THE ARMENIAN BUSINESS CYCLE AND TRADE SHOCKS FROM RUSSIA AND EU*

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Abstract – A high degree openness of a small, emerging country, can expose its economy to greater volatility because of shocks to trade. We examine the impact of business cycles in Russia and the European Union (EU28) on the Armenian economy, motivated by the fact that they are the main trading partners of Armenia. We use a three-country model with inventory management decisions to describe the trade comovements as well as business cycle fluctuations in these countries. The model predicts that business cycles in Russia and the EU28 have significant effect on the volatility of Armenian economy.
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1. INTRODUCTION

Countries are interconnected through trade. Shocks affecting one country are to a certain extent "world-wide" shocks. In particular, shocks originating in large countries are likely to have greater impact on relatively small economies. In order to trace the transmission mechanism of these shocks, we develop a asymmetric three-county international real business cycle (RBC) model. Since in the real world countries are different in size, our model is more realistic when compared to models which employ two symmetric countries.

In this paper we extend the Alessandria, Kaboski, and Midrigan's (2013), hereafter AKM (2013), two symmetric country model to asymmetric three country case. The primary goal is to show that large countries have large impact on emerging economies through trade linkages. We explore if a productivity shock in a large country can be decisive for an emerging country's business cycle (BC).

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The literature related to real business cycle properties finds some discrepancies among data and theoretical models, which are typically called puzzles. Backus, Kehoe, and Kydland (1992), herefater BKK, were the first to demonstrate the existence of the consumption - output quantitative puzzle and also net export comovement discrepancy. They examined data for 11 OECD countries for the period 1954Q1-1985Q3 and found that net exports are counter cyclical in most countries and cross country output correlations were larger than that of consumption, but standard two symmetric country international RBC models fail to replicate these facts.

These BKK puzzles were studied by many researchers in different frameworks of theoretical models in an attempt to explain the presence of such discrepancies. AKM (2013) presents a solution or rather an explanation for these puzzles. The authors develop a general equilibrium model with inventory management and international trade. This model can generate volatile and persistent fluctuations in international trade that are largely attributed to movements in a trade wedge of the type documented by Levchenko, Lewis, and Tesar (2010). This two country symmetric international real business cycle model is capable to generate counter cyclical net exports and do a step forward to solve the problem with consumption-output anomaly. The key point of this work is the presence of inventories which generate trade wedges. The intuition behind the model with inventories is the following: after a good productivity shock, imports expand more strongly and exports are dampened as domestic firms build their inventories of both goods.

In another research, AKM (2010b) documented that when the crisis was at its peak and trade collapsed, US imports of automobiles fell more dramatically than final sales of imported cars in the US. Then, during the rebound of US trade, US imports of autos grew much faster than final sales of imported autos. The same dynamics were noticed for US inventories of imported goods, especially these stocks were deteriorated during recession and they were been restocked during the trade recovery. Inventories are therefore one explanation for counter cyclical net exports.

The model improves, but does not solve the consumption-output anomaly. After including inventories in the model cross country consumption and output correlations were reduced, but the effect on cross country consumption correlation was much stronger. The intuition is straightforward because it is cheaper to consume from the stock of goods held locally than from goods that must be shipped internationally. Since the sizes of inventories are different across countries, the correlation of consumption across countries, as well as synchronization of output are reduced.

Our contribution to the international RBC literature is that we compute RBC moments and consider BKK puzzles for pair of countries (one which is small and the other is big), and construct a three asymmetric country international RBC model to match its theoretical moments dynamics with those calculated from the data. Our three asymmetric country, general equilibrium model with complete markets, free trade and inventory management decision is calibrated for Armenia, Russian Federation, and European Union (EU28). Here Armenia captures the role of small open economy, and its main trading partners Russia and EU, which are big and developed countries (EU). We choose Russia and EU because they are the main trading partners of Armenia; about 24% of Armenian trade is with Russia, and 27% with EU. We find that one standard deviation productivity shock in Russia has 0.3% impact on the Armenian economy and one standard deviation shock in EU has 0.3% impact as well. And after computing theoretical moments we find that our results support our intuition: the three asymmetric country framework solves the consumption-output anomaly, and shows the same qualitative properties, which we observe from empirical studies of these three countries.

The remainder of this paper is organized as follows. Section 3 presents some stylized facts of Armenia, EU, and Russia's BCs. In Section 4, the three country asymmetric model is presented. In Section 5 the calibration parameters of the model is discussed. Section 6 provides the results and the main findings of the paper. Section 7 concludes.

2. Stylized facts

We begin by presenting some stylized facts from historical data for Armenia, Russia, and the EU, related to GDP (Y), consumption (C), investment (I), and net export (NX). The latter are de-trended using the Hodrick-Prescott (HP) filter, with smoothing parameter $\lambda = 1600$. The cross country correlations, as well as BC comovements are considered for these series. From the data explored here, we observe that GDP of Armenia is more volatile compared to those of Russia and EU. This can be explained by the fact that Armenia has a small economy which is very sensitive not only to the domestic but also to the external shocks and fluctuations.

In Figure 1 the output gap for all these countries is reported. This gap is defined as the deviation of GDP from its trend. From this Figure, we observe that the periods of improvements and recessions coincide across countries, which may be indicative of a global effect driving the economies of these three countries. This fact is well known in the literature and has been documented by many researchers (Kose et al, 2003; Baxter and Kouparitsas, 2005).

The quantitative illustration of these comovements and BC properties are presented in Table 1, 2 and 3. Table 1 reports the standard deviation of GDP (Y), as well as the ratio of the standard deviation of each of consumption (C), investments (I), and net exports (NX), to that of GDP. From Table 1 we can see that in two of these three countries the fluctuation of consumption is much less than that of the output, and for Russia we can see the inverse relation - the standard deviation of the consumption in this country is bigger than that of output. These results can be explained by the fact that both Armenia and EU implemented policies to smooth consumption in bad times. In case of Russia such policies were not advanced to affect consumption levels. For investment we can see the same dynamics for all three countries, with investment being twice as volatile as output. All of these properties for these countries shown in the Table 1 are very similar to the properties examined by BKK (1993) and Aguiar and Gopinath (henceforth AG, 2007).

FIGURE 1. Real GDP of Armenia, Russia and EU

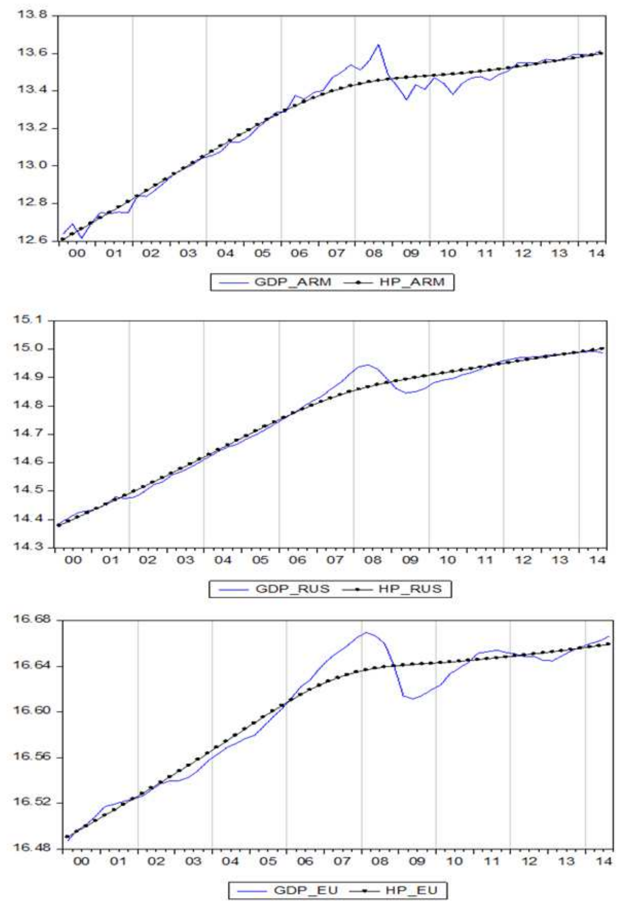


TABLE 1. Comovements

Cyclical Properties					
	Std. Dev.	Ratio of Std. Dev. to that of Y			Autocorr.
Country or Region	Y	NX	C	I	C
Armenia	0.04	0.008	0.79	2.91	0.52
EU	0.01	0.003	0.50	2.47	0.88
Russia	0.02	0.020	1.22	2.30	0.86

Notes: Y denotes output, NX net exports, C consumption, and I investment.

AG (2007) show that in emerging countries over the period 1980-2000 consumption and investment are more volatile than output and also that for net export is counter cyclical, while the opposite is true for developed countries. Our results are consistent with these facts if we classify Armenia and Russia as developing economies, and the EU as developed. The only deviation is that for Armenia standard deviation of consumption over

TABLE 2. Correlation with Output (Y)

Country or Region	C	I	NX
Armenia	0.60	0.79	-0.32
EU	0.90	0.95	0.31
Russia	0.88	0.96	-0.83

Notes: NX denotes net exports, C consumption, and I investment.

output is less than 1. This can be explained by the fact that during 2008-2009 financial crisis fiscal stimulus helped to smooth consumption (Harutyunyan and Serobyan, 2016).

Head (1995) documents, that relatively large countries experience less volatile output and investment, and larger correlations of consumption and investment with output than do small countries. In the case of Armenia, and as shown in Table 2, the correlation of consumption and investment with output is smaller than those observed for the larger Russia and the EU.

Table 3 captures the comovements of consumption and output in these three economies. It shows that the consumption-output anomaly is present in the data, with cross country correlations of output being greater than those of consumption. We next present our three asymmetric country international real business cycle model to address these diverging trends.

TABLE 3. International Comovements: Correlation with the same variable

	C			Y		
Country or Region	Armenia	EU	Russia	Armenia	EU	Russia
Armenia	1	0.41	0.62	1	0.72	0.80
EU	0.41	1	0.63	0.72	1	0.87
Russia	0.62	0.63	1	0.80	0.87	1

Notes: Y denotes output, and C consumption.

3. MODEL

Our model extends the two country, free trade, complete market, general equilibrium (GE), inventory/retailing AKM(2013) framework to have three asymmetric countries:

$Country_1$, $Country_2$, $Country_3$, $(Country_i, i = 1;2;3)$. Each country has its own productivity, degree of home bias in consumption of intermediate goods, and habit formation in goods from different countries. There are producers and retailers in each of these economies. Retailers buy intermediate goods from producers and sell them to consumers. Each type of retailer acts as monopolistic supplier for his particular intermediate good. Consumers purchase these varieties and use an aggregation technology to transform home and foreign intermediate goods into a final good. This final good is used for consumption and investment.

In each period t, the economy experiences one of finitely many states η_t. The history of events up to date t with the given initial state η_0 is $\eta^t = (\eta_0, ..., \eta_t)$. The probability of any particular history η^t is denoted as $\pi(\eta^t)$.

All variables have subscripts and superscripts. Superscripts i, where i=1;2;3 denote countries where the allocations are used, and subscripts H, F, T denote the countries from where these allocations come from (here $H \neq F \neq T$).

3.1. **Consumers.**

There are infinitely lived identical consumers in each country. During their lifetime consumers maximize the following utility function with respect to consumption and labor.

$$\sum_{t=0} \sum_{\eta^t} \beta^t \pi(\eta^t) U[c_i(\eta^t) - h_i C_i(\eta^{t-1}), l_i(\eta^t)], i = 1;2;3 \tag{1}$$

Their utility depends not only on current consumption but also on past aggregate consumption, which allows for habit formation. The consumers in each country i purchase intermediate goods produced in $Country_i$, $i = 1;2;3$ and these allocations are denoted as $y^i_H(j, \eta^t)$, $y^i_F(j, \eta^t)$, $y^i_T(j, \eta^t)$, where $H = 1;2;3$, $F = 1;2;3$, $T = 1;2;3$ and $H \neq F \neq T$ (here j $\in$ [0,1] indexes the intermediate good in the continuum). They all use the same aggregating technology to transform these intermediate goods to final goods, which are used for consumption $c_i(\eta^t)$ and investment $x_i(\eta^t)$.

$$D_i(\eta^t)^{\frac{\gamma-1}{\gamma}} = (\int_0^1 v_H^i(j,\eta^t)^{\frac{1}{\theta}} y_H^i(j,\eta^t)^{\frac{\theta-1}{\theta}} dj)^{\frac{\theta(\gamma-1)}{(\theta-1)\gamma}}$$

$$+(\tau_F^i)^{\frac{1}{\gamma}}(\int_0^1 v_F^i(j,\eta^t)^{\frac{1}{\theta}} y_F^i(j,\eta^t)^{\frac{\theta-1}{\theta}} dj)^{\frac{\theta(\gamma-1)}{(\theta-1)\gamma}}$$

$$+(\tau_T^i)^{\frac{1}{\gamma}}(\int_0^1 v_T^i(j,\eta^t)^{\frac{1}{\theta}} y_T^i(j,\eta^t)^{\frac{\theta-1}{\theta}} dj)^{\frac{\theta(\gamma-1)}{(\theta-1)\gamma}} \tag{2}$$

There are weights on intermediate goods in this aggregation technology. These weights $v_H^i(j,\eta^t)$, $v_F^i(j,\eta^t)$, $v_T^i(j,\eta^t)$ are subject to idiosyncratic shocks which are *iid* across j and t. As in AKM (2013) we assume that these taste shocks have a Pareto distribution. Domestic shocks are drawn from $G_H^i(v) = 1 - v^{-a_H^i}$ and foreign shocks are drawn from $G_F^i(v) = 1 - v^{-a_F^i}$ and from $G_T^i(v) = 1 - v^{-a_T^i}$. Here in total we have 9 taste shocks in the economy. When these idiosyncratic shocks differ from each other the inventories for domestic and imported goods are kept in different sizes. These demand shocks also lead to precautionary stockout avoidance in the market. The parameters $\tau_F^i, \tau_T^i \in [0,1]$ in this aggregation technology capture the Home biasness of intermediate goods.

The final composite good is used for consumption, investment, and investment adjustment costs:

$$c_i(\eta^t) + x_i(\eta^t)(1 + \frac{\xi}{2}(\frac{x_i(\eta^t)}{x_i(\eta^t - 1)} - 1)^2) = D_i(\eta^t)$$

The law of motion for country-specific capital is,

$$k^i(\eta^{t+1}) = (1-\delta)k^i(\eta^t) + x^i(\eta^t) \tag{3}$$

where δ is capital depreciation rate.

In each country consumers purchase domestic and imported intermediate goods. For country i consumer prices are $p_H^i(j,\eta^t)$, $p_F^i(j,\eta^t)$ and $p_T^i(j,\eta^t)$ for goods from H , F and T respectively. They supply labor in their own countries and earn wages $W_i(\eta^t)$, rent capital and get capital income at the rental rate $R_i(\eta^t)$ and profits $\Pi_i(\eta^t)$. The consumers also trade Arrow securities $B_i(\eta^{t+1})$ that are purchased at time t and pay off one unit in state η^{t+1}. The price of such security is denoted by $Q(\eta^{t+1}|\eta^t)$, which are the same across countries. Keeping these all assumptions in mind we get the consumer's period t budget constraint, which for country i consumers take the following form:

$$\sum_{i=\{1,2,3\}} \int_0^1 p_i^i(j) y_i^i(j) dj + \sum_{\eta^{t+1}} Q(\eta^{t+1}) B_i(\eta^{t+1}) = W_i l_i + R_i k_i + \Pi_i + B_i \tag{4}$$

The consumer takes prices and profits as given and maximizes (1) subject to (2)-(4).

3.2. **Producers.**

There is a representative producer in each country. Each producer produces intermediate goods and supplies them both to domestic and foreign markets. Intermediate goods in the country i are produced by competitive firms using the following technology:

$$M_i(\eta^t) = A_i(\eta^t) K_i(\eta^t)^\alpha L_i(\eta^t)^{1-\alpha}, i = 1;2;3 \tag{5}$$

where $M_i(\eta^t)$ is output, $A_i(\eta^t)$ is aggregate productivity, $K_i(\eta^t)$ is aggregate capital and $L_i(\eta^t)$ is aggregate labor used for production in country i.

The production in each country is subject to a productivity shock. Aggregate productivity in the country is defined as AR(1) process.

$$\log A_i(\eta^t) = \rho_i \log A_i(\eta^{t-1}) + \epsilon_i(\eta^t)$$

Producers in each country maximize their static profit taking prices as given.

3.3. **Retailers.**

There is a unit mass of retailers which sell intermediate goods produced in $Country_i$ $i = 1;2;3$. The retailers purchase intermediate goods from producers and these purchases are denoted by $z_i(j, \eta^t)$. As it is explained in AKM(2013) the retailers have to keep inventories to avoid stockout because they make their purchases at time t before learning $v_i(j, \eta^t)$s. This stock on hand is denoted as $z_i(j, \tilde{\eta}^t)$, where $\tilde{\eta}^t$ is the history up to date t excluding the demand realization at time t. The retailer chooses its price $p_i(j, \eta^t)$ after $v_i(j, \eta^t)$ shock. Unsold stock can be returned, but only at $t + 1$, so the retailer can sell it at next period at $\omega_i(\eta^{t+1})$ price after incurring the inventory-carrying costs of depreciation.

The profit maximization problem of country i retailer selling home goods is the following:

$$\max_{z^i_H(j,\tilde{\eta}^t), p^i_H(j,\eta^t)} \sum_{t=0}^{\infty} \sum_{\eta^t} Q(\eta^t)[p^i_H(j, \eta^t) y^i_H(j, \eta^t) - \omega^i_H(\eta^t)[z^i_H(j, \tilde{\eta}^t) - s^i_H(j, \eta^{t-1})]]$$

$$s.t. y^i_H(j, \eta^t) \leq z^i_H(j, \tilde{\eta}^t)$$

(6)
$$s^i_H(j, \eta^t) = (1 - \delta_s(\eta^t))[z^i_H(j, \tilde{\eta}^t) - y^i_H(j, \eta^t)]$$

The home retailer that sells foreign intermediate goods faces a similar problem with wholesale costs $\omega^i_F(\eta^t)$ and $\omega^i_T(\eta^t)$. The retailers in foreign countries also face analogous problems.

4. Equilibrium

In this economy, an equilibrium is defined as an allocation of aggregate and individual quantities $\{C(\eta^t), c(\eta^t), L(\eta^t), l(\eta^t), K(\eta^t), k(\eta^t), M(\eta^t), y(\eta^t), B(\eta^t), \Pi(\eta^t)\}_{t=0}^{\infty}$, and disaggregate goods $\{y_i(j, \eta^t), s_i(j, \eta^t), z_i(j, \tilde{\eta}^t)_{i=1;2;3}\}_{t=0}^{\infty}$ for $Country_i$, $i = 1; 2; 3$, and prices of goods $\{\{p_i(j, \eta^t)\}_{i=1;2;3}, \omega(\eta^t)\}$ and factors in $\{W(\eta^t), R(\eta^t)\}_{t=0}^{\infty}$ for all three countries and Arrow security prices $\{Q(\eta^{t+1|\eta^t})\}_{t=0}^{\infty}$, such that:

(1) The allocations satisfy the consumers' problems, the intermediate producers' problems, and retailers' problems in all three countries when prices are given,
(2) Individual consumption $c(\eta^t)$ equals aggregate consumption, $C(\eta^t)$,
(3) The retail goods, labor, and capital markets clear in each country. The intermediate goods markets and Arrow security markets clear for the world economy.

There are some market clearing conditions.

(4) Arrow securities are in zero net supply. The bond market clearing condition stands as $B_1(\eta^t) + B_2(\eta^t) + B_3(\eta^t) = 0$

(5) All capital and labor is used in intermediate goods production $L(\eta^t) = l(\eta^t)$, $K(\eta^t) = k(\eta^t)$

(6) The resource constraint for intermediate goods requires that production equal orders:

$$M_i(\eta^t) = \int_0^1 [z_H^i(j,\tilde{\eta}^t) - s_H^i(j,\eta^{t-1})]dj + \int_0^1 [z_F^i(j,\tilde{\eta}^t) - s_F^i(j,\eta^{t-1})]dj$$

$$+ \int_0^1 [z_T^i(j,\tilde{\eta}^t) - s_T^i(j,\eta^{t-1})]dj \tag{7}$$

It should be noted that in this last equation that intermediate goods produced in $Country_1$ go to domestic retailers of $Country_1$'s goods $z_H^i(j)$, to $Country_2$'s and $Country_3$'s retailers of exported home goods, respectively $z_F^i(j)$ and $z_T^i(j)$.

(7) The resource constraint for individual retail goods is as follows:

$$y_i(j,\eta^t) = c_i(j,\eta^t) + x_i(j,\eta^t), i = 1;2;3$$

Producers in all three countries are perfectly competitive, so each factor is priced at its marginal product:

$$r_t = \alpha\omega_t \frac{m_t}{k_{t-1}}$$

$$w_t = (1-\alpha)\omega_t \frac{m_t}{l_t}$$

and products are sold at price equal to the marginal cost of production, $\omega = r^\alpha w^{1-\alpha}/A$.

Given prices, consumers in $Country_i$, $i = 1;2;3$ choose the amount of intermediate goods $y^i_H(j), y^i_F(j), y^i_T(j)$ necessary to deliver D units of final good. The pricing for Arrow securities is defined as $Q(\eta^t) = \beta^t \pi(\eta^t) \frac{U_c(\eta^t)/P(\eta^t)}{U_c(\eta^0)/P(\eta^0)}$.

Consumer demand for the retail varieties takes the following form:

$$y^i_H(j) = v^i_H(j)(\frac{p^i_H(j)}{P_H})^{-\theta}(\frac{P_H}{P})^{-\gamma}D$$

$$y^i_F(j) = v^i_F(j)\tau^i_F(\frac{p^i_F(j)}{P_F})^{-\theta}(\frac{P_F}{P})^{-\gamma}D$$

$$y^i_T(j) = v^i_T(j)\tau^i_T(\frac{p^i_T(j)}{P_T})^{-\theta}(\frac{P_T}{P})^{-\gamma}D$$

The aggregate price indexes for $Country_1$ through $Country_3$ produced output are respectively:

(8) $$P_H = (\int_0^1 v^i_H(j)p^i_H(j)^{1-\theta}dj)^{\frac{1}{1-\theta}}$$

(9) $$P_F = (\int_0^1 v^i_F(j)p^i_F(j)^{1-\theta}dj)^{\frac{1}{1-\theta}}$$

(10) $$P_T = (\int_0^1 v^i_T(j)p^i_T(j)^{1-\theta}dj)^{\frac{1}{1-\theta}}$$

The aggregate price index for overall output is

(11) $$P = [P_H^{1-\gamma} + \tau^i_F P_F^{1-\gamma} + \tau^i_T P_T^{1-\gamma}]^{\frac{1}{1-\gamma}}$$

5. Calibration

In this section we describe the main parameter values considered in our model, which are reported in Table 4. We use GHH instantaneous utility function, and allow habit persistence in consumption. Here with external habit the household takes the path C_{-1}

as given

$$U(c,l) = log((c - hC_{-1}) - \frac{\psi}{1+\eta} l^{1+\eta})$$

For several parameters, we assign values that are standard in the international real business cycle literature, hence they are the same across countries. These are the preference parameters $\beta, \gamma, \psi, \eta$ and technology parameters δ, α. Our period is a quarter so $\beta = 0.99$. The depreciation rate of capital and the capital share are respectively $\delta = 0.025$ and $\alpha = 0.33$. We choose the relative weight on leisure ψ in the utility function in order to match a labor supply of one-third and set η so that the Frisch elasticity is 2. We also assign the elasticity of substitution between domestic and imported goods a standard value $\gamma = 1.5$. The values of parameters $\{\theta, \delta_{s,0}, \delta_{s,1}, a^i_H, a^i_F, a^i_T\}$ which determine the inventory dynamics are taken from the AKM (2013).

The remaining parameters are calibrated for Armenia, Russia and EU and they capture the asymmetry between the three countries. We calibrate the parameters τ^i_F, τ^i_T for Home biasness to be equal to the ratio of import to GDP which also includes import for the $Country_i, i = 1;2;3$. We set our habit parameters $h^i_H, i = 1;2;3$ to match the autocorrelations of consumption in these three countries. We estimate the coefficient $\rho^i, i = 1,2,3$ of aggregate productivity process in each country which is defined as AR(1) process. For Armenia this parameter is estimated to be 0.628, and for EU and Russia the estimation gives 0.700 and 0.701 respectively.

6. Results

We first describe our three asymmetric country international RBC model properties and compare them with those from the data. The results show that our model is able to capture the main BC properties of three countries and the numbers are pretty close to each other. The cross country correlations which we get from the model are presented below in the Table 5.

TABLE 4. Model parameters

Parameter	Description	Value
β	Discount factor	0.99
γ	Armington elasticity	1.5
θ	Elasticity across varieties	3
$\delta_{s,0}$	Inventory depreciation	0.016
$\delta_{s,1}$	Elasticity of inventory depreciation	-0.0044
μ	Elasticity of inventory costs	0
η	Frisch elasticity	0.5
h_H^1	Habit parameter for Armenia	-0.36
h_F^2	Habit parameter for EU	0.5
h_T^3	Habit parameter for Russia	0.43
δ	Capital depreciation	0.025
α	Capital share	0.33
a_H^i	Home taste shocks	1.3
a_F^i	Foreign taste shocks	1.0001
a_T^i	Foreign taste shocks	1.0001
τ_F^H	Foreign weight on imported goods from EU to the Armenia	0.047
τ_T^H	Foreign weight on imported goods from Russia to the Armenia	0.035
τ_H^F	Foreign weight on imported goods from Armenia to the EU	0.00002
τ_T^F	Foreign weight on imported goods from Russia to the EU	0.01273
τ_H^T	Foreign weight on imported goods from Armenia to the Russia	0.00006
τ_F^T	Foreign weight on imported goods from EU to the Russia	0.03550

From the results of calibrated model we get that all cross country correlations of output are greater then that of consumption. Hence our model is able to solve consumption-output anomaly observed in the data. Other interesting fact about this model is that it can also generate net export countercyclicality for the two emerging countries and a procyclical net export for the third developed country. Similar dynamics were observed in the data, in Section 2. That is for the EU the correlation of net exports with output is 0.31, and the same correlations for Armenia and Russia are respectively -0.32 and -0.83. The similar correlations observed in the model are 0.08 for EU, -0.09 and -0.30 for Armenia and Russia respectively.

TABLE 5. International Comovements: Correlation with the same variable

	C: Model			C: Data		
Country or Region	Armenia	EU	Russia	Armenia	EU	Russia
Armenia	1	0.39	0.65	1	0.41	0.62
EU	0.39	1	0.68	0.41	1	0.63
Russia	0.65	0.68	1	0.62	0.63	1
	Y: Model			Y: Data		
Country or Region	Armenia	EU	Russia	Armenia	EU	Russia
Armenia	1	0.46	0.75	1	0.72	0.80
EU	0.46	1	0.68	0.72	1	0.87
Russia	0.75	0.68	1	0.80	0.87	1
	NX correlation with Y: Model			NX correlation with Y: Data		
Armenia	-0.09			-0.32		
EU	0.08			0.31		
Russia	-0.30			-0.83		

Notes: Y denotes output, NX net exports, and C consumption.

From these we conclude that the asymmetry among countries in the model as well as the inclusion of third country into the model are able to solve the well known mismatches between models and data, which has been announced in international RBC literature. However, the model fails to generate some other moments which would be consistent with the data. We attribute this outcome to the absence of exact calibration of some parameters for these three countries, such as taste shocks, inventory depreciation, elasticity of inventory depreciation, elasticity of inventory costs due to lack of data.

Now, we turn to the effect of productivity shock transmission across countries. Figure 2 and Figure 3 show the Impulse response functions for all three countries' outputs, when there is a one standard deviation positive productivity shock in Russia and one standard deviation positive productivity shock in EU respectively.

From Figure 2 can be seen that 1% positive productivity shock in Russia, has a persistent effect on Armenian economy and a relatively small impact on EU. It also has a large effect in Russia. For the output of Armenia this positive productivity shock brings increase by 0.3% during 40 quarters and it increases the output of EU by 0.1%. These dynamics can be explained by the business cycle transmission mechanisms which have

FIGURE 2. Impulse response functions of output to 1 percent positive productivity shock in Russia

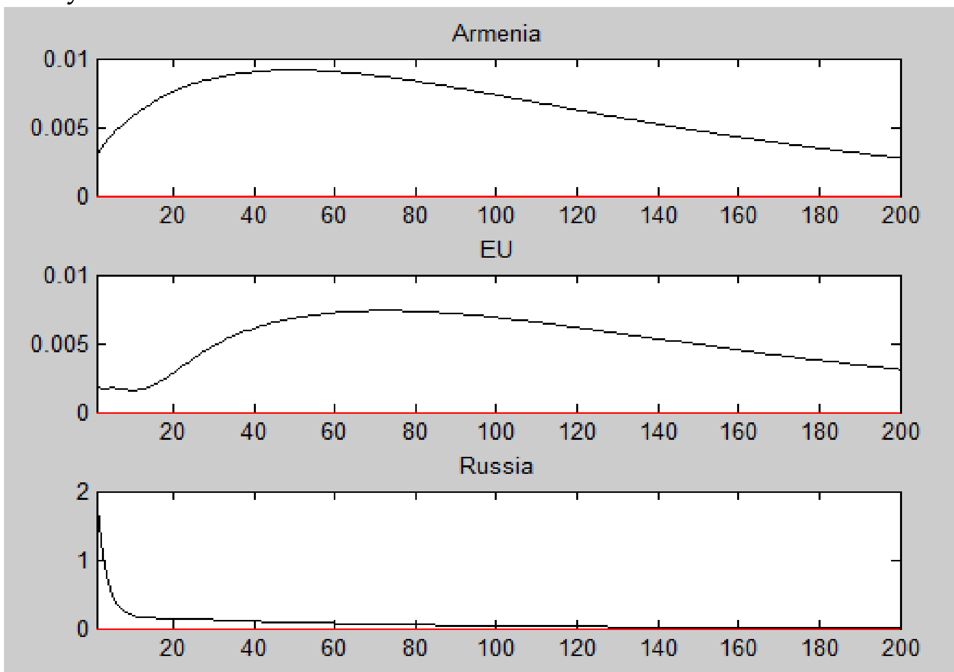
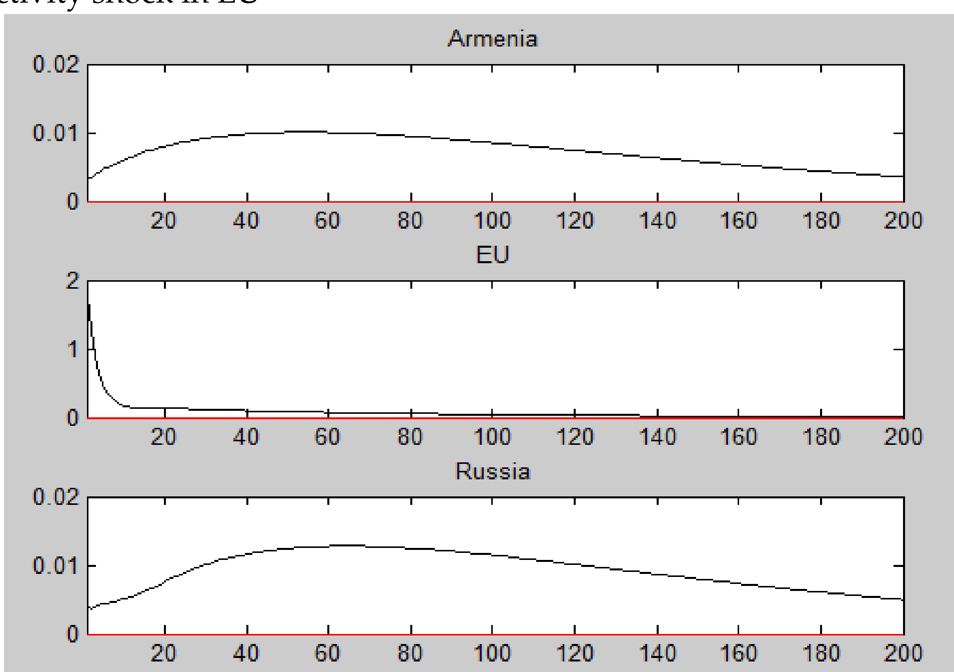


FIGURE 3. Impulse response functions of outputs to 1 percent positive productivity shock in EU

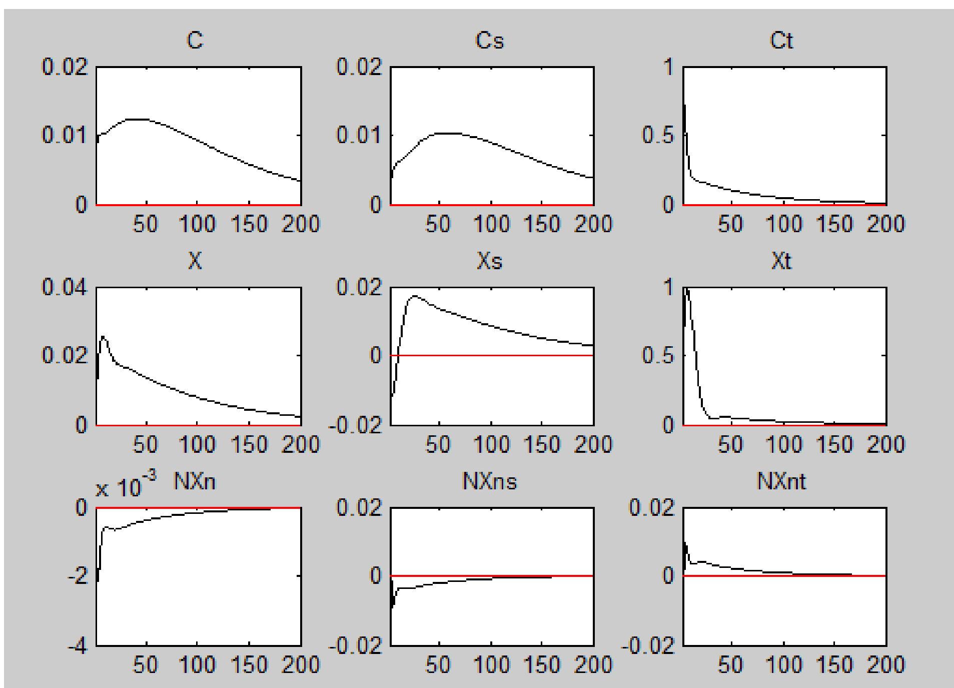


two ways to affect economies: trade linkages and productivity process correlations. Russia trades relatively more with Armenia than the EU hence the effect of a shock in Russia is felt more strongly in Armenia, than in the EU.

Figure 3 shows the effect of a 1% positive productivity shock originating in the EU. This shock has a large effect on Armenia and Russia. It increases the outputs of these countries by 0.3%. This is explained by the fact that the EU is one of the major trading partner for both countries.

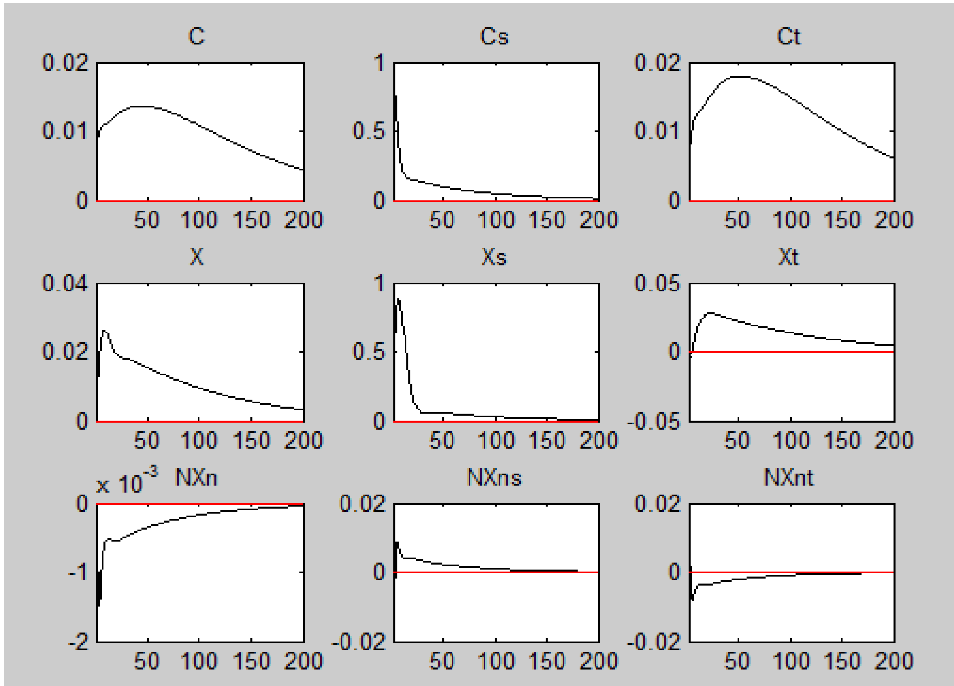
We can also observe the dynamics for the other variables. How the positive productivity shock originated in Russia transmit to Armenia and EU by trade linkages, what are the impulse response functions in these aggregate variables. All these features are presented in the next Figure 4 and Figure 5 respectively in cases of 1% positive productivity shock originated in Russia, and in EU.

FIGURE 4. Impulse response functions of 1 percentage positive productivity shock in Russia



From the results presented in these figures we can see that consumption goes up in all three countries when there is one standard deviation positive productivity shock in Russia or in the EU. That happens because these shocks, being correlated with each other and also transmitted by trade linkages, increase the outputs of the three countries, which directly affects the consumption in all countries. We can see also in Figure 4 that in case of 1% positive productivity shocks in Russia, investments in Armenian and Russian

FIGURE 5. Impulse response functions of 1 percentage positive productivity shock in EU



economies rise up from the steady state level, but in EU they are lowered. This can be explained by moving the investment capacities to relatively more productive place from less productive ones.

7. CONCLUSION

Developed economies can have a great impact on emerging countries, with trade linkages as one of the transmission channels. To address these linkages, this paper studies the impact of Russian and EU27 real business cycles on the Armenian economy. An asymmetric three-country RBC model is constructed to evaluate this impact. The results follow the intuition that productivity shocks generated both in Russia and EU have significant effects on Armenian output, and moderate impact on each other, but shocks generated in Armenia have only negligible impact on Russia and EU. To show the goodness of the model we compare BC moments implied from the model with those of actual data. The model developed here is able to capture the main BC properties of all three countries and at the same time it solves BKK puzzles observed for Armenia, Russia and EU.

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