OPTIMAL ECONOMIC POLICY AND OIL PRICES SHOCKS IN RUSSIA

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ABSTRACT

The goal of the paper is to explain and analyze whether the Central Bank of Russia should include commodity prices into the lists of variables they try to respond. We augmented New Keynesian DSGE small open economy model of Dib (2008) with the oil stabilization fund and new Taylor-type monetary policy rule and estimated the model using Bayesian econometrics. The results show that Central Bank's mild response to the oil price changes may be desired in terms of minimizing fluctuations of inflation and output only in the case when stabilization fund would be absent, while this response is redundant when "excess" oil revenues can be saved in the fund.

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I. INTRODUCTION

Russian economy is located on a natural resources-rich area. This reality significantly influences economic development and policy of the country. In such a situation the economy is vulnerable to the large extent to commodities demand fluctuations on external market, especially, to the price (quotes) behavior.

Commodity prices in the countries, which are significantly dependent on the raw materials-intensive sectors, have implication not only to the GDP and export/import growth but also to the budget deficit and other related issues like social policy and inequality. For example, negative commodity prices shocks during recent financial crises can be considered as the key factors that led to significant welfare losses and poverty increase in Russia, while positive shocks have counter effects during before the crises period (World Bank, 2008; Cerami, 2009).

Commodity pricing modeling is an active area of modern economic research. Significant commodity prices fluctuations is an important factor influencing real economic variables, especially in the countries with large dependency on export/import of natural resources. Russia definitely belongs to this group: crude oil revenues account for approximately one third of total export. Additional significant source of export incomes (more than one tenth) in Russia is generated by natural gas. In term of import, Russia does not have significant shares of commodities in its import bundle.

In such conditions it is natural to consider the possibility of economic policy to fine tune the real economy, achieve inflation stability and to weaken the negative influence of commodity prices shocks. In terms of monetary policy, authorities realize the existence of many channels though which asset (commodity) market is related to the real sectors and inflation. Central Banks should analyze the necessity to react to commodity prices and to change the effect of them on the real economic variables. The identification of economy drivers from the position of commodity market can be very useful for the economy stabilization during the periods of significant up- and downturns.

On the way from fixed to floating exchange rate regimes in Russia still play fiscal policy an important role in comparison to the monetary one and carry it significant burden of macroeconomic adjustment. In terms of fiscal policy regulators can manage such fiscal variables as revenues and expenditure to mitigate the influence of commodity prices shocks. The relations between government policy and natural resources prices pass through different channels, including fiscal spending, savings and other. An important element in this mechanism is the oil reserve fund. At the beginning of 2004 Stabilization fund was established in the Russian Federation. The goal of it was to balance federal budget when the oil prices fall below some cup-off point. In 2008 the fund was split into two parts: a Reserve Fund (invest in low-yield securities and is used when oil prices fall) and National Welfare Fund (invest in riskier assets). In the booming period the Funds absorb the excess liquidity and, as a result, reduce inflationary pressure and overheating of the economy.

Regardless of the existence of many channels through which economic policy can soften negative effects of commodity prices fluctuations, policy management often (in contradiction to the recommendations of the standard theory to be countercyclical) leads to the increasing business cycle expansions and contractions caused by changing prices of natural resources or at least is not effective in mitigating real variables deviations from their long-term values, that is, it is acyclical. The procyclicality of economic policy is especially acute in commodity-rich countries like Russia.

In the light of the importance of commodity markets modeling within coherent macroeconomic models, we investigate the question whether Central Bank of Russian should react to the fluctuations of the oil prices. We use production-intensive DSGE small open economy model with oil producing sector of Dib (2008) and introduce stabilization fund assuming that oil revenues taxed by the export duty may be used as government expenditures or savings in the fund. Central Bank is represented by monetary policy rule, which may include oil price. The model is calibrated and estimated on the Russian data using Bayesian techniques. For the purpose of economic policy optimization we test standard and augmented with oil prices policy rules for their ability to macroeconomic adjustments. The rule that is the most efficient in terms of fluctuations minimization would be treated as the most optimal.

The results shows that Central Bank may consider mild respond to the oil price, however, the economic gain in terms of fluctuations minimization is very small when there is stabilization fund in the country. The effect is more significant if the fund would be absent implying that either Central Bank or stabilization fund should stabilize the economy when oil prices deviate from the steady-state level and there is no significant necessity in using both of them.

The rest of the paper is organized as follow. In the next section a discussion on New Keynesian macroeconomic model augmented with oil prices elements is discussed. Then, methodology and short data analysis are presented. Finally, we report the results. At the end some conclusions are offered.

II. NEW KEYNESIAN DSGE MODEL

There are different ways of incorporating commodities into the model. We selected a standard NK DSGE small open economy model of Dib (2008). This model is a good candidate to describe the Russian economy, which is small and open and heavily depends on oil export.

In general, the DSGE model describes the behavior of households, which consume, save and work, intermediate firms in oil, tradable (also called manufacturing) and non-tradable sectors, which rent capital, labor and use oil to produce intermediate goods and services; final producer, which aggregates intermediate production and import; government; Central Bank; mechanisms of market imperfections, that is, elements of monopolistic competition, wage and price stickiness; shocks and equilibrium relations. We present here only the part of the model which differs from Dib (2008).

At the beginning we transform the model of the Central Bank to take into account the possibility of reaction to the oil prices. At the second stage the model is augmented with reserve fund and in this case the fiscal policy plays a greater role.

III. CENTRAL BANK MODEL MODIFICATION

Central bank monetary policy rule is assumed to have the following form

$$\log\left(\frac{R_t}{R}\right) = \rho o_R \log\left(\frac{R_{t-1}}{R}\right) + \left(1 - \rho o_R\right) * \ldots$$

$$\ldots * \left(\rho o_\pi \log\left(\frac{\pi_t}{\pi}\right) + \rho o_Z \log\left(\frac{Z_t}{Z}\right) + \rho o_{\mu u} \log\left(\frac{\mu u_t}{\mu u}\right) + \rho o_e \log\left(\frac{e_t}{e}\right) + \rho o_{P_X} \log\left(\frac{P_{X,t}^*}{P_X^*}\right)\right) + e_{R,t},$$

(1)

which implies that interest rate is set based on the previous interest rate, R_{t-1}, inflation level, π_t, real output, Z_t, money growth rate, μu_t, nominal exchange rate, e_t, and oil price, $P_{X,t}^*$; $e_{R,t}$ denotes monetary policy shock; R, π, Z, μu, e, P_X^* are steady-states values of the corresponding variables. We have added to the classical Taylor rule the term oil price. Basically the goal of this study is to find optimal value of the parameter $\rho o_{P_X^*}$ such that it minimizes economic fluctuations.

In addition, we assumed (as in Sosunov and Zamulin, 2007) that some share, w^{rs}, of foreign revenues from oil export, $S_t p_{X,t}^* Y_{X,t}^{ex}$, forms additional amount of Central Bank's reserves:

$$Rs_t = w^{rs} S_t p_{X,t}^* Y_{X,t}^{ex}$$

(2)

and this purchase is financed by issuing necessary amount of money, M_t/P_t, such that total money growth rate is:

$$\mu u_t = \frac{M_t/P_t + \sum_{i=1}^{t} Rs_i}{M_{t-1}/P_{t-1} \sum_{i=1}^{t-1} Rs_i}.$$

(3)

Finally, reserves are introduced to international position of the country and its current account balance is given by

$$\frac{b_t^*}{\kappa_t R_t^*} = \frac{b_{t-1}^*}{\pi_t^*} + p_{X,t}^* Y_{X,t}^{ex} + \frac{p_{M,t}}{S_t} Y_{M,t}^{ex} - Y_{F,t} - \frac{Rs_t}{S_t}$$

(4)

where $b_t^* = B_t^* / P_t^*$ is a real foreign borrowing, $Y_{F,t}$ denotes import volume, $p_{M,t}$ is an import price in domestic currency, S_t is a real exchange rate, $Y_{X,t}^{ex}$ is an oil export volume, $p_{X,t}^*$ denotes oil prices in foreign currency, R_t^* is a foreign interest rate, and κ_t is an international risk-premium.

IV. EXTENSION: STABILIZATION FUND

So far oil prices have impact mainly on the oil-producing sector (see Dib, 2008) and to some extent on the Central Bank reserves. However, oil revenues are also using in fiscal policy making. In particular, in Russia there is a special export tax (duty) on oil and petroleum products. Proceeds from this duty till 2004 were included into the central budget as government expenditures. In fact, it brought a lot of instability into government sector and this effect so far was not captured in the model since government expenditures in Dib (2008) were assumed to be a simple AR(1) process. To soften potential vulnerability of the Russian economy to the oil price movements, stabilization fund was formed so that "excess" oil revenues from the oil export were not spent in total but some part may be saved in the fund. To keep government expenditures stable in case of oil revenues decrease, accumulated in the fund resources may be used.

We assume that government expenditures in the current period are related to the previous expenditures. In addition, oil revenues (received share from the export duty[1]), interest rate revenues on funds assets, and change in the fund assets may be used by the government:

$$g_t = \rho_G g_{t-1} + 0.1*\left(s_t + p_{X,t}^* + y_{X,t}^{ex}\right) + (r_t - 1)*swf_{t-1} - \left(swf_t - swf_{t-1}\right) + e_{G,t}, \quad (5)$$

where small letters denote log-deviations from the steady-state of corresponding variables denoted by capital letters, that is, g_t is government expenditures, r_t is domestic interest rate, swf_t is stabilization fund, and $e_{G,t}$ is government expenditures shock. We assume that on average 10% of oil revenues are taxed by the government.

If the oil revenues are used by the government and cannot be accumulated in the fund (the case before 2004), then as in Dagher, Gottschalk and Portillo (2012) we assume that

$$SWF_t = SWF_{t+1} = 0, \quad (6)$$

otherwise, we assume that government expenditures are constant share of GDP (forward looking government rule):

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[1] It should be noted that the revenue of oil companies should be reduced by export duty.

$$\frac{G_t}{Z_t} = \frac{G_{t+1}}{Z_{t+1}} \tag{7}$$

so that excess oil revenues will be accumulated in the stabilization fund.

We define optimal policy as the monetary rule that minimizes fluctuations of inflation and GDP providing the two times larger weight to the former in the quadratic loss functions.

V. METHODOLOGY AND DATA

The model is log-linearized around its steady-state and estimated using the instruments of Bayesian econometrics in Dynare package on quarterly data covering the period from 2003Q1 to 2012Q2.

Key variables, which describe the evolution of the proposed economic system, are real per capita government expenditures, oil, tradable and non-tradable production, quarterly interest rate, inflation, real exchange rate, foreign inflation and GDP. The data is seasonally adjusted by X12-ARIMA filter and trend component is extracted with Hodrick-Prescott filter. Government expenditures are measured in 2008 Russian rubles and are calculated as the final expenditures of public sector. Percentage changes in oil production are approximated by the percentage changes in mineral resources extraction. Tradable sector is represented by agriculture, fishing, forestry, and different manufacturing sectors. Non-tradable production is measured by the sum of outputs in production and transportation of electricity, gas and water (utilities), construction, wholesale and retail trade, hotels and restaurants, transportation and communication, finance, insurance and real estate, public governance, education, health and social services and other services. Each types of economic activity is expressed in 2008 rubles per capita. Interest rate is an average quarterly nominal credit rate. Russian inflation is measured as the change in CPI. Price of oil is the 2008 price index of oil export average prices measured in euros per barrel. World economy is represented by EU-27 countries. This approximation is reasonable since trade turnover between Russia and EU-27 countries constitutes around 40% of total Russian turnover. Correspondingly, real exchange rate is the nominal exchange rate of ruble per euro multiplied by EU-27 CPI and divided by Russian CPI. Foreign inflation is measured as the change in EU-27 nominal deflator and foreign output is the nominal EU-27 GDP divided by the deflator.

The model parameters (see Dib (2008) for model parameters description) are calibrated in the following way. Discount factor β which measure impatience of the households is set at 0.9961. It is calculated as a reciprocal of real interest rate and corresponds to the average (steady-state) quarterly inflation level of 2.4% and nominal credit rate of 2.8%. Choosing standard in the RBC literature value for intertemporal elasticity of substitution 0.5, we can define parameter τ – the inverse of the former – at 2. Similarly the inverse ratio of Frisch labor elasticity, χ, is calibrated at standard value of one and labor elasticity of substitution across sectors, ς, can be defined also as a unity. Capital depreciation rate is typically set in the literature at 0.025 level.

Production functions parameters are calculated based on the input-output tables of Russian economy. To model the production process in oil sector we need to assume that share of natural recourse income, η_X, is 0.2 as in Stuber (1998) and Macklemet. al (2000) since this factor of production is not explicitly shown in the data. Then, based on 0.8 return to scale for capital

and labor, their shares, α_X and γ_X, are 0.37 and 0.43, respectively. Shares of capital, labor and oil inputs in manufacturing and non-tradable sectors are set at 0.45, 0.49 and 0.07 (α_M, γ_M and η_M) and 0.55, 0.44 and 0.01 (α_N, γ_N and η_N), respectively (they were calculated using input-output tables).

We assume that average steady-state markup constitutes 25%, which is in line with the findings for Russian economy (Zabolotskiy, 2005). As a result, parameter measuring degree of monopolistic competition, θ, is equal to 5. Elasticity of substitution for different types of labor is set at 6 implying wage markup of 20%. Elasticity of substitution between manufacturing, non-tradable and imported goods, ν, is 0.67 as estimated by Belomestnova (2002) and New Economic School (2005) and used in Zamulin and Sosunov (2007). It means that these goods are complements. On the other hand, Knobel (2011) on the 2000-2010 data estimated import price elasticity at 0.95 – in comparison to 0.67 closer to the substitution region. In addition, Zamulin and Sosunov (2007) tested their DSGE model of Russian economy using two values: estimated 0.67 and hypothetical 1.5, where the letter captures the case of goods substitution.

Parameter w_{ex} is calibrated at 0.24 based on the average share of non-oil export in GDP for 2000-2011 period. Shares of non-tradable, w_N, imported, w_F, and domestically produced and used manufactured good, w_M, are calculated on the 2002-2011 data as 0.69, 0.27 and 0.04, respectively. Risk premium parameter $\aleph$ is the average for 2000-2010 period ratio of net international investment position of country to GDP and is evaluated at 5.2%. The following variables constitutes the next shares of GDP: 50% has consumption, 22% investment, 18% government expenditures, 34% export, 23% manufacturing export, 10% oil export, 22% import, 60% non-tradable goods, 25% manufacturing and 14% oil extraction.

On average 65.6% of people are employed in non-tradable sector, 33.8% in manufacturing and 0.6% in oil sector and households allocate one third of their time for employment (the latter one is a standard assumption). It is assumed that each quarter 15% of oil export revenues forms additional volume of reserves. Values of natural recourse, technology levels in manufacturing and non-tradable sectors are set to unity at steady-state.

VI. OPTIMAL MONETARY POLICY

The results of estimation show that pricing structure in manufacturing sector is more flexible with Calvo pricing parameter equal to 0.51, while in non-tradable one it is 0.73 implying more rigid adjustment (for imported goods it is 0.65). Wage adjustment parameters are close in oil, manufacturing and non-tradable sectors – around 0.5 – implying average period for salary change half a year. Estimated capital adjustment parameters signals that most quickly capital is changing with new investments in manufacturing sector while the adjustment is more rigid in oil and non-tradable sectors.

Autoregressive parameters for technology evolution in manufacturing and non-tradable sectors are 0.07 and 0.26, respectively, and for natural resource it is 0.81 implying that the shock is relatively persistent. Government expenditures are also relatively stable with the AR parameter 0.94, oil price coefficient is 0.74. Foreign GDP evolves as AR process with coefficient equal to 0.68,

coefficient for foreign inflation is 0.36 and for foreign interest rate it is 0.06. Standard deviations of shocks lie in the [0.03, 0.10] range (see Appendix A for more details).

The analysis of impulse response functions shows that negative monetary policy shock leads immediately to the rise of domestic inflation. While output also rises, the magnitude of its increase is significantly lower. Similarly, consumption rises a little bit and converges to the steady-state. By sectors, production in manufacturing industry starts rising and after achieving the pick of growth in 4-6 quarters starts gradually declining. Production in non-tradable and oil sectors also rises but are very close to the steady-state level. Similarly to the production behaves investments in these sectors. Real exchange rate depreciates which correspondingly lead to the increase of reserves.

Positive oil price shock mildly influences the economic system. First of all, production significantly rises in the oil sector itself, while in manufacturing and non-tradable sector it decreases temporally. The cumulative effect on GDP is relatively small. The shock leads to the currency appreciation that finally neglects the effect of rising euros revenues from oil production implying small reduction in reserves formation (oil export decreases, this strange result may be caused by absence of oil price domestic and foreign differential combined with exchange rate appreciation). Employment, compensation level, capital stock (also investments) and price of capital (Tobin's q) in oil production sector rise and gradually converge to their long-term values.

Finally, we consider reserve formation positive shock. This shock has a very small influence on almost all economic variables. As a result, positive increase of reserves immediately disappears in the next quarter. Nevertheless, it should be noted that real exchange rate appreciates and foreign debt slightly rises. Reserve increase is financed by new money issuing, while the demand for real money balances from the households' side decreases.

In Table 1 we present the results monetary policy rule estimation and optimization. It suggests that Central Bank of Russian Federation sets up refinancing rate unsmoothly reacting more to the current and expected future event and poorly relying on the past interest rate trajectory (ρo_r is relatively small).

Response to inflation is accommodative, not too aggressive. The reaction to the changes in output is even smaller since output stabilization is not the primary goal. The most strongly CBR responds to the changes in nominal exchange rate since ruble stability is one of the most important goals of the monetary regulator. It appears that CBR also mildly react to the oil prices: the rise of oil price by 1% will trigger refinancing rate to rise on average by 0.12%. It means that CBR conducts countercyclical monetary policy and take into account oil price quotes.

Then we run three key optimization exercises: (i) keeping all parameters except ρo_{p_X} as estimated and optimizing with respect to the reaction to oil price, (ii) optimizing all parameters except ρo_r keeping it at the estimated value, and (iii) optimizing against all monetary policy rule parameters.

Suggested reaction in the first case is significantly lower that estimated and constitutes only 0.03% of 1% oil price increase. On the other hand, the last two cases suggest that response to oil price shock should be slightly lower that the estimated level at the 0.1 level.

The model suggests also CBR to ignore completely past values of refinancing rate. The estimated response to inflation is close to the optimal. It is suggested to increase the response to the nominal exchange rate from 1.66 to the aggressive level 2.26.

If we compare optimal rule without response to oil price (case 0) with such a response (case 3), suggested parameters of reaction are almost the same for all variables that can be compared.

TABLE 1: OPTIMAL REACTION UNDER DIFFERENT POLICY RULES

Monetary policy rule	ρo_r	ρo_π	ρo_z	ρo_e	ρo_{p_X}
Estimated	0.07	1.06	0.47	1.66	0.12
Optimization 0	0.00	1.12	-0.06	2.27	-
Optimization 1	-	-	-	-	0.03
Optimization 2	-	1.14	-0.04	2.25	0.10
Optimization 3	0.00	1.12	-0.06	2.26	0.10

Source: Author research

Received results are intuitive, except suggested reaction to the output. To research this issue we test the same rule augmented with the response to the output change. Estimated results are close to the previous one. Optimal rules are also close to those without output change (Table 2). Optimal reaction to the output level is suggested to be almost zero while CBR should respond to the change in output: each 1% change in the output change should be followed by corresponding 0.3% change in the refinancing rate.

TABLE 2: OPTIMAL REACTION UNDER POLICY RULES WITH OUTPUT CHANGE VARIABLE

Monetary policy rule	ρo_r	ρo_π	ρo_z	ρo_e	ρo_{p_X}	ρo_{dz}
Estimated	0.07	1.07	0.46	1.64	0.12	0.42
Optimization 1	-	-	-	-	0.02	-
Optimization 2	-	1.14	-0.04	2.25	0.10	0.3
Optimization 3	0.01	1.13	-0.05	2.25	0.10	0.3

Source: Author research

Robustness tests were ran for three alternative types of models: model with flexible wages but sticky prices, model with sticky wages but flexible prices and model with flexible wages and prices. Results suggest that optimal response to the oil price shock is close to zero as in the first optimization cases.

In addition, we consider the influence of different monetary policy regimes on the optimization results. Since 1999 Central Bank of Russia has introduced managed floating regime continuously decreasing interventions on the exchange market. This regime with some modifications exists till the current moment. The most significant reform was conducted in 2005, when monetary regulator made a step to floating exchange rate, having officially introduced the band for the ruble. Central Bank sell or buy foreign currency only when the exchange rate is at the interval border. It should imply that the coefficient at exchange rate in the monetary policy rule should decrease with the passage of time (fixed regime would imply infinite coefficient and floating zero value). For this reason, the model is reestimated on the 2005-2012 data set. However, Central Bank reaction to the exchange rate did not change significantly (coefficient

changed by less than 3%). The recommendation for the optimal rule also changed not too much: suggested response to the oil price is negligible and to the exchange rate it decreased a little bit.

There is a necessity to consider the potential influence of Dutch Disease on received results. Since 2007 oil price started rising very rapidly. We also reestimated and analyzed optimal monetary policy for the 2003-2006 period to eliminate the case of potential Dutch Disease. Estimated reaction to the exchange rate is higher now and constitutes 1.92. Other parameters do not changed significantly. In contrast to the previous cases, response to the exchange rate appears to be close to the optimal without necessity to raise it above 2.25 level.

Taking into account the presence of rigidities in the economic system, we may suggest to respond mildly ($\rho o_{p_X} \approx 0.1$) to the oil price movements. Such positive response may mean that increasing oil prices leads to general economy increase overheating the economy and correspondingly lower refinancing rate will stabilize it at acceptable inflation level, keep under the control exchange rate movements and other variables on lesser importance. However, the improvement in the value of the loss function when the Central Bank starts reacting to the oil prices (from 0.0 to 0.1) is not significant (less than 1%) implying that monetary policy should not react to oil prices and this reaction cannot generate economically significant results.

With introduction of oil revenues into government expenditures in both cases of stabilization fund presence and absence economic fluctuations significantly rise. Recommended response to oil quotes without stabilization fund (equation (6) is active) is slightly higher than recommended response when the fund is active (equation (7) is used instead of (6)). It means that the necessity in monetary policy rule reaction to the oil prices is higher when there are no stabilization fund, however, it is still of the 0.1 magnitude. It should be noted that in both cases Central Bank might form part of its reserves from the oil revenues as well.

Mitigating effect of the fund on the Russian economy was also found by Merlevede et al. (2007). They simply introduced fund presence dummies, which captures the drop of oil price elasticity of government expenditures. Monetary policy was modeled in a standard way and its influence on the oil revenue management is secondary.

Konorav (2011) model also showed that introduction of stabilization fund into the model did not change significantly ranking of alternative monetary policy rules/ regimes with respect to inflation and exchange rate (oil prices were not considered). Welfare improvement was proportional across all rules.

The recommendation to the monetary authority not to react to the oil prices (at least when the fund is present) is also in line with the dominating general recommendation to oil-importing countries (see, for example, Bernanke, Gertler& Watson, 1997 and 2004).

VII. CONCLUSIONS

To conclude, despite of the wide literature on constructing and estimating DSGE models, there are no models for Russian economy which took into account the influence of exporting oil prices on the macroeconomic variables and answer the question on optimal monetary policy reaction on prices fluctuations. This paper should fill this gap, which ultimately can positively influence the effectiveness of policy management in Russia and other countries with similar economic structures. It should be also noted that these results are obtained within the model where reserve forming mechanism is introduced. It means that fluctuations of macroeconomic variables may be

smoothed both with the help of stabilization fund and Central Bank policy in the form of Taylor-rule.

Suggested optimal monetary policy implies positive mild direct response to the oil price shocks: 1% of oil price increase should trigger CBR to raise refinancing rate by 0.1% but only in the case of stabilization fund absence; otherwise, the gain of response is not significant. It highlights the importance of policy coordination with respect to the commodity shocks softening. Similar suggestion was made by Dagher, Gottschalk and Portillo (2012). Fiscal smoothing (stabilization fund) can help to stabilize the economy and improve welfare; however, pure Central Bank reserves accumulation without fiscal backing cannot guarantee macroeconomic stability. Our paper also shows that this stability can be improved if monetary policy reacts to oil prices (when fiscal fund is absent).

Collier et al. (2009) argue that there are more effective than stabilization fund instruments absorbing "excess" oil revenue. They propose to invest money to deepen capitalization of the economy through public spending. To mitigate potential crowding out and Dutch Disease, public spending should be designed in such a way that they will increase the competitiveness of private investments. On the other hand, monetary policy is not considered for consumption smoothing.

This and other alternative views on the reaction to the oil windfalls may form a good ground for future research.

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APPENDICES

Appendix A. Priors and posteriors

TABLE A1: SPECIFIED PRIOR DISTRIBUTIONS AND ESTIMATED POSTERIOR MODES

Parameter	Description	Domain	Prior			Posterior mode
			Density	Mean	St.d.	
ϕ_M	Calvo pricing parameter in manufacturing sector	$[0,1]$	Beta	0.5	0.05	0.51
ϕ_N	Calvo pricing parameter in non-trading sector	$[0,1]$	Beta	0.5	0.05	0.73
ϕ_F	Calvo pricing parameter for importing goods	$[0,1]$	Beta	0.5	0.05	0.65
φ_M	Calvo wage parameter in manufacturing sector	$[0,1]$	Beta	0.5	0.05	0.50
φ_N	Calvo wage parameter in non-trading sector	$[0,1]$	Beta	0.5	0.05	0.53
φ_X	Calvo wage parameter for oil	$[0,1]$	Beta	0.5	0.05	0.45
ψ_X	Capital adjustment parameters in oil sector	R	Normal	11.0	4.0	9.44
ψ_M	Capital adjustment parameters in manufacturing sector	R	Normal	2.0	0.5	2.11
ψ_N	Capital adjustment parameters in non-trading sector	R	Normal	7.0	1.0	7.69
ρo_R	Interest rate smoothing parameter of monetary policy	R	Normal	0.1	0.05	0.07
ρo_π	Monetary policy reaction parameter on inflation	R	Normal	1.5	0.5	1.06
ρo_Z	Monetary policy reaction parameter on final good	R	Normal	0.5	0.2	0.47

(continued)

$\rho o_{\mu u}$	Monetary policy reaction parameter on money growth	R	Normal	0.5	0.2	1.01
ρo_e	Monetary policy reaction parameter on exchange rate	R	Normal	2.0	0.2	1.66
ρo_{P_X}	Monetary policy reaction parameter on oil price	R	Normal	0.1	0.05	0.12
σ_R	St.d. of monetary policy shock	R^+	Inverse Gamma	0.2	∞	0.09
ρ_{AM}	AR parameter for technology evolution in manufacturing sector	R	Normal	0.5	0.25	0.07
σ_{AM}	St.d. of technology shock in manufacturing sector	R^+	Inverse Gamma	0.2	∞	0.07
ρ_{AN}	AR parameter for technology evolution in non-trading sector	R	Normal	0.5	0.25	0.26
σ_{AN}	St.d. of technology shock in non-trading sector	R^+	Inverse Gamma	0.2	∞	0.04
ρ_{P_X}	AR parameter for price of oil evolution	R	Normal	0.5	0.25	0.74
σ_{P^X}	St.d. of price of oil shock	R^+	Inverse Gamma	0.2	∞	0.04
ρ_L	AR parameter for natural recourse evolution	R	Normal	0.5	0.25	0.81
σ_L	St.d. of natural recourse shock	R^+	Inverse Gamma	0.2	∞	0.10
ρ_G	AR parameter for government expenditures evolution	R	Normal	0.5	0.25	0.94
σ_G	St.d. of government expenditures shock	R^+	Inverse Gamma	0.2	∞	0.10
ρ_{R^*}	AR parameter for foreign interest rate evolution	R	Normal	0.5	0.25	0.06
σ_{R^*}	St.d. of foreign interest rate shock	R^+	Inverse Gamma	0.2	∞	0.04
ρ_{π^*}	AR parameter for foreign inflation evolution	R	Normal	0.5	0.25	0.36
σ_{π^*}	St.d. of foreign inflation shock	R^+	Inverse Gamma	0.2	∞	0.03
ρ_{Y^*}	AR parameter for foreign GDP evolution	R	Normal	0.5	0.25	0.68
σ_{Y^*}	St.d. of foreign GDP shock	R^+	Inverse Gamma	0.2	∞	0.03
σ_{Rs}	St.d. of reserves shock	R^+	Inverse Gamma	0.2	∞	0.09

Source: Author research

Note: for Inverse Gamma distribution mode and degrees of freedom are presented

OPTIMALNA EKONOMSKA POLITIKA I NAFTNI ŠOKOVI U RUSIJI

SAŽETAK

Cilj ovog rada je objasniti i analizirati treba li Centralna banka Rusije uključiti cijene robe na liste varijabli na koje pokušavaju odgovoriti. Proširili smo Dibov Novi Keynesianski DSGE model male otvorene ekonomije (2008) s fondom naftne stabilizacije i novo pravilo monetarne politike Taylorovog tipa te smo procijenili model koristeći Bayesovu ekonometriju. Rezultati pokazuju da je blagi odgovor Centralne banke na promjene cijena nafte možda i poželjan u smislu minimiziranja fluktuacije inflacije i outputa samo u slučaju u kojem ne bi postojao fond za stabilizaciju, dok je takav odgovor suvišan kad se „višak" zarade od nafte može uštedjeti u navedenom fondu..

Ključne riječi: optimalna monetarna politika, cijena nafte, stabilizacija, stabilizacijski fond