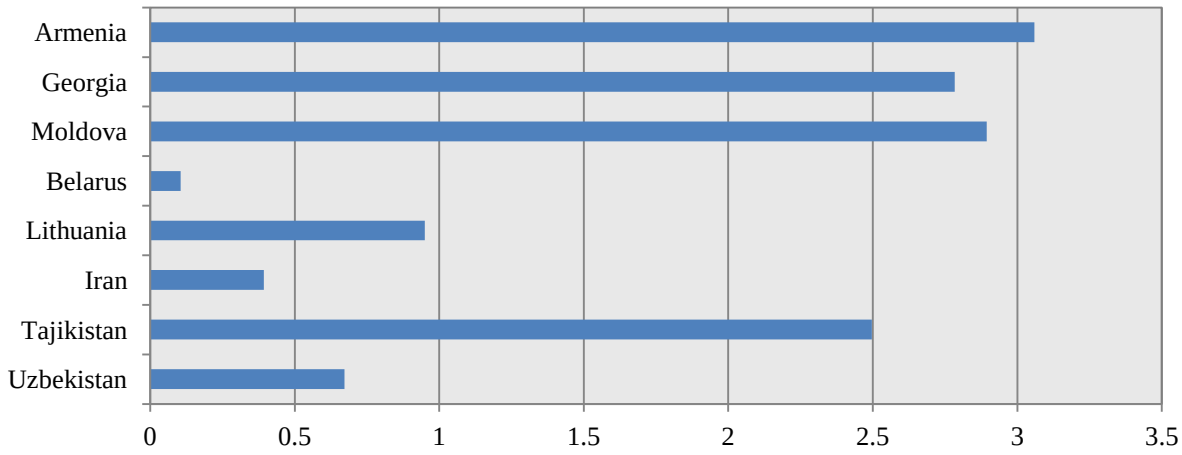
Starting from 1990s more than 800.000 people have migrated from Armenia to the countries with big Armenian Diaspora due to the hard socio-economic situation after the collapse of the USSR. And despite the passage of almost 2 decades the rate of migration is exponentially growing, thus making Armenian economy very much dependant on the remittances coming from abroad amounting to more than 1 bln. $ in the recent years[2].

It is worth to mention that the world migration and migration from Armenia should be perceived on different qualitative levels given the gender structure of emigrants from Armenia, its geopolitical conditions, as well as a non-diversified geographic structure of host countries for the Armenian emigrants. Moreover, the absence of alternative absorption institutions lead to a situation when most of the remittances received by resident of Armenia are utilized through the consumption channel and, thus, making the economy very much viable even to the smallest exogenous shocks. On the other hand, when deeming the ration of net migration to the population for a range of countries (see Figure 1.), one might notice that the highest indicators are attached to the countries of Armenia, Moldova, Georgia and Tajikistan. But, unlike Tajikistan with the high fertility rate of 3.4, Armenia and Moldova are lagging very much behind with the rates of 3.05 and 2.8, respectively[3]. And if there is no risk of the war retrieving in Moldova it does exist in Armenia in the scope of which it should also be mentioned that the net migration in Azerbaijan during the last decades turned out to be positive and reach the level of 56.000 people per year. However, besides consideration of the quantitative indicators, they should be given also the qualitative

[2] Source: http://data.worldbank.org/indicator/BX.TRF.PWKR.CD
[3] Source: http://data.worldbank.org/indicator/SP.DYN.TFRT.IN

assessment with the purpose of revealing the gender, geographic and age structure of the Armenian migrants.

Figure 1. Ratio of net migration to the population of the country, in % for years of 2009-2013



Source: Calculated based on the data of the World Bank: http://data.worldbank.org/indicator/SP.POP.TOTL

According to the data compiled in Table 1, it should be noted that although the ratios of the gender-based repatriates and permanent migrants are identical, the permanent migrants are on average younger than those who decided to come back to Armenia. This indicates that most of the Armenian migrants make their decision to permanently leave the country at the earlier age, whereas the decision on repatriation is made at the older age. It should be noted that people from the rural areas comprise the most active group of migrants both in terms of the temporary labor migration and the permanent one. Their decision to stay abroad is mainly explained by the lack of opportunities at home and inability to maintain the minimum consumer basket through running of

Table 1. Socio-demographic characteristics of the Armenian migrants for the years of 2002-2010						
Group	Gender		Average Age	Residence in Armenia		
	Male	Female		Yerevan	Other Cities	Villages
Permanent migrants	72%	28%	35	31%	30%	39%
Temporary migrants	85%	15%	38	19%	37%	44%
Migrants who are coming back for permanent stay	72%	28%	41	34%	36%	30%
All migrants	79 %	21%	38	26%	35%	39%
Source: AST/OSCE Returnee Survey 2010, time interval of 2002-2010.						

small-scale farms, especially given the fact that Armenia has rejected the practice of the VAT exemption[4] for the producers of the agricultural products.

Table 2. Socio-demographic characteristics of the Armenian migrants for the years of 2002-2010 (continuation)			
Group	Country of temporary or permanent residence	Share of the migrants who have professional higher education	Main groups of the qualifications
Permanent migrants	Russia (77%) USA (5%) Ukraine (2%) Countries of the EU (10%) Other, CIS (3%) Others (2%)	40%	Economics (13%) Architecture/ Construction (12%) Education (12%) Medicine (12%) Art/ Culture (9%) Natural Sciences (7%)
Temporary migrants	Russia (94%) USA (1%) Ukraine (2%) Other, CIS (1%)	39%	Economics (17%) Architecture/ Construction (15%) Social Sciences (10%)

[4]According to the statue of the WTO member states, the scheme of VAT exemption for the local producers of the agricultural products on the first level of the sales is considered to be a breach of the 3rd article of GATT and creates unfair economic conjuncture between the local producers and importing organizations..

	Georgia (1%) Others (1%)		Natural Sciences (7%)
Migrants who are coming back for permanent stay	Russia (85%) USA (2%) Ukraine (4%) Countries of the EU (3%) Other, CIS (3%) Others (3%)	40%	Social Sciences (18%) Architecture/ Construction (11%) Education (11%) Engineering (11%) Pharmacy (9%)
All migrants	Russia (87%) Ukraine (5%) USA (3%) Countries of the EU (8%) Other, CIS (4%) Others (3%)	39%	Economics (13%) Architecture/Construction (13%) Social Sciences (11%) Engineering (9%) Education (8%) Pharmacy (8%)
Source: AST/OSCE Returnee Survey 2010, time interval of 2002-10.			

Share of the people with the higher education is equivalent in the groups of the permanent, temporary migrants and permanent repatriates (see Table 2). This might indicate that the level of education, most probably, doesn't influence the decision of the Armenian migrants to return, and, moreover, there is not any precise tendency for the people who have higher education to permanently emigrate from Armenia. Despite the above-mentioned, it is quite alarming that 1/3 of all the migrants comprise people who are professionals in the fields of pharmacy, education, arts and culture, since the latter are the cornerstones of the public sector. Specialists in the fields of

the health and education are not only very active in the permanent migration, but also are characterized by low rate of repatriation.

When considering the geographic structure of the recipient countries it can be tracked down that Russia is the most popular destination for the Armenian migrants with the respective indicator of 90%. The latter shows the non-diversification of the geographic structure which might have an adverse effect on the economic activity in Armenia once Russian labor market is hit by various internal and external shocks. Thus, having considered the migratory processes in Armenia and having revealed their main features, including the high dependence of the Armenian economy from the Russian labor market, I will be suggesting to account for this factor in the Real Business Cycle model of the Armenian economy that will be introduced in the next section, particularly, to assess how exactly the foreign wage shocks propagate into the Armenian economy with the purpose of underlining the importance of this factor.

2.2 Real Business Cycle (RBC) model with labor exports: case of Armenia

2.2.1 Review of empirical literature

Among the theories aiming to explain economic fluctuations caused by disturbances economy is hit by, RBC model is considered to be the benchmark model that helps to build up respective propagation mechanisms of the shocks and reveal their consequences for the real economy. Nevertheless, the basic RBC model performs poorly in matching the variability of hours worked. It was fairly noted by Hansen (1985) that in the job market workers mostly enter fixed hours contract and do not choose how long they want to work. Fixed hours contract particularly implies that at a given period there will be employed and unemployed households, hence the labor indivisibility assumption introduces the unemployment into the RBC model, making it more realistic for Armenian Economy where the official unemployment rate is 27,5 % (ILO report,

2010). It should be noted thought that this assumption implies that agents have a non-convex consumption set which precludes us from getting a mapping of Pareto-optimal allocation. To overcome this issue Hansen introduce "lotteries" about whether or not each individual works thus effectively convexifying the consumption set.

The labor indivisibility assumption is justifiable for the case of the Armenian economy given the fact that majority of Armenian workers are employed on the basis of the fixed hours contract in the public, construction and manufacturing sectors both in Armenia and in Russia. Therefore, I will be applying Hansen's approach (1985) modified by Tlelima (2009), where households choose the probabilities and not hours of working for both Armenian and foreign labor markets. We denote q_{1t} , q_{2t} as the probabilities of being employed at home or abroad, respectively, and h_0^d, h_0^f as hours stipulated in the contracts in period *t*, this implies that the probability of non-wage employment[5] will be 1 - q_{1t} - q_{2t}. The equilibrium per capita hours of labor thus will be defined by:

$$h_t^f + h_t^d = q_{1t}h_0^d + q_{2t}h_0^f \ , \qquad (1)$$

where h_t^d - demanded hours of labor domestically;

h_t^f - demanded hours of labor abroad.

The expected labor income will respectively be defined by:

$$E_t\{h_t w_t\} = w_t^d h_t^d + w_t^f h_t^f, \qquad (2)$$

where w_t^d - domestic wages;

w_t^f - foreign wages.

[5] Non-wage employment is the conventionally known unemployment.

To enable the replication of the Armenian economy through the proposed model I will be matching the selected economic indicators given the actual data the same way as done by Tlelima (2009).

Table 3. Selected Macroeconomic Indicators for Armenia: 2000Q1 -2007Q4[6]	
Variable	**Ratio of GDP**
Output	1.00
Net foreign factor income	0.73
Consumption	1.20
Investment	0.16

In our case, though, the summary provided in the Table 3 is based on the quarterly data from 2000-2007. It should be mentioned that here the government spending component is excluded from GDP to ensure the plausible matching since the model used doesn't take into account governmental interference. As can be seen in the table, households' average consumption exceeds the output with the ratio of 1.2 which is consistent with the exponentially increasing trade deficit. Net foreign factor income, which makes up 73% of GDP, can be deemed as the main way of its financing. The last point is discussed thoroughly by Baruah, Kumar(2009) with the emphasis on the ways remittances of the Armenian construction-workers have become vital for the domestic economic activity.

2.2.2 A model for an economy with labor exports

As discussed in the review of the literature this contribution will be using the Hansen's model with a feature of labor exports (Tlelima 2009) as benchmark framework for our analysis.

[6] Armenian Statistical Office: http://www.armstat.am/en/?nid=82

HOUSEHOLDS

We consider the economy to consist of a continuum identical households i={0,1} which will help us to further introduce our model in aggregate terms with the purpose of analyzing the domestic economy. Unlike Tlelima (2009) the general form of the utility function is used in the current model, where a household is choosing consumption and probability. Thus, the full period's utility function is:

$$U\ (c_t, q_{1t}, q_{2t}) = q_{1t}\ \{\ \frac{c_t^{1-\gamma}}{1-\gamma} + \mathrm{A}\ \frac{\left(1-h_0^d\right)^{1-\vartheta}-1}{1-\vartheta}\ \}\ +\ q_{2t}\ \{\ \frac{c_t^{1-\gamma}}{1-\gamma} + \mathrm{A}\ \frac{\left(1-h_0^f\right)^{1-\vartheta}-1}{1-\vartheta}\ \}\ +$$

$$+\ (1-\ q_{2t}\ -\ q_{1t})\ \{\ \frac{c_t^{1-\gamma}}{1-\gamma}\}\ =\ \frac{c_t^{1-\gamma}}{1-\gamma} + q_{1t}\mathrm{A}\ \frac{\left(1-h_0^d\right)^{1-\vartheta}-1}{1-\vartheta}\ +\ q_{2t}\mathrm{A}\frac{\left(1-h_0^f\right)^{1-\vartheta}-1}{1-\vartheta}\ , \qquad (3)$$

where $h_0 = h_0^d + h_0^f$, with normalization of time endowment to unity: 1 - h_0 is leisure in t. From the equation 1, we can express the respective probabilities in the following way: $q_{1t} = \frac{h_t^d}{h_0^d}$ and $q_{2t} = \frac{h_t^f}{h_0^f}$. As a result, the equation (3) will have the form of:

$$U\ (c_t, q_{1t}, q_{2t}) = \frac{c_t^{1-\gamma}}{1-\gamma} +\ h_t^d\alpha_1 + h_t^f\alpha_2, \qquad (4)$$

where $\alpha_1 = \mathrm{A}\ \frac{\left(1-h_0^d\right)^{1-\vartheta}-1}{(1-\vartheta)h_0^d}$, $\alpha_2 = \mathrm{A}\ \frac{\left(1-h_0^f\right)^{1-\vartheta}-1}{(1-\vartheta)h_0^f}$

A > 0 and 0 < h^j < 1, $j = d, f$

In order to moderate volatility of the investment and be able to separate foreign bonds and capital after log-linearization capital adjustment costs are introduced in our model of small open economy as proposed by Schmitt- Grohe and Uribe (2003). Thus, the law of motion for capital will be as follows:

$$k_{t+1} + \frac{1}{2}\ \xi\ (k_{t+1} - k_t)^2 = (1-\delta)k_t +\ i_t\ , \qquad (5)$$

where k_t is capital stock owned by household at time t,

δ is quarterly depreciation rate,

i_t is investment expenditure at time t,

ξ (■) is a function of net investment.

In addition, we assume that households have the possibility to hold foreign bonds as well as borrow from international markets. As argued by McCandless (2008), when a household is a net debtor he faces the higher interest rate on the international markets and vice versa. McCandless also points out the importance of considering interest rate as a function of the country's risk premium since it ensures existence of the steady state around which the log-linearization is to be done. Thus, all above-mentioned is described by:

$$r_t^f = r^* - \phi B_t \quad , \tag{6}$$

where B_t is country's total stock of foreign bonds,

r_t^f is the rate at which households are borrowing from international markets,

r^* is the fixed world interest rate,

Φ is country's risk premium and is > 0

Summarizing all the points the household's problem can be described as choosing a sequence of $\{b_t, c_t, h_t^d, h_t^f, k_{t+1}\}_{t=0}^{\infty}$ in order to maximize:

$$E_t \sum_{t=0}^{\infty} \left(\frac{c_t^{1-\gamma}}{1-\gamma} + h_t^d \alpha_1 + h_t^f \alpha_2 \right), \tag{7}$$

subject to the budget constraint:

$$b_t + c_t + k_{t+1} + \frac{1}{2} \xi (k_{t+1} - k_t)^2 = w_t^d h_t^d + w_t^f h_t^f + r_t k_t + (1-\delta) k_t + (1 + r_{t-1}^f) b_{t-1} \tag{8}$$

as well as labor market clearing condition:

$$h_t^f + h_t^d = \overline{h} \tag{9}$$

With the purpose of preventing the ever growing consumption financed through the foreign debt no-Ponzi game condition is added:

$$\lim_{t\to\infty} \frac{b_t}{\left(1+r_t^f\right)^t} = 0 \tag{10}$$

Denoting $\beta \in (0;1)$ as the discount factor of the household and λ_t, μ_t as the Lagrange multipliers on (8) and (9) respectively, the optimization problem takes the following form:

$$L = E_t \sum_{t=0}^{\infty} \beta^t \{ \frac{c_t^{1-\gamma}}{1-\gamma} + h_t^d \alpha_1 + h_t^f \alpha_2 - \mu_t \left(b_t + c_t + k_{t+1} + \frac{1}{2} \xi (k_{t+1} - k_t)^2 - w_t^d h_t^d - \right.$$

$$\left. wtfhtf + rtkt - 1 - \delta kt - 1 + rt - 1fbt - 1 + \lambda t(-htf - htd + h) \right) \} \tag{11}$$

The respective first order conditions of the problem would be:

$$\frac{\partial L}{\partial c_t}: c_t^{-\gamma} - \mu_t = 0 \tag{12a}$$

$$\frac{\partial L}{\partial h_t^d}: \alpha_1 + \mu_t w_t^d - \lambda_t = 0 \tag{12b}$$

$$\frac{\partial L}{\partial h_t^f}: \alpha_2 + \mu_t w_t^f - \lambda_t = 0 \tag{12c}$$

$$\frac{\partial L}{\partial k_{t+1}}: -\mu_t\left(1 + \xi(k_{t+1} - k_t)\right) + \beta E_t \mu_{t+1}(\xi(k_{t+2} - k_{t+1}) + r_{t+1} + (1-\delta)) = 0 \tag{12d}$$

$$\frac{\partial L}{\partial b_t}: -\mu_t + \beta E_t \mu_{t+1}(1 + r_t^f) = 0 \tag{12e}$$

$$\frac{\partial L}{\partial \mu_t}: b_t + c_t + k_{t+1} + \frac{1}{2} \xi (k_{t+1} - k_t)^2 = w_t^d h_t^d + w_t^f h_t^f + r_t k_t + (1-\delta) k_t + (1 + r_{t-1}^f) b_{t-1} \tag{12f}$$

$$\frac{\partial L}{\partial \lambda_t}: h_t^f + h_t^d = \overline{h} \tag{12g}$$

and the no-Ponzi game condition (10).

FIRMS

For the given sequence of $\{r_t, w_t^d\}_{t=0}^{\infty}$ and factor productivity z_t firm exploits capital k_t and labor $h_{d,t}$ to produce goods and services based on the standard Cobb- Douglas production function:

$$y_t = z_t k_t^{\theta} h_{d,t}^{1-\theta}, \tag{13}$$

where $\theta \in (0; 1)$ and productivity is defined by the AR(1) process as follows :

$$\log z_t = (1-\rho^z)\log \bar{z} + \rho^z \log z_{t-1} + \varepsilon_t^z \tag{14}$$

$$\rho^z \in (-1; 1), \varepsilon_t^z \sim i.i.d.N(0, \sigma_z^2)$$

Thus, the profit maximization problem of the representative firm would be:

$$\max_{h_t^d, k_t}\{ z_t k_t^{\theta} h_{d,t}^{1-\theta} - w_t^d h_{d,t} - r_t k_t\} \tag{15}$$

As a result, the first order conditions are:

$$\theta z_t k_t^{\theta-1} h_{d,t}^{1-\theta} = r_t \tag{16a}$$

$$(1-\theta) z_t k_t^{\theta} h_{d,t}^{-\theta} = w_t^d \tag{16b}$$

(16a) and (16b) imply that under neoclassical assumption production factors are paid the marginal products.

MARKET CLEARING CONDITIONS

The capital letters in this section will stand for aggregate variables. As already mentioned we have assumed that households are identical to each other and defined on the unit interval, thus in equilibrium we would expect the aggregate variables to follow the behavior of the individual counterparts:

$$B_t = b_t$$
$$K_t = k_t$$
$$C_t = c_t$$
$$H_t = h_t$$
$$I_t = i_t$$

The resource constraint of the economy is derived through the aggregation of (8):

$$B_t + C_t + I_t = w_t^d H_t^d + r_t K_t + w_t^f H_t^f + \left(1 + r_{t-1}^f\right) B_{t-1} \quad (17a)$$

$$or \qquad (B_t - B_{t-1}) + C_t + I_t = Y_t + w_t^f H_t^f + r_{t-1}^f B_{t-1}, \quad (17b)$$

where $I_t = K_{t+1} + \frac{1}{2}\,\xi\,(K_{t+1} - K_t)^2 - (1-\delta)K_t$ is aggregate investment expenditure.

From (17b) we can derive the balance of payments condition that is also needed to ensure clearing of the foreign exchange market:

$$B_t - B_{t-1} = Y_t + w_t^f H_t^f + r_{t-1}^f B_{t-1} - C_t - I_t \quad (18)$$

By applying the national income accounting identity $Y_t = X_t + C_t + I_t$ to equation (18) we are going to have the BOP (balance of payments condition):

$$B_t - B_{t-1} = X_t + w_t^f H_t^f + r_{t-1}^f B_{t-1} \quad (19)$$

The right side of the equation stands for the current account surplus or deficit which will be expressed through the change in net foreign assets. To conclude the market clearing conditions we also need to add labor market clearing condition, given by:

$$H_t^f + H_t^d = \overline{H} \quad (20)$$

THE MODEL IN AGGREGATE TERMS

After rearrangement and substitution of the given equations we have eliminated the Langrange multipliers as well as foreign interest rate. As a result we have a system of 11 equations, the model comprises 9 variables and 2 stochastic processes: $C_t, B_t, K_{t+1}, r_t, H_t^d, H_t^f, w_t^d, X_t, Y_t, z_t, w_t^f$.

$$\alpha_1 - \alpha_2 = w_t^f C_t^{-\gamma} - w_t^d C_t^{-\gamma} \quad (21a)$$

$$\frac{1}{\beta}\left(1 + \xi(K_{t+1} - K_t)\right) = E_t\left(\frac{C_t}{C_{t+1}}\right)^{\gamma}\{\,\xi(K_{t+2} - K_{t+1}) + r_{t+1} + 1 - \delta\} \quad (21b)$$

$$E_t(\frac{C_{t+1}}{C_t})^{\gamma} = \beta(1 + r^* - \phi B_t) \quad (21c)$$

$$\theta z_t K_t^{\theta-1} H_{d,t}^{1-\theta} = r_t \quad (21d)$$

$$(1-\theta) z_t K_t^{\theta} H_{d,t}^{-\theta} = w_t^d \quad (21e)$$

$$B_t + C_t + K_{t+1} + \frac{1}{2}\xi (K_{t+1} - K_t)^2 = Y_t + w_t^f H_t^f + (1-\delta)K_t + (1 + r^* - \phi B_{t-1})B_{t-1} \quad (21f)$$

$$B_t - B_{t-1} = X_t + w_t^f H_t^f + (r^* - \phi B_{t-1})B_{t-1} \quad (21g)$$

$$Y_t = z_t K_t^{\theta} H_{d,t}^{1-\theta} \quad (21h)$$

$$H_t^f + H_t^d = \overline{H} \quad (21i)$$

$$\lim_{t\to\infty} \frac{B_t}{\left(1+r_t^f\right)^t} = 0 \quad (21j)$$

$$\log w_t^f = (1-\rho^w)\log \bar{w} + \rho^w \log w_{t-1} + \varepsilon_t^w \quad (21k)$$

$$\rho^w \in (-1;1)\,, \varepsilon_t^w \sim i.i.d.N\,(0, \sigma_w^2)$$

$$\log z_t = (1-\rho^z)\log \bar{z} + \rho^z \log z_{t-1} + \varepsilon_t^z \quad (21\,l)$$

$$\rho^z \in (-1;1)\,, \varepsilon_t^z \sim i.i.d.N\,(0, \sigma_z^2)$$

Most of the equations above are standard for the RBC model of the small open economy but some of them enter the system stemming from the specification of the model with labor exports. For instance, equation (21a) equates marginal benefits of working domestically and on the foreign labor market. In this equation, α_1 and α_2 are the marginal disutilities of labor, implying equality in case there is no wage differential between domestic and foreign labor marker. As Baruah, Kumar (2009) argue, marginal disutility from foreign labor supply is higher than that of domestic work due to bad working conditions in the Russian construction sector with no health insurance and not developed unions. Rationality assumption informs that agents will

tend to work abroad in case the costs associated with it are compensated by the high wages on the foreign labor markets.

Equations 21f and 21g imply that it may happen that the economy will run a trade deficit along with accumulation of foreign assets which will depend on the size of the foreign labor income, which is in line with the empirical observation of a high net foreign factor income ratio to the GDP for the Armenian economy.

LOGLINEAR APPROXIMATION

A. STEADY STATE

The steady state solution of the model is as follows:

$$\alpha_1 - \alpha_2 = \overline{w^f}\bar{C}^{-\gamma} - \overline{w^d}\bar{C}^{-\gamma} \quad (22a)$$

$$\frac{1}{\beta} = \bar{r} + 1 - \delta \quad (22b)$$

$$\frac{1}{\beta} = 1 + r^* - \phi\bar{B} \quad (22c)$$

$$\bar{r} = \theta\bar{z}\left(\frac{\overline{H^d}}{\bar{K}}\right)^{1-\theta} \quad (22d)$$

$$\overline{w^d} = (1-\theta)\,\bar{z}\left(\frac{\bar{K}}{\overline{H_d}}\right)^{\theta} \quad (22e)$$

$$\bar{C} + \delta\bar{K} = \bar{Y} + \overline{w^f H^f} + (r^* - \phi\bar{B})\bar{B} \quad (22f)$$

$$\bar{X} + \overline{w^f H^f} + (r^* - \phi\bar{B})\bar{B} = 0 \quad (22g)$$

$$\bar{Y} = \bar{z}\overline{K^{\theta}}\,\overline{H_d^{1-\theta}} \quad (22h)$$

$$\bar{H} = \overline{H^d} + \overline{H^f} \quad (22i)$$

where $\bar{S} = S_t = S_{t+i}$ for any S_t and all $i \in Z$

From the 22b and 22c the $\bar{r}$ and $\bar{B}$ can be determined as:

$$\bar{r} = \frac{1}{\beta} - (1 - \delta) \tag{23}$$

$$\bar{B} = \frac{(1-\frac{1}{\beta}+r^*)}{\phi} \tag{24}$$

Equation 22g will determine $\bar{X}$, given $\overline{w^f}$ and $\overline{H^f}$.

From 22d and 22e the steady state level of domestic wage will be:

$$\overline{w^d} = (1-\theta)(\frac{\theta}{\bar{r}})^{\frac{\theta}{1-\theta}} \tag{25}$$

Given 25, the capital steady state value can be determined as follows:

$$\bar{K} = (\frac{\overline{w^d}}{1-\theta})^{\frac{1}{\theta}}\overline{H^d} \tag{26}$$

Consistent with the labor indivisibility assumption, one third of time endowment makes up the aggregate hours worked:

$$\overline{H^d} + \overline{H^f} = 0.333 \tag{27}$$

$\overline{H^d}$, $\overline{H^f}$ are further determined based on the empirical data to replicate long run average shares of domestic and "foreign" employment. Given this, the rest of the steady state values can be found from the respective equations.

For instance, the value of steady state consumption will be:

$$\overline{C^{-\gamma}} = \frac{\overline{w^f} - \overline{w^d}}{a_1 - a_2} \tag{28}$$

B. LOG-LINEARISATION

We denote $\widehat{s_t} = \log\frac{S_t}{\bar{S}}$, where $\bar{S}$ is the steady state value of S_t. Thus the model is now expressed in variables that stand for the log deviation from their steady state: $\widehat{c_t}$, $\widehat{k_{t+1}}$, $\widehat{b_t}$, $\widehat{r_t}$, $\widehat{h_t^d}$, $\widehat{h_t^f}$, $\widehat{w_t^d}$, $\widehat{x_t}$, $\widehat{y_t}$.

$$\widehat{c_t} = \frac{\overline{w^f}\,\widehat{w_t^f} - \widehat{w_t^d}\,\overline{w^d}}{(\overline{w^f} - \overline{w^d})\gamma} \tag{29a}$$

$$\overline{K}(1+\beta)\xi\,\widehat{k_{t+1}} = \gamma\widehat{c_t} - \gamma E_t\widehat{c_{t+1}} + \overline{K}\xi\widehat{k_t} + \beta\xi\,\overline{K}E_t\widehat{k_{t+2}} + \beta\bar{r}E_t\widehat{r_{t+1}} \tag{29b}$$

$$\beta\phi\bar{B}\widehat{b_t} = \gamma\widehat{c_t} - \gamma E_t\widehat{c_{t+1}} \tag{29c}$$

$$\widehat{r_t} = \widehat{z_t} + (\theta-1)\widehat{k_t} + (1-\theta)\,\widehat{h_t^d} \tag{29d}$$

$$\theta\,\widehat{h_t^d} = \widehat{z_t} + \theta\widehat{k_t} - \widehat{w_t^d} \tag{29e}$$

$$\bar{B}\widehat{b_t} + \bar{C}\widehat{c_t} + \overline{K}\left(\widehat{k_{t+1}} - (1-\delta)\widehat{k_t}\right) = \bar{Y}\widehat{y_t} + \overline{w^f H^f}\left(\widehat{w_t^f} + \widehat{h_t^f}\right) + \widehat{b_{t-1}}((1+r^*)\bar{B} - 2\phi\bar{B}^2) \tag{29f}$$

$$\bar{B}\widehat{b_t} = \bar{X}\widehat{x_t} + \overline{w^f H^f}\left(\widehat{w_t^f} + \widehat{h_t^f}\right) + \widehat{b_{t-1}}((1+r^*)\bar{B} - 2\phi\bar{B}^2) \tag{29g}$$

$$\widehat{y_t} = \widehat{z_t} + \theta\widehat{k_t} + (1-\theta)\,\widehat{h_t^d} \tag{29h}$$

$$\overline{H^d}\,\widehat{h_t^d} + \overline{H^f}\,\widehat{h_t^f} = 0 \tag{29i}$$

And the 2 stochastic processes:

$$\widehat{w_t^f} = \rho^w\,\widehat{w_{t-1}^f} + \varepsilon_t^w \tag{30a}$$

$$\widehat{z_t} = \rho^z\widehat{z_{t-1}} + \varepsilon_t^z \tag{30b}$$

where the distributions of ε_t^w and ε_t^z are given by 21k and 21 l.

2.2.3 Calibration of the model

The parameterization strategy used in the paper is to match steady state values of the theoretical model to the long-run values of the selected macroeconomic indicators for the Armenian economy as stipulated in the first section. As mentioned in the first section, the ratios calculated and presented in the table 3 exclude the presence of the government to ensure plausible matching with the theoretical model. In this way, taking into account the significance

of the income earned by Armenian construction-workers in Russia the model's parameters are selected to be consistent with Armenia's average net foreign factor income for the period of 2000Q1-2007Q4, which is 73% of GDP, after excluding government. Obtaining the parameter values and steady states consist of 2 sets: one is determined based on the empirical data and literature while the other is solved given the information from the first set.

I start consideration of the first set from the average quarterly real interest rate $\bar{r}$, which is 4.34 % based on the data that covers 2000Q1-2007Q4 period for Armenia. The US quarterly real interest rate is taken as the proxy for the world interest rate, r^* and is equal to 1.4 %. Both indicators are obtained from the database of the World Bank. The values of $\overline{H^f}$ and $\overline{H^d}$ are obtained from the reports of OSCE on labor migration from Armenia and country study of International Labor Organization on migration and development in Armenia. Authors argue, that the share of Armenian construction-workers in Russia makes up around 25 % of the total labor force in Armenia, which implies that 75% of the workers are employed domestically. In this way, the values for $\overline{H^f}$ and $\overline{H^d}$ are as follows: $\overline{H^f} = 0.333 * 0.25 = 0.0832, \overline{H^d} = 0.333 * 0.75 = 0.2497$. The most frequently used value of the capital share,θ, is 0.4 in the literature. But it should be noted that majority of authors refer to this value when considering advanced economies. As fairly argued by Mendoza (1995) the value for the developing and emerging markets should be smaller; for our purposes we will be using the value of 0.38 to ensure the ratio of foreign to domestic wages to be 3.8[7].

The value for the household's discount factor $\beta = 0.97$ (from equation 23) is chosen in a way that given $\overline{r}$, the quarterly rate of depreciation for the Armenian economy will be around 1.75 % . The latter is based on the calibration by Easterly and Rebelo (1993) with yearly

[7] The value is consistent with the observations in the country study by International Labor Organization.

depreciation rate of 7 %. As they argue, the depreciation rates in the developing countries are lower than that of developed countries due to the lower efficiency of the investment projects and more pronounced corruption in the former ones. Following Uribe (2002) and Mendoza(1991) I set the parameters of debt elasticity of interest rate premium,ϕ , and capital adjustment cost, ξ, to be 0.01 and 0.028 respectively. Value for the persistence of the productivity shock ρ^z is chosen to be 0.41 in line with Mendoza's average persistence for developing countries, σ_z^2 is set 0.04. To pin down the values for ρ^w and σ_w^2 I run the OLS regression based on the seasonally adjusted, logged, detrended data on the wages of the Armenian construction-workers in Russia. The results in the Table 2 suggest to assign the values of 0.724 to persistence of the foreign wage shock and 0.0075 to σ_w^2.

Table 4. Results of the OLS regression based on the data 2000Q1-2007Q2

Dependent variable: $\widehat{w_t^f}$	Coefficient	Std. Error	t-Statistic	Prob.
$\widehat{w_{t-1}^f}$	0.724099	0.125896	5.751555	0.0000
R-squared	0.524411	Mean dependent var		0.000323
Adjusted R-squared	0.524411	S.D. dependent var		0.100769
S.E. of regression	0.069494	Akaike info criterion		-2.463438
Sum squared resid	0.144881	Schwarz criterion		-2.417180
Log likelihood	39.18329	Hannan-Quinn criter.		-2.448359

The inter-temporal elasticity of substitution, γ, is chosen to be 1.002 which is used by Mendoza (1991), Uribe and Yue(2006) and Aguiar, Gopinath (2007).

After determining the values for the first set of parameters and steady states I use it to solve endogenously for the second set. In this way, given , r^*, ϕ from equation 24 $\bar{B}$ = -1.692 and is negative, implying that the country is net debtor. This is consistent with the fact that net rate of return on capital $\bar{r} - \delta = 0.0259$ and is bigger than the world interest rate, $r^* = 0.014$. It follows, that in equilibrium, residents will dissave in foreign markets to make the domestic rates equal.

The domestic wage rate can be found from equation 25 given the values of $\theta, \bar{r}$:$\overline{w^d} = 2.34$ and further $\bar{K} = 8.26$ is obtained from equation 26. Now enough information is provided to find the value of the state aggregate output from 22h, $\bar{Y} = 0.943$. This means that $\frac{\bar{I}}{\bar{Y}} = 0.1532$, which is consistent with the empirical data we analyzed in the first section. Knowing that $\frac{Net\ foreign\ factor\ income}{GDP\ (without\ gov.)} = 0.73$, the following is stated: $\frac{\overline{w^f H^f} + (r^* - \phi\bar{B})\bar{B}}{\bar{Y}} = 0.73 => \overline{w^f H^f} +$ $+ (r^* - \phi\bar{B})\bar{B} = 0.73 * 0.943 = 0.69$, from this $\overline{w^f} = 8.9$, thus the foreign wages are about 3.8 higher than domestic wages which is in line with the conjunctures of the Armenian labor market. From equation 22f, $\bar{C} = 1.48$ and the ratio of consumption to GDP, excluding government, is $\frac{\bar{C}}{\bar{Y}} = 1.57$. The latter is slightly higher than the value given in the Table1 of the section 1, nevertheless the fact that consumption expenditures exceed output by 57 % is taken to be sufficient to approximate the Armenian Economy. Ultimately, to pin down the values for the a_1 and a_2 I refer to the equation 28 from where $a_1 - a_2 = \overline{C^\gamma}\left(\overline{w^f} - \overline{w^d}\right) = 4.4$. Following Hansen (1985) and Tlelima(2009), I set the value of $a_1 = -2$ and then $a_2 = -6.4$, which ensure the ratio between the disutilities to be 3.2 making it reasonably approximate with the ratio of the foreign and domestic wages. The summary of the parameter and steady state values are given in below presented tables 5 and 6, respectively.

Table 5. Parameters

Parameter	Value	Description
a_1	-2.0	disutility of working in Armenia
a_2	-6.4	disutility of working in Russian construction sector
ϕ	0.01	debt elasticity of interest rate premium
θ	0.38	capital share in the output
δ	0.0175	quarterly rate of depreciation
β	0.97	discount factor
Ξ	0.028	capital adjustment cost parameter

r^*	0.014	fixed world interest rate
γ	1.002	Intertemporal elasticity of substitution
ρ^w	0.724	persistence of the foreign wage shock
ρ^z	0.41	Persistence of the productivity shock
σ_w^2	0.007	variance of ε_t^w
σ_z^2	0.04	Variance of ε_t^z

Table 6. Steady State Values

$\bar{B}$	$\bar{C}$	$\bar{K}$	$\overline{H^d}$	$\overline{H^f}$	$\bar{H}$	$\bar{X}$	$\bar{Y}$	$\overline{w^d}$	$\overline{w^f}$	$\bar{r}$
-1.692	1.48	8.26	0.2497	0.0832	0.333	-0.69	0.943	2.343	8.9	0.0434

2.2.4 Results

2.2.4.1 Impulse Responses to total factor productivity (TFP) shocks

Figure 2. Impulse Responses to Total Factor Productivity (TFP) Shocks

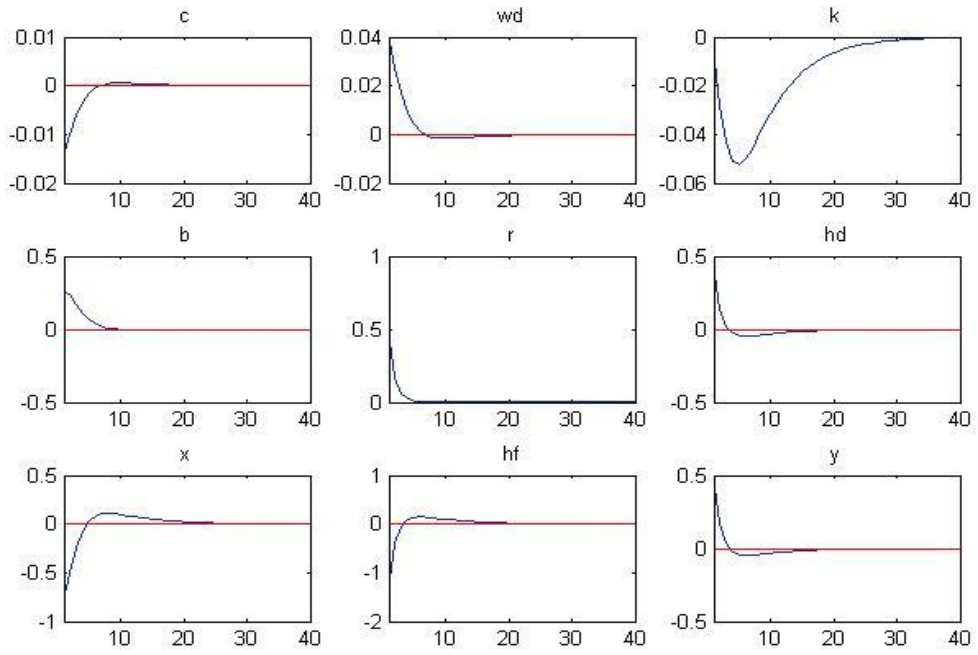
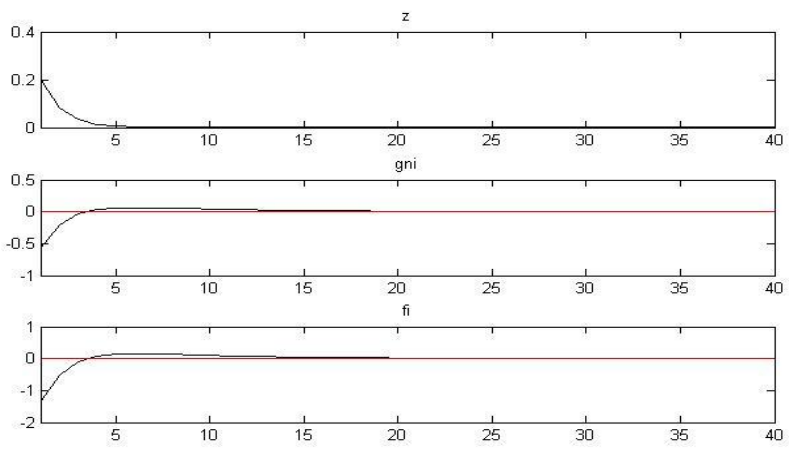


Figure 3. Impulse Responses to Total Factor Productivity (TFP) Shocks (continuation)



The model used in the paper doesn't aim to mimic all the empirical features of the Armenian economy given the simplifying assumption we are making. Nevertheless, the qualitative results obtained can be applied to analyze the ways Armenian economy behaves given its strong dependence on Russian economy.

Before considering the effect foreign wage shock has on the Armenian economy I will analyze firstly the impact of the productivity shocks on the real economy. Figure 2 shows the impulse responses of the model's variables to a standard deviation shock to TFP. As we can see a positive shock translates into a higher output and also raises the marginal product of labor, $\widehat{w_t^d}$. The substitution effect of real wage increase dominates over income effect thus resulting in an increased domestically supplied labor. The latter leads to reduction of foreign labor supply $\widehat{h_t^f}$ given the assumption of fixed total hours of labor. As Figure 3 shows, this results in a decline of the factor income from abroad thus dragging down GNI. We can see also that a positive TFP shock entails trade deficit which is explained by the fact that Armenian economy is very much

import-oriented and a large portion of its imports covers inputs that are further used in the domestic production.

The pattern of the positive response of the foreign asset holdings, $\widehat{b_t}$, is in line with theoretical expectations, particularly an increased income makes agents to raise their domestic and foreign savings to insure themselves against adverse effect during the economic downturn. The pronounced effect of the positive TFP shock on the savings can also be noticed from the decreased consumption. For the conditions of Armenian economy people respond to even a slightest positive shock with a considerable cushion of safety. In this way, the increased real interest rate are perceived as higher price for today's consumption triggering high savings. In addition, the increase in the interest rate is perceived as purely temporary and bearing in mind that it will fall in the future people tend to disinvest, which explain the negative response of the capital to a positive TFP shock.

2.2.4.2 Impulse responses to foreign wage shocks

The fluctuations of the model's variables around their steady state as a result of a foreign wage shock are represented in the Figure 4, from which we notice the strong positive response of the foreign supplied labor. And due to the switch from the domestic to foreign labor supply the output decreases. It should, however, be noted that after a 4^{th} period it not only goes back to but soon exceeds its steady state level, meaning that on this stage the increased net foreign factor income outweighs the drop in GDP. As already mentioned, remittances of the Armenian construction-workers makes up a great part of the country's GDP with the consumption expenditure channel as the main way of their utilization. The latter is visible also on the Figure 4 where a positive foreign wage shock entails an increase in consumption that lasts around 20

periods. At the same time, the positive response of the domestic wages can be explained by the decreased domestic labor supply.

The behavior and the relationship of real interest rate and the capital stock is in line with the theoretical expectations that stand for the negative relationship between the two. Considering the response of the net exports, the positive pattern can be noticed that is followed by going below the steady state in the 10^{th} period. As already discussed, Armenian economy being very much dependent on import of intermediate goods and productive inputs is very viable to external shocks, particularly; those imports might fall with output in the first periods thus resulting in a positive response of net exports to a positive foreign wage shock. Nevertheless, taking into account also the large import component in the consumption basket of an average Armenian household, increased consumption will pull up the imports. In our case, the correlation of imports with output is much stronger than that of consumption which might explain the large positive response of the net exports variable. As results suggest, the foreign savings, $\widehat{b_t}$ drop which can be connected with the "artificial" exploitation of foreign reserves in order to restore favorable environment to boost imports, especially taking into consideration that many policy makers in Armenia are a part of the importing business.

Figure 4. Impulse Responses to Foreign Wage Shocks

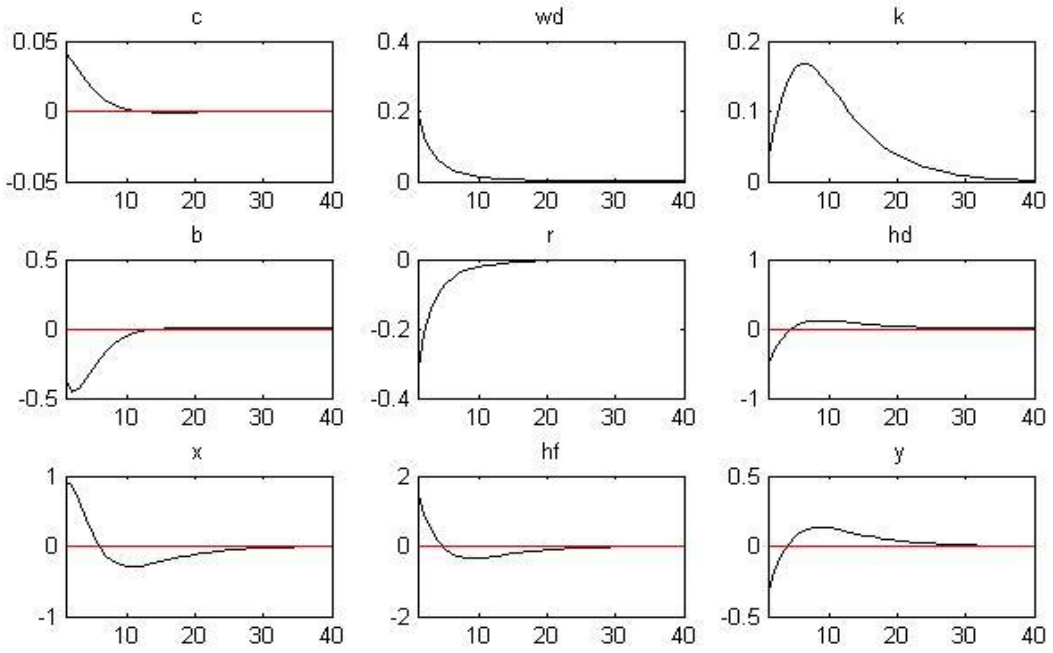
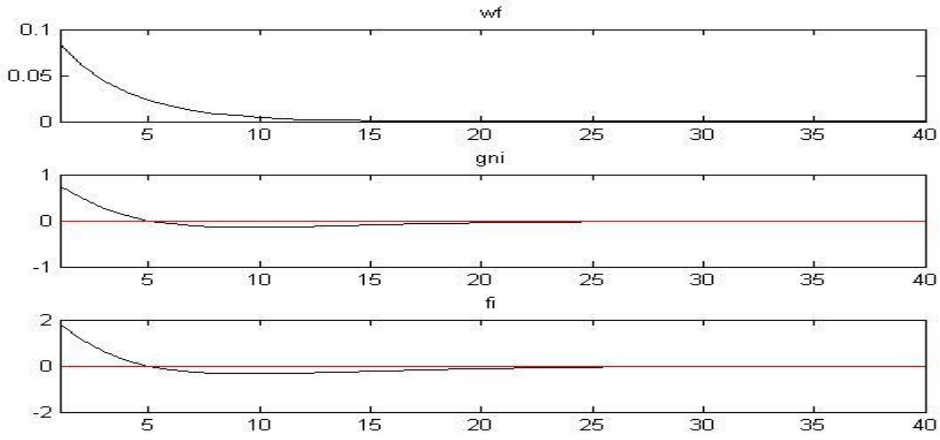


Figure 5. Impulse Responses to Foreign Wage Shocks (continuation)



To conclude, we have seen that both shocks have considerable and not unambiguous effects on the real economy but the effect of a foreign wage shock was a way stronger and long-lasting in comparison with a TFP shock. Thus, this has reinstated the significance of accounting

for the factor of migration once the Central Bank of Armenia is adopting certain decisions on the further prospects of the monetary policy.

3. VAR-MODEL OF THE MONETARY TRANSMISSION MECHANISM: CASE OF ARMENIA

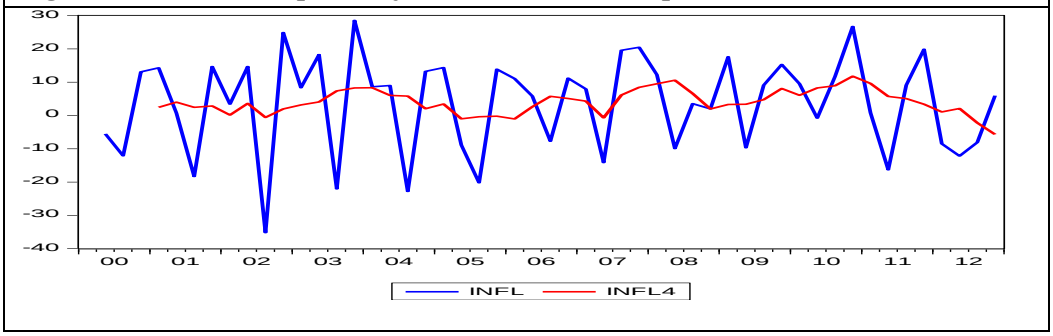
3.1 Overview of the monetary transmission mechanism and traditional VAR-model: case of Armenia

After years of high inflation in 90s, Armenia has managed to stabilize the price level soon but it has also faced a number of challenges related to the conduct of monetary policy. Adhering to policies of targeting monetary aggregates became ineffective due to incipient re-monetization and de-dollarization leading to instability in money demand. Due to the latter, the Central Bank of Armenia announced a transition to a "hidden" inflation targeting on 1st January 2006 with the intention to move to a full-featured inflation targeting in the medium term. From then on, monetary policy in Armenia can be characterized by strengthening banking sector and supervision. Nevertheless, a range of factors preclude working of the main transmission channels, particularly, due to the low level of monetization aggregate demand reacts insignificantly to the changes in the interest rates on loans. On the other hand, a high level of credit to the private sector denominated in foreign currency lowers the sensitivity of borrowers to changes in the domestic interest rate. The bank lending channel is characterized by the inability of banks to properly evaluate the credit risks thus increasing the spread which leads to a decrease in the efficiency of the balance channel. Asset prices channel in Armenia is not likely to work given not well developed capital markets. The financial sector is represented mostly by the banks that hold 97% of the total assets thus preventing operation of the considered channel through the income and wealth effects.

Apart from the above-mentioned points, the model that Central Bank is hinging on when working out the monetary policy recommendations doesn't account for a range of exogenous factors, particularly, the factor of migration which, as shown in the previous chapter, proves to

have a significant effect on the macroeconomic situation of the country. In the current chapter, I will subsequently analyze the VAR-model which lies in the nucleus of the model used by the Central Bank of Armenia and will address the issue of the price puzzle existing in recent years. Being a statistical model VAR has been widely used to estimate the monetary transmission and capture the linear interdependencies among the multiple time series. For the purposes specified in the paper, I will be using the VAR model specified by Stock and Watson (2001).

Figure 6. Annualized quarterly inflation and four-quarter inflation



Firstly, we have to find out which measurement of inflation better suits our model: annualized quarterly inflation (INFL - price level change compared to the previous quarter) or four-quarter inflation (INFL4 -price level change compared to the same quarter of the previous year). As we can see from the Figure 6 the co-movement of the two is moderate with the INFL being more volatile. To start estimation by the VAR model I will further aim to determine the degree of integration for the variables to be included in the analysis: INFL, INFL4, URAMESA, IQ. The results of the ADF test for level and 1st differences compiled in the Table 7 suggest that all the variables to be considered have unit root and are integrated of order 1 – I(1).

Table 7. Results of Augmented Dickey Fuller test for level and 1st difference.

ADF test results: Level
Null Hypothesis: unit root
Sample: 2001Q2 2012Q4*

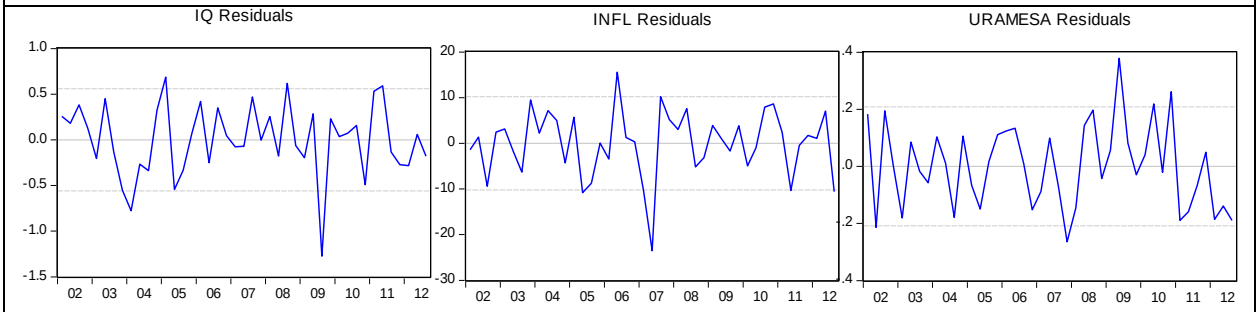
Series	Prob.	Lag	Max Lag	Obs
INFL	0.2555	3	10	47
INFL4	0.2902	0	10	47
URAMESA	0.4784	1	10	49
IQ	0.5476	1	10	50

ADF test results: 1st difference
Null Hypothesis: unit root
Sample: 2001Q2 2012Q4*

Series	Prob.	Lag	Max Lag	Obs
INFL	0.0000	2	10	47
INFL4	0.0000	0	10	47
URAMESA	0.0000	0	10	49
IQ	0.0000	0	10	50

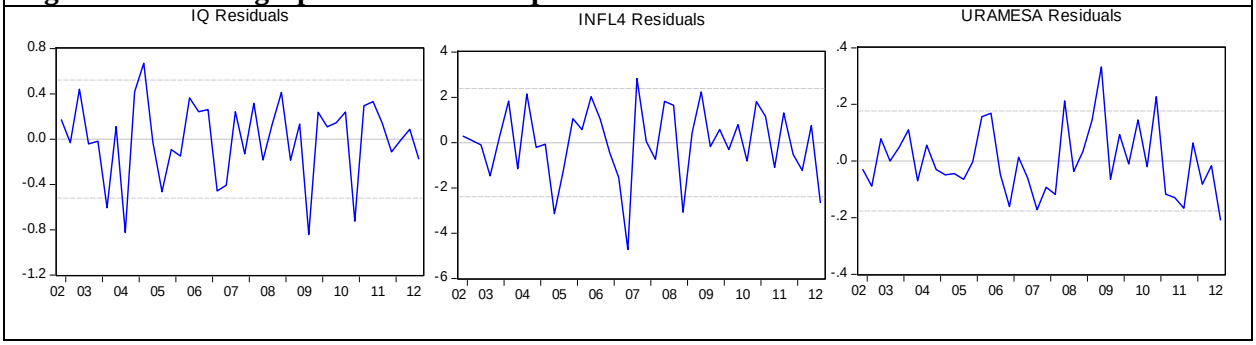
Now, we turn to estimation of 2 three-variable VAR models similar to Stock and Watson (2001) for the 2 different inflations measure INFL and INFL4 as well as the unemployment rate URAMESA and the interest rate IQ. For the both models we set the lag intervals from 1 to 5. It should be noted that we estimate quite many coefficients (for each equation 3*5+1 = 16 on approximately 50 observations and many of the coefficient estimates are 0 at statistically

Figure 7. Residual graphs for 1st model specification.



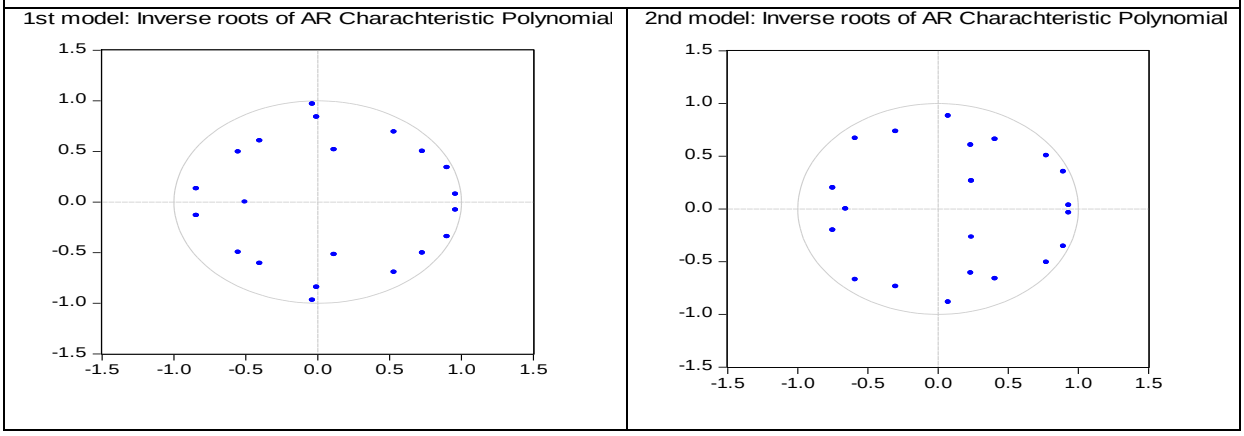
significant level). When checking for the optimal lag length in 2 models different criteria suggest different outcomes (see Table A1, A2) but the largest for both VARs is 7. Test for the lag exclusion for the models (see Table A3, A4) suggest that the 3rd, 4th and 5th lags are jointly insignificant at 5% in the first model, and the 2nd - 5th lags in the second. In the long run, we will be estimating the 2 models with lag length of 7.

Figure 8. Residual graphs for 2nd model specification.



Examination of the residual graphs from 2 models based on the Figures 7 and 8 reveals certain outliers, particularly 2007 for both INFL4 and INFL which can be attributable to the global crisis and 2009 for interest rate that can be explained by the around 30% devaluation of AMD in March of 2009. Check of the inverted AR roots indicates stability of the 2 estimated VARs given that all the roots lie inside the unit circle. Nevertheless, in case of 1st model there are roots that are almost 1 which in practice entails the same consequences as if it was 1 implying certain results to be not valid (such as impulse response standard errors). The results of testing for the remaining autocorrelation by LM and Portmanteau tests suggest that there is missing dynamics

Table 8. Inverse roots of AR Characteristic Polynomial for 2 VAR models



in both models, especially in INFL mode. Investigation of the correlograms at the same time fortifies that there is remaining autocorrelation and cross-correlation across equations (see Table A5, Figures A1, A2). As the results in Tables A6, A7 of Appendix suggest, when checking for Granger causality within the system it turns out that there is no Granger causality between inflation and unemployment of any direction (no Philips curve). But there is significant Granger causality for the other variable pairs. In the 1st model both inflation and unemployment rate affect interest rate at 10% significance level, interest rate and inflation together affect unemployment rate, and interest rate Granger cause unemployment rate. In the 2nd model inflation and unemployment rate together Granger cause interest rate, unemployment rate affects interest rate.

For now we keep the original ordering of the variables and calculate the impulse response functions for the 2 VAR model specifications with INFL and INFL4. The IRFs are similar for the 2 VARs except for the inflation variable; INFL4 has more persistent responses than INFL (see Figure A3, A4). The responses of the variables to their own shocks are the most persistent ones and die out after 11th quarter. Response of the inflation rate to an interest rate shock is slightly positive and dies out only towards the 10th quarter which contradicts the theory since monetary tightening should, on the contrary, decrease inflation. The latter phenomenon is called "price puzzle" and is also contemplated in Stock and Watson (2001). Response of the unemployment rate to the interest rate shock is slightly negative within 2 - 5 quarters but further become positive and die out at the end of the specified period. Response of interest rate to a positive inflation shock is slightly negative in 2nd quarter but slightly positive in the 3rd quarter, followed by negative pattern from then on. As for unemployment rate, its response to a positive inflationary shock is suprisingly positive and turns into negative only after 7th quarter. To

separate the variation in an endogenous variable into the component shocks to the VAR we investigate the variance decomposition. The latter provides information about the relative importance of each random innovation in affecting the variables in the VAR. In case of inflation and interest rate, the relative importance of random innovation in unemployment rate increases over time whereas it decreases for the considered variables. In case of the unemployment rate, the importance of other factors are constant over time (see Figure A5 – A8). With the purpose of addressing the issues encountered in the current model I will introduce a new VAR specification in the subsequent section.

3.2 VAR-model with exogenous world commodity prices

The VAR model specified in the previous subsection turned out to be stable, however most of the findings, particularly, IRFs contradicted the theoretical expectations, including the presence of the "price puzzle". In this sub-section I will be concentrating on the model with INFL4 and also introduce nominal effective exchange rate into it. Firstly, the impact of exchange rate changes on inflation could be significant due to the relatively high share of imports in GDP - 48% in 2011[8]. Secondly, a significant share of the households' savings are kept in foreign currency due to huge flow of remittances from abroad. Correspondingly, the revaluation or devaluation potentially impact on consumer spending through the wealth effect.

In order to overcome the issues encountered in the previous model, I will include the exogenuos variable of world commodity price index that may predict domestic inflation and unemployment rate. Rise of oil prices that entail increase in the world commodity prices has been taken into account as the indicator of economic activity in the foreing state, which in case of Armenia is Russia. Around 80% of all remittances to Armenia are coming from Russia. It is

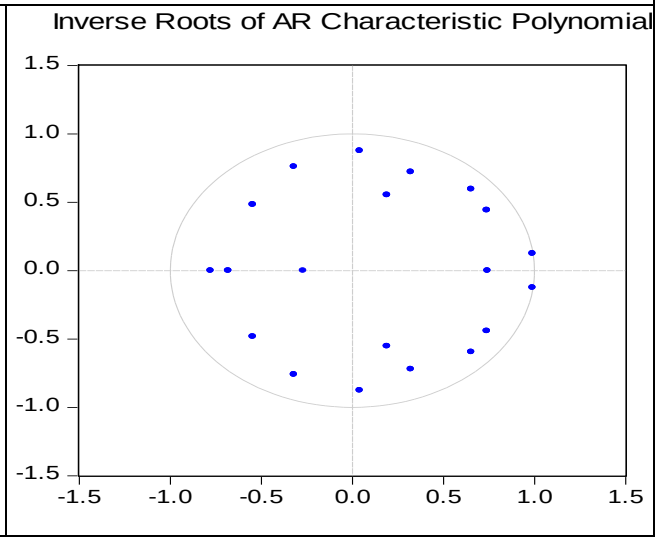
[8] Source: http://data.worldbank.org/indicator/NE.IMP.GNFS.ZS

believed that the rapid growth of remittances is mainly due to rising energy prices because the latter has raised incomes and prices in the Russian non-trade sector in which most of the Armenian labor migrants are working. Furtherly, adhering to the same steps as previously the lag exclusion test and lag length criteria suggest to use 5-lag model. Now for each equation we estimate 5*4+1+1 coefficients. The LM-test results suggest that no autocorrelation is detected in the variable up to 12th lag. The inverted AR roots are again inside the unit circle, although some of them are still very close to unity, the VAR is stable but close-to-unity roots indicate that we work with integrated series (see Table 9).

Table 9. LM-test results on autocorrelation and inverted AR roots for the modified model

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 03/26/13 Time: 19:32
Sample: 2000Q1 2012Q4
Included observations: 37

Lags	LM-Stat	Prob
1	22.04118	0.1419
2	26.88292	0.0428
3	10.94992	0.8126
4	14.51388	0.5605
5	10.85653	0.8183
6	7.822866	0.9540
7	16.47821	0.4201
8	13.79708	0.6138
9	24.74493	0.0745
10	15.50672	0.4879
11	11.84976	0.7543
12	16.15425	0.4422



Compared to the first models the results of the current model suggest a range of significant Granger causal effect between variables. As shown in Table 10, there is Granger causality in both directions for the unemployment rate and exchange rate, the block of specified variables of the model Granger cause interest rate,exchange rate and unemployment rate. In addition, exchange rate is also Granger caused by the interest rate.

Table 10. Granger Causality Test for the modified model

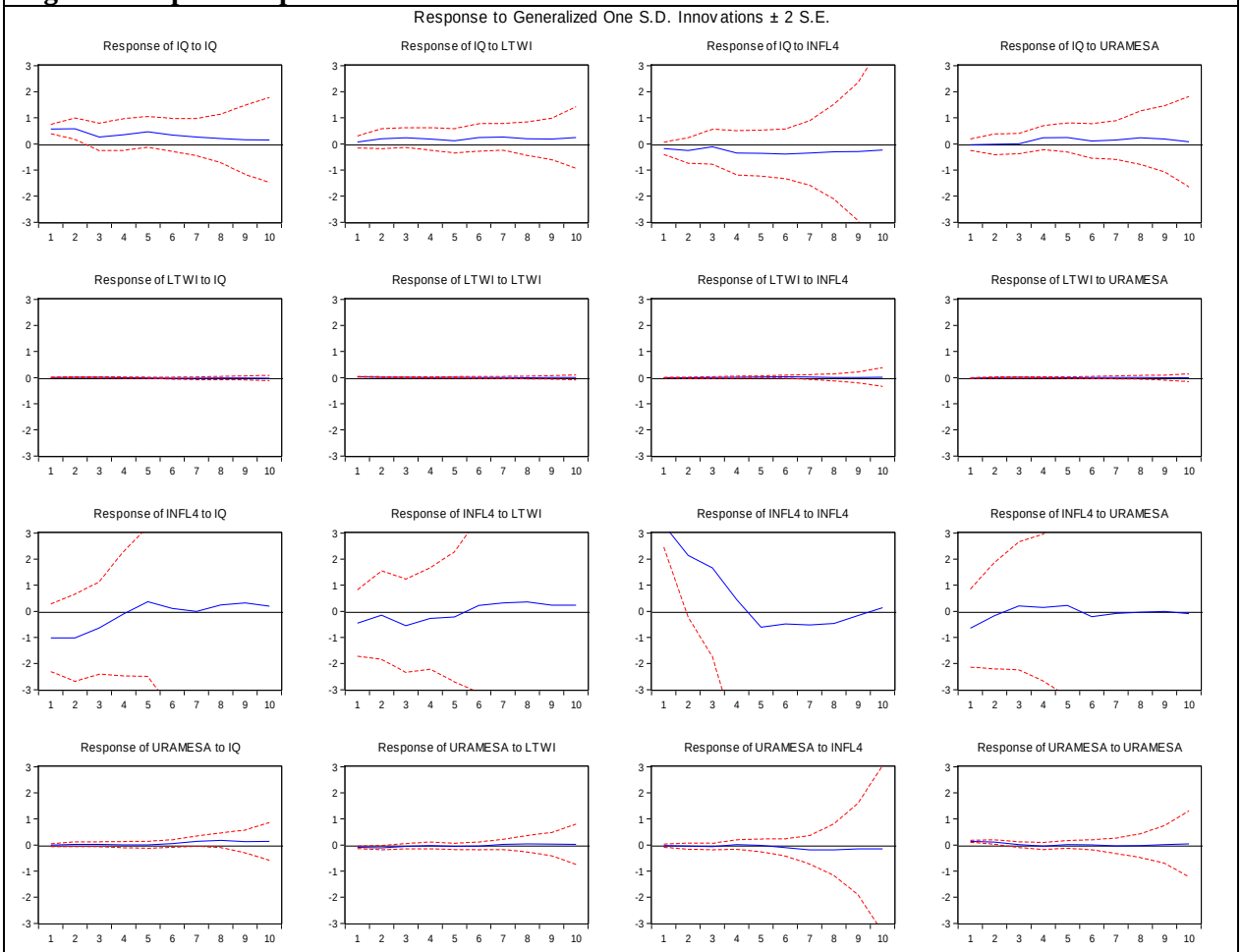
Granger Causality Test: H_0 - no Granger causality	*p-value*
Interest rate (IQ)	
All (INFL4, URAMESA,LTWI)	0.0609*
Inflation rate (INFL4)	0.1051
Unemployment rate (URAMESA)	0.1394
Exchange rate (LTWI)	0.3200
Inflation rate (INFL4)	
All (IQ, URAMESA, LTWI)	0.9983
Interest rate (IQ)	0.9784
Unemployment rate (URAMESA)	0.9727
Exchange rate (LTWI)	0.9097
Unemployment rate (URAMESA)	
All (IQ, INFL4, LTWI)	0.0010***
Interest rate (IQ)	0.0154
Inflation rate (INFL4)	0.4364
Exchange rate (LTWI)	0.0037***
Exchange rate (LTWI)	
All (IQ, INFL4, URAMESA)	0.0001***
Interest rate (IQ)	0.0001***
Inflation rate (INFL4)	0.3266
Unemployment rate (URAMESA)	0.0007***

Note : Granger test statistics for the causality is computed using LR test and has Chi-squared distribution. *, **, *** show not rejection of null hypothesis at the significance level of 10%, 5 %, 1 % respectively.

To see whether the problems encountered in the model of previous sub-section ,especially price puzzle, are overcome, now we will be investigating the impulse-response functions of our new VAR model. The Generalized Impulses are used for the ordering not to matter in case there is correlation between the shocks. Ultimately, as we can see from the graphs beneath the "price

puzzle" is overcome with the response of inflation to monetary tightening being negative. Inflation shock has no effect on umeployment rate which is in line with theory. Whereas the response of inflation to unemployment rate shock is negative which fortifies the foundations of Philips curve. As for the exchange rate positive shock, implying appreciation of the currency, the positive response of the interest rate and negative response of the inflation rate are in line with theoretical expectations.

Figure 9. Impulse response functions for the modified model



As for the variance decomposition, variation in IQ due to random innovation in IQ is decreasing over time while the importance of others is increasing. Variation in inflation rate is mostly due to innovation in inflation variable itself and is constant over time. Unlike the latter 2, variance

decomposition of unemployment rate and exchange rate show different patterns. Variation in unemployment rate is mainly due to innovation in exchange rate and own variable which are decreasing over time and after 7^{th} quarter the interest rate and inflation innovations are becoming relatively more important for the given variation (see Figure A9).

CONCLUSION

In this contribution the issue of "price puzzle" in the VAR-model of monetary transmission mechanism for Armenia was identified, when inflation rate was rising as a response to the monetary tightening, and was further addressed by indirectly accounting for migration factor in the model. Particularly, assessing the migratory processes in Armenia for the recent decade it has been revealed that Armenia, along with Moldova, Georgia, Tajikistan takes the leading places by the ratio of the net migration to the population of the country. Nevertheless, it should be noted that despite the high ratio countries mentioned other than Armenia sustain high fertility rate which helps the latter to avoid the critical situation of the diminishing population. Analyzing the case of Armenia in more details in the scope of the Real Business Cycle (RBC) model framework, monetary neutrality and indivisible labor proposition of Hansen was assumed and variables characterizing the migratory processes in Armenia were further introduced into the RBC model.

Taking into account the fact that remittances from Russia and net foreign factor income covers a significant portion of the Armenian GDP I analyzed how the exogenous shocks on the Russian labor market in the form of wage increase have affected the Armenian economy. It was found that total productivity factor (TFP) and foreign wage shocks have had ambiguous and significant effects on the real economy, nevertheless effect of the latter was stronger and more long-lasting. Thus, this reinstated my point on the importance of considering and incorporating migration factor into the VAR-model to better replicate the reality and avoid the distorted forecasts which contradict the theoretical expectations.

While assessing the traditional VAR-model of the monetary transmission mechanism for Armenia based on the steps proposed by Stock and Watson (2001), several distortions and non-

compliance with the theoretical expectations have been spotted, in particular, the Phillips curve was not sustained , price puzzle was revealed, which implied inflation rate rise in line with the monetary tightening. Taking into account the significance of migration factor incorporation in the model (as previously shown) it was proposed to introduce an exogenous variable into model which was describing the migration processes in Armenia, in particular , this variable was the level of energy prices in Russia . I assume that the rise in energy prices leads to higher incomes and prices in the Russian non-trade sector, where most of the Armenian migrants work, given that the lion's share of remittances of Armenian migrants is coming from Russia. Accounting for this factor helped to overcome the problems inherent in the previous model , in particular , the results suggest tendencies inherent to the Phillips curve , and salvation to the price puzzle since in the modified model inflation rate now reacts negatively to a one percent increase in interest rates, which corresponds to the basic theoretical assumptions.

Appendix

Table A1. Results of VAR Lag Order Selection Criteria for VAR model with INFL

Endogenous variables: IQ INFL URAMESA
Exogenous variables: C
Sample: 2000Q1 2012Q4
Included observations: 43

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-360.3070	NA	4378.211	16.89800	17.02088	16.94331
1	-217.3243	259.3640	8.621287	10.66625	11.15774*	10.84750
2	-207.7765	15.98712	8.464678	10.64077	11.50089	10.95795
3	-191.2153	25.41945	6.058465	10.28908	11.51783	10.74221
4	-179.2151	16.74440	5.443487	10.14954	11.74691	10.73860*
5	-172.0618	8.983319	6.261020	10.23543	12.20142	10.96043
6	-161.8392	11.41122	6.430264	10.17857	12.51318	11.03950
7	-144.2879	17.14313*	4.889200*	9.780833*	12.48407	10.77770

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A2. Results of VAR Lag Order Selection Criteria for VAR model with INFL4

Endogenous variable: IQ INFL4 URAMESA
Exogenous variables: C
Sample: 2000Q1 2012Q4
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-267.0980	NA	147.1279	13.50490	13.63157	13.5507
1	-119.5320	265.6189	0.144422	6.576601	7.083264*	6.7597*
2	-112.9484	10.86303	0.164426	6.697418	7.584080	7.01800
3	-98.65912	21.43386	0.128967	6.432956	7.699615	6.89094
4	-88.54629	13.65232	0.127078*	6.377314	8.023972	6.97269
5	-84.03336	5.415516	0.170321	6.601668	8.628323	7.33444
6	-79.81117	4.433300	0.240742	6.840558	9.247212	7.71072
7	-57.55082	20.03431*	0.145759	6.177541*	8.964192	7.18510

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A3. Results of the VAR Lag Exclusion Wald Test for the model with INFL				
VAR Lag Exclusion Wald Tests				
Sample: 2000Q1 2012Q4				
Included observations: 45				
Chi-squared test statistics for lag exclusion:				
Numbers in [ ] are p-values				
	IQ	INFL	URAMESA	Joint
Lag 1	60.63116 [4.31e-13]	5.744479 [0.124726]	33.12670 [3.03e-07]	115.7656 [0.000000]
Lag 2	9.933136 [0.019143]	7.064849 [0.069859]	1.338135 [0.720098]	23.63562 [0.004916]
Lag 3	4.378617 [0.223376]	5.206895 [0.157259]	0.114293 [0.990069]	11.09332 [0.269367]
Lag 4	5.180379 [0.159055]	11.66053 [0.008641]	0.627334 [0.890147]	16.80337 [0.051886]
Lag 5	3.092632 [0.377563]	1.527929 [0.675839]	0.590553 [0.898592]	5.465284 [0.792010]
df	3	3	3	9

Table A4. Results of the VAR Lag Exclusion Wald Test for the model with INFL4				
VAR Lag Exclusion Wald Tests				
Sample: 2000Q1 2012Q4				
Included observations: 42				
Chi-squared test statistics for lag exclusion:				
Numbers in [ ] are p-values				
	IQ	INFL4	URAMESA	Joint
Lag 1	60.94300 [3.70e-13]	11.70473 [0.008466]	62.40197 [1.80e-13]	134.0099 [0.000000]
Lag 2	8.049115 [0.045007]	1.784505 [0.618313]	3.341074 [0.341967]	16.10623 [0.064696]
Lag 3	8.413498 [0.038196]	1.074310 [0.783279]	3.421089 [0.331142]	14.27884 [0.112746]
Lag 4	5.416930 [0.143692]	1.433740 [0.697645]	2.702406 [0.439819]	10.17204 [0.336738]
Lag 5	6.193995 [0.102544]	1.685355 [0.640195]	1.841972 [0.605844]	10.77125 [0.291715]
df	3	3	3	9

Table A5. Results of the LM test for the remaining autocorrelation

1st model with INFL

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2000Q1 2012Q4
Included observations: 43

Lags	LM-Stat	Prob
1	13.99186	0.1226
2	11.06983	0.2710
3	7.820658	0.5523
4	20.61279	0.0145
5	8.235747	0.5106
6	5.262498	0.8109
7	13.32672	0.1484
8	4.759214	0.8548
9	10.08640	0.3435
10	5.333010	0.8044
11	3.637497	0.9336
12	6.855438	0.6522

Probs from chi-square with 9 df.

2nd model with INFL4

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2000Q1 2012Q4
Included observations: 40

Lags	LM-Stat	Prob
1	7.062017	0.6307
2	8.185299	0.5156
3	8.766173	0.4591
4	11.06687	0.2712
5	6.975204	0.6397
6	5.114074	0.8243
7	15.36025	0.0815
8	7.527712	0.5823
9	13.00104	0.1626
10	1.864272	0.9934
11	6.223251	0.7174
12	6.855438	0.9345

Probs from chi-square with 9 df.

Figure A1. Autocorrelations of variables with the standard error bounds for the 1st model with INFL

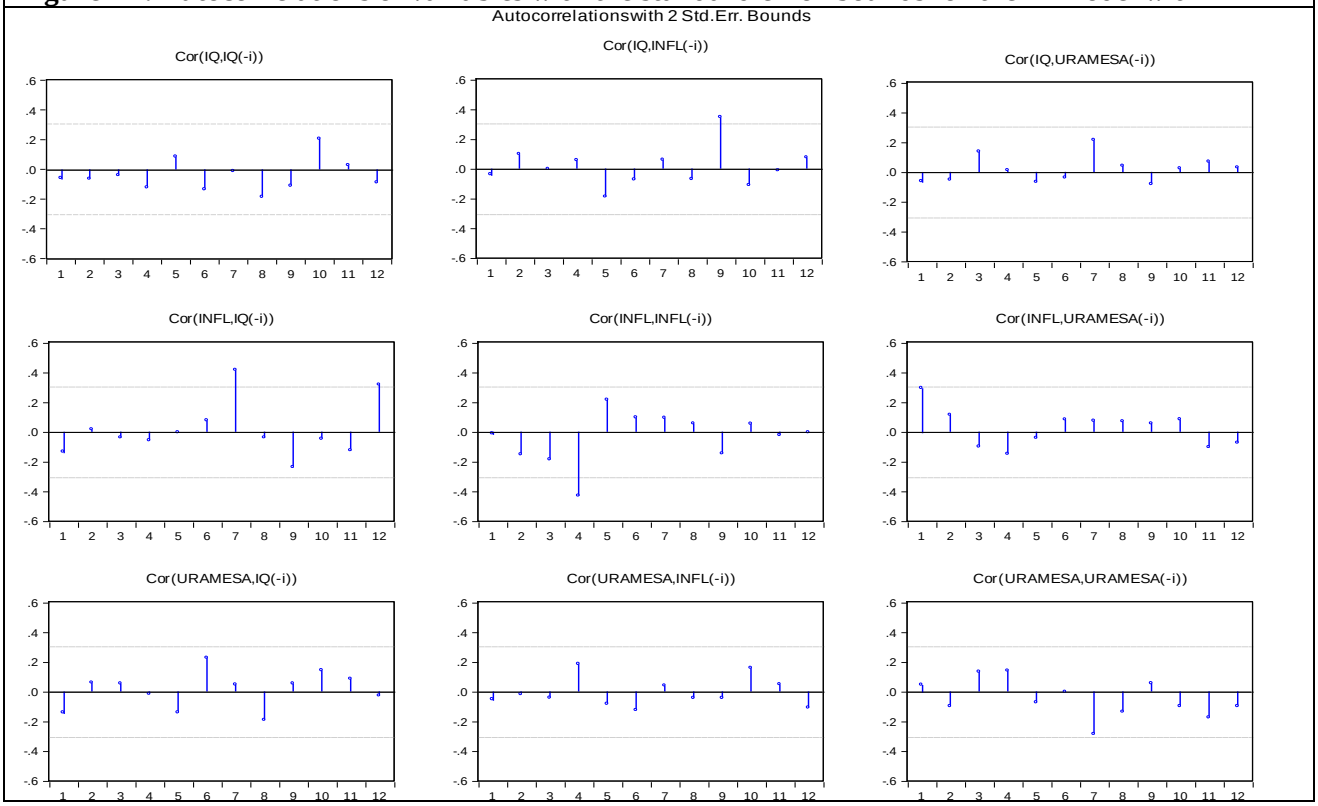


Figure A2. Autocorrelations of variables with standard error bounds for the2nd model with INFL4

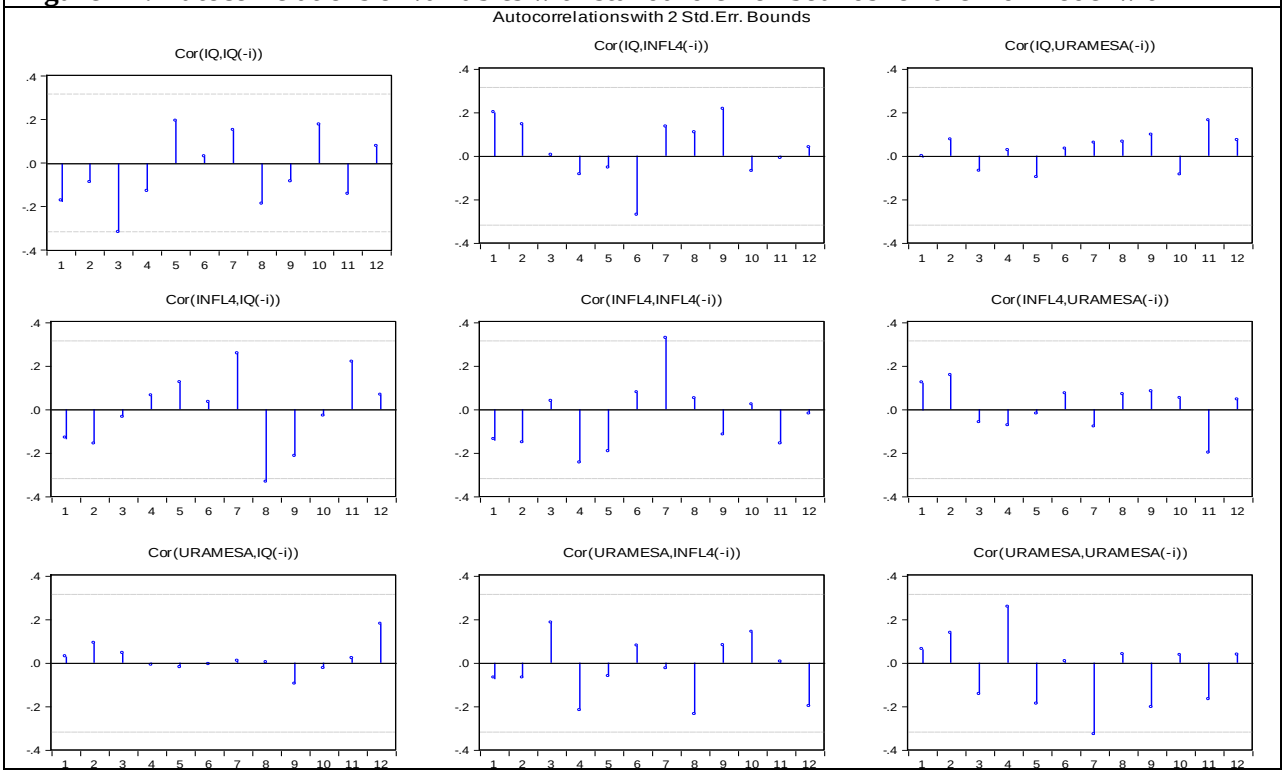


Table A6. Granger Causality Test for 1st model with INFL

Granger Causality Test: H_0 - no Granger causality	*p-value*
Interest rate (IQ)	
All (INFL, URAMESA)	0.0934*
Inflation rate (INFL)	0.1274
Unemployment rate (URAMESA)	0.2044
Inflation rate (INFL)	
All (IQ, URAMESA)	0.4003
Interest rate (IQ)	0.5002
Unemployment rate (URAMESA)	0.2097
Unemployment rate (URAMESA)	
All (IQ, INFL)	0.0016***
Interest rate (IQ)	0.0006***
Inflation rate (INFL)	0.5698

Note : Granger test statistics for the causality is computed using LR test and has Chi-squared distribution. *, **, *** show not rejection of null hypothesis at the significance level of 10%, 5 %, 1 % respectively.

Table A7. Granger Causality Test for 2nd model with INFL4

Granger Causality Test: H_0 - no Granger causality	*p-value*
Interest rate (IQ)	
All (INFL4, URAMESA)	0.0146**
Inflation rate (INFL4)	0.1432
Unemployment rate (URAMESA)	0.0985*
Inflation rate (INFL4)	
All (IQ, URAMESA)	0.4021
Interest rate (IQ)	0.7515
Unemployment rate (URAMESA)	0.1705
Unemployment rate (URAMESA)	
All (IQ, INFL4)	0.2854
Interest rate (IQ)	0.1661
Inflation rate (INFL4)	0.5040

Note : Granger test statistics for the causality is computed using LR test and has Chi-squared distribution. *, **, *** show not rejection of null hypothesis at the significance level of 10%, 5 %, 1 % respectively.

Figure A3. Impulse response functions for the 1st model with INFL

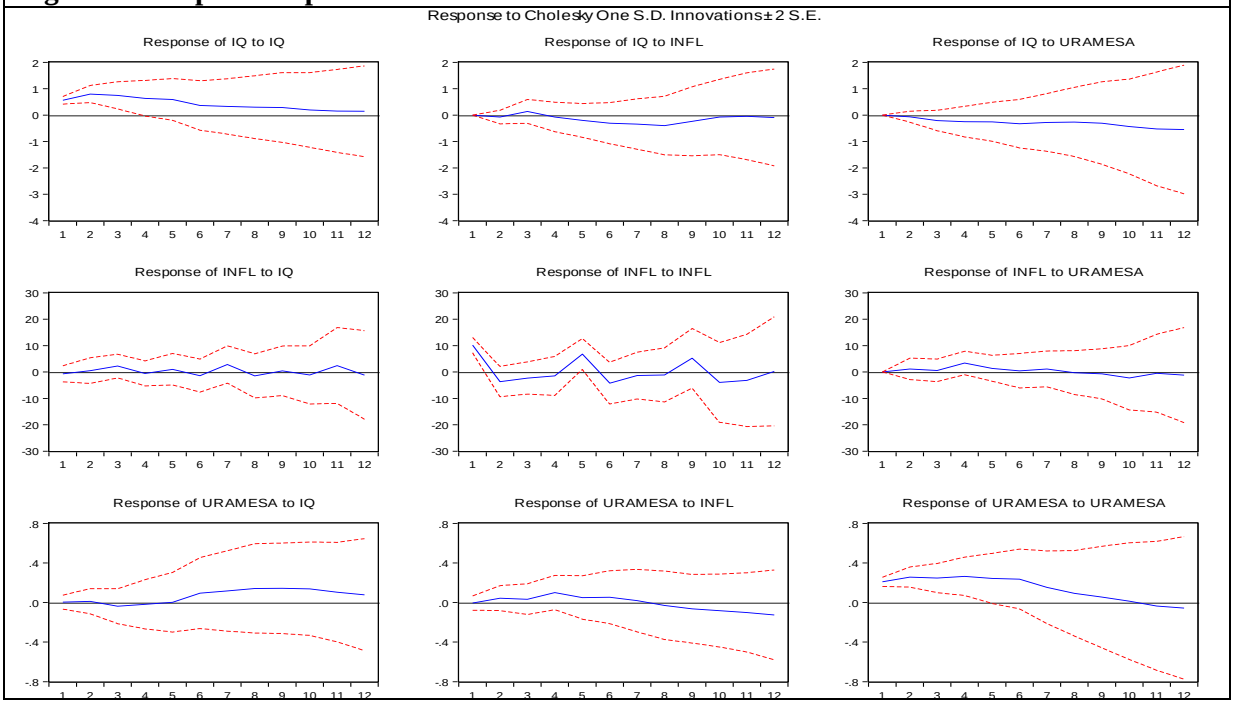


Figure A4. Impulse response functions for the 2nd model with INFL4

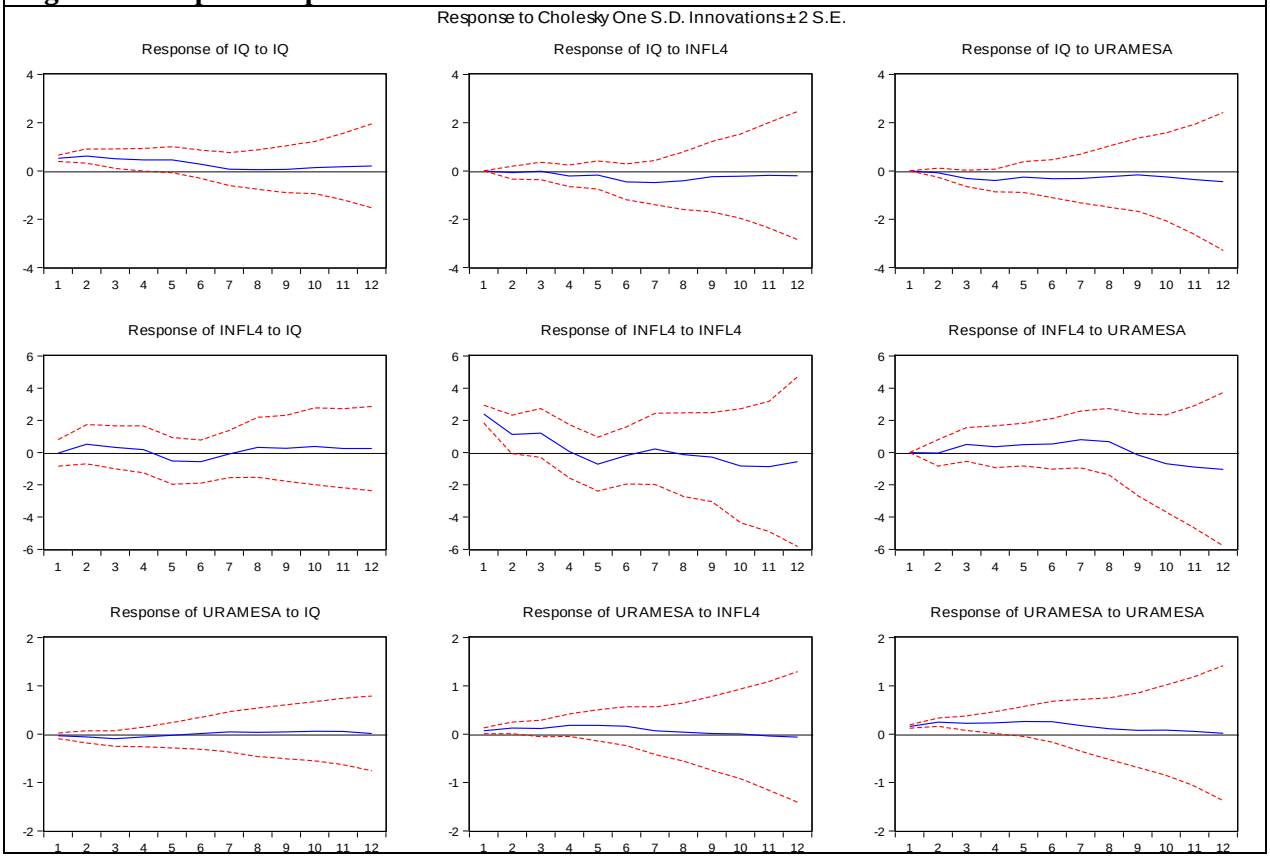


Figure A5. Impulse response functions for the modified model with INFL4

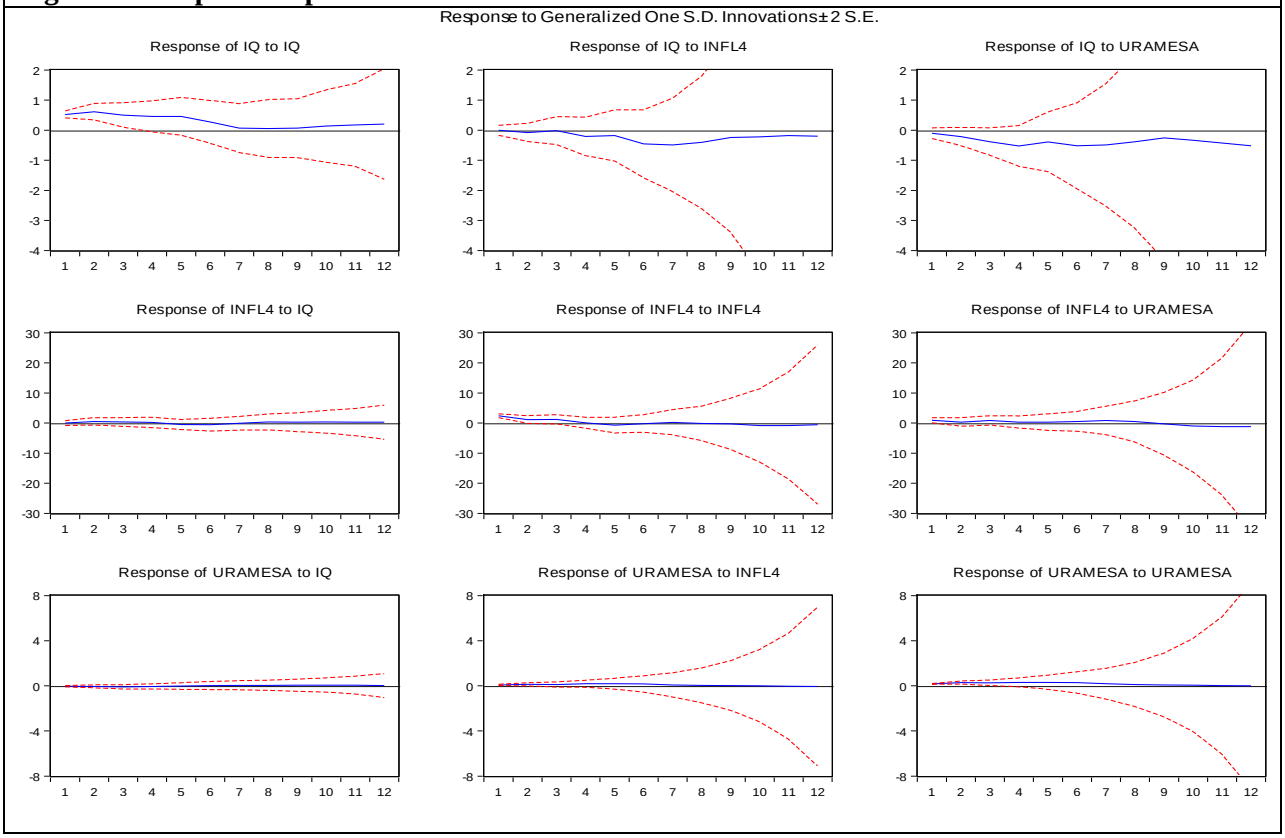


Figure A6. Variance decomposition of variables in the modified model with INFL4

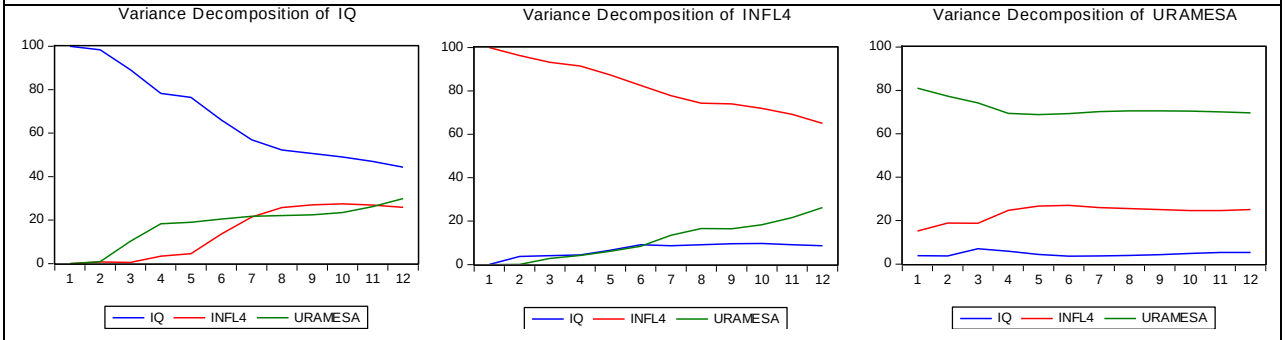


Figure A7. Impulse response functions for the modified model with INFL

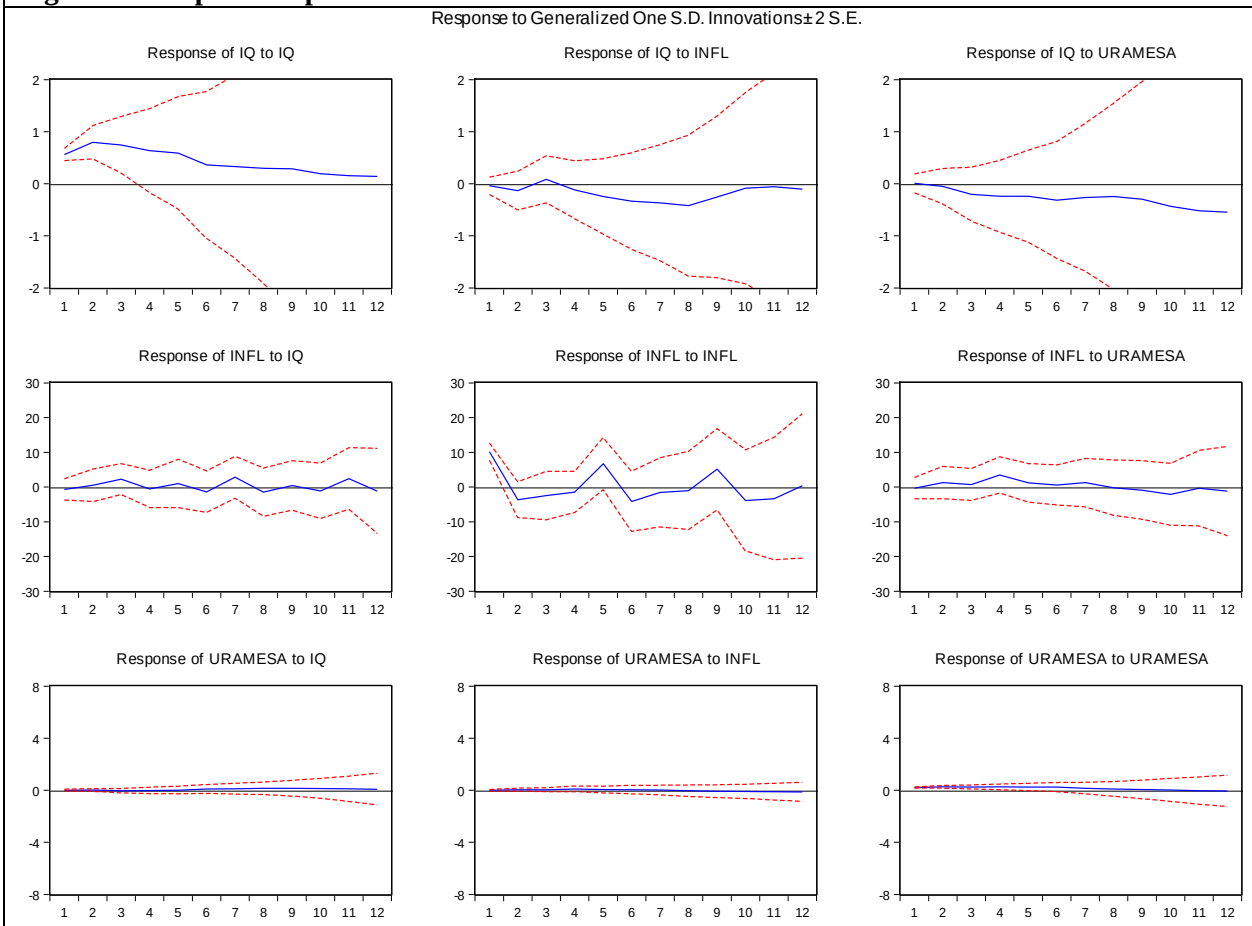


Figure A8. Variance Decomposition of variables for the modified model with INFL

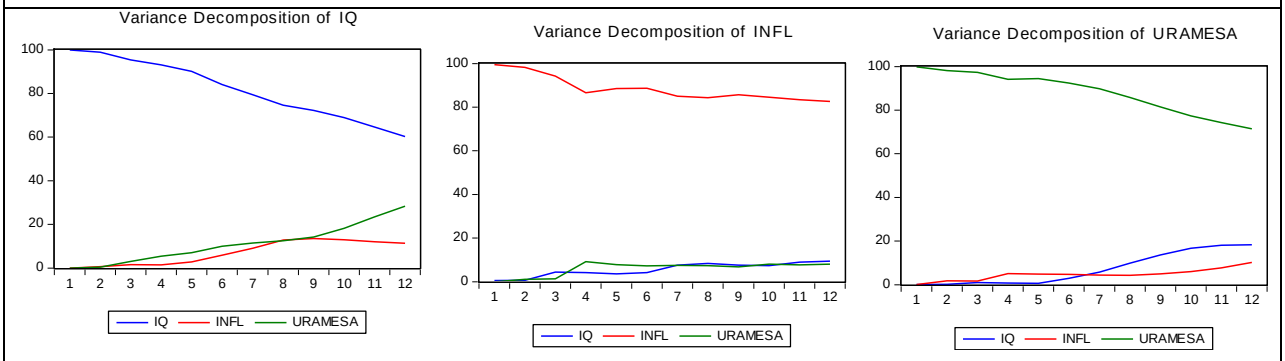
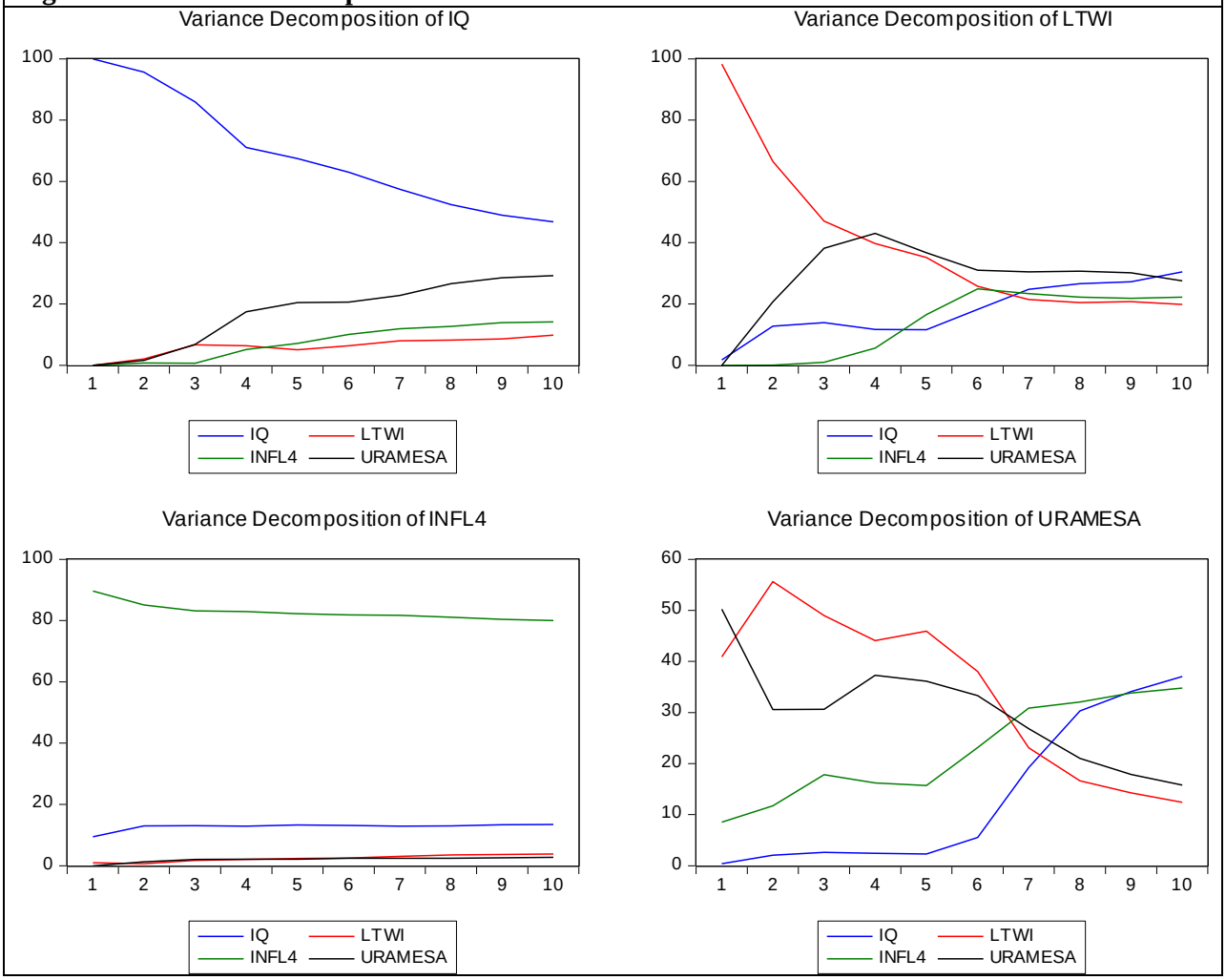


Figure A9. Variance decomposition of the variables for the final model



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