Ekaterina Pyltsyna [1]

THE CHANGE OF FISCAL MULTIPLIER WHEN SWITCHING FROM MANAGED EXCHANGE RATE REGIME TO THE FLOATING ONE [2]

This study investigated the change of government spending multiplier when switching from managed exchange rate regime to the floating exchange rate regime for emerging countries. It was found that on-impact multiplier in floating exchange rate regime is smaller by 0.5 than the one in the managed exchange rate regime. In addition, it was found that the openness of the economy affects values of government spending multipliers. Also, for the first time, micro-founded government spending multiplier was estimated for Russia. The study was conducted with the use of panel SVAR and DSGE models.

JEL Classification: E62, E63.

Keywords: fiscal multiplier, government expenditures, exchange rate regime change, panel SVAR, DSGE, emerging countries, Russia.

---

[1]National Research University Higher School of Economics (Moscow, Russia). Laboratory for Macroeconomic Analysis, Junior Research Fellow, epylcyna@hse.ru

[2]Many thanks to my supervisor - Malakhovskaya Oxana - for lots of useful and thoughtful comments

This work is an output of a research project implemented as part of the Basic Research Program at the National Research University Higher School of Economics (HSE)

Introduction

In this paper, the question of the effectiveness of fiscal policy in emerging markets under different exchange rate regimes is tackled. I have estimated a panel SVAR model to answer this question. This is the first study of the fiscal multiplier in emerging countries based on the panel model. The advantage of this approach is that it makes it possible to mutually exclude country-specific shocks and estimate cleared of such shocks multiplier of government expenditures. Also, in this paper, a theoretical DSGE model has been constructed to confirm the empirical results. The need for the confirmation of the empirical results is due to the limited data of emerging countries.

The change in the monetary regime affects both the economy as a whole and the effectiveness of fiscal policy. A lot of studies both theoretical and empirical are devoted to the measurement of the fiscal multipliers and their dependence on the monetary policy regime. Most of them find diminishing values of the fiscal multipliers when moving from a managed exchange rate regime to a floating exchange rate regime (Kraay, 2012, Born et.al., 2012, Ilzetzki et.al., 2013).

However, most of the works are devoted to the study of the change in multipliers in developed countries, whereas for emerging countries there are only a few studies. On the other hand, there is a trend of transition of emerging countries to the floating exchange rate regime. Therefore, the problem of insufficient knowledge about the effectiveness of fiscal policy in these countries arises. It is indeed a problem as to build forecasts and make decisions fiscal and monetary authorities in emerging countries should be aware of the change in the effectiveness of fiscal policy when the exchange rate regime is changed.

The novelty of this particular study is to obtain estimates of the fiscal multiplier for emerging markets on the basis of a panel model, taking into account different exchange rate regimes. In addition, the impact of the openness of the economy on the fiscal multiplier was investigated. Moreover, based on the model for emerging countries, a micro-based fiscal multiplier for Russia was firstly estimated.

The result of the work is an assessment of the change in the fiscal multiplier in emerging countries when switching from a managed exchange regime to the floating. For on-impact fiscal multiplier this change turned out to be equal to 0.5. A significant influence of the country's openness on the value of the fiscal multiplier was also obtained. The estimation of the on-impact fiscal multiplier for Russia was 0.2 ± 0.1. It means that if Russian government increase expenditures by 1 bln, then Russian GDP would on-impact increase by 0.2 bln.

The next part of the paper contains 5 main sections. The first of them includes a review of theoretical and empirical works on the fiscal multipliers. The second section contains an overview of a panel data model for emerging countries and outlines estimation results. The third section describes the methodology for the DSGE model, the model calibration and the obtained results within this model. The fourth section presents the methodology and data used to evaluate the DSGE model on Russian data. In conclusion, the summary of the results and perspectives of further research are presented.

1 Literature review

1.1 The methodology for empirical model

The factors that can have an impact on the fiscal multipliers are their time-span (short-run or long-run) (Ilzetzki, Mendoza, and Végh, 2013), the nature of the shock (whether they are permanent or temporary) (Barro and Redlick, 2011), price rigidity (Woodford, 2011), inequality level (Brinca, Holter, Krusell, Malafry, 2014), fiscal policy of other countries (Auerbach, Gorodnichenko, 2013), the country's debt level (Ilzetzki, Mendoza, and Végh, 2013), the country's business cycle stage (Auerbach and Gorodnichenko, 2012a, Auerbach and Gorodnichenko, 2012b, Kraay, 2014, Gechert and Rannenberg, 2014), whether pro-cyclical / counter-cyclical fiscal policy is (Vegh, Vuletin, 2015), the source of government spending (Corsetti, Meier and Muller, 2011), the time structure of spending (Ramey, 2011), the exchange rate regime (Kraay, 2014, Born, Jußen and Muller, 2012, Ilzetzki, Mendoza and Végh, 2013), the activeness and direction of the monetary policy (Coenen et.al., 2010 - direction, Leeper, Walker, Yang, 2010, Woodford, 2011 - activeness), and, perhaps, the openness of the economy. This list of factors may be incomplete, but it includes all those factors whose influence has been actively studied empirically and for which confirmations of the dependencies of multipliers on them has been found. I have mentioned all these factors because in empirical SVAR model I try to take into account most of these factors. Specifically, the factor that I did not include in SVAR is inequality level as the data of index Gini is available only yearly (in chapter 2 I explain why quarterly data is needed).

What is also taken into account in empirical part is the endogeneity problem between GDP and the government spending. In order to obtain an exogenous impact of the shock of government spending on GDP one of the three methodologies is usually used: 1) SVAR (mainly with the Cholesky identification) (Auerbach and Gorodnichenko, 2012b); 2) the instrument variable for government spending, which does not correlate with the other macroeconomic shocks (change of representative in the US Congress (Covall et.al., 2010), fluctuations in votes on elections (Fishback and Kachanovskaya, 2010) or World Bank financing (Kraay, 2014)); 3) the component of government spending which is not affected by the business cycle (usually military expenditures are used, for example, Barro, 1981). In this paper I took the first approach, because the second one is hardly applicable to the panel data of the countries. The third approach was recently questioned as due to the work of Ramey and Shapiro (1998) the sector that is chosen affect considerably the estimates of the multiplier.

Secondly, the DSGE model was built in this paper to study fiscal multipliers; therefore, methodology of DSGE model is quickly discussed below.

1.2 The methodology that is used to construct DSGE models

In DSGE models for studying the fiscal multiplier, the majority of studies included 5 sectors in the model: households, firms, a central bank with a monetary policy rule, fiscal block with a budget policy rule and an external sector. In almost all works two types of firms are introduced: producing final goods and producing intermediate goods. Taking into account nominal rigidities changes the estimates of multipliers as shown in Woodford (2011); therefore, introduction of two types of firms is necessary for the DSGE models that study fiscal multipliers. The external sector is modeled by the introduction of uncovered interest rate parity and the introduction of an equation linking the dynamics of exports, imports and net foreign assets (balance of payments equation). This standard introduction has been applied in many works, for example, Adolfson et.al. (2005). Therefore, in this work I would follow pretty much the same strategy. Particular attention in the construction of DSGE models built for the study of fiscal multipliers should be paid to the two blocks: households and the fiscal block.

Households

The most significant feature in the modeling of households is the inclusion of two types of households (Ricardian and NonRicardian) or the inclusion of inseparability of consumption and labor in the utility function of households. In J. Gali et.al. (2007) the authors proved that the inclusion of NonRicardian households in the model allowed a positive response of household's consumption to the shock of government spending, whereas in models without NonRicardian households, only a negative response is possible.[1]. The possibility of obtaining

[1] It is also worth noting that in many studies, researchers received a positive but weaker consumption response to an increase in government spending than in Gali et.al. (2007). For example: Furlanetto (2006), Forni et.al. (2008)

a positive response is necessary since the positive reaction of consumption to an increase in government spending is found in the empirical literature. For example, in the works of Blanchard and Perotti (2002) and Mountford and Uhlig (2009).

An important work, in addition to Gali et.al. (2007), was the work of Lopez-Salido et.al. (2008), in which the authors showed, that for a positive reaction of consumption to an increase in government spending, either NonRicardian households or the inseparability of consumption and labor in the utility function of households were needed. In this paper inseparable of consumption and labor utility function for households is used as in Nakamura and Steinsson (2014).

Fiscal authorities

Despite the fact that the main focus of the research is the study of fiscal multipliers, the fiscal block is given by a sufficiently small set of equations in the literature. A common specification of the fiscal rule is the inclusion of stabilizing budget balance taxes. In this case, the fiscal policy rules are written as the following two equations:

$$t_t = \phi_b b_t + \phi_g g_t \tag{1.1}$$

$$g_t = \rho_g g_{t-1} + \eta_t^g \tag{1.2}$$

where g is government spending, t are taxes, b is budget deficit, η^g is the shock of government spending, the rest of the variables are the coefficients of the model. All variables are expressed in relation to GDP. This rule is used in the works of Coenen (2004), Furlanetto (2006), Gali et.al. (2007). In the current paper these two equations are used to model fiscal block; however, the budget is assumed to be balanced. The specification sometimes includes various changes in the other papers.

Variations of the government spending functions are used with the inclusion of a constant in government spending as in the works of Coenen (2007), Linnemann et.al. (2000) or the real budget deficit could be included in the dynamics of government spending like in Corsetti et.al. (2012) and Corsetti (2011). As for tax changes transfers could be included as in Coenen (2007) or different type of taxes could be also introduced as in Schmitt-Grohé and Uribe

(2007). Another variation is to change the budget constraint and use, for example, the intertemporal budget constraint (Forni et.al. (2008)) or assume some level of budget deficit as in Coenen et.al. (2007). As the tax structure was not the focus of the study and there is no rule for budget deficit in emerging countires unlike the EU I did not include those changes in the DSGE model. Thus, DSGE model in this paper is a commonly used DSGE model to study fiscal multipliers. The novelty is its calibration for emerging countries based on the other papers and its estimation for Russia.

1.3 The openness of the economy

In this paper not only the values of fiscal multipliers are obtained but also the influence of the openness of the economy on fiscal multipliers is studied. This effect was investigated in some other papers; however, only indirectly. Nakamura and Steinsson (2014) used a rather unusual tool as a definition of an open economy. The multiplier was built on the panel data for various USA states and the multiplier of the open economy was the coefficient of government spending in this panel. The conclusion about a significantly larger multiplier in a more open economy was based on a comparison of the state multiplier, obtained in the panel, and the USA multiplier, obtained by aggregating states' data.

Another paper that also studied the impact of openness of the economy on the fiscal multiplier is the work of Ilzetzki, Mendoza and Végh (2013). They stated that in an economy with barriers to trade, the multiplier was higher. One of the results of Kraay's work (2014) was that the fiscal multiplier in export-oriented countries was smaller, but as a tool for government spending, they used loans granted to countries by official creditors, which could significantly differ from the actual government spending in these countries. As an argument in favor of the increase in the fiscal multiplier value with a higher share of exports in GDP can serve the work of Kim, Roubini (2008). In this work the authors, using VAR for the US, came to the conclusion that when the budget deficit increases, the current account increases, which increases GDP as GDP includes current account. Although there are contradictory results. In the work of Beetsma, Roel, Giuliodori, Klaassen (2008) an increase in the budget deficit leads to a decrease in the trade balance. The analysis was carried out using a panel VAR for the countries of the European Union.

2 A panel SVAR for emerging countries

2.1 Modeling Methodology

In this paper, I studied only the multiplier of government expenditures, the tax multiplier was out of the scope. Two multipliers were calculated: on-impact and long-run, where by the long-run multiplier I meant the multiplier for the horizon N for $N \to \infty$ (for numerical calculations $N = 10$ years).

$$\text{Impact Multiplier} = \frac{\Delta Y_t}{\Delta G_t}$$

$$\text{Long-run Multiplier} = \lim_{N\to\infty} \frac{\Delta Y(t+N)}{\Delta G_t}$$

I estimated a panel SVAR model to compute the multipliers. Government spending and GDP are endogenous to each other: GDP affects government spending, since the focus of fiscal policy usually depends on the rate of economic growth, and government spending affects GDP, because it is directly included in the calculation of GDP. In order to take into account the interdependence of variables from each other, a SVAR model can be constructed. The equation for panel SVAR is written as follows:

$$AY_{n,t} = \alpha_n + \sum_{k=1}^{K} C_k Y_{n,t-k} + Bu_{n,t}. \quad (2.1)$$

where t is the time in quarters, n is the country number in the panel, C_k is the matrix of the individual and cross-country effects of the k-th lag of the variables to the current value of the variables. B is the diagonal matrix, u_t is the vector of orthogonal, independent and identically distributed shocks with $Eu_{n,t} = 0$ and $E[u_{n,t}u'_{n,t}] = I$, where I is an identity matrix. The matrix A admits an on-impact relationship between the endogenous variables $Y_{n,t}$. It is assumed that the matrices A, B, C_k are invariant in time and in space (independent for the number of the country).

$Y_{n,t}$ is a vector that in different specifications consists of the following real variables in levels:

1) government spending and GDP

2) government spending, private consumption, investment in capital, export, import, GDP,

CPI index, central bank rate, the national currency exchange rate to the SDR basket. [1] In addition, the variable $\frac{Ex+Im}{2} \cdot G$ was included in the vector $Y_{n,t}$ to account for the influence of the openness of the economy on the value of the budget multiplier. The choice of variables is due to the availability of data from 1998 for all countries since a balanced panel was built. 3) in addition to the variables in option 2, the inclusion of the multiplier dependence on the budget deficit, the business cycle phase and the co-movement of the business cycle stage and fiscal policy (including the variables $budgetDeficit \cdot G + outputGap \cdot G + dummy[sign(outputGap) \cdot \ DeltaG > 0]$ to the vector $Y_{n,t}$, respectively) was made.

The inclusion of the products of macro variables and government spending is an attempt to exclude (in the calculation of the multiplier) not only linear effects of these variables on GDP but also to control for non-linear ones. From the equation 2.2, which was obtained from the system of two equations below, it can be seen that, for example, if the budget deficit is high, then if β_1 is negative, the multiplier of government spending decreases.

$$\begin{cases} \Delta Y_t = mult \cdot \Delta G_t \\ mult = \alpha + \beta_1 \cdot budgetDeficit + \beta_2 \cdot outputGap + \\ \qquad + \beta_3 \cdot dummy[sign(outputGap) \cdot \Delta G > 0] + \beta_4 \cdot \dfrac{Ex+Im}{2} \end{cases} \Longrightarrow$$

$$Y_t = \alpha \cdot G_{t-1} + \beta_1 budgetDeficit \cdot G_{t-1} + \beta_2 outputGap \cdot G_{t-1} + ... \qquad (2.2)$$

where the variable $budgetDeficit$ is the budget deficit, $outputGap$ is the output gap estimated by "The Economist" reflecting the stage of the business cycle. The choice of the output gap calculated by this methodology was related to the availability of data for many countries throughout the sampling period. *Sign* is a function that shows the sign of the dependent variable, $\frac{Ex+Im}{2}$ is half of the sum of exports and imports and reflects the openness of the economy. $dummy[sign(outputGap) * \Delta G > 0]$ is the co-movement of fiscal policy and the stage of the business cycle.

[1] the basket includes the US dollar, euro, Japanese yen, Chinese yuan and British pound. Weights are recalculated by the IMF every 5 years, at the moment of estimations the weights of the currencies are 0.58252, 0.38671, 11.900, 1.0174, 0.085946, respectively. The basket is calculated in dollars.

Estimates of multipliers were calculated from the impulse response functions of GDP to the shock of government spending in the panel SVAR. All specifications were built using fixed effects. I chose 1 lag, in view of the limited amount of data. Seasonal smoothing was performed using the 'X12 - ARIMA' method. The identification was carried out according to Cholesky. The order of the variables corresponds to the order in which they are presented in the above specifications. When the change of the multiplier with the change of exchange rate regime was explored the sample period was divided into 2 parts: before the transition from the managed exchange rate regime to the floating exchange rate regime of the countries in the sample and after.

2.2 Description of the data

In order to use the SVAR methodology, quarterly data is required, otherwise the assumption that GDP in the current period does not affect government spending may be less valid since within a year government can usually respond to GDP shocks. The data source was the IMF database from 1991Q1 to 2016Q4. Data on the output gap was used from the "The Economist" database. All variables were included in real terms. Since there was a need for a balanced panel to evaluate the panel SVAR, in the specifications with the key rate, the period from 2003Q1 to 2015Q1 was taken, and without it, from 1996Q1 to 2015Q1.

Emerging countries were defined according to the World Bank classification. There are other classifications, however, according to this classification, the largest number of countries are attributed to this level of development. Since the sample was not very large, the preference was given to this classification. Countries that were included in the sample are listed in the table 2.1.

The moment of transition to the floating exchange rate regime was chosen according to the International Monetary Fund, the Bank of England and the Bank of Norway. The division of countries into open and closed countries was made at the 30% threshold of the ratio of the half-sum of the absolute values of exports and imports to GDP. The 30% threshold was chosen as in the work of the IMF (Ilzetzki et al., 2013) for developed countries. In addition, in almost all specifications this boundary divides the sample almost equally.

Table 2.1

The transition to a floating exchange rate and countries' classification

Country	The moment of the change of exchange regime to the floating exchange regime	The year from which World Bank classifies the country as emerging
Armenia	2006	-
Albania	2009	2008Q1
Brazil	1999	-
Chile	1999	2012
Colombia	1999	1994
Czech Republic	1998	2006
Hungary	2001	2007
Indonesia	2005	-
South Korea	2001	2002
Mexico	2001	-
Peru	2002	-
Philippines	2002	-
Poland	1998	2009
Romania	2005	-
South Africa	2000	-
Thailand	2000	-
Guatemala	2005	2009
Serbia	2006	-
Dominican Republic		-
Georgia	2009	-
India	2005	-
Moldova	2010	-
Russia	2015	-
Turkey	2006	-

Source: IMF, World Bank, official pages of central banks.

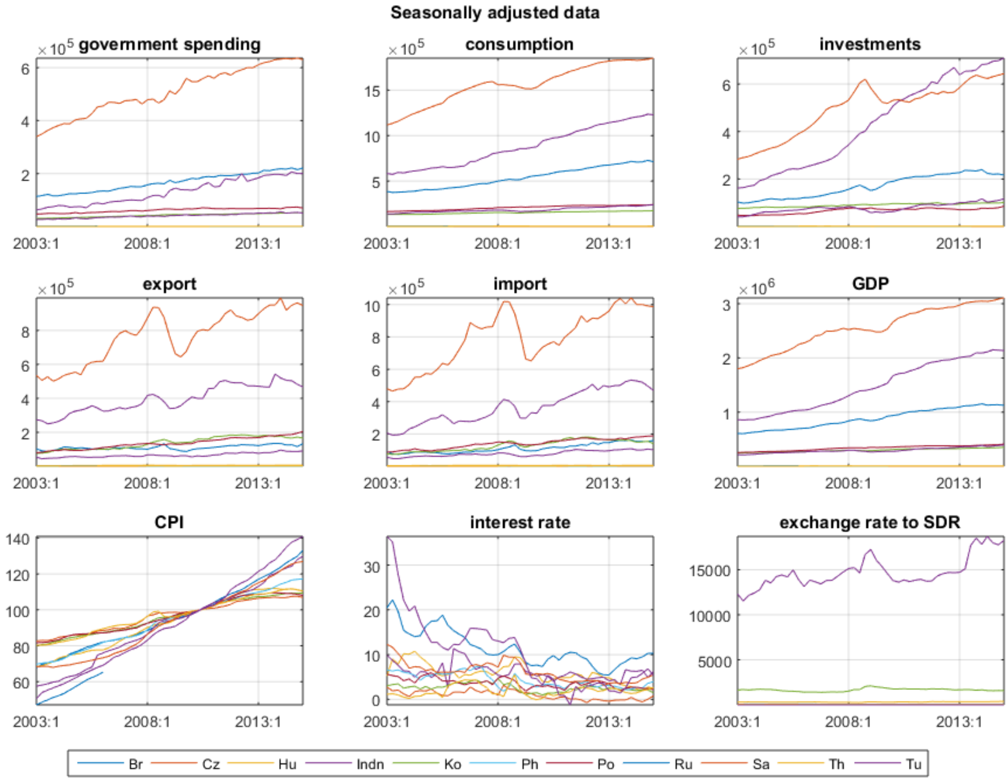

Figure 2.1 — Country data in the base specification as indices, where the first value corresponds to a value of 100 for each country

The figure 2.1 shows the data obtained for the main macro variables and for the countries for which the baseline specification was constructed (this specification is described in the "Results of the model" section), the first values of all the rows are normalized to 100. It can be seen that, in general, the dynamics of the series are quite similar, which suggests that estimating the panel data model could give more accurate estimates than separable estimations for each country.

2.3 Model Results

The estimation results show that the inclusion of a central bank's rate and other macroeconomic variables changes the values of multipliers calculated from the impulse responses of GDP to the shock of government spending. The inclusion of the output gap and the budget deficit leads to a reduction in the sample of the countries, but the results obtained with the addition of the output gap and the budget deficit are different from the results obtained without them. In particular, the value of the long-run multiplier becomes negative. Therefore, as the **baseline specification**, a model was chosen with the inclusion of the output gap, other macroeconomic variables and central bank's rates. The inclusion of a budget deficit changes the results relative to the model without it and without an output gap but slightly changes the results of the model with the included output gap. This can be seen if we compare the values of the multipliers with the output gap and with the output gap and the budget deficit.

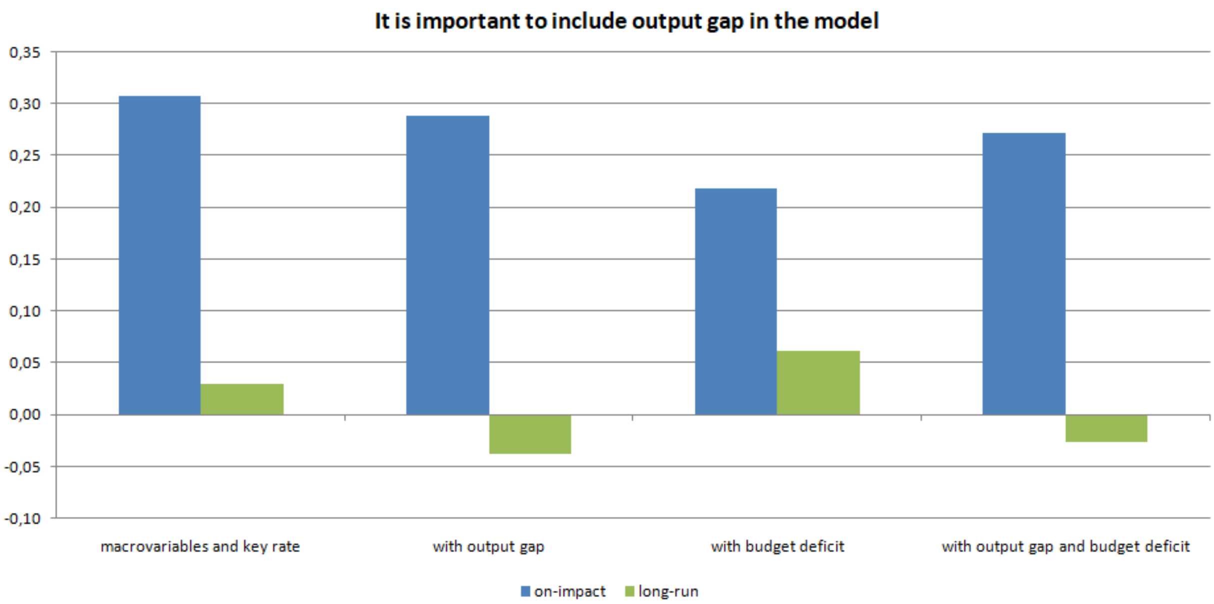

Figure 2.2 — Fiscal multipliers with output gap and budget deficit

One of the important results (but not the main focus of the study) is that the budget multiplier depends on the openness of the economy. In the figure 4.2, the multiplier values are presented for the baseline model specification. The on-impact multiplier for open economies is near zero, whereas for closed economies it is almost 0.3. The long-run multiplier for open economies is -0.15, and for the closed ones it is almost 0. Therefore, when calculating the change in the multiplier, the variable $G \cdot \frac{Ex+Im}{2}$ was included to calculate the multiplier's dependence on the openness of the economy.

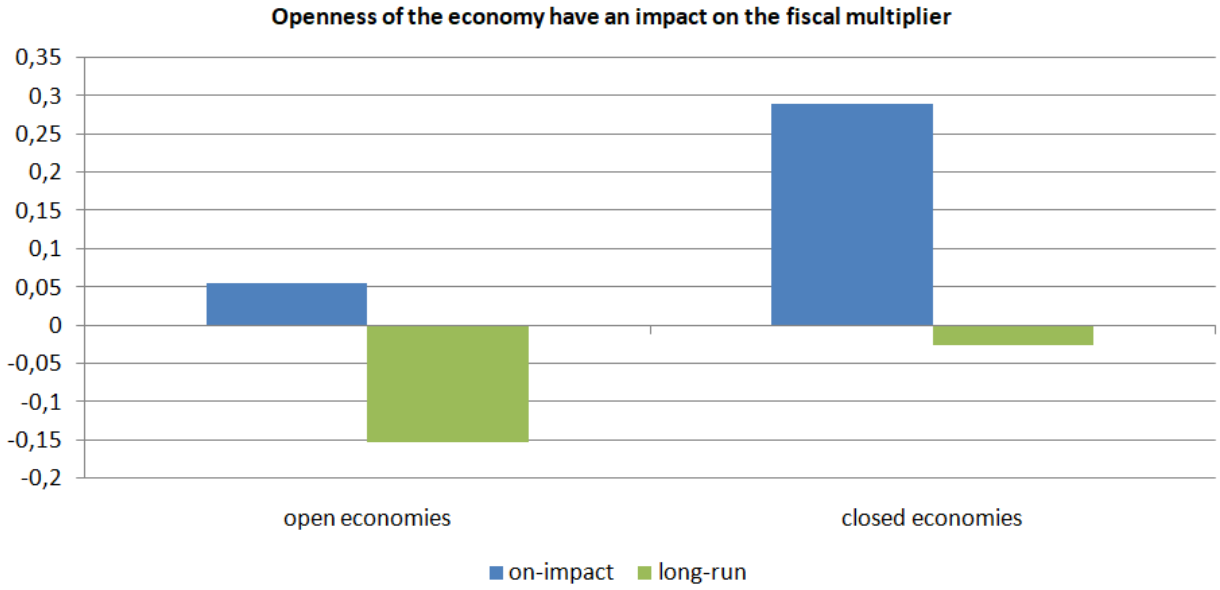

Figure 2.3 — Fiscal multipliers for open and closed economies

From the entire sample only Indonesia and Turkey were chosen to study the change of the multiplier when the exchange rate regime was changed. Only these countries changed the exchange rate regime for the period, where the data is available for all variables of the baseline specification. Therefore, I perform my analysis of the change of the budget multiplier when exchange rate regime is changed only for these two countries; however, as multipliers of these 2 countries are close to the values of the multipliers for the whole sample, it could be implied that the same change of multipliers would happen in the other emerging countries when they change exchange rate regime. Moreover, multipliers and their change calculated from DSGE model for these 2 countries are close to the values in empirical analysis; therefore, I could perform the analysis for the whole sample via DSGE model and see that the results are close to the results for these 2 countries (see section 3 for these results). That would support the idea of extrapolation of the results from 2 countries on the whole sample.

At the same time, since the data for variables from the baseline specification was available for Indonesia and Turkey from 1999Q4, the values of multipliers under the managed exchange rate regime were estimated according to data from 2001Q1 - 2004Q4 (before 2001Q1 in Turkey, the central bank rate was more than 100%, so to avoid the inclusion of structural breaks, this part of the sample was not included in the estimation of multipliers). Under the floating exchange rate regime, the evaluation was carried out on data from 2006Q1 to 2015Q1.

Table 2.2

The change of the fiscal multiplier when exchange rate regime changes

	11 countries	Indonesia and Turkey	managed exchange rate regime	floating exchange rate regime
on-impact	0.29	0.61	1.03	0.49
long-run	-0.04	0.03	0.95	0.001

Source: authors calculations.

Thus, according to the panel SVAR estimates, the decrease in the multiplier when the exchange rate regime changes from managed to the floating is 0.5, while the value of the long-run multiplier becomes nearly zero.

Based on the impulse response functions (figures 4.4 and 4.5), it can be seen that private consumption on-impact is declining. The decrease in consumption may be explained by the fact that the majority of households know that the increase in expenditures will be financed by the increase in taxes in the future. So, they start saving for higher future taxes. Investments on-impact grow in both regimes, which is non-standard in comparison with developed countries. This may be the case when firms are considering the period of expansionary fiscal policy as favorable for investments. It could be so, if government with expansionary fiscal policy also conducts the policy which supports firms. However, with the floating exchange rate, investments are crowd out and starting from the third quarter after the shock in government spending, investments become smaller compared to their values before the shock. In the long run investments remain at the levels which are lower than initial levels. Net export is also declining, mainly due to increase in import. At the same time, the scale of the change in net export is comparable to the changes in investment and consumption, which confirms the importance of this channel in the study of fiscal multipliers. Thus, the value of the on-impact multiplier is less than 1 due to a decrease in net exports, and the long-run multiplier is reduced by the reduction in investments.

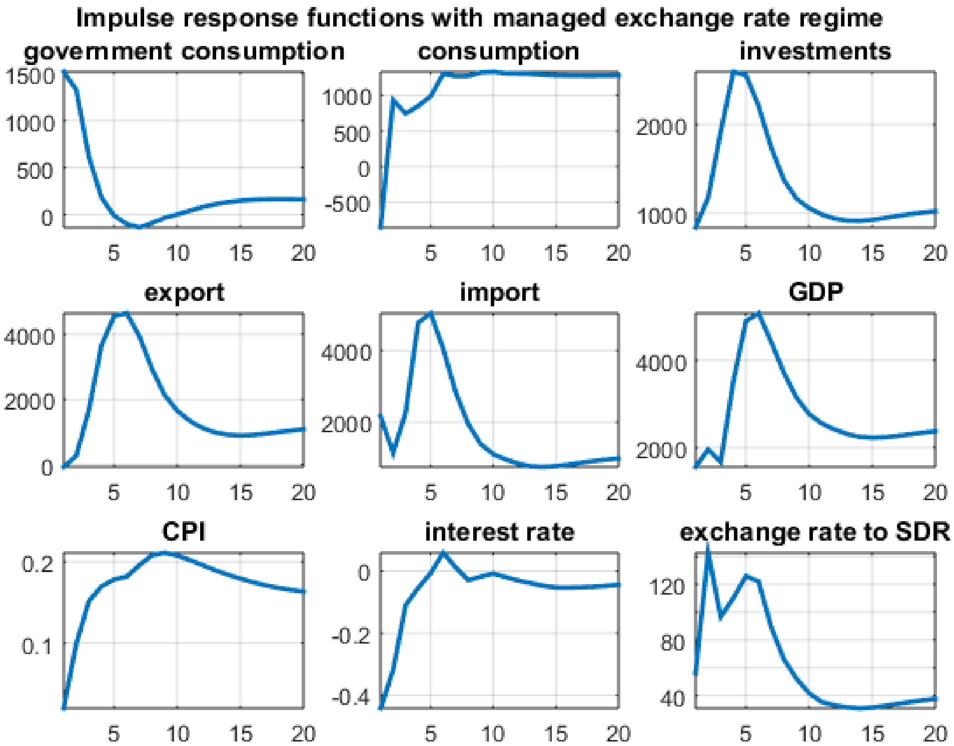

Figure 2.4 — Fiscal multipliers for managed exchange rate regime

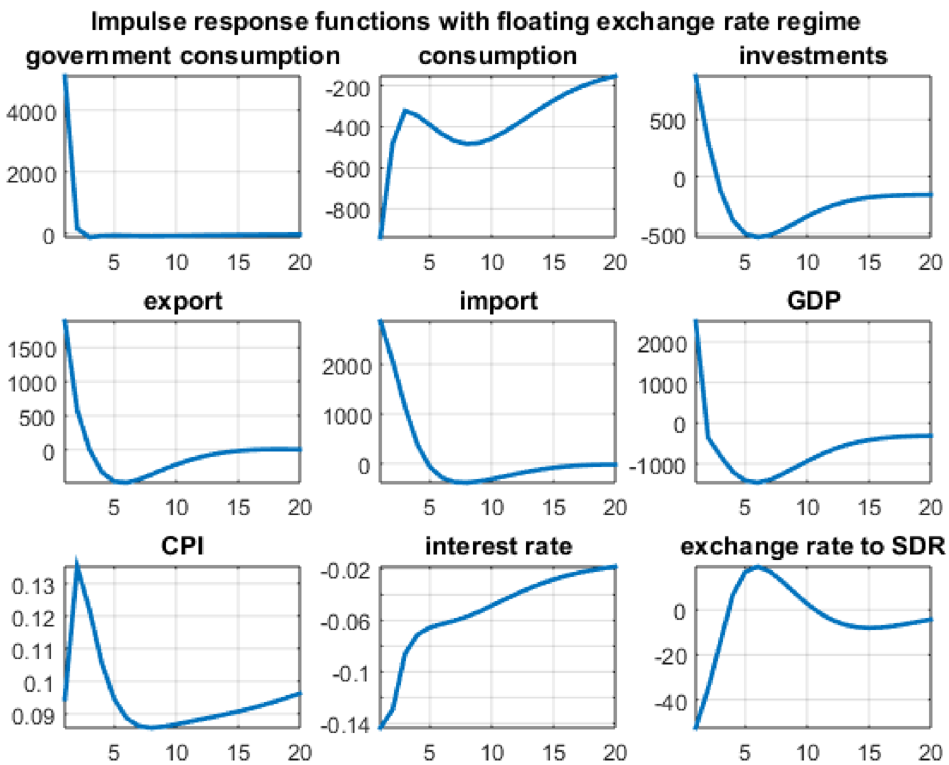

Figure 2.5 — Fiscal multipliers for floating exchange rate regime

In Appendix 1 impulse response functions with confidence bounds are presented constructed using bootstrap. 5% and 95% quantiles of the distributions are taken from 100,000 trajectories. As the calculations were done using numerical method the confidence intervals turned out to be a little asymmetric and even intersecting with each other in some places. From these bounds one can see that, indeed, the GDP response in a managed exchange rate regime is positive and greater than with a floating regime which contains 0 in the bounds.

Thus, the multipliers for emerging countries are less than 1, which means that with the increase in government spending, the remaining components of GDP do not increase, and some components even decline. This indicates the ineffectiveness of this policy in stimulating the economy in these countries. At the same time, under the managed exchange rate regime, the on-impact multipliers are more by 0.5 than under the floating exchange rate. Long-run multipliers are less than on-impact multipliers for both regimes. Additionally, in closed economies multiples are greater than in open economies.

3 DSGE model

3.1 Model Description

The DSGE model was built based on the work of Nakamura and Steinsson (2014). The main difference between this paper and that by Nakamura and Steinsson (2014) is the inclusion of the exchange rate and the rule for monetary policy for the foreign economy in the model. Below I briefly describe the main characteristics of the model of Nakamura and Steinsson (2014) and the changes I made to the model.

In the economy there is a continuum of households, each of which maximizes the discounted amount of one-period utility. The utility function is inseparable in terms of labor and consumption, in consumption both domestically produced goods and imported goods are consumed.

$$\max_{\{u_t\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, L_t(x)), \quad C_t = [\phi_h^{1/\eta} C_{Ht}^{\frac{\eta-1}{\eta}} + \phi_f^{1/\eta} C_{Ft}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{3.1}$$

$$u(C_t, L_t(x)) = \frac{(C_t - \chi L_t(x)^{1+\nu^{-1}}/(1+\nu^{-1}))^{1-\sigma^{-1}}}{1-\sigma^{-1}}, \qquad C_{It} = \int_0^1 c_{it}(z)^{\frac{\theta-1}{\theta}} dz \tag{3.2}$$

where E_0 is the mathematical expectation at time 0, β is the discount factor, $u(C_t, L_t(x))$ is the utility function of consumption and labor respectively, ν is the inverse elasticity of labor , η - elasticity of substitution between domestic and foreign goods, $c_{it}(z)$ - consumption of good z at the moment of time t, θ - elasticity of substitution between different types of goods, C_{It} - aggregate consumption of all domestic (H) or foreign (F) goods at the time t, $I \in \{H, F\}$. At the same time, when the discounted sum of utility functions is maximized, the consumer takes into account the budget constraint of each period:

$$P_t C_t + E_t[M_{t,t+1} B_{t+1}(x)] \leqslant B_t(x) + (1-\tau_t) W_t(x) L_t(x) + \int_0^1 \Sigma_{ht}(z) dz - T_t \tag{3.3}$$

where P_t is the price level, $M_{t,t+1}$ is the stochastic discount factor, $B_t(x)$ is the payment at the beginning of the period t on portfolio of the securities owned by the household x, τ_t

is the income tax rate, W_t is the wage that is set in a perfectly competitive labor market, $\Sigma_{ht}(z)$ is the profit that firm z receives at time t, T_t is a lump-sum tax.

Firms producing intermediate goods generate y_{ht} according to the production technology $y_{ht}(z) = f(L_t(z), K(z)) = L_t^{\alpha} K_t^{1-\alpha}$, where α is the share of labor in the production, and z is a firm's index, while capital is amortized and replenished by investments ($K_t = (1 - \delta)K_{t-1} + \delta I_t$). Thus, there is no technological progress in the economy (there is no coefficient of total factor productivity.) Each firm z seeks to maximize its profit:

$$E_t \sum_{j=0}^{\infty} M_{t,t+j}[p_{ht+j}(z) y_{ht+j}(z) - W_{t+j}(x) L_{t+j}(z)] \tag{3.4}$$

where p_{ht} is the price of the product of firm z at the time t. At the same time, domestic households, foreign households and the home government constitute demand for the company's products:

$$y_{ht}(z) = (nC_{Ht} + (1-n)C^{*}_{Ht} + nG_{Ht})\Big(\frac{p_{ht}(z)}{P_{Ht}}\Big)^{-\theta} \tag{3.5}$$

where n is the size of the domestic economy (it ranges from 0 to 1) or its share in the world economy, and $1 - n$, respectively, the size of the rest of the world, C^* - consumption in the foreign economy (it's the rest of the world), G_{Ht} - government spending in the domestic economy. Pricing in the intermediate goods market occurs according to Calvo mechanism, i.e. at each point in time only a part of firms can change their prices, other firms retain the prices of the previous quarter. The market of intermediate firms is monopolistically competitive. Firm-aggregator of intermediate goods operates on a completely competitive market of final goods, i.e. receives a zero profit. The market for foreign firms is similar to the market of domestic firms (all equations and parameters for foreign and domestic firms are similar).

Governments in both domestic and foreign economies demand for their own country's products, and the central bank sets an interest rate according to the Taylor rule:

$$g_{ht}(z) = G_{It}\Big(\frac{p_{it}(z)}{P_{It}}\Big)^{-\theta} \tag{3.6}$$

$$r_t = \rho r_{t-1} + (1-\rho)(\phi_\pi \pi_t + \phi_y y_t) \tag{3.7}$$

where $g_{ht}(z)$ is government demand for the products of firm z, ϕ_{pi}/ϕ_y is the relative weight of inflation in the loss function of the Central Bank, which consists of an output gap and inflation. At the same time, the government budget is balanced in each period due to lump-sum taxes, government spending follows the AR(1) process.

Since the model that was built by Nakamura and Steinsson (2014) was built for USA states, in the domestic country and abroad country the same currency (dollars) was used. Therefore, I modified the model to allow for different currencies and different monetary policies in domestic and foreign countries. Firstly, a nominal exchange rate was added, which is determined according to the uncovered interest rate parity, the real exchange rate is determined according to the ratio of prices multiplied by the nominal exchange rate (by definition of the real exchange rate).

$$1 + r_{ft} = (1 + r_{ht})\frac{E_t S_{t+1}}{S_t} \tag{3.8}$$

$$Q_t = \frac{S_t P_t^*}{P_t} \tag{3.9}$$

where r_{ft} is the rate in the foreign economy, S_t is the nominal exchange rate (direct), Q_t is the real exchange rate. Secondly, with an introduction of foreign rates in the model, a monetary rule was added for the foreign economy, which targets inflation (since the monetary authorities of developed countries target inflation and make up a larger share of the world GDP). Thirdly, in the loss function of the domestic monetary authorities, the nominal exchange rate was added to assess the change in the multiplier when the exchange rate regime was changed. The change in the regime was modeled as a decrease in the coefficient of the exchange rate (ϕ_e) in the Taylor rule.

$$r_{ft} = \rho_f r_{f(t-1)} + (1 - \rho_f)\phi_{\pi t}\pi_t \tag{3.10}$$

$$r_t = \rho r_{t-1} + (1 - \rho)(\phi_\pi \pi_t + \phi_y y_t + \phi_e s_t) \tag{3.11}$$

3.2 Model calibration

The model was calibrated in accordance with empirical papers and papers with DSGE models by countries, which were presented in the table 2.1 (countries that entered the initial empirical sample). A total number of 104 works were considered [1]. The received values of structural parameters were averaged for each country and then averaged between countries. Such averaging was carried out in order not to put more weight to the values of the parameters in the countries for which more research papers were found, and not to take into account in the final calculation the work of one author for one country several times. The figure 3.1 presents the averaged values of the parameters by country (definition of parameters is in Appendix 3). All parameters are calibrated according to the values from other papers, except for the correlation of domestic government spending with foreign government spending, the size of the economy and the stationary ratio of government spending to GDP. All these parameters were estimated based on their sample representations averaged through the period of the sample (for example, the size of the economy was calculated as the share of nominal GDP in dollars in relation to the world GDP averaged for the period of the empirical sample). The robustness check was performed for those parameters that have the largest ration of sample variance to the sample mean (hose parameters are nu, eps_phi, phiY, corrG and nn). In the section 3 the results are presented.

The resulting average values of the parameters differ from the values of the parameters in the Nakamura and Steinsson (2104) calibration (hereinafter and in the figure, N & S); however, the difference can be explained. For example, the parameter of intertemporal elasticity [2] turned out to be greater for emerging markets, compared to the value of the parameter for the United States. This may be due to the fact that in the US people are more patient and confident in their future, so they are ready to exchange less consumption tomorrow for the

[1] The works are accessible via the link https://www.overleaf.com/read/hqbnsjqyyvrj

[2] Inverse value to the parameter of inverse elasticity

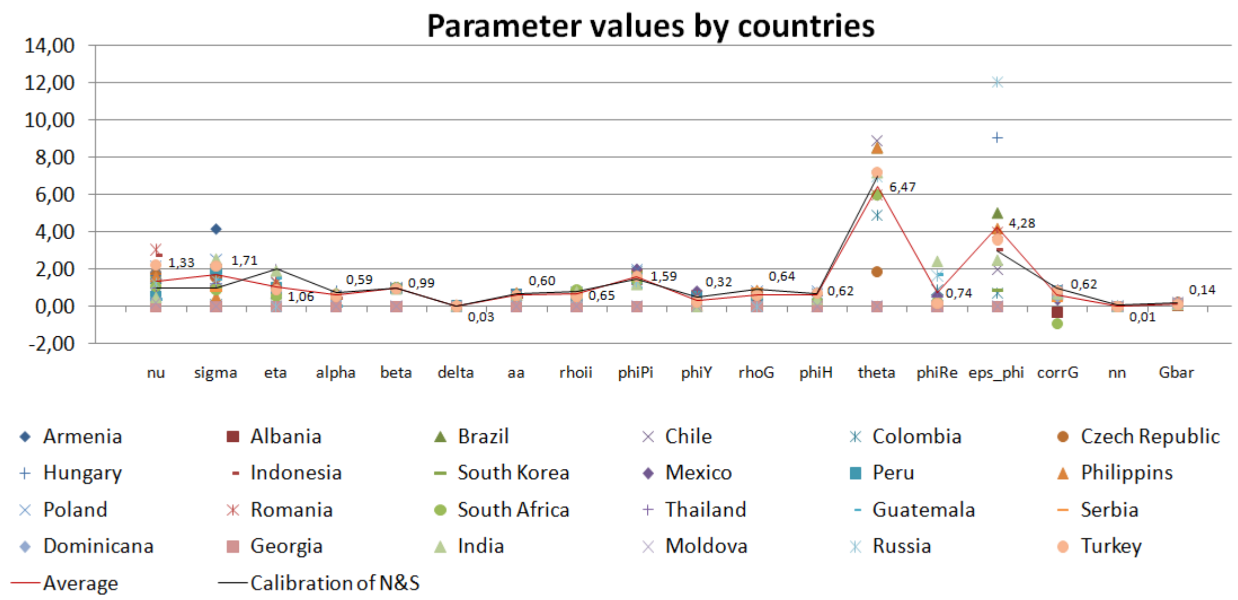

Figure 3.1 — Values of the parameters for each country

consumption today.

In addition, the USA is more conservative in changing rates, since monetary policy in developed countries is usually more consistent with its previous behavior. Additionally, due to the great influence of the United States on the world economy, the monetary authorities are rather limited in their decisions: with a considerable volatility of the Fed rates, the volatility of a lot of financial indicators can significantly increase, triggering panic on the financial markets. The fiscal authorities also take more inertial decisions according to the calibrated parameters.

3.3 Results of the calibrated DSGE model

The figure 3.2 below shows the values of the multipliers in the DSGE model for all countries from the initial sample, the DSGE models for countries from the baseline specification, and the empirical estimates of the panel SVAR. The multipliers in the calibrated DSGE model were close enough to the values obtained in the empirical analysis. The values of on-impact multipliers are positive and small (not more than 1), long-run multipliers are near zero. The change in the multiplier when the exchange rate regime is changed is, for the whole sample, and for the countries of the base specification, 0.4 (in the empirical analysis 0.5). At the same time, when DSGE models were estimated for each country by their calibration and then multipliers' values were averaged I obtained the change of on-impact multiplier equal to 0.44 (managed ex.rate multiplier - floating ex. rate multiplier = 0.68 - 0.24). Moreover, if the model is calibrated for Turkey and Indonesia and then the values of the multipliers are averaged we get 0.5 for on-impact multiplier and -0.02 for long-run one (on-impact: 0.37 - for Turkey, 0.64 for Indonesia, long-run: -0.02 and -0.03 accordingly; SVAR results: 0.61 on-impact, 0.03 long-run). **Thus, it can be argued that the DSGE estimates confirm the conclusions of the panel SVAR regarding the change in the on-impact fiscal multiplier when the exchange regime changes**. The values of long-run multipliers are quite the same in the floating exchange rate regime in both SVAR and DSGE models (for both DSGE models - the averaged calibration and the average for multipliers by country - the value of long-run multipliers turned out to be near zero). The difference in estimates is observed only for the long-run multiplier values for the managed exchange rate regime: in SVAR it is about 1, in DSGE - about 0. However, the study of this issue will remain for future research.

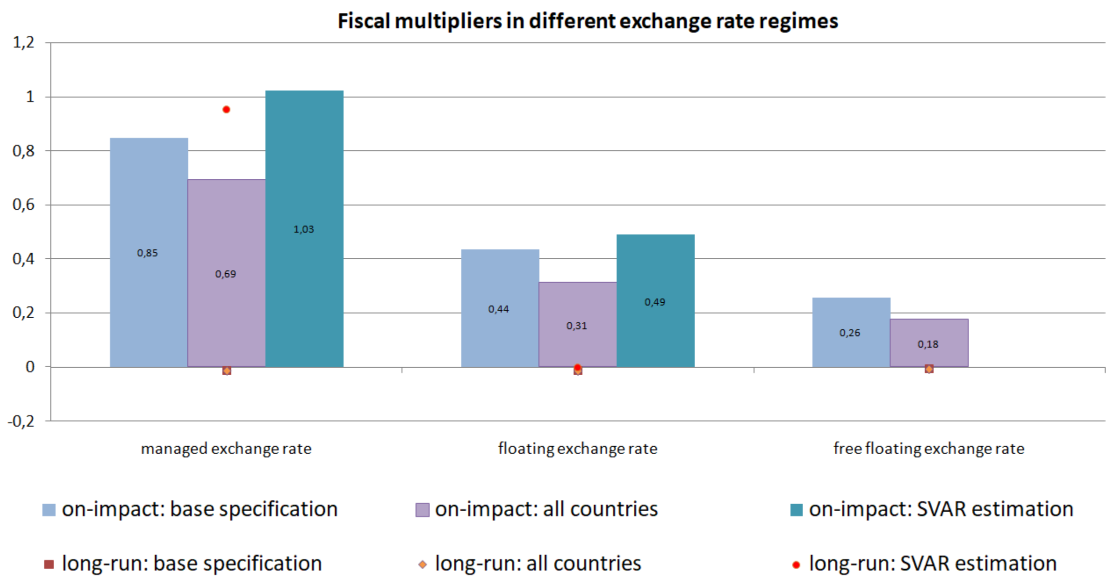

Figure 3.2 — Fiscal multipliers' values for SVAR and DSGE models

Values of multipliers in different exchange rate regimes in DSGE models were obtained with the variation of the coefficient of the nominal exchange rate in the Taylor rule. The bigger is the coefficient the more managed is the exchange rate. It was assumed that coefficients higher than $\frac{1}{3}$ would mean managed exchange rate regime for the country and smaller than

$\frac{1}{3}$ - floating exchange rate regime. In the sample of papers the mean value of coefficients higher than $\frac{1}{3}$ turned out to be 1.68 and the mean value for coefficients smaller than $\frac{1}{3}$ was 0.28 (the coefficient for inflation in the Taylor rule was 1.6). Thus, a floating exchange rate for emerging markets still suggests some reaction of monetary authorities to the value of the exchange rate. Therefore, for comparison, the results of the DSGE model for a free-floating exchange rate (the coefficient at the exchange rate in the Taylor rule 0) are also given. It can be seen that with a further decrease in the manageability of the exchange rate, the on-impact fiscal multipliers continue to decline, while the long-run multipliers remain near 0.

Just like in the SVAR model, the multipliers in the DSGE model depend on the openness of the economy: in closed economies, on-impact multipliers are greater. This was verified using a variation in the weight parameter of domestic products in the consumption bundle (which is the standard measure of openness in the literature for DSGE models[3]). It is worth noting that the scale of the difference in multipliers for closed and open economies is less based on empirical data than in DSGE model. Long-run multiples remain near zero in DSGE, while SVAR values are small, but still slightly more negative (-0.15).

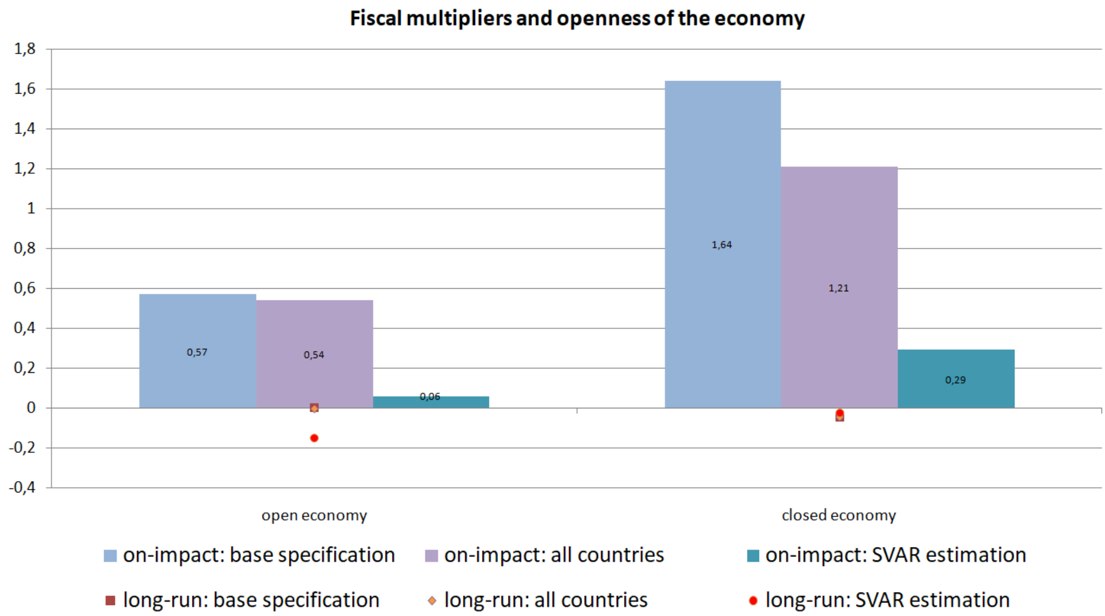

Figure 3.3 — Value of the multipliers in DSGE and SVAR models: analysis of the multipliers' dependence on the openness of the economy

[3]for example, Clarida, Gali, Gertler, 2001

Impulse response functions of DSGE model are given in Appendix 2. Although this was not the goal of the analysis, the dynamics of impulse responses of investments are quite similar. The dynamics of consumption varies, however, SVAR confidence intervals capture 0. Therefore, the difference can be considered insignificant (although the confidence intervals for 100,000 iterations turned out to be quite wide). [4]

3.4 Sensitivity analysis

The analysis was carried out for 4 parameters: eps_phi, phiY, corrG and nn. To do this, for each parameter, a grid of its values was built with 0.1σ steps, where σ is the standard deviation of the parameter from the sample of the countries. The parameters were ranged from -3 σ to 3 σ. As a result, it was revealed that the multipliers are most sensitive to the coefficient of the output gap in the Taylor rule. If I change it by more than 2.5σ, the values of the multipliers change exponentially, therefore, in the figure 3.4 the values are presented only from -2.5σ to 2.5σ. Within the limits of 2.5σ, the on-impact multipliers change systematically and for one σ they can vary by values of the order of 0.3. Long-run multipliers remain in the area of near-zero values.

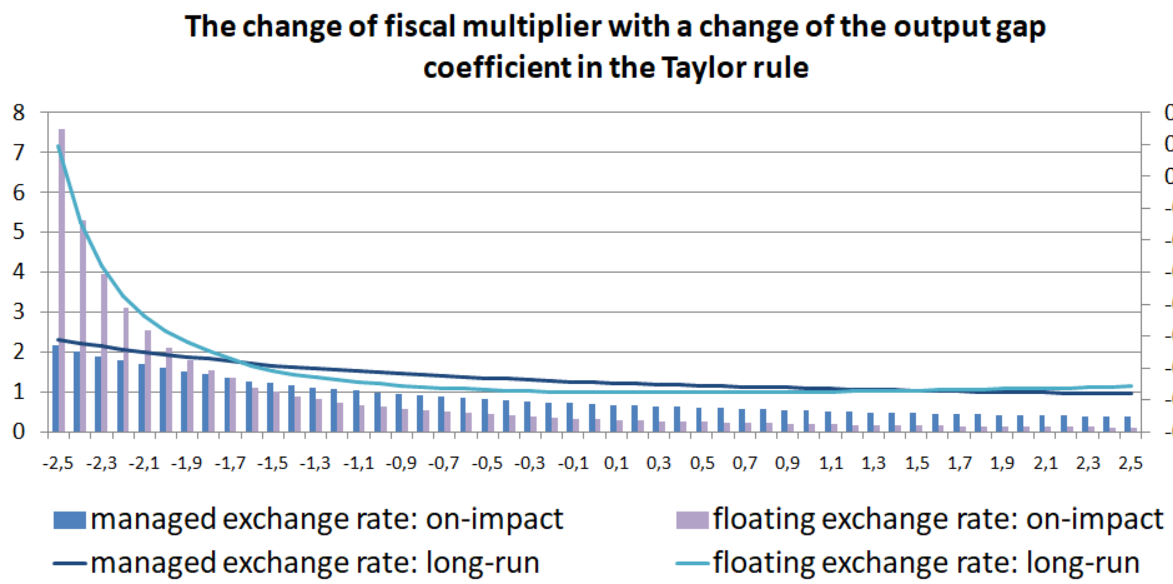

Figure 3.4 — Sensitivity analysis for phiY

The sensitivity to this parameter is due to the fact that the higher the value of this parameter

[4] since in the calibrated DSGE all parameters are known, there are no confidence intervals for impulse response functions.

the more monetary authorities will react to the output gap. The more they react to output gap the faster it is closed and therefore, the lower the values of the multipliers are. In the figure 3.4, it is seen that as the value of the coefficient decreases (the multipliers on the left side of the graph), the multiplier value increases as the Central Bank becomes more tolerant to the positive output gap.

4 Estimation of the fiscal multiplier on the Russian data

4.1 Description of the data

Any country could be chosen for estimation of the fiscal multipliers; however, I chose Russia as nobody, to my knowledge, has estimated micro-founded fiscal multiplier for Russia. To estimate the DSGE model that was described in the previous section on Russian data, data from 2000Q1 to 2017Q4 was collected to ignore the 1998 crisis and some recovery period after it. The source of data for private consumption, government spending, investment, GDP, the CPI, the GDP deflator and the average salaries was the Russian official statistical agency "Rosstat". Data on the key rate was used from the Bank of Russia website, data on the ruble exchange rate against the dollar and euro, as well as FFE and EONIA rates and price indices in the USA and Eurozone (17 countries) were obtained using the Thomson Reuters and Thomson Reuters DataStream databases. All the variables, except for inflation and rates, were translated into real values with the help of the CPI in nominal values, then they were seasonally adjusted using the 'X12' procedure. To obtain loglinerized values logarithms of the variables after seasonal adjustment were taken and detrended values with the help of the Hodrick-Prescott filter were obtained. Inflation variables were obtained by smoothing the price index, moving to the growth rates and detrending the data. Rates were transformed into net quarter values (1 was added to the values divided by 400).

Data on foreign variables and the exchange rate for the model was obtained by weighing the variables for the US and Eurozone with weights 0.55 and 0.45 respectively (which corresponds to the weight of the Bank of Russia's dual currency basket). Data prior to 2011, received from the Russian statistical agency, was adjusted to take into account the change in the methodology used by it in calculating variables from the system of national accounts (in 2011 Rosstat implemented the international methodology). For these purposes, regressions of data on the new methodology were constructed for data on the old methodology for the period in which Rosstat calculated the values in both methodologies. In general, it has been obtained across all the series that, before 2011, they should be changed by a constant for correction.

All parameters in the model were estimated using Bayesian technique with the usage of the MCMC algorithm for numerical estimation of a posterior distribution statistics. As prior values for the parameters, values from other studies on Russian data were taken, which were found when the model was calibrated in the previous section. The list of studies on Russian data included works: Polbin (2014), Semko (2013), Novak (2014), Malakhovskaya and Minaboutdinov (2013), Zamulin and Sosunov (2006). The average values of the parameters for emerging markets were taken for those parameters for which there were no values in the above-mentioned papers (these parameters are elasticity of substitution between domestic and foreign goods and persistence of government spending shocks). As a prior distributions for the preference parameters, the gamma distribution was taken, for parameters distributed from 0 to 1, the beta distribution was taken and for the parameters of the Taylor rule, the normal distribution was taken, as in the work of Malakhovskaya and Minabutdinov (2013).

4.2 Estimation results

The baseline specification is the estimation of the model according to quarter on quarter data from 2000Q2 to 2017Q4, including the series of private consumption, investment, government spending, GDP, exchange rate, inflation, wages and foreign inflation. Based on this results, the on-impact multiplier was estimated at 0.19 ± 0.13, and the long-run value was insignificantly different from 0 ($-8 \cdot 10^{-4} \pm 5 \cdot 10^{-3}$). The standard error was calculated as a sample standard deviation among the decile estimates of the multipliers. Namely, at each moment of time the deciles of impulse responses for GDP and for government spending were calculated, then the corresponding deciles of government spending were divided by corresponded decile estimates of GDP, after that the sample standard deviation was calculated based on 10 obtained multipliers in each point in time.

The estimated multipliers for Russia are consistent with the values obtained for emerging countries in SVAR model (on-impact multipliers less than 1 and zero long-run multipliers). In addition, it can be seen from the impulse response functions that, as in the case of empirical results (see the impulse response functions to them in Appendix 1), the on-impact reaction of GDP is reduced by net export (consumption and investments in the figure 4.3, grow, and the multiplier is less than 1 means that net export decreases). Long-run multiplier decreases to 0 due to the crowding out effect of investments and decrease in consumption.

It should be noted that due to the fact that the data is not long enough posterior estimates of the parameters are close to the prior ones. In Appendix 4, a table with the prior and a posterior parameter values is presented.

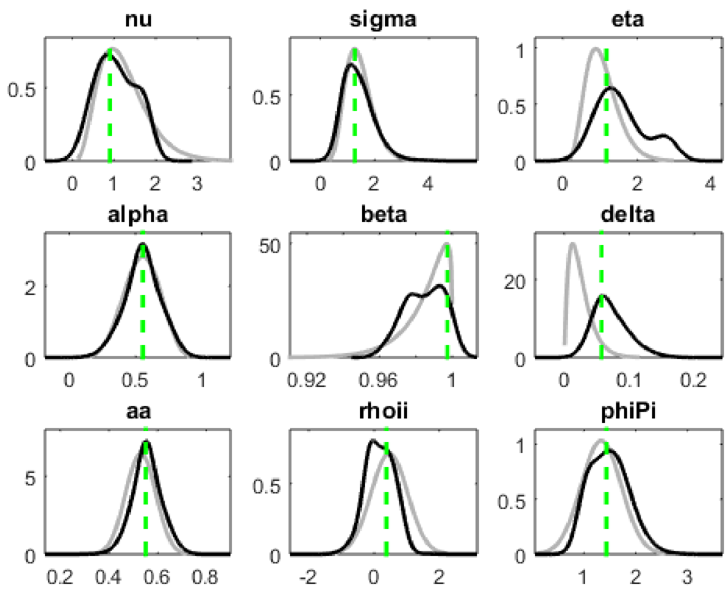

Figure 4.1 — Posterior estimates

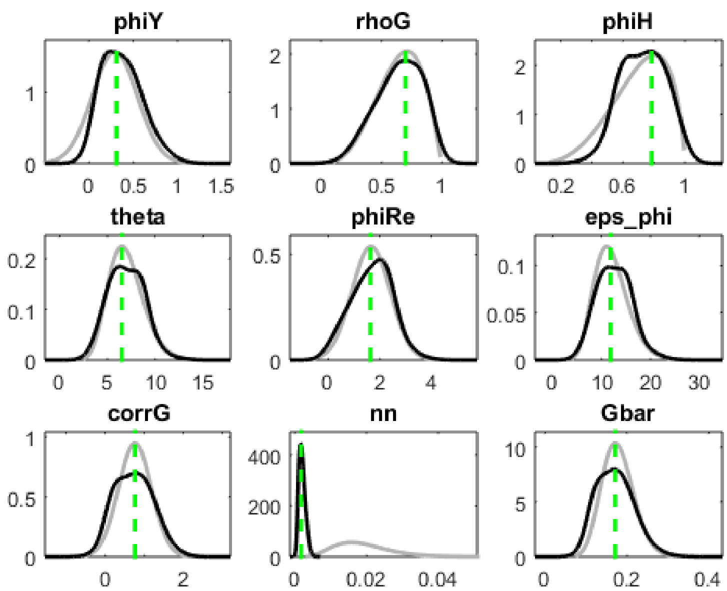

Figure 4.2 — Posterior estimates

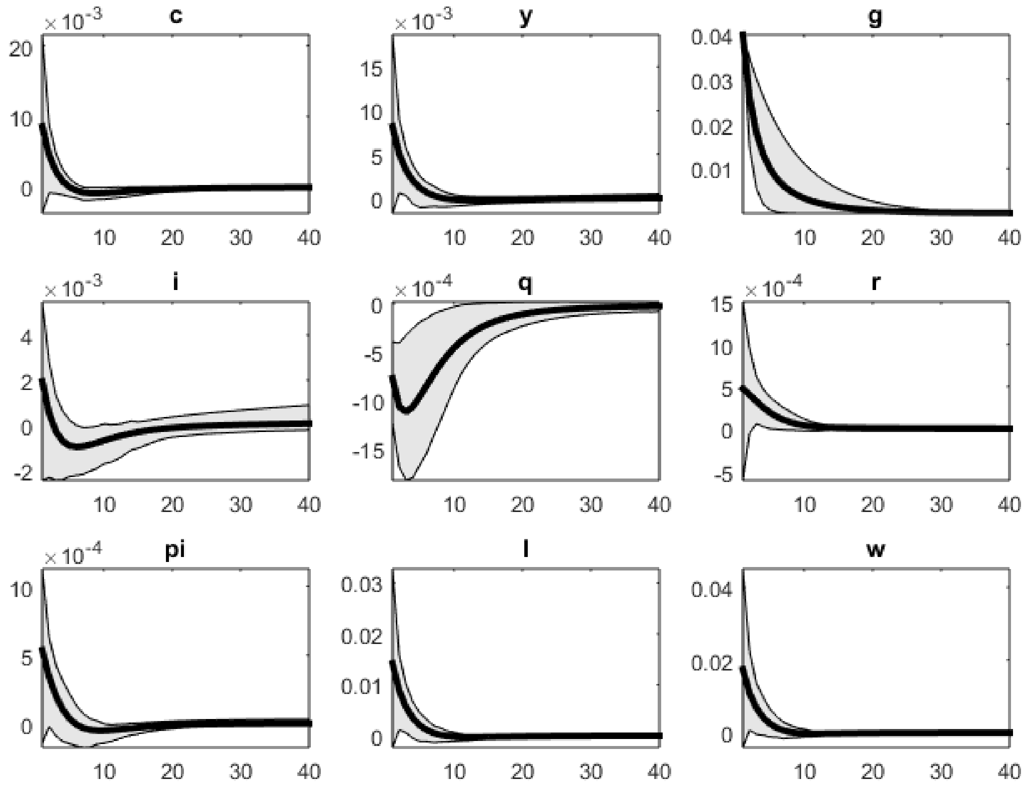

Figure 4.3 — Impulse response functions: basic DSGE specification. c - consumption, y - GDP, g - government expenditures, i - investments, q - real exchange rate, r - interest rate, pi - inflation, l - labor, w - wages.

4.3 Robustness check of the estimation results

To test the results of the model for robustness, three other model specifications were used. Firstly, the model was estimated on data until 2015. The use of the data only until 2015 further reduces a small sample of Russian data but excludes the change in the exchange rate regime (which was done in 2015 in Russia). Secondly, the model was also evaluated on year-on-year data, where the transition from nominal variables to the real ones was made using the GDP deflator. Thirdly, series of Russian and foreign rates were added to the baseline specification, which is why the beginning of the sample was shifted to 2003Q1, since the data on the minimum repo rate of the Bank of Russia is available from this quarter (the key rate after its introduction is equal to minimum repo rate). All these specifications showed the on-impact multipliers less than 1, and the long-run multiplier near zero. Standard errors were calculated according to the same methodology as was used in the baseline specification.

Table 4.1

Estimation of the fiscal multiplier for Russia in different specifications

	baseline specification	before 2015	YoY	with interest rates
on-impact	0.19 (0.13)	0.20 (0.17)	0.50 (0.22)	0.21 (0.17)
long-run	$-8 \cdot 10^4$ $(5 \cdot 10^3)$	$-2 \cdot 10^3$ $(3 \cdot 10^3)$	$7 \cdot 10^3$ $(3 \cdot 10^2)$	$-4 \cdot 10^3$ $(2 \cdot 10^3)$

Source: authors calculations. Standard errors are given in parentheses.

From empirical studies for Russia, the closest values of the on-impact multipliers were obtained in the work of Vlasov and Deriugin (2018). They had the on-impact multiplier equal to 0.25, the annual multiplier was 0.27. In the work of Kamenskikh and Ivanova (2011), estimates of annual multipliers varied from 0.13 to 0.55 depending on the type of government expenditures (housing, defense sector, social sphere, etc.). Several different estimates of long-run multipliers were obtained in Gromov (2015): annual multiplier was 0.14, three-year multiplier was 0.18. Thus, the estimates of the on-impact multiplier in the DSGE model are close to the empirical studies; however, the long-run multipliers in the DSGE model are lower, although the time periods of the long-run multipliers in the empirical works differ. In this regard, the comparison of long-run multipliers is rather limited.

Conclusion

In this paper, I investigated the dependence of the fiscal multiplier on the openness of the economy and its change when the exchange rate regime was changed. The estimation was conducted for emerging markets with the usage of a panel SVAR model (multiplier values were calculated from the impulse response functions of GDP to the shock of government spending) and DSGE model.

In a panel SVAR model factors which influence the fiscal multiplier were taken into account. SVAR included, in addition to GDP and government spending, private consumption, investment in capital, export, import, the CPI index, the central bank key rate, the national currency exchange rate to the SDR basket, and the output gap. Cholesky identification and quarterly data from 2003 to 2016 were used. It was found that the multiplier of government expenditures depends on the openness of the economy. For open economies, the multiplier is less than the multiplier for closed economies. The estimated change of the on-impact government spending multiplier (when switching from managed exchange rate regime to the floating one) was 0.5. It means that when government increases its expenditures by 1 bln, GDP increases by 0.5 bln more when the exchange rate is managed compared to the situation where the exchange rate is floating. The long-run multipliers in almost all specifications were close to 0. In addition, the dependence of the multiplier on the variables found by other researchers was also confirmed. In particular, the stage of the business cycle and the monetary policy were the most important factors that significantly affect the results of the fiscal multipliers' estimation. The change of fiscal multiplier due to the change in the exchange rate regime was estimated only according to the data of Indonesia and Turkey, since the remaining countries either did not change the exchange rate regime in the specified period, or for these countries there were no data on factors that significantly influenced the estimated values of the multipliers. Therefore, to confirm the empirical results, a theoretical DSGE model was constructed.

The DSGE model was built on the basis of the work of Nakamura and Steinsson (2014). Modification of the model included the addition of a nominal exchange rate and uncovered interest rate parity which described its dynamics; foreign rates and Taylor rule for foreign monetary authority; and the addition of the nominal exchange rate to the domestic Taylor rule. The model was calibrated according to the other studies. A total number of 104 studies were selected for the countries used in the empirical sample. The averaging of the parameters' values was done, firstly, within the counties in order not to put more weight on the values for countries for which more papers were collected. Then, obtained mean values of the parameters for each country were averaged over all countries and one DSGE model was simulated with averaged parameter values. The results were also checked for robustness in case of the calibration of DSGE model for each country individually and then averaging multipliers across countries. The results were similar in both cases. It was found that the change of the government spending multiplier when the exchanged rate regime is changed from managed to floating is 0.4 for on-impact multiplier in the first case of averaging. The on-impact multiplier changed by 0.44 in the second case of averaging. The values for long-run multipliers were near 0 for both cases.

According to the results of estimations obtained both in SVAR and in theoretical DSGE models, when the exchange rate regime changes, the on-impact fiscal multiplier decreases by 0.4 - 0.5. The multiplier values both on-impact and long-run, are small (less than 1), long-run multipliers in almost all specifications were close to zero. According to the impulse response functions, the small values of the multipliers were related to the crowding out effect of investments and the decline of net export. Robustness check of the results showed the greatest sensitivity of the results of the DSGE model to the coefficient of the output gap in the domestic Taylor rule.

Moreover, in this paper, the fiscal multiplier for Russia was estimated. Quarterly data was used from 2000 to 2017 for such macroeconomic variables as private consumption, government spending, investment, GDP, CPI, GDP deflator, ruble/dollar and euro exchange rates, US and Eurozone (17 countries) inflations. The on-impact multiplier of government expenditures turned out to be equal to 0.19, and the long-run multiplier was near zero. These values are close to the average values obtained for emerging markets (in SVAR model), with the on-impact multiplier values somewhat below the average multiplier for emerging markets. The multiplier values are close to some empirical estimates of multipliers for Russia (for example, Vlasov, Deryugina, 2018).

In future research papers, the multiplier estimates obtained from the DSGE model can be tested for robustness by adding technological growth to the production function of intermediate firms, as well as adding to the model for Russia the oil sector.

Bibliography

1. Adolfson M., Laséen S., Lindé J., Villani M.. 2005. "Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through."

2. Auerbach A., Gorodnichenko Y. 2012a. "Fiscal Multipliers in Recessions and Expansions."

3. Auerbach A., Gorodnichenko Y. 2012b. "Measuring the Output Responses to Fiscal Policy."

4. Auerbach A., Gorodnichenko Y. 2013. "Output Spillovers From Fiscal Policy."

5. Barro R. 1981. "Output Effects of Government Purchases."

6. Barro R., Redlick C. 2011. "Macroeconomic Effects from Government Purchases and Taxes."

7. Beetsma, Roel, Giuliodori M., Klaassen F. 2008. "The effects of public spending shocks on trade balances and budget deficits in the European Union." Journal of the European Economic Association 6(2-3).

8. Blanchard O., Perotti R. 2002. "An Empirical Characterization Of The Dynamic Effects Of Changes In Government Spending And Taxes On Output."

9. Born B., Jußen F., Muller G. J. 2012. "Exchange rate regimes and fiscal multipliers."

10. Brinca P., Holte H. A., Krusell P., Malafry L. 2014. "Fiscal Multipliers in the 21st Century."

11. Christiano LJ, Eichenbaum M. 2005. "Nominal rigidities and the dynamic effects of a shock to monetary policy."

12. Clarida, Richard, Jordi Gali, and Mark Gertler. 2001. "Optimal Monetary Policy in Open versus Closed Economies: An Integrated Approach." American Economic Review, 91 (2): 248-252.

13. Coenen G., Straub R. 2004. "Non-Ricardian households and fiscal policy in an estimated DSGE model of the euro area."

14. Coenen, Günter; McAdam, Peter; Straub, Roland. 2007. "Tax reform and labour-market performance in the euro area: a simulation-based analysis using the New Area-Wide Model."

15. Coenen, Günter, Erceg C., Freedman C., Furceri D., Kumhof M., Lalonde R., Laxton D., Lindé J., Mourougane A., Muir D., Mursula S., Resende C., Roberts J., Roeger W., Snudden S., Trabandt M., Veld J. 2010. "Effects of fiscal stimulus in structural models."IMF Working Paper.

16. Cohén, Lauren, Covall J., Malloy C. 2010. "Do Powerful Politicians Cause Corporate Downsizing?"

17. G. Corsetti., Kuester K., Müller G. 2011. "Floats, pegs and the transmittion of fiscal policy."

18. Corsetti G., Müller G., Meier A. 2012. "Fiscal Stimulus with Spending Reversals."

19. Fishback V., Kachanovskaya V. 2010. "In search of the multiplier for federal spending in the states during the Great Depression." NBER Working Paper No. 16561

20. Forni L., Monteforte L., Sessa L. 2008. "The general equilibrium effects of fiscal policy: Estimates for the Euro area."

21. Furlanetto F. 2006. "Fiscal Shocks and the Consumption Response when Wages are Sticky."

22. Gali J., Lopez-Salido JD, Valles J. 2007. "Understanding the effects of government spending on consumption."

23. Gechert S., Rannenberg A. 2014. "Are Fiscal Multipliers Regime-Dependent? A Meta Regression Analysis."

24. Gromov Alexander. 2015. "The impact of government expenditures on the economic growth."

25. Ilzetzki E., Mendoza E. G. and Végh C. A. 2013. "How Big (Small?) are Fiscal Multipliers?"

26. Kamenskyh Marina, Ivanova Nadezhda. 2011. "The effectiveness of government expenditures in Russia."

27. Kim S., Roubini N. 2008. "Twin deficit or twin divergence? Fiscal policy, current account, and real exchange rate in the US."

28. Kraay A. 2014. "Government Spending Multipliers in Developing Countries: Evidence from Lending by Official Creditors."

29. Kraay A. 2012. "How Large Is the Government Spending Multiplier? Evidence from World Bank Lending, The World Bank."

30. Leeper E., Walker T., and Yang S. 2010. "Government Investment and Fiscal Stimulus."

31. Linnemann, Schabert. 2000. "Fiscal Policy in the New Neoclassical Synthesis"

32. Lopez-Salido J., Rabanal P. 2008. "Government spending and consumption-hours preferences."

33. Oxana A. Malakhovskaya, Alexey R. Minabutdinov. 2013. "Are commodity price shocks important? A bayesian estimation of a dsge model for Russia."

34. Mountford A., Uhlig H. 2009. "What are the effects of fiscal policy shocks?"

35. Nakamura E., Steinsson J. 2014. "Fiscal Stimulus in a Monetary Union: Evidence from U.S. Regions."

36. Novak A. 2014. "Intertemporal preferences of russian households: the estimation on disaggregated data."

37. Polbin A. 2014. "The construction of a DSGE model for the economy with high dependence on oil export."

38. Polbin A. 2014. "The econometric estimation of the structural macroeconomic model for Russia."

39. Ramey V. 2011. "Identifying Government Spending Shocks: It's all in the Timing."

40. Ramey V., Shapiro M. 1998. "Costly capital reallocation and the effects of government spending." Carnegie-Rochester Conference Series on Public Policy 48 (1998) 145-194 North-Holland.

41. S. Schmitt-Grohé and M. Uribe. 2007. "Optimal simple and implementable monetary and fiscal rules."

42. Roman Semko. 2013. "Optimal Economic Policy and Oil Prices Shocks in Russia."

43. Smets F., Wouters R. 2003. "An estimated dynamic stochastic general equilibrium model of the euro area."

44. Kirill Sosunov, Oleg Zamulin. 2006. "Can Oil Prices Explain the Real Appreciation of the Russian Ruble in 1998-2005?"

45. Vegh D., Vuletin G. 2015. "Procyclical And Countercyclical Fiscal Multipliers: Evidence From Oecd Countries."

46. Vlasov Sergei, Derugina Elena. 2018. "Fiscal multipliers in Russia."

47. Woodford, Michael. 2011. "Simple Analytics of the Government Expenditure Multiplier." American Economic Journal: Macroeconomics, 3 (1): 1-35.

48. The change of the exchange regime:
http://www.norges-bank.no/contentassets/01ae4f02ee2f452e9279505519839011/1nbconf_roger.pdf
https://www.bcb.gov.br/pec/depep/Seminarios/2016_XVIIISemAnualMetasInfBCB/SMETASXVIII-%20Klaus%20Schmidt.pdf
http://www.bankofengland.co.uk/education/Documents/ccbs/handbooks/pdf/ccbshb29.pdf
http://www.imf.org/external/pubs/ft/fandd/basics/target.htm
http://www.imf.org/external/pubs/ft/wp/2015/wp15228.pdf

49. Countries classification:
http://datahelpdesk.worldbank.org/knowledgebase/articles/906519

50. Official pages of central banks:
https://www.cba.am/ru/SitePages/mpstrategy.aspx
https://www.bankofalbania.org/web/Monetary_Policy_Document_7190_2.php?kc=0,2,9,0,0
https://www.bcb.gov.br/en/#!/n/INFLATION

http://www.bcentral.cl/en/faces/pmonetaria/ipom?_afrLoop=710830134150993&_afrWindowMode=0&_afrWindowId=h2cyzuk7z_177#!%40%40%3F_afrWindowId%3Dh2cyzuk7z_177%26_afrLoop%3D710830134150993%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dh2cyzuk7z_209

https://www.cnb.cz/en/monetary_policy/

http://www.banrep.gov.co/en/temas-a/5838

https://www.mnb.hu/en/monetary-policy

http://www.bi.go.id/en/moneter/Contents/Default.aspx

http://eng.bok.or.kr/broadcast.action?menuNaviId=1612

http://www.banxico.org.mx/politica-monetaria-e-inflacion/indexEn.html

http://www.bcrp.gob.pe/eng-docs/Monetary-Policy/Inflation-Report/2017/inflation-report-march-2017-summary.pdf

http://www.bsp.gov.ph/monetary/overview.asp

http://www.nbp.pl/homen.aspx?f=/en/onbp/polityka_pieniezna.html

http://www.bnr.ro/Direct-Inflation-Targeting-3646.aspx

https://www.resbank.co.za/MonetaryPolicy/Pages/MonetaryPolicy-Home.aspx

http://www.tcmb.gov.tr/wps/wcm/connect/TCMB+EN/TCMB+EN/Main+Menu/MONETARY+POLICY

https://www.bog.gov.gh/monetary-policy/our-monetary-policy-framework

https://www.nbs.rs/internet/english/30/index.html

http://www.bancentral.gov.do/english/monetary_policy/program/program2016.pdf

https://www.nbg.gov.ge/index.php?m=533

https://www.rbi.org.in/scripts/FS_Overview.aspx?fn=2752

http://www.bnm.org/en/content/medium-term-monetary-policy-strategy-0

http://cbr.ru/DKP/

https://www.bou.or.ug/bou/monetary_policy/framework.html

https://www.bot.or.th/English/MonetaryPolicy/MonetPolicyKnowledge/Pages/Framework.aspx

http://www.banguat.gob.gt/en/docs/report_monpol_march08.pdf

Appendix 1

Impulse response functions to the government spending shock with confidence bounds

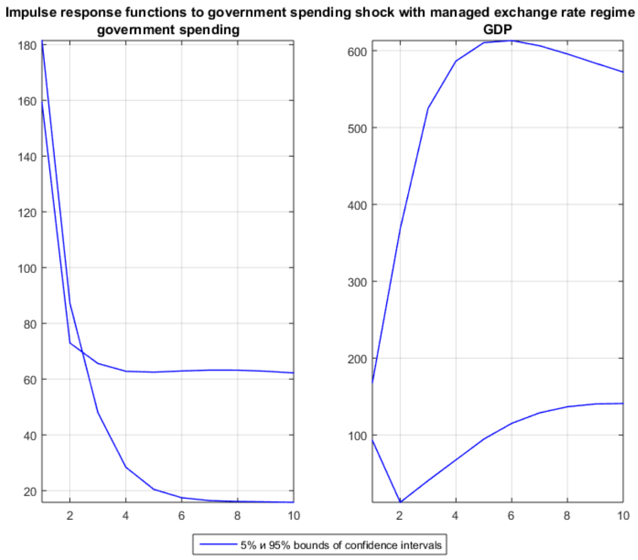

Figure 4.4 — for managed exchange rate regime, blue lines are the bounds of confidence intervals. The asymmetry of impulse response functions is due to the fact they they were obtained numerically with the usage of bootstrap. The reaction of GDP in the first period between 100 and 200 is the reaction of real GDP to the government spending shock around 170 (y-axis of the graphs).

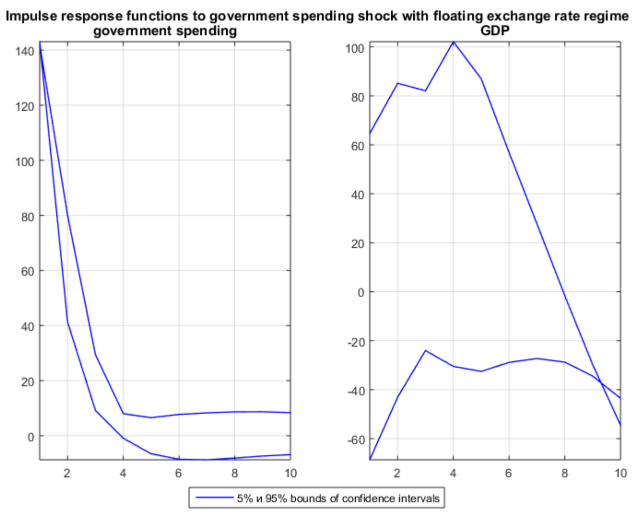

Figure 4.5 — for floating exchange rate regime.

Appendix 2

Impulse response functions to the government spending shock in DSGE

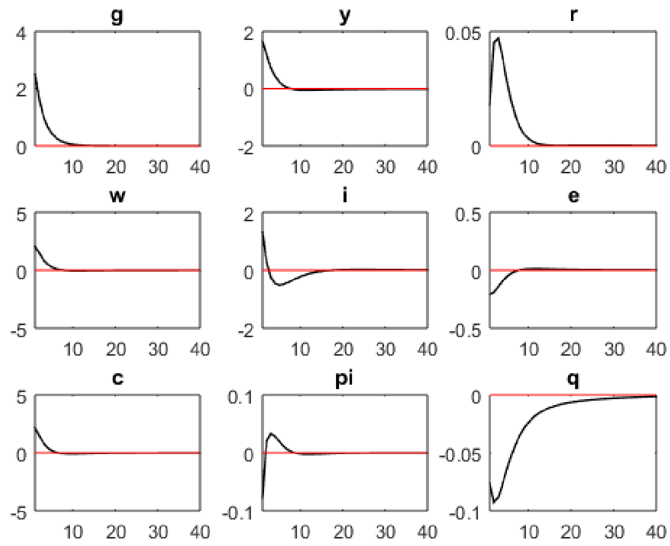

Figure 4.6 — managed exchange rate regime: g - government expenditures, y - GDP, r - central bank rate, w - wages, i - investments, e - nominal exchange rate, c - consumption, pi - inflation, q - real exchange rate

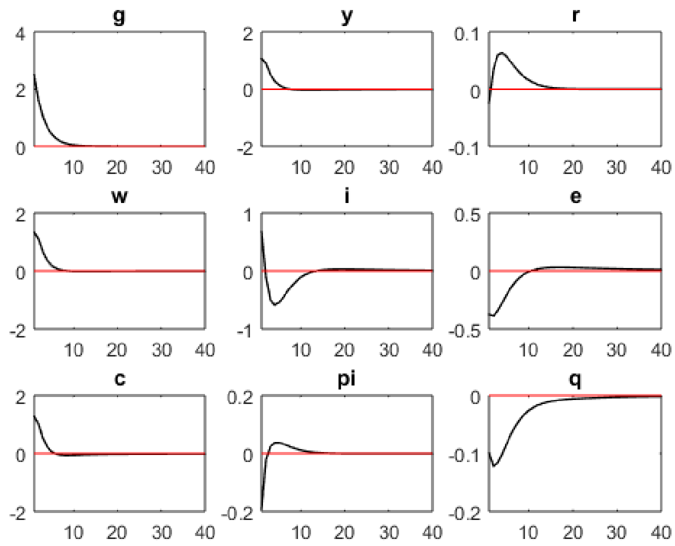

Figure 4.7 — floating exchange rate, the same variables

Appendix 3

Parameters description and their notation

Table 4.2

Обозначение параметров

Parameter	Notation
Frisch-elasticity of labor supply	nu
Intertemporal elasticity of substitution	sigma
Elasticity of substitution between home and foreign goods	eta
Calvo parameter (the probability to retain the prices)	alpha
Subjective discount factor	beta
Rate of depreciation of capital	delta
Curvature of production function (share of labor)	aa
Lagged dependence in Taylor Rule	rhoii
Inflation, output and exchange response in Taylor Rule	phiPi, phiY and phiRe
Persistence of government spending shock	rhoG
Weight of home goods in home consumption basket	phiH
Elasticity of substitution between varieties	theta
Capital adjustment cost parameter	eps_phi
Correlation of home and foreign gov spending shocks	corrG
Size of home region	nn
Steady state government spending-output ratio	Gbar

Appendix 4

Baseline estimation of parameter values

Table 4.3

Estimation of parameter values for Russia: base specification

parameters	prior mean	posterior mean	90% confidence interval		prior distribution	posterior sd
nu	1.228	1.0473	0.4589	1.7382	gamm	0.5768
sigma	1.429	1.3875	0.6041	2.1702	gamm	0.4951
eta	1.061	1.5677	0.8472	2.7732	gamm	0.4339
alpha	0.546	0.5514	0.3490	0.7767	beta	0.1344
beta	0.985	0.9846	0.9705	1.0000	beta	0.0135
delta	0.025	0.0707	0.0315	0.1123	beta	0.0176
aa	0.530	0.5549	0.4645	0.6498	beta	0.0608
rhoii	0.466	0.1706	-0.3494	0.9141	norm	0.5600
phiPi	1.333	1.4804	1.0012	1.9488	norm	0.3868
phiY	0.290	0.3678	0.0614	0.7081	norm	0.2546
rhoG	0.641	0.6430	0.3552	0.8675	beta	0.1800
phiH	0.700	0.7283	0.5662	0.9679	beta	0.1760
theta	7.000	6.9560	3.9865	9.3842	gamm	1.8323
phiRe	1.660	1.6757	0.2591	2.6940	norm	0.7420
eps_phi	12.050	12.5659	7.2732	17.5569	gamm	3.4472
corrG	0.762	0.7276	0.1419	1.4843	norm	0.4211
nn	0.019	0.0020	0.0009	0.0033	beta	0.0076
Gbar	0.178	0.1706	0.1164	0.2378	beta	0.0387

Ekaterina Pyltsyna
National Research University Higher School of Economics (Moscow, Russia). Laboratory for Macroeconomic Analysis, Junior Research Fellow.
E-mail: epylcyna@hse.ru