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Abstract

Russian monetary policy has been challenged by large and continuous private capital outflows and a sharp drop in oil prices during 2014, with both ongoings having put a significant depreciation pressure on the ruble and having led the central bank to eventually give up its exchange rate management strategy. Against this background, this paper estimates a small open economy model for Russia, featuring an oil price sector and extended by a specification of the foreign exchange market to correctly account for systematic central bank interventions. We find that shocks to the oil price and private capital flows substantially affect domestic variables such as inflation, output and the exchange rate. Simulations of the model for the estimated actual strategy and five alternative regimes suggest that the vulnerability of the Russian economy to external shocks can substantially be lowered by adopting some form of an inflation targeting strategy. Foreign exchange intervention-based policy strategies to target the nominal exchange rate or the ruble price of oil, on the other hand, prove inferior to the policy in place.

Keywords: monetary policy, exchange rate interventions, oil price, capital flows

JEL Classification: E52, F31, F41, G15

1 Introduction

After Russian GDP growth already slowed down in 2013, increased political uncertainty and sanctions have amplified capital outflows and the economic downturn in 2014. In addition, the sharp fall in oil prices in the second half of the year reduced capital inflows and output growth even further. In order to prevent a sharp depreciation of the ruble and an increase in domestic inflation as a result thereof, the central bank raised its key policy rate in six steps by 1150 basis points during 2014. In addition, it directly intervened in the foreign exchange market by selling parts of its currency reserves until it officially allowed the ruble to freely float. Whereas a strong devaluation could not have been prevented and the exchange rate management has been eventually given up, raised interest rates might have posed an additional obstacle for the already weak economy. Against this background, this work aims at analyzing and assessing the monetary policy of the Russian central bank in the presence of simultaneously occurring shocks to the oil price and capital outflows. To correctly account for specific features of the Russian economy, the oil sector as well as a mirco-founded foreign exchange market are introduced into an small open economy DSGE model estimated for Russia. Simulations are conducted for different alternative policy strategies that are subsequently assessed on the basis of the effects they have on particular variables of interest.

This study adds to the literature on the optimal reaction of monetary policy in the presence of commodity price shocks, in particular for the Russian economy, and the implementation of foreign exchange interventions into dynamic stochastic general equilibrium (DSGE) models. Bernanke, Gertler, and Watson (1997) and Gertler, Galí, and Clarida (1999) argue that an insufficient monetary policy reaction to oil price shocks amplifies the negative influences of the shock. Their conclusion stems from the empirical evidence of the 1970s when the Federal Reserve raised interest rates to little to curb the impact of the oil price shocks on inflation and inflation expectations. On the other hand, the policy tightening was too strong that it led to adverse implications for the real economy. While these conclusions can be applied to other oil-importing economies, implications on the effects of commodity price shocks and optimal monetary policy would differ for exporting countries such as Russia. In an estimated DSGE model for Canada, Dib (2008) finds that commodity price shocks significantly contribute to real business cycle dynamics. In that context, flexible exchange rates can offset some of the negative effects from external shocks. Sosunov and Zamulin (2007) and Semko (2013) employ DSGE models calibrated as well as estimated for the Russian economy to conclude that a monetary policy reaction to oil price shocks is redundant if oil revenues can be saved in some stabilization fund. Sosunov and Zamulin (2007) find consumer price inflation (CPI) targeting to be the optimal monetary policy in the case of Russia. Herz, Hohberger, and Vogel (2015) calibrate the model by Ratto, Roeger, and Veld (2009) to the Russian economy to conclude that

CPI targeting is superior to the alternative of targeting the ruble price of oil, a strategy following the idea proposed by Frankel (2005) to target the price of the most important export commodity expressed in local currency.

The most recent and detailed work on the Russian economy within a DSGE framework is the one by Malakhovskaya and Minabutdinov (2014). They find evidence for commodity export shocks affecting domestic production in the short-run as well as the long-term. However, although the authors account for many important features of the Russian economy, they assume a completely floating exchange rate and by that ignore the implications that exchange rate management might has on the transmission of shocks. To address this deficiency, the framework of this study is designed to explicitly account for the exchange rate policy of the Bank of Russia (CBR) that has been described as a strategy to smooth the behavior of the ruble's exchange rate against the US dollar and later a dual-currency basket consisting of the dollar and the euro.

Whereas the inclusion of the nominal exchange rate in the policy rate reaction function is a common feature of small open economy (SOE) models, little work has been done so far to take into account direct central bank interventions on the foreign exchange market that are characteristic for most of the economies targeting the dynamics of their nominal exchange rate. Benes, Berg, Portillo, and Vavra (2015) built on a financial sector following Edwards and Vegh (1997) and construct a model in which sterilized central bank interventions stabilize the exchange rate but also change the portfolio composition of domestic commercial banks that entail further macroeconomic consequences via changes in the domestic credit rates. Herrera, González, and Rodríguez (2013) extend their framework by considering an oil-exporting sector and calibrate the model parameters to the Colombian economy to argue that foreign exchange intervention increases the volatility of credit supply and consumption compared to the alternative policy strategy of inflation targeting via an interest rate rule. Another approach to account for foreign exchange interventions has been proposed by Montoro and Ortiz (2016) who built on Bacchetta and Van Wincoop (2006) to incorporate market microstructure of exchange rate determination into a SOE model. In particular, they assume that the foreign exchange market is operated by risk-averse dealers that process sale and purchase orders for foreign securities in exchange for domestic bonds from foreign investors and the domestic central bank. Interventions of the latter will cause the ratio of domestic to foreign assets held by the dealers and their demanded risk premium to change causing immediate movements in the nominal exchange rate. Based on their calibrated model, they argue that intervention can shelter the domestic economy from external shocks, in particular if they are rule-based. Malovana (2015) conducts a similar analysis for the Czech Republic. However, she excludes rule-based interventions from the estimated model specifications and analyzes their implication for the transmission of shocks in calibrated simulations only.

We build on the idea proposed by Montoro and Ortiz (2016) and further expand their model by an oil-exporting sector as well as productive capital. The resulting framework exhibits all necessary features of the Russian economy in general and the monetary policy in particular and enables the analysis of the effects that shocks to the oil price and capital flows, two key external disturbances, have on domestic variables in the presence of different monetary policy strategies.

The remainder of the paper is structured as follows: Section 2 presents the derivation of the model equations. Details on the estimation are outlined in Section 3.2. Estimation results and an analysis of the vulnerability of the domestic economy based on the estimated parameters and shocks are presented in Section 4, whereas Section 5 analyzes alternative policy strategies to cope with external shocks based on the estimated model parameters and the policy strategy in place. Section 6 concludes.

2 Model

The model used for estimation and simulation in the following sections is built on the standard small open economy (SOE) model in the spirit of Galí and Monacelli (2005), Monacelli (2005) and Justiniano and Preston (2010), featuring several kinds of rigidities like Calvo (1983)-pricing, partial indexation, habit formation and deviations from the law of one price for internationally-traded goods. However, it is extended in several ways to exhibit important characteristics of the Russian economy. In particular, we include an oil sector whose export revenues generate income for domestic households. For an appropriate representation of the monetary policy, we follow Montoro and Ortiz (2016) in incorporating a foreign exchange market on which the central bank can influence its currency's exchange rate via sales and purchases of foreign securities. Finally, contrary to standard SOE models that abstract from investment, we allow for the formation of productive capital to gauge the effects that monetary policy has on its dynamics via the interest rate channel. The remainder of this section derives the model equations from the optimal behavior of the different agents and sectors in the economy and the consequential equilibrium conditions for particular markets and dynamics of individual variables. The full set of log-linearized model equations used for estimation and simulations can be found in Appendix A.

2.1 Households

The domestic economy is populated by a continuum of symmetric households. Households obtain utility from the consumption of goods and disutility from hours worked. The expected present value of lifetime utility for a representative household is given by:

$$E_0\left[\sum_{t=0}^{\infty}\beta^t\varepsilon_t^b U\left(\frac{(C_t-H_t)^{1-\sigma}}{1-\sigma}-\frac{\varepsilon_t^l L_t^{1+\phi}}{1+\phi}\right)\right] \tag{1}$$

where C_t is total consumption, $H_t = hC_{t-1}, 0 \leq h \leq 1$ is external habit formation and L_t is labor effort. The parameters σ and ϕ capture the intertemporal elasticity of substitution and the inverse Frisch labor supply elasticity, respectively. ε^b is a shock to the discount factor β whereas ε^l represents a labor supply shock. Households earn the nominal wage W_t on their supplied labor services, receive interest income from holding domestic bonds B_t, and rental income from the supply of capital goods K_t to domestic intermediate goods producers. In addition, households receive profits Π_t from firms, commodity exports, and foreign exchange dealers. Income is spent on consumption and investment goods at the price level P_t. The household's budget constraint is thus given by:

$$\begin{aligned}&P_t\left(C_t+I_t\right)+B_t+\tfrac{\psi}{2}\left(B_t-\bar{B}\right)^2+\Psi\left(u_t\right)K_{t-1}=\\&\left(1+\tilde{r}_{t-1}\right)B_{t-1}+W_tL_t+\tilde{r}_{k,t}u_tK_{t-1}+\Pi_t,\end{aligned} \tag{2}$$

where $\frac{\psi}{2}\left(B_t-\bar{B}\right)^2$ describe portfolio adjustment costs in the sense of Schmitt-Grohe and Uribe (2003), while u_t denotes the utilization rate of installed capital and $\Psi(\cdot)$ the costs associated with its adjustment. Following the specification in Christiano, Eichenbaum, and Evans (2005), they are zero in steady state. In each period, households maximize the present value of their expected lifetime utility by choosing the optimal levels of consumption, investment, hours worked, capital rented, its utilization rate, and domestic bond holdings subject to their budget constraint and the capital accumulation function which is given by:

$$K_t=(1-\delta)K_{t-1}+F_t\left(I_t,I_{t-1}\right), \tag{3}$$

where $0 \leq \delta \leq 1$ is the depreciation rate and $F_t(I_t, I_{t-1}) = \left[1-S\left(\frac{\varepsilon_t^i I_t}{I_{t-1}}\right)\right]I_t$ is the cost of investment adjustments with ε_t^i being an investment specific disturbance evolving according to an AR(1) process, with an i.i.d. error term η_t^i with zero mean and variance $\sigma^2_{\eta^i}$. Following Christiano et al. (2005), the function $S(\cdot)$ and its first derivative equal zero in steady state, while $S''(\cdot) = \varkappa > 0$.

The resulting first order conditions are as follows:

$$\begin{aligned}
\varepsilon_t^b \left(C_t - H_t\right)^{-\sigma} &= \lambda_t & (4)\\
\varepsilon_t^l L_t^{\varphi} \varepsilon_{b,t} &= \lambda_t w_t & (5)\\
\beta \frac{\lambda_{t+1}}{\lambda_t} \left(\tilde{r}_{k,t+1} + T_{t+1}\left(1-\delta\right)\right) &= T_t & (6)\\
\lambda_t T_t F_t^{'} \left(I_t, I_{t-1}\right) + \lambda_{t+1} T_{t+1} F_{t+1}^{'} \left(I_{t+1}, I_t\right) &= \lambda_t & (7)\\
\beta \lambda_{t+1} \frac{1+\tilde{r}_t}{1+\Psi\left(B_t - \bar{B}\right)} \frac{1}{\pi_{t+1}} &= \lambda_t & (8)\\
\tilde{r}_{k,t} &= \Psi'\left(u_t\right), & (9)\\
& & (10)
\end{aligned}$$

where T_t is the shadow price of capital.

Consumption and savings Combining the first order conditions with respect to consumption and bond holdings, results in the following optimal intertemporal consumption-savings decision:

$$\frac{\varepsilon_t^b \left(C_t - H_t\right)^{-\sigma}}{\varepsilon_{t+1}^b \left(C_{t+1} - H_{t+1}\right)^{-\sigma}} = \beta \frac{1+\tilde{r}_t}{1+\Psi\left(B_t - \bar{B}\right)} \frac{1}{\pi_{t+1}}. \tag{11}$$

Total consumption is a composite index defined by:

$$C_t = \left[\left(1-\alpha\right)^{\frac{1}{\eta}} \left(C_{H,t}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(C_{F,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{12}$$

where $C_{H,t}$ and $C_{F,t}$ denote indexes of tradeable consumption goods produced domestically and abroad given by:

$$C_{H,t} = \left(\int_0^1 C_{H,t}^{\frac{\epsilon-1}{\epsilon}} \left(i\right) \mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}} \text{ and } C_{F,t} = \left(\int_0^1 C_{F,t}^{\frac{\epsilon-1}{\epsilon}} \left(i\right) \mathrm{d}i\right)^{\frac{\epsilon}{\epsilon-1}}, \tag{13}$$

where α is the share of foreign goods in the domestic consumption basket, $\eta > 0$ is the elasticity of substitution between domestic and foreign goods, and $\epsilon > 1$ is the elasticity of substitution between varieties of goods indexed by $i \in [0, 1]$.

The optimal allocation of consumption expenditures within each category of goods is given by:

$$C_{H,t}\left(i\right) = \left(\frac{P_{H,t}\left(i\right)}{P_{H,t}}\right)^{-\theta} C_{H,t} \text{ and } C_{F,t}\left(i\right) = \left(\frac{P_{F,t}\left(i\right)}{P_{F,t}}\right)^{-\theta} C_{F,t}, \tag{14}$$

with $P_{H,t}$ and $P_{F,t}$ being the price indexes for the domestic and foreign consumption bundles. Finally, consumption across domestic and foreign goods (imports) is optimally allocated according to:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \text{ and } C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t, \tag{15}$$

with P_t being the total consumer price index:

$$P_t = \left[(1-\alpha)\left(P_{H,t}\right)^{1-\eta} + \alpha\left(P_{F,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{16}$$

Investment and capital accumulation Households own the total capital stock of the economy that they rent out to domestic producers at the rental rate $\tilde{r}_{k,t}$. They can alter the effective capital stock used for production either by investment in new capital I_t or by adjusting its rate of utilization u_t. From the first order condition with respect to the capital stock the following expression for the shadow price of capital is obtained:

$$T_t = E_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}\left(T_{t+1}\left(1-\delta\right)\right) + \tilde{r}_{k,t+1}u_{t+1} - \Psi\left(u_{t+1}\right)\right]. \tag{17}$$

Thus, the shadow price of capital depends positively on its expected value and expected real returns, adjusted for depreciation and the degree of utilization, and negatively on the expected real return on bonds.

New capital is invested according to:

$$\begin{aligned} &T_t S'\left(\frac{\varepsilon_t^i I_t}{I_{t-1}}\right)\frac{\varepsilon_t^i I_t}{I_{t-1}} - \beta E_t T_{t+1}\frac{\lambda_{t+1}}{\lambda_t} S'\left(\frac{\varepsilon_{t+1}^i I_{t+1}}{I_t}\right)\left(\frac{\varepsilon_{t+1}^i I_{t+1}}{I_t}\right)\frac{\varepsilon_{t+1}^i I_{t+1}}{I_t} + 1 \\ &= T_t\left(1 - S\left(\frac{\varepsilon_{t+1}^i I_{t+1}}{I_t}\right)\right). \end{aligned} \tag{18}$$

Analogously to private consumption, total investment expenditures are an aggregate of domestic and foreign investment goods:

$$I_t = \left[(1-\alpha)^{\frac{1}{\eta}}\left(I_{H,t}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}\left(I_{F,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{19}$$

so that total investment spending is optimally allocated to domestic and foreign goods according to:

$$I_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} I_t \text{ and } I_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} I_t. \tag{20}$$

For simplicity, we assume that the share of foreign goods, the elasticities of substitution between different types as well as different origins of goods are the same for consumption and investment. Furthermore, final goods can be used for both purposes, so that all relevant price indexes relate to both spending aggregates.

Wage setting and labor supply Following Erceg, Henderson, and Levin (2000), we assume that each monopolistically competitive household $h \in [0,1]$ supplies a differentiated labor service $L_t(h)$ to the production sector. Each period only a random fraction $1-\theta^w$ of households can adjust its wage. A household that is able to adjust will set a new optimal nominal wage, $\tilde{W}_t(h)$, taking into account the expected time until the next possible adjustment. Households that are not able to optimally reset their wage adjust their current wage to past inflation:

$$W_t(h) = \left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma^w} W_{t-1}(h), \tag{21}$$

where $0 \leq \gamma^w \leq 1$ is the degree of wage indexation. Adjusting households set their wage to maximize their expected intertemporal utility subject to the demand for their individual labor service given by:

$$L_t(h) = \left[\frac{W_t(h)}{W_t}\right]^{-(1+\lambda^w)/\lambda^w} L_t. \tag{22}$$

Individual labor services are bundled by an employment agency into the labor index L_t according to the following Dixit-Stiglitz aggregation function:

$$L_t = \left[\int_0^1 L_t(h)^{\frac{1}{(1+\lambda^w)}} \mathrm{d}h\right]^{(1+\lambda^w)}, \tag{23}$$

where $\lambda^w > 0$ is the net wage markup. Given the individual wages $W_t(h)$ demanded by each of the households, the employment agency minimizes the cost for the production of a given amount of the labor index which is sold to the production sector at the aggregate wage index W_t:

$$W_t = \left[\int_0^1 W_t(h)^{-\frac{1}{\lambda^w}} \mathrm{d}h\right]^{-\lambda^w}. \tag{24}$$

It follows for the dynamic representation of the wage index:

$$W_t = \left[(1-\theta^w)\left(\tilde{W}_t\right)^{-\frac{1}{\lambda^w}} + \theta^w \left(\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\gamma^w} W_{t-1}\right)^{-\frac{1}{\lambda^w}}\right]^{-\lambda^w}. \tag{25}$$

2.2 Production and retail sectors

Intermediate goods producers There exists a continuum of monopolistically competitive intermediate goods producers indexed by $j \in [0,1]$. Each firm j uses physical capital K_{t-1} and labor services provided by households L_t as inputs to produce intermediate goods Y according to the following Cobb-Douglas production function:

$$Y_t(j) = A_t\left(u_t(j)\, K_{t-1}(j)\right)^{\psi} L_t(j)^{1-\psi} - \Phi, \tag{26}$$

where A_t denotes a total factor productivity shock, with $\ln A_t = \rho_a \ln A_{t-1} + \eta_t^a$ where η_t^a is an i.i.d. normal shock with zero mean and variance $\sigma^2_{\eta_t^a}$, u_t the utilization rate of physical capital and Φ fixed costs. Intermediate producers take factor prices as given and minimize their costs for a particular level of output. For the labor demand it follows that:

$$L_t = \frac{1-\psi}{\psi} \frac{\tilde{r}_{k,t} u_t K_{t-1}}{W_t}. \tag{27}$$

The ratio of capital and labor will be the same across all intermediate goods producers and equal to the average proportion. Marginal costs of production are then given by:

$$MC_t = A_t^{-1} \tilde{r}_{k,t}^{\psi} W_t^{1-\psi} \psi^{-\psi} (1-\psi)^{-(1-\psi)}. \tag{28}$$

We assume that producers of domestic goods are capable of discriminating prices between goods sold on the domestic market and exports X_t, so that the price of the latter, $P_{X,t}$, is set in foreign currency. Real marginal costs of goods produced for external demand are given by:

$$MC_{X,t} = \frac{P_t MC_t}{\tilde{e}_t P_{X,t}}, \tag{29}$$

where $\tilde{e}_t$ is the nominal exchange rate expressed in domestic currency per foreign currency units.

For nominal profits of firm j on domestic and foreign markets it then follows:

$$\Pi_{H,t}(j) = (P_{H,t}(j) - MC_t) \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-(1+\lambda^p)/\lambda^p} Y_t - MC_t \Phi, \tag{30}$$

$$\Pi_{X,t}(j) = (P_{X,t}(j) - MC_{X,t}) \left(\frac{P_{X,t}(j)}{P_{X,t}} \right)^{-(1+\lambda^p)/\lambda^p} X_t - MC_{X,t} \Phi. \tag{31}$$

Intermediate goods producers set prices for their products following Calvo (1983), so that in each period only a random fraction of $1-\theta$ firms can set prices optimally. Analogously to the wage-setting problem, the remaining prices are adjusted according to a simple indexation rule:

$$P_{H,t}(j) = \left(\frac{P_{H,t-1}}{P_{H,t-2}} \right)^{\delta^h} P_{H,t-1}(j), \tag{32}$$

$$P_{X,t}(j) = \left(\frac{P_{X,t-1}}{P_{X,t-2}} \right)^{\delta^x} P_{X,t-1}(j), \tag{33}$$

where $0 \leq \delta^h \leq 1$ and $0 \leq \delta^x \leq 1$ are the degrees of price indexation. Producers that are allowed to re-optimize their prices know the probability of being able to adjust in the future. Profit maximization, taken the aggregate price level and the total demand as given, results in the following first order conditions:

$$E_t \sum_{i=0}^{\infty} \left(\beta\theta^h\right)^i \lambda_{t+i} Y_{H,t+i}(j) \left(\frac{\tilde{P}_{H,t}(j)}{P_{H,t}} \left(\frac{\left(P_{H,t-1+i}/P_{H,t-1}\right)^{\delta^h}}{P_{H,t+i}/P_{H,t}} \right) - (\lambda^p) MC_{t+i} \right) = 0 \tag{34}$$

and

$$E_t \sum_{i=0}^{\infty} \left(\beta\theta^x\right)^i \lambda_{t+i} X_{t+i}(j) \left(\frac{\tilde{P}_{X,t}(j)}{P_{X,t}} \left(\frac{\left(P_{X,t-1+i}/P_{X,t-1}\right)^{\delta^x}}{P_{X,t+i}/P_{X,t}} \right) - (\lambda^p) MC_{X,t+i} \right) = 0. \tag{35}$$

Domestic retailers Perfectly competitive domestic retailers bundle intermediate goods to transform them into final goods they sell on the domestic market according to the following technology:

$$Y_{H,t} = \left[\int_0^1 Y_{H,t}(j)^{\frac{1}{(1+\lambda^p)}} \mathrm{d}j \right]^{(1+\lambda^p)}. \tag{36}$$

Given the prices of individual intermediate goods $P_{H,t}(j)$ set by each of the firms, the retailer minimizes the cost for the production of a given amount of the final good which is sold to the households at the aggregate price index $P_{H,t}$:

$$P_{H,t} = \left[\int_0^1 P_{H,t}(j)^{-\frac{1}{\lambda^p}} \mathrm{d}j \right]^{-\lambda^p}. \tag{37}$$

Given the optimal price setting behavior of the intermediate goods producers and the partial indexation in (34), it follows for the dynamics of the domestic goods price index:

$$P_{H,t} = \left[\left(1-\theta^h\right) \tilde{P}_{H,t}(j)^{-1/\lambda^p} + \theta^h \left(P_{H,t-1} \left(\frac{P_{H,t-1}}{P_{H,t-2}} \right)^{\delta^h} \right)^{-1/\lambda^p} \right]^{-\lambda^p}. \tag{38}$$

Exporters Analogously to domestic retailers, perfectly competitive exporting firms bundle intermediate goods produced for the foreign market and transform them into final goods according to the following technology:

$$X_t = \left[\int_0^1 X_t(j)^{\frac{1}{(1+\lambda^p)}} \mathrm{d}j \right]^{(1+\lambda^p)}, \tag{39}$$

Given the prices of individual intermediate goods $P_{X,t}(j)$ set by each of the firms, the exporter minimizes the cost for the production of a given amount of the exported good which is sold to the rest of the world at the aggregate price index $P_{X,t}$:

$$P_{X,t} = \left[\int_0^1 P_{X,t}(j)^{-\frac{1}{\lambda^p}} \mathrm{d}j \right]^{-\lambda^p}. \tag{40}$$

Given the optimal price setting behavior of the intermediate goods producers and the partial indexation in (35), it follows for the dynamics of the exported goods price index:

$$P_{X,t} = \left[(1-\theta^x) \tilde{P}_{X,t}(j)^{-1/\lambda^p} + \theta^x \left(P_{X,t-1} \left(\frac{P_{X,t-1}}{P_{X,t-2}} \right)^{\delta^x} \right)^{-1/\lambda^p} \right]^{-\lambda^p}. \tag{41}$$

Total demand for export goods in the rest of the world is, analogously to the demand for imported goods at home presented in Equation (15), given by

$$X_t = \alpha^* \left(\frac{P_{X,t}}{P_t^*} \right)^{-\eta^x} Y_t^*. \tag{42}$$

Importers We follow Justiniano and Preston (2010) in assuming that there exist monopolistically competitive retailers of imported goods for which the law of one price holds at the docks. Importers bundle foreign differentiated goods according to the following technology:

$$M_t = \left[\int_0^1 M_t(j)^{\frac{1}{(1+\lambda^p)}} \mathrm{d}j \right]^{(1+\lambda^p)}. \tag{43}$$

Analogously to retailers of domestic products and exporters, only a fraction of $1-\theta^m$ importers is capable of optimally adjusting prices, while the remaining retailers follow a simple indexation rule. Importers take the demand for foreign goods and its aggregate price level as given and maximize the expected value of future profits under consideration of the probability of price resets in the future. The optimal price set in the current period then results from the following first order condition:

$$E_t \sum_{i=0}^{\infty} (\beta\theta^m)^i \lambda_{t+i} M_{t+i}(j) \left(\frac{\tilde{P}_{M,t}(j)}{P_{M,t}} \left(\frac{(P_{M,t-1+i}/P_{M,t-1})^{\delta^m}}{P_{M,t+i}/P_{M,t}} \right) - (\lambda^p) MC_{M,t+i} \right) = 0, \tag{44}$$

with

$$MC_{M,t} = \frac{\tilde{e}_t P_t^*}{P_{M,t}} \tag{45}$$

being the real marginal cost for importers, the purchasing price in domestic currency units relative to the price level of imported goods. The law of motion for the price index of imported goods is then given by:

$$P_{M,t} = \left[(1-\theta^m) \tilde{P}_{M,t}(j)^{-1/\lambda^p} + \theta^m \left(P_{M,t-1} \left(\frac{P_{M,t-1}}{P_{M,t-2}} \right)^{\delta^m} \right)^{-1/\lambda^p} \right]^{-\lambda^p}. \tag{46}$$

2.3 Oil-exporting sector

The economy is endowed with an infinite amount of oil that is exported at an exogenous world market price in foreign currency, $P_{o,t}$. In every period, revenues of the oil sector in local currency units are then given by:

$$Y_{o,t} = \tilde{e}_t P_{o,t} O_t, \tag{47}$$

where O_t is the exported volume, that is assumed to be constant. Any variation in the export revenues thus stems from movements in the world market price or the nominal exchange rate. The real foreign currency price is assumed to follow an AR(1) process in logs, with an i.i.d. shock term with zero mean and variance $\sigma^2_{\eta^{po}}$. All profits of the oil sector are transferred to the households.

2.4 Foreign exchange dealers

Following Montoro and Ortiz (2016), we extend the otherwise standard model by a continuum of risk-averse dealers d on the unit interval that operate the secondary bond market by executing orders they receive from households, foreign investors and the domestic central bank. Whereas households and foreign investors hold only domestic and foreign bonds, respectively, the central bank engages in both types of securities. It is assumed to exchange the domestic bonds it issues for foreign securities. Each of the dealers receives purchase or sale orders for domestic bonds from households and the central bank, $\omega_t\left(d\right)$ and $\omega_{CB,t}\left(d\right)$, as wells as purchase or sale orders for foreign bonds from foreign investors and the central bank, $\omega^*_t\left(d\right)$ and $\omega^*_{CB,t}\left(d\right)$. All dealers receive the same amounts of orders, that are exchanged among each other. At the end of every period, the holdings of domestic and foreign bonds of each dealer, $B_t\left(d\right)$ and $B^*_t\left(d\right)$, are given by:

$$B_t\left(d\right) + \tilde{e}_t B^*_t\left(d\right) = \omega_t\left(d\right) - \omega_{CB,t}\left(d\right) + \tilde{e}_t\left(\omega^*_t\left(d\right) + \omega^*_{CB,t}\left(d\right)\right). \tag{48}$$

All dealers' profits are transferred to the households.

Dealers are assumed to be risk-averse and short-sighted. They maximize their expected end-of-period utility which is given by the following constant absolute risk aversion function:

$$-E_t\left(d\right) e^{-\gamma\Omega_{t+1}(d)}, \tag{49}$$

where γ is the coefficient of absolute risk aversion and $\Omega_{t+1}\left(d\right)$ is total investment after returns of dealer d, given by:

$$\Omega_{t+1}\left(d\right) = \left(1+r_t\right) B_t\left(d\right) + \left(1+r^*_t\right) E_t\left(d\right) \tilde{e}_{t+1} B^*_t. \tag{50}$$

Substituting for the dealer's resource constraint and log-linearizing the excess return on foreign bonds, with $e_t = \ln \tilde{e}_t$, leads to:

$$\Omega_{t+1}(d) \approx (1+r_t)\left[\omega_t(d) - \omega_{CB,t}(d) + \tilde{e}_t\left(\omega_t^*(d) + \omega_{CB,t}^*(d)\right)\right] \tag{51}$$

$$+ \left(r_t^* - r_t + E_t(d)\, e_{t+1} - e_t\right) B_t^*(d). \tag{52}$$

Maximization of the utility function with respect to end-of-period foreign bond holdings results in the following first order condition:

$$-\gamma\left(r_t^* - r_t + E_t(d)\, e_{t+1} - e_t\right) + \gamma^2 B_t^*(d)\, \sigma_{\Delta e}^2, \tag{53}$$

with $\sigma_{\Delta e}^2$ being the unconditional variance of the rate of nominal exchange rate depreciation. This last term results from assumptions about the exchange rate in period $t+1$, the only non-predetermined variable in the optimization problem. From (53) it follows for the demand for foreign bonds of each dealer d:

$$B_t^*(d) = \frac{r_t^* - r_t + E_t(d)\, e_{t+1} - e_t}{\gamma \sigma_{\Delta e}^2}. \tag{54}$$

Thus, demand for foreign bonds is positively affected by an interest rate differential to domestic bonds, an expected appreciation of the foreign currency, lower risk aversion and lower exchange rate volatility.

2.5 Central bank

The monetary authority sets the short-term interest rate according to a Taylor (1993)-type monetary policy rule. In particular, it reacts to deviations of the consumer price inflation from its target as well as excessive deviations of the nominal depreciation rate of the ruble. The lagged value of the policy rate is considered to account for its rather smooth dynamics. We assume that (in log-linear representation):

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left(\phi_\pi \pi_t + \phi_{\Delta e} \Delta e_t\right) + \eta_t^r, \tag{55}$$

where ρ_i is the degree of interest rate smoothing, ϕ_π and $\phi_{\Delta e}$ are the reaction coefficients to movements of the inflation rate and the degree of exchange rate depreciation, and η_t^r is an i.i.d. normal error with zero mean and variance $\sigma_{\eta^r}^2$, capturing non-systematic interest setting behavior.

In addition to the interest rate as a standard monetary policy operating target, the central bank uses interventions on the foreign exchange market as an instrument to stabilize the behavior of the nominal exchange rate. The monetary authority finances the acquisition of foreign exchange reserve by the issuance of its own securities B_t. Following Montoro and Ortiz (2016), we assume that the central bank is capable to fully sterilize its interventions so that it is able to control the interest rate paid on its bonds, regardless of the volume of securities issued or bought. As outlined in the previous section, securities in the foreign exchange market are traded via risk-averse dealers which execute the orders they receive from households, foreign investors and the domestic central bank. In contrast to the capital flows generated by foreign investors, purchases and sales of international reserves by the central bank are assumed to be carried out systematically. In particular, a monetary authority intended to mitigate exchange rate fluctuations is expected to counter appreciation (depreciation) pressures on its currency resulting from the excess demand for (supply of) domestic assets and thus to purchase (sell) foreign bonds in exchange for domestic ones. Following the standard approach for interest rate rules, the foreign bond sale orders from the central bank are expressed (in log-linear representation) as:

$$\omega^*_{CB,t} = \phi_{\Delta e,int} \Delta e_t + \eta^{int}_t, \tag{56}$$

with $\phi_{\Delta e,int}$ being the reaction coefficient to movements of the degree of exchange rate depreciation, and η^{int}_t an i.i.d. normal error term with zero mean and variance $\sigma^2_{\eta^{int}}$, capturing non-systematic foreign exchange interventions. Different from the dynamic behavior of the policy rate, the volume of interventions does not exhibit persistence over time but rather strongly depends on current economic conditions the central bank is reacting to. Thus, it is reasonable to not consider a smoothing parameter in the intervention equation.

2.6 Foreign economy

Based on the small open economy assumption, the behavior of foreign economy variables is assumed to be exogenous to the development of domestic variables. We follow Justiniano and Preston (2010) in specifying the dynamics of the rest of the world output, inflation and interest rate as an VAR(2) in logs, such that:

$$\begin{bmatrix} y^*_t \\ \pi^*_t \\ r^*_t \end{bmatrix} = \begin{bmatrix} \rho^*_{11} & \rho^*_{12} & \cdots & \rho^*_{16} \\ \rho^*_{21} & \rho^*_{22} & \cdots & \rho^*_{26} \\ \rho^*_{31} & \rho^*_{32} & \cdots & \rho^*_{36} \end{bmatrix} \begin{bmatrix} y^*_{t-1} \\ y^*_{t-2} \\ \pi^*_{t-1} \\ \cdots \\ r^*_{t-2} \end{bmatrix} + \begin{bmatrix} \eta^{y^*}_t \\ \eta^{\pi^*}_t \\ \eta^{r^*}_t \end{bmatrix}, \tag{57}$$

where $\eta^{y^*}_t$, $\eta^{\pi^*}_t$ and $\eta^{r^*}_t$ are i.i.d. normal shocks with zero mean and standard deviations $\sigma_{\eta^{y^*}}$, $\sigma_{\eta^{\pi^*}}$ and $\sigma_{\eta^{r^*}}$.

2.7 Aggregation and market clearing

Goods and factor markets Domestic goods market clearing requires non-oil goods production, net of utilization adjustment costs, to be equal to the demand for consumption, investment, non-oil exports and imports $M_t = C_{F,t} + I_{F,t}$:

$$Y_t = C_t + I_t + X_t - M_t + G_t + \omega(u_t) K_{t-1}, \tag{58}$$

where G_t captures government spending that is assumed to be exogenous and follow an AR(1) process in logs, with an i.i.d normal error term with zero mean and variance $\sigma^2_{\eta^g}$. Total real GDP is then defined as the sum of non-oil GDP and oil revenues:

$$GDP_t = \frac{\tilde{e}_t P_{o,t} O_t + P_{H,t} Y_t}{P_{Y,t}}, \tag{59}$$

where $P_{Y,t}$ is the GDP deflator. The capital market clears when the capital supplied by domestic households equals the demand from domestic producers at the market rate for rented capital $\tilde{r}_{k,t}$. The market for labor is in equilibrium when the labor supplied by domestic households equals the labor demand from domestic producers at the aggregate wage.

Prices By definition, the GDP deflator equals the weighted average of the individual price levels of its components:

$$P_{Y,t} = (\phi_c + \phi_i) P_t + \phi_o (\tilde{e}_t P_{o,t}) + \phi_x \tilde{e}_t P_{X,t} - \phi_m P_{M,t}, \tag{60}$$

with ϕ_c, ϕ_i, ϕ_o, ϕ_x and ϕ_m being the shares of consumption, investment, oil revenues, non-oil exports and imports to GDP, respectively. The real exchange rate is defined as:

$$Q_t = \frac{\tilde{e}_t P^*_t}{P_t}. \tag{61}$$

Foreign exchange market As outlined in Montoro and Ortiz (2016), market clearing in the domestic market for foreign bonds requires the aggregate demand of foreign investors and the central bank to equal the end-of-period holdings of foreign bonds by all dealers:

$$\int_0^1 B^*_t(d)\,\mathrm{d}d = \int_0^1 \left(\omega^*_t(d) + \omega^*_{CB,t}(d)\right) \mathrm{d}d = \omega^*_t + \omega^*_{CB,t}. \tag{62}$$

Aggregating (54) over the continuum of dealers and substituting total demand by (62), the following modified uncovered interest rate parity (UIP) condition is obtained:

$$E_t e_{t+1} - e_t = r_t - r^*_t + \gamma \sigma^2_{\Delta e} \left(\omega^*_t + \omega^*_{CB,t}\right). \tag{63}$$

The expression explicitly assumes that there is information homogeneity across all dealers so that the average expectation of the future nominal exchange rate is the same for all of them.

Risk aversion and short-sightedness of foreign exchange dealers results in an augmentation of the standard UIP condition by a time-variant risk premium that depends on foreign capital flows and central bank interventions. According to (63), the latter affect the nominal exchange rate through two mechanisms: the portfolio balance channel and the expectations channel. The former is defined by the last part of the UIP condition. Central bank interventions change the composition of domestic and foreign assets in the dealers' portfolios that have been chosen optimally based on their assessment of the respective returns and risks. A holding of a higher share of either security in their portfolio has thus to be compensated by a higher relative risk-adjusted return. Purchases (sales) of foreign bonds by the central bank increase (reduce) the relative share of foreign bonds in the dealers' portfolios. This will lead them to ask for a lower (higher) risk premium to be compensated for a relatively lower (higher) quantity of domestic currency they hold, resulting in a nominal appreciation (depreciation). The effect of central bank interventions on the exchange rate is the higher, the larger the risk premium factor $\gamma\sigma^2_{\Delta e}$, i.e. the more risk-averse dealers are or the higher the risk (uncertainty) in terms of the expected exchange rate volatility. The expectations channel is captured by the expected next period exchange rate. Rule-based interventions affect agents' beliefs about the future interventions and thus the dynamics of the exchange rate. All other variables kept equal, this will result in respective dynamics of the exchange rate already today.

Foreign capital flows are assumed to be non-fundamental in the sense that they are not explained by any other model variable and evolve according to the following equation (in logs):

$$\omega^*_t = \rho_{\omega^*}\, \omega^*_{t-1} + \eta^{\omega^*}_t, \tag{64}$$

where $\eta^{\omega^*}_t$ is an i.i.d. normal shock with zero mean and variance $\sigma^2_{\eta^{\omega^*}}$.

Flow budget constraint The aggregation of the households budget constraint, the oil export revenues, profits of the foreign exchange dealers, firms and retail sectors as well as the equilibrium in the domestic bond market leads to the following flow budget constraint of the domestic economy:

$$B_t = (1 + \tilde{r}_{t-1})\, B_{t-1} + \tilde{e}_t P_{o,t} O_t + \tilde{e}_t P_{X,t} X_t - P_{M,t} M_t - \frac{\psi}{2}\left(B_t - \bar{B}\right)^2. \tag{65}$$

3 Estimation

3.1 Data

For estimation 13 quarterly time series from the beginning of 2000 till the second quarter of 2015 are used. These include GDP, consumption, investment, the consumer price index, the producer price index as a proxy for prices of domestic goods, wages, the real exchange rate, the three-month interbank rate, capital flows, the oil price as well as series for foreign output, inflation and interest rates. Data for GDP, its aggregates and wages is taken from the Federal State Statistics Service (Rosstat). They are seasonally adjusted and transformed to real variables with the GDP deflator from the CBR. Finally, they are divided by the active labor force series from the OECD to obtain per capita values.

For the price variables, we seasonally adjust the indexes of domestic goods and consumer prices obtained from Rosstat and take the first log-differences to calculate the respective inflation rates. We take period averages of the 3-month MIBOR rate from the Bank of Russia and divide them by 400 to obtain the quarterly interest rate series. For the capital flows, data on private sector capital flows by the CBR is used and divided by nominal GDP in US dollars.

All foreign variables as well as the oil prices and the real exchange rate are expressed in terms of the dual-currency basket, that has been used as an exchange rate benchmark by the Bank of Russia since 2005. The weights of the US dollar and the euro have been adjusted five times. Since 2007 the basket weights of the dollar and the euro have been 0.55 and 0.45, respectively. We use this ratio for the whole sample under consideration. As has been argued by Malakhovskaya and Minabutdinov (2014), this simplification can be justified by the share of Russian exports to the euro area and Switzerland relative to the exports to its 15 main trade partners being around the same number. Foreign GDP, inflation and interest rate are thus weighted averages of the respective US and euro area time series, that are processed in the same way as the domestic variables described above. The real exchange rate is calculated by equating the changes in the nominal exchange rate index constructed from the bi-lateral ruble exchange rates against the dollar and the euro and the inflation differential between Russia and the weighted foreign average. Finally, the quarter-average spot price of Brent oil is converted to be expressed in terms of the currency basket and divided by the weighted average foreign consumer price index to obtain the respective real series.

Prior to estimation, all observable series are demeaned.

3.2 Priors and calibration

Most of the prior choices are motivated by Justiniano and Preston (2010). These include the ones for the consumption utility σ set to 1.20 with a standard deviation of 0.40, the inverse Frisch elasticity φ with mean 1.50 and standard deviation 0.75, and the habit parameter h centered around 0.50 with a standard deviation of 0.25. The priors for the elasticities of substitution between domestic and foreign goods are set for, both, the home country and the rest of the world to a mean of 1.50 and a standard deviation of 0.75. Priors for all Calvo parameters are set to a mean of 0.5 and a standard deviation of 0.10, whereas the priors for the degrees of indexation are set to the same mean but a standard deviation of 0.25. Choices for the priors for the fix cost parameter as well as the investment adjustment and capital utilization adjustment costs are set according to Smets and Wouters (2003). Priors for the central bank's reaction functions also follow common practice. The prior of the inflation reaction coefficient is set to 1.50 with a standard deviation of 0.30, whereas the priors for the exchange rate reaction parameters are centered around 0.50 with a standard deviation of 0.13 in both rules. The prior for the interest rate smoothing parameter is set to 0.80 and a standard deviation of 0.10. We fit an AR(1) process for the actual data on oil prices and capital flows to define the priors for the respective AR(1) parameters at a mean of 0.20 and 0.40 and standard deviations of 0.15, respectively. For all remaining AR(1) parameters, the respective priors are centered around 0.80 with a standard deviation of 0.10. For most of the standard deviations of model shocks, the prior means are chosen to be 0.01 with a standard deviation of 2. The choices for the shocks to capital flows, the oil price and central bank interventions are motivated by estimates of respective AR(1) processes. The complete set of prior choices is presented in Table 5.

The remaining parameters and steady-state values are calibrated, since they are either difficult to estimate or there exist strong evidence for a particular value in the data. Standard choices are made for the discount parameter ($\beta = 0.99$), implying a steady-state real interest rate of 4 percent, the share of capital in the production function ($\psi = 1/3$), the rate of depreciation of private capital ($\delta = 0.025$), i.e. an annual depreciation of 10 percent, and the net wage markup ($\lambda^w = 0.15$). The shares of consumption, investment, non-oil exports and imports to total output are calibrated to their average value over the sample period. In a similar way, the share of foreign goods in consumption and investment is fixed at 0.23. Matching the ratio of central bank reserves to GDP, the respective model equivalent, the ratio of domestic bonds to output is set to 0.9. Analogously, the proportion of oil exports to GDP is set to 0.17, the average of oil, oil products and gas. We choose this rather broad definition of commodity exports to properly account for the significance they have for the Russian economy. The close co-movements of crude oil and natural gas prices do not raise objections to treat the two commodities as one. As for the parameters of the UIP condition, the variance of the nominal exchange rate depreciation is calibrated to its sample period average of 0.0065, whereas the degree of risk aversion is set to 200. With the latter we deviate from the respective value in Bacchetta and Van Wincoop (2006) and Montoro and Ortiz (2016). Our choice is motivated by an estimate of the UIP equation using actual data on the exchange rate, the interest rate differential, private capital flows and central bank interventions. Following Justiniano and Preston (2010), we use coefficient estimates of a VAR(2) for the interaction of the three foreign variables in the model.

The complete set of calibrated parameters is presented in Table 4.

We use the MATLAB preprocessor Dynare (see Adjemian, Bastani, Karamé, Juillard, Maih, Mihoubi, Perendia, Pfeifer, Ratto, and Villemot, 2011) to solve and subsequently estimate the model using Bayesian techniques. Chris Sims' optimization routine CSMINWEL is used to obtain an initial estimate of the posterior mode, based on prior distributions and observable time series for endogenous model variables. To approximate the distribution of the parameters, we employ a random walk Metropolis-Hastings algorithm with two chains, each consisting of 500,000 parameter vector draws.

4 Results

4.1 Parameter estimates and model fit

The posterior means and probability intervals of the estimated parameters and the standard deviations of the model disturbances are presented in Table 6. All of them fall into a plausible range. Remarkably, prices for domestic and imported goods on the home market exhibit both, a higher frequency of prices changes (indicated by respectively lower Calvo parameters) and a higher degree of indexation when compared to exported goods, possibly as a result of a less stable price level development at home. Another remarkable difference is estimated for the elasticity of substitution between home and foreign goods from the domestic and the foreign perspective. In contrast to the demand for Russian goods abroad, demand for foreign goods in Russia is by less than a half influenced by relative price movements, pointing at a higher substitutability of Russian goods. Monetary policy is estimated to react modestly to variations in the inflation rate and the exchange rate, with the respective reaction coefficients being 1.44 and 0.50, while strongly smoothing the dynamics of the policy rate, with the AR(1) parameter estimated to be 0.93. The reaction coefficient for exchange rate movements in the intervention rule is estimated to be 0.90. Since there is no benchmark in the literature to assess the plausibility of this value, we compare the smoothed series for central bank interventions that has been employed in the estimation process to actual data that is available from the CBR from mid-2008. Figure 1 plots the smoothed series for central bank interventions against the actual interventions, demeaned over the respective sample, in relation to nominal GDP. The correlation of both series is 0.86 and the smoothed series in particular tracks the spikes of the actual data very well. We consider this finding as an important performance benchmark of the model used to characterize the Russian monetary policy and thus regard the setup capable of analyzing the actual and alternative policy strategies.

4.2 Historical decomposition

Figures 2, 3 and 5 show the historical decompositions of the real exchange rate, real GDP and the consumer price inflation rate. From 2005 on, oil prices have put an appreciation

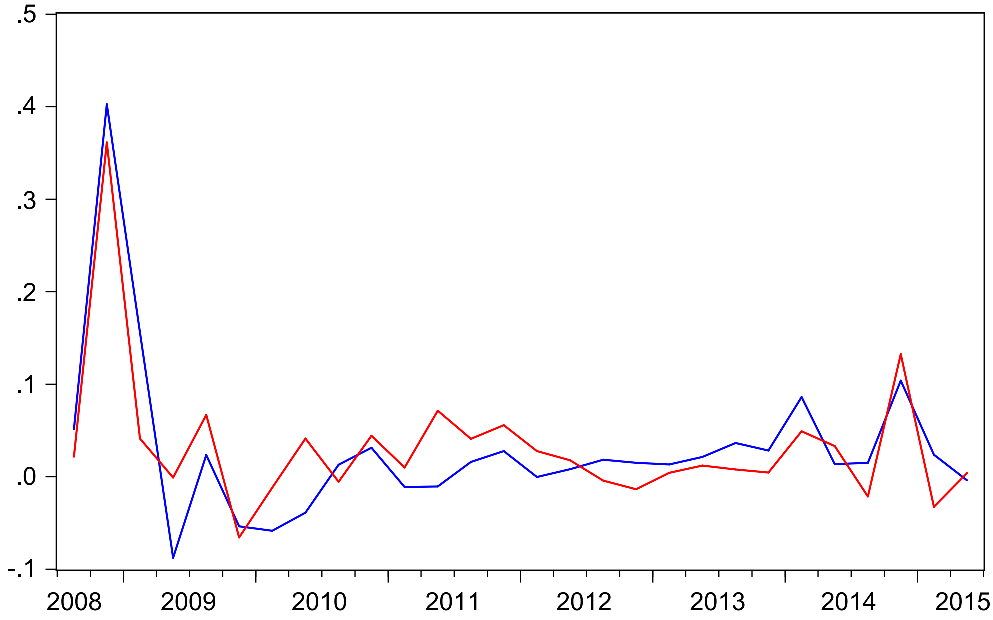

Figure 1: Smoothed central bank interventions (red) and actual demeaned interventions (blue) in relation to nominal GDP

pressure on the real ruble rate. In periods of high or rising oil prices, the central bank actively counters these dynamics by direct interventions or, to a lesser extent, policy rate rises. In crises times, there are mainly shocks to foreign capital flows affecting the value of the ruble. From the third quarter of 2008 well through 2009 and also, but to a lesser extent, at the turn of the years 2014 and 2015, capital outflows curbed the ruble's exchange rate. Whereas during the global financial crisis the CBR could soften the depreciation pressure via direct interventions and policy rate increases, the most recent Russian crisis episode is characterized by a non-sufficient policy response to keep the currency's value stable. This finding does not come as a surprise. After all, the ruble's depreciation at the end of 2014 has been much stronger than at the start of 2009. In addition, the CBR announced to let its currency freely float during the latest episode of depreciation. At least concerning its direct interventions, there is evidence in the historical decomposition for the monetary authority to have complied with its announcement.

Fluctuations in total real GDP are primarily caused by shocks to technology and domestic demand. Negative shocks to the latter, in particular investment, have been the main driver of the most recent downturn that has started to unfold already in mid-2013, whereas they have been stimulating the economy prior to that by the same token. The oil price has positively affected total Russian output in all quarters from spring 2007 on. This holds true even for the drop in prices during the global financial crisis and in particular the most recent, from June 2014 onwards. This finding can be explained by

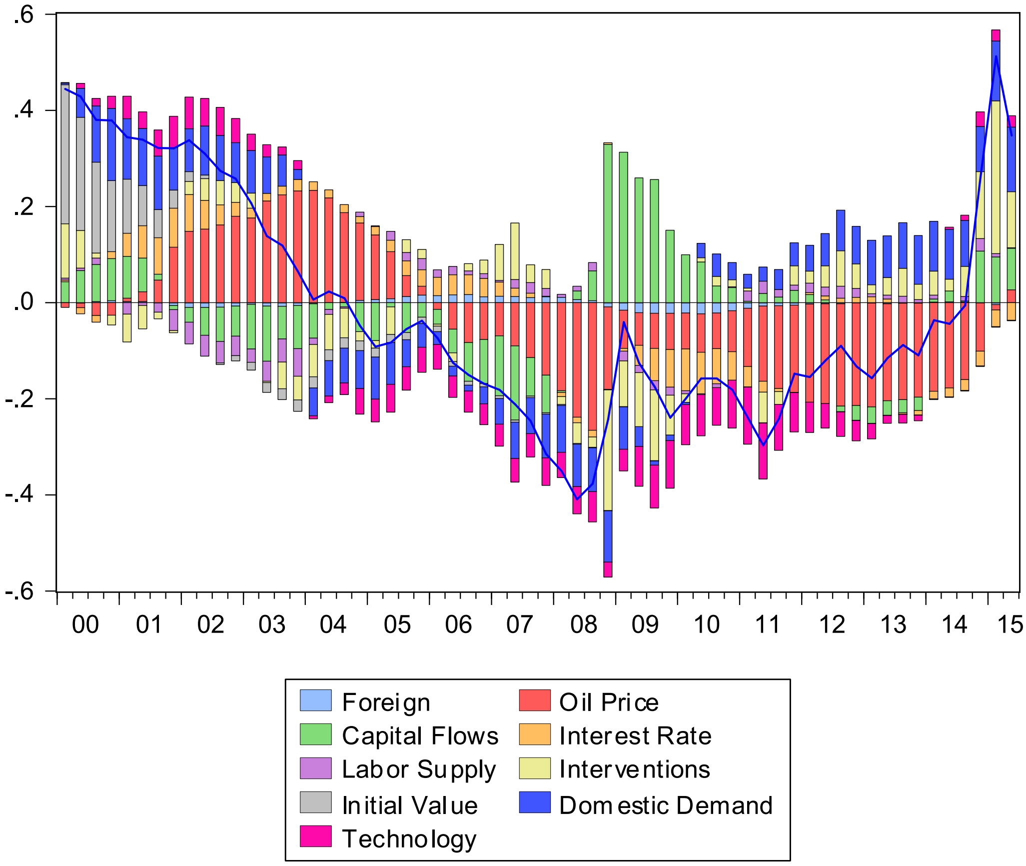

Figure 2: Historical decomposition of the quarterly real exchange rate depreciation (solid line)

the concurrent depreciation of the ruble's exchange rate during both episodes, limiting the decline in the commodity price expressed in domestic currency.

As concerns inflation, there does not appear to be a particular pattern of shocks influencing its rate in normal times, primarily owed to a relatively stable exchange rate. When large capital outflows put depreciation pressure on the ruble, however, the extent to which the central bank is able to offset their impact is crucial for the dynamics of the price level. During the global financial crisis, the CBR could keep the ruble relatively stable and lower the inflation rate in an environment of low economic activity. At the end of 2014, on the contrary, the insufficient and later scrapped strategy of preventing a depreciation dramatically increased the prices of imported goods and consequently also total inflation.

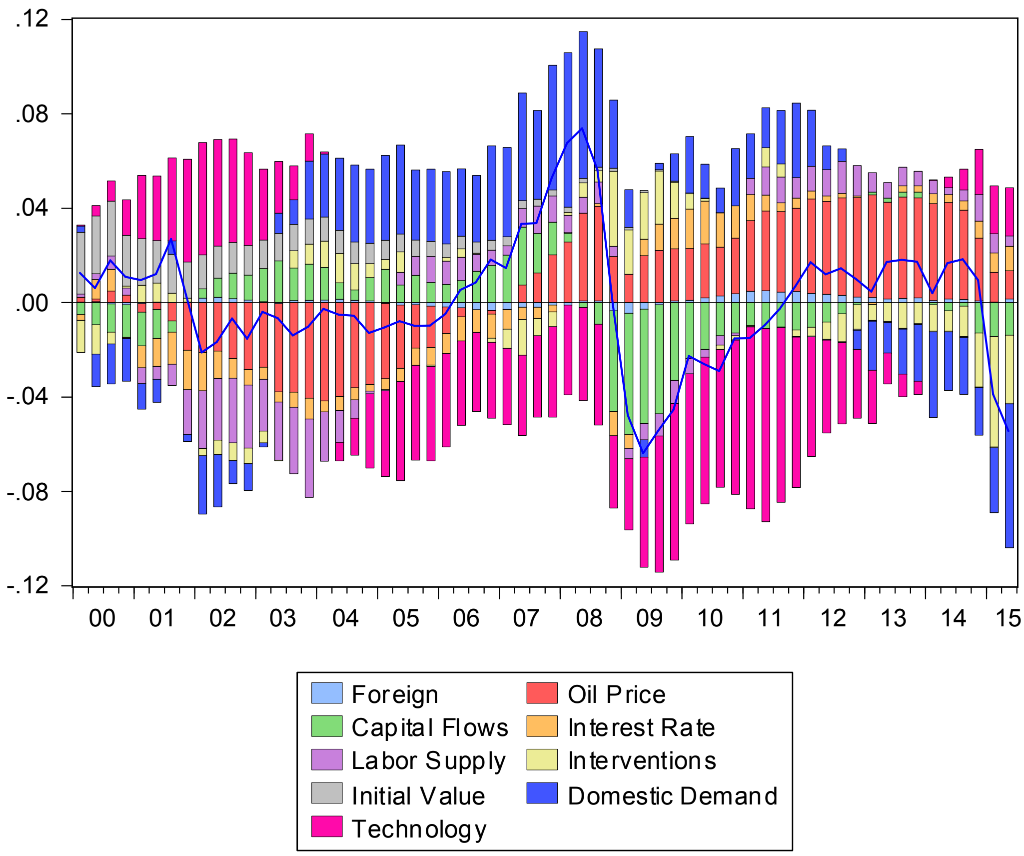

Figure 3: Historical decomposition of quarterly real GDP (solid line) relative to its steady state

4.3 Forecast error variance decomposition

The forecast error variance decompositions for selected time horizons and variables based on the estimates of the model are presented in Table 1.[1] Around one half of the variations of domestic GDP can be explained by domestic demand shocks. More than one-third, in particular in the long-run, go back to investment shocks and their effect on deviations of the productive capital stock from its steady state. This finding corresponds to the historical decomposition of output according to which private investment shocks, seen individually, contributed most to GDP fluctuations in the past. Domestic supply shocks, mainly to technology, account for another quarter of domestic output variations. Capital flows and central bank interventions strongly affect GDP in the very short term, but rather weakly from two years onwards. Finally, oil price shocks account for roughly one-tenth of output fluctuations in the short-run as well as the long-term.

Fluctuations of the rate of consumer price inflation are primarily driven by monetary

[1]Unless otherwise noted, all simulation results and reported variances in this work are based on simulations with the model parameters and standard deviations of shocks being calibrated to their respective estimated posterior means.

shocks, non-fundamental capital flows and domestic demand shocks, with their respective relative importance being almost constant over time. Prices for domestically produced goods are stronger affected by preference shocks and oil price disturbances, with the latter having a strong impact on households' incomes, consumption and hence their wage setting, affecting domestic producers' costs and consequently prices. Dynamics of prices for imported goods are to larger extent driven by shocks to capital flows and non-systematic interventions, since they, both, directly influence the behavior of the nominal exchange rate. Non-oil exports and imports are strongly affected by fluctuations of the oil price, with the impact of the latter influencing the real exchange rate strongest in the long-run, creating a channel to weigh on trade via relative price variances.

Based on the findings that nearly all domestic variables are substantially influenced by shocks to oil prices and capital flows at all horizons, the following sections focus on the effects that the two disturbances have on the Russian economy, given the estimated monetary policy in place. Starting with an isolated consideration of either shock, a situation is analyzed in which both disturbances hit the economy simultaneously. While the narrative considers the effects of positive shocks, the derived conclusions hold true in absolute terms also for the respective negative disturbances.

4.4 Effects of oil price shocks

Following a positive oil price shock (Figure 6), household incomes rise on impact, leading to higher consumption expenditures. As a consequence, the marginal rate of substitution between consumption and labor increases, resulting in higher wages and consequently rising marginal costs and higher prices for domestically produced goods and total consumer prices. The consequent decline in real interest rates further stimulates household spending. These effects are very short-term, however. With their positive impact on the balance of payments, higher oil prices lead to a nominal and real exchange rate appreciation that is only in part offset by central bank interventions. The resulting relatively lower prices for foreign goods lead to an increase in imports and a decline in total consumer prices. On the other hand, foreign demand for domestically produced goods decreases sharply and persistently in the wake of the local currency's appreciation. The decline is, however, overcompensated by the increase in domestic demand due to higher incomes from oil exports, despite the fact that their rise is weaker when expressed in local currency units. Consequently, non-oil GDP is affected positively by the higher commodity prices, in particular also due to an increased capital stock as a result of risen investment spending.

In absolute terms, oil price shocks have the largest long-run effects on the real exchange rate, investment, non-oil exports, and imports. These findings largely correspond to the ones in Malakhovskaya and Minabutdinov (2014).

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	1.6	17.1	11.4	9.9	8.2	4.7	32.0	9.6	5.5	0.1
Consumption	2.8	2.4	2.0	26.2	11.4	35.8	0.5	2.0	16.8	0.0
Investment	0.0	0.4	0.6	2.7	2.3	20.4	0.0	72.2	1.4	0.0
Exports	0.2	15.2	15.3	5.6	33.6	19.1	0.1	1.5	3.7	5.6
Imports	3.4	11.9	9.9	5.0	35.6	23.7	0.1	8.2	2.3	0.0
Real wages	6.2	0.0	0.1	16.5	20.4	42.7	0.2	2.2	11.7	0.1
Inflation	10.6	20.0	20.1	4.7	15.6	23.5	0.1	0.5	4.4	0.5
Dom. prices	10.6	9.5	10.3	6.7	22.8	32.8	0.2	0.7	6.1	0.4
Real ER	0.2	45.3	30.6	2.3	8.6	10.6	0.1	0.3	2.0	0.1
4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	0.7	7.0	7.6	19.8	7.4	4.5	13.4	30.4	8.9	0.3
Consumption	1.2	5.8	7.6	29.8	13.8	21.4	0.5	3.6	16.2	0.2
Investment	0.4	0.2	0.4	3.2	3.8	22.1	0.0	68.5	1.3	0.1
Exports	3.2	6.5	9.2	6.4	50.8	15.0	0.1	2.8	3.1	2.9
Imports	2.5	11.3	14.8	6.2	41.7	4.9	0.1	15.8	2.5	0.4
Real wages	3.3	3.0	4.1	29.6	22.4	25.6	0.3	3.7	8.0	0.1
Inflation	10.2	20.5	22.2	4.2	14.5	23.0	0.1	0.4	4.2	0.7
Dom. prices	9.8	10.3	11.5	6.0	22.3	32.7	0.2	0.7	6.0	0.5
Real ER	1.2	25.7	24.4	3.8	26.7	14.3	0.1	1.0	2.7	0.2
8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	1.4	3.6	3.9	20.5	8.0	10.4	7.3	38.0	6.5	0.3
Consumption	3.6	4.3	5.5	29.0	22.8	17.4	0.4	4.6	12.2	0.3
Investment	1.2	0.2	0.2	3.8	6.5	23.0	0.0	63.8	1.1	0.1
Exports	8.4	3.3	4.3	6.9	58.9	9.4	0.1	5.0	2.2	1.6
Imports	7.6	6.1	7.8	5.4	50.3	4.3	0.0	16.3	1.6	0.6
Real wages	4.9	2.6	3.4	29.8	28.8	19.5	0.3	4.1	6.4	0.2
Inflation	10.3	20.2	21.8	4.1	14.7	23.3	0.1	0.4	4.2	0.9
Dom. prices	9.7	10.1	11.4	5.9	22.3	33.1	0.2	0.7	6.0	0.6
Real ER	5.0	18.4	17.6	4.7	38.0	11.2	0.1	2.4	2.3	0.3
∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	2.6	3.5	4.0	21.3	9.7	14.3	4.5	35.2	4.5	0.3
Consumption	6.0	5.4	6.8	23.2	24.9	16.0	0.2	9.8	7.2	0.4
Investment	2.8	1.6	2.1	4.7	10.5	22.8	0.0	54.3	0.9	0.3
Exports	10.3	7.4	9.4	7.1	47.2	5.0	0.0	10.7	1.2	1.6
Imports	10.6	9.0	11.4	4.4	45.8	6.2	0.0	10.7	1.0	1.0
Real wages	6.3	4.1	5.2	24.5	27.8	17.9	0.2	9.7	4.0	0.3
Inflation	10.5	20.1	21.9	4.1	15.0	22.8	0.1	0.5	4.2	0.9
Dom. prices	10.0	10.2	11.6	5.8	22.9	32.1	0.2	0.7	5.8	0.7
Real ER	7.1	17.0	17.5	5.2	36.3	8.0	0.1	6.4	1.7	0.7

Table 1: Forecast error variance decomposition at different horizons

4.5 Effects of capital flow shocks

According to the model specification, a capital inflow shock (Figure 7) increases the relative share of dealers' assets denominated in domestic currency, leading to an immediate appreciation of the latter. Its magnitude is weakened by the central bank's cutting of the domestic interest rate as well as direct interventions on the foreign exchange market. With constant world market prices, the nominal appreciation reduces the oil export revenues expressed in local currency units. Import prices decrease sharply in light of a stronger domestic currency. Due to lower interest rates and consequently lower capital costs, prices for domestically produced goods also drop, leading to a decline in total consumer prices. Consumption and investment spending is increased as a consequence of the unexpectedly risen ex-post real interest rate on savings. Nevertheless, in consequence of the sharp increase in its nominal value, the domestic currency also appreciates in real terms. Foreign demand for domestic non-oil goods drops, whereas imports increase as a result. The gradual reduction of capital inflows in combination with lower domestic interest rates cause the exchange rate to depreciate again after two quarters. In consequence of the low persistence of capital flow shocks, their direct effects dissolve already after one year. The expansive monetary policy in reaction to the initial currency appreciation, however, remains in place. This leads to reverse dynamics of the nominal exchange, overshooting its steady state level. With the inflation rate only slightly above its trend, this results in a real depreciation of the domestic currency, with the real exchange rate persistently exceeding its steady state level from the sixth quarter onwards. Dynamics of the GDP aggregates reverse in the light of this turnaround of relative prices. Exports of non-oil goods increase, whereas imports drop sharply. Domestic demand that has been initially stimulated by the capital inflows decreases in light of gradually increasing real interest rates. The reaction of total GDP follows a similar pattern.

In absolute terms, capital flow shocks have the largest long-run effects on the real exchange rate, the rate of nominal exchange rate appreciation, the domestic currency price of oil as well as investment, non-oil exports, and imports. The reaction of the central bank is not sufficient to counter the shock and to prevent it from having an impact on the domestic economy. On the contrary, due to their persistence, its measures affect real variables long after capital flows have returned to their steady state. For all real variables the unconditional variance is remarkably higher compared to the conditional variance up to the sixth quarter, when the shock dissolves completely.

4.6 Effects of simultaneous oil price and capital flow shocks

In addition to the analysis of the effects of oil price and capital flow shocks hitting the economy independently from each other, we also examine the case in which both disturbances occur simultaneously. The rationale is twofold: on the one hand, it appears

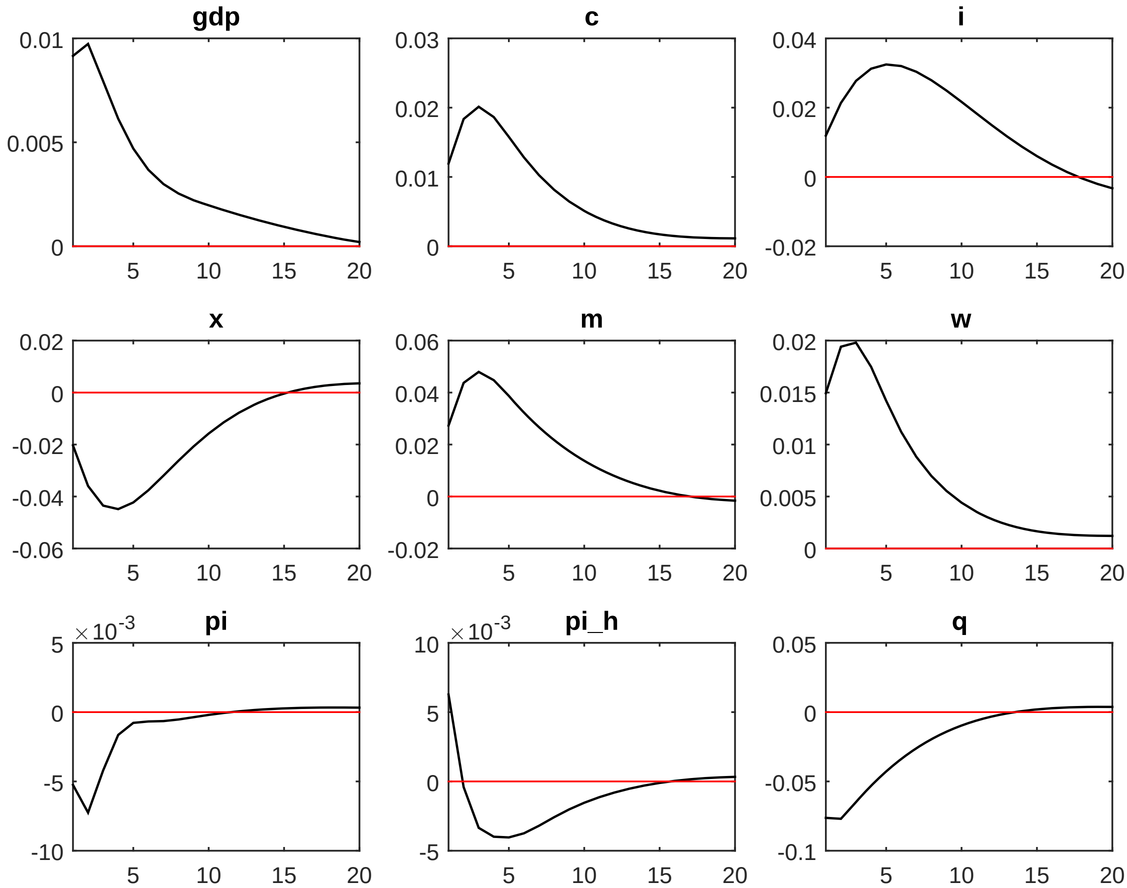

Figure 4: Impulse response functions following a simultaneous 1 s.d. shock to the oil price and capital flows

to be reasonable that flows of foreign capital into or out of an oil-dependent economy are closely linked to the revenue prospects of the commodity sector. Whereas oil exporting firms profit directly from higher oil prices, the rest of the economy benefits from higher incomes and other second round effects. Public finances, on their part, are strongly influenced by revenues from commodity exports so that oil price dynamics have a notable impact on the attractiveness of sovereign bonds. On the other hand, a scenario of large capital outflows and falling oil prices features two main shocks the Russian economy has been confronted with during the year 2014. To analyze the effects that these two disturbances have on the domestic economy given the monetary policy strategy in place, the oil price is again shocked with the estimated intensity. In addition, the correlation of the capital flow shock to the oil price disturbance is calibrated to 0.4789, the correlation of the two respective smoothed shocks' series in the estimation.

The effects of a positive oil price shock on real domestic variables are amplified in the presence of a concurrent capital inflow shock (Figure 4). The nominal exchange rate appreciates more strongly, despite increased central bank interventions and a lowered policy rate. As a consequence, prices for imported goods drop sharply in comparison to the separately occurring oil price shock. Although wages increase as in the former case, lower capital costs curb the increase in prices for domestically produced goods. Total consumer prices decrease on impact. Hence, there is no tradeoff for the monetary authority to stabilize either inflation or the exchange rate. The dimension of the nominal appreciation of the latter outweighs the reduction in the price level, so that the domestic currency appreciates in real terms, curbing non-oil exports and stimulating imports. As in the single-shock scenarios, domestic demand increases as a consequence of, both, higher commodity export revenues and ex-post real returns on bonds. The absolute effects on non-oil GDP, consumption, investment, non-oil exports and imports peak after three to five quarters and decrease gradually afterwards.

In absolute terms, simultaneously occurring shocks to oil prices and capital flows have the largest long-run effects on the real exchange rate, non-oil exports and imports as well as investment. Whereas both trade aggregates are affected to a comparable extent as in the single oil shock scenario, the impact on investment is lower. Due to a stronger nominal appreciation on impact and a faster return to the initial level in the quarters thereafter, the effect on the commodity price in local currency units and also the real exchange rate is much smaller and less persistent than without a concurrent capital flow shock.

5 Alternative monetary policy strategies

Based on the findings in the previous section, we analyze to which extent alternative monetary policy strategies could possibly limit the impact of external shocks, in particular to oil prices and capital flows, on the domestic economy. The variances of model variables following an oil price shock, a capital flow shock and both shocks occurring simultaneously, relative to the policy strategy in place, are presented in Tables 2, 7 and 8.

5.1 Inflation targeting

As a first policy alternative, a strategy is considered according to which the central bank adjusts its policy rate only in reaction to deviations of the inflation rate from its trend. The respective parameter ϕ_π is calibrated to its estimated value, whereas the exchange rate coefficient $\phi_{\Delta e}$ is set to zero. The central bank does not engage in any direct interventions on the foreign exchange market. Since its ability to control the exchange rate via the policy rate only is rather limited, the central bank takes lower (higher) import prices due to an appreciation (depreciation) as given and loosens (tightens) monetary policy to fuel (curb) domestic inflation to keep the overall price level rather stable.

Following an oil price shock, the central bank lowers its policy rate by more than under the actual strategy. However, it can not curb the effects on domestic variables, since the stronger appreciation of the domestic currency leads to even greater balance sheet effects and thus higher consumption, wages, domestic inflation and the total price index. The impact is less persistent, though, since the lower interest rate leads to a faster return of the exchange rate to its pre-shock level in light of a gradually weakening impulse from the oil price. Over the medium and long-term horizon, most domestic variables are less affected by the shock than under the estimated policy in place. The higher impact on domestic prices and the total price level stems almost fully from the initial impulse.

In the presence of a capital inflow shock, the central bank cuts the interest rate by less than under the actual policy to limit deflationary pressures on domestic prices, leading to an even stronger appreciation and higher imports in the very short-term. In contrast to the policy in place, the weaker policy reaction results in a less strong and persistent deviation from its steady-state so that the appreciation pressure on the domestic currency is remarkably lower in the course of the fast expiring shock. Consequently, the exchange rate overshoots its long-run trend by less with respectively weaker effects on the other variables. The total impact of the capital flow shock on the domestic economy under an inflation targeting strategy is remarkably lower compared to the actual policy.

In the case of simultaneously occurring shocks to oil prices and capital flows, the central bank does not have to react on impact, as falling import prices due to a very strong appreciation and higher domestic inflation following increased wage dynamics even. In light of the reduction of the initial shock impulses and the relatively loose monetary policy, the domestic currency appreciation quickly reverses, causing the central bank to raise its interest rate, as higher import prices increase total inflation. Its high persistence keeps the interest rate above its steady state and the exchange rate overvalued in real terms, with a negative impact on exports and a stimulus for imports. The relative variance of nearly all variables is nonetheless smaller under inflation targeting compared to the estimated policy in place. Total inflation is slightly stronger affected under the alternative strategy, in particular because of a strong increase in domestic prices on impact and a reversion of the exchange rate appreciation in the subsequent quarter.

5.2 Strict inflation targeting

Similar to the first policy alternative, we assume a strategy according to which the central bank reacts only to movements in the inflation rate. Contrary to the former alternative, however, we assume that the reaction is very strong. To capture this, the respective parameter is set to $\phi_\pi = \infty$. All other monetary policy parameters do not change compared to the moderate inflation targeting strategy.

By definition, the domestic inflation rate does not deviate from its trend, since the central bank adjusts its policy rate to whatever extent it takes to counter any shocks, with the respective effects on other domestic variables. Following an oil price shock that leads to an initial increase in the price level of domestically produced goods due to higher wages, the domestic interest rate increases by more, fueling a stronger appreciation of the domestic currency and a larger impact on exports and imports. Lower import prices compensate for the moderate increase in the domestic price level to stabilize total inflation. Except for the latter two variables, the home economy is affected stronger by oil price shocks compared to the policy in place.

In reaction to a capital inflow shock, the central bank lowers the policy rate to curb the effects of a stronger appreciation on prices. Consumption increases due to a decreased real interest rate, as do wages in light of a higher marginal rate of substitution between consumption and labor and consequently domestic prices. As under the current policy, the effects are not persistent and revert after less than one year. With capital flows returning to its trend, an enduringly lower interest rate and zero inflation cause the real exchange rate to overshoot its long-term level by even more than under the policy strategy in place. On the two-year horizon, most domestic variables are substantially more affected under strict inflation targeting. The larger imbalance leads, however, to a faster return to the steady state. In the long-run, only real wages are slightly more affected by this policy alternative, with all other domestic variables exhibiting a lower degree of impact.

Whereas the initial effect on inflation is the same on impact under both strategies, inflation targeting and strict inflation targeting differ in their policy reaction following the simultaneous disturbances to oil prices and capital flows. A lowered policy rate under the latter strategy curbs the currency's appreciation on impact and its reversion in the periods thereafter. Domestic prices increase only modestly, as lower capital costs more than outweigh the rise in wages. Consequently both, consumption and investment expenditures, are stimulated stronger. In the medium and long-run, the overall lower degree of real appreciation substantially reduces the volatility in most of the domestic variables, as compared to the actual policy strategy and the moderate inflation targeting alternative.

5.3 Hybrid inflation targeting

As a third policy alternative, we analyze a strategy according to which the central bank focuses primarily on movements of the inflation rate but also on deviations of output from its trend. Following Taylor (1993), we set the respective reaction coefficients to 1.5 and 0.5.

In the presence of an oil price shock, the central bank raises the interest rate only modestly to allow for a stronger appreciation of the domestic currency. This in turn has several positive effects on the authority's targeted variables: oil price revenues in domestic currency units increase by less than under the actual strategy, curbing the rise

1 Quarter	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	2.28	2.41	2.81	0.24	2.03
Consumption	1.13	1.70	1.06	0.66	1.02
Investment	0.39	0.44	0.52	0.30	1.01
Exports	0.91	0.79	1.10	0.29	1.53
Imports	1.23	1.36	1.27	0.48	1.34
Real wages	1.58	1.91	1.07	1.67	0.73
Inflation	0.00	0.00	4.77	23.15	14.77
Dom. prices	5.17	4.91	0.26	27.36	0.78
Real ER	2.67	2.33	3.19	0.11	2.66
4 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.79	0.85	0.84	0.20	1.31
Consumption	0.46	0.55	0.60	0.28	1.11
Investment	0.30	0.30	0.46	0.33	0.95
Exports	0.49	0.41	0.65	0.35	1.22
Imports	0.49	0.47	0.63	0.30	1.18
Real wages	0.73	0.63	0.74	0.56	1.22
Inflation	1.11	0.00	1.66	7.05	4.84
Dom. prices	4.28	3.26	0.46	17.93	0.53
Real ER	0.99	0.86	1.22	0.20	1.61
8 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.68	0.73	0.70	0.28	1.17
Consumption	0.41	0.46	0.58	0.39	1.00
Investment	0.36	0.34	0.57	0.50	0.89
Exports	0.51	0.42	0.69	0.50	1.13
Imports	0.45	0.42	0.62	0.42	1.07
Real wages	0.66	0.56	0.71	0.59	1.16
Inflation	1.13	0.00	1.67	7.04	4.98
Dom. prices	2.50	1.93	0.37	10.67	0.33
Real ER	0.89	0.77	1.12	0.30	1.49
∞	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.78	0.81	0.87	0.54	1.14
Consumption	0.64	0.65	0.93	0.78	1.00
Investment	0.64	0.58	1.01	1.01	0.88
Exports	0.70	0.59	0.94	0.80	1.11
Imports	0.62	0.56	0.85	0.70	1.06
Real wages	0.87	0.75	1.00	0.91	1.16
Inflation	1.12	0.00	1.87	7.25	4.98
Dom. prices	2.34	1.78	0.67	10.24	0.32
Real ER	0.95	0.82	1.20	0.40	1.47

Table 2: Variances following simultaneous shocks to oil prices and capital flows under inflation targeting (IT), strict inflation targeting (SIT), hybrid inflation targeting (HIT), a fixed exchange rate (FIX) and ruble price of oil targeting (ROIL), relative to current policy

in domestic demand, wages and thus the domestic goods inflation. In addition, prices for imported goods fall more sharply, limiting the increase in total inflation. On the other hand, the stronger currency appreciation holds true also in real terms, translating to a higher volatility of non-fuel exports and imports.

The reaction of the monetary policy to a capital inflow shock under hybrid inflation targeting is similar to the ordinary inflation targeting case, with the effects on most of the variables being almost identical. Simultaneously occurring shocks to the oil price and capital flows lead to a fall in the rate of total inflation, as import prices fall more sharply in light of a strongly appreciating currency, whereas domestic prices rise only moderately against the background of a modest increase in wages. As under the inflation targeting strategy, the fast reduction in capital flows and the return of the oil price to its pre-shock level, put depreciation pressure on the domestic currency in the subsequent quarters. The initial effects on prices reverse quickly leading to an increase in the real interest rate and consequently higher domestic demand. Over the medium and long-term, the strategy of hybrid inflation targeting does not outperform the previous two alternatives and does not appear to be superior to the policy in place.

5.4 Fixed exchange rate

This alternative policy is characterized by the central bank's strategy to fix its currency's exchange rate by conducting unlimited direct interventions on the foreign exchange market. Consequently, the reaction coefficient in the intervention rule is set to $\phi_{\Delta e,int} = \infty$. The interest rate is not used as a policy instrument, as in reality it cannot be set independently of the foreign exchange market operations. Since in the model specification it is assumed that the central bank is capable to fully sterilize its interventions, the latter does not have any effects on the former so that it remains at its steady state level.

Foreign capital shocks are completely offset by the monetary policy serving excess demand for and demanding excess supply of foreign currency via sales and purchase of its reserves. Domestic variables remain unaffected.

Shocks to the oil price, however, translate one-to-one to higher revenues quoted in domestic currency, stimulating consumption and total output. Trade aggregates are affected less, since the impact of the disturbance on the real exchange rate is modest. Absent this channel and with the oil price gradually returning to its pre-shock level, the effects of its initial increase on income and spending decline. Except for the very short-term, the domestic economy as a whole is shielded better from a commodity price shock under an exchange rate peg, compared to the policy in place and different kinds of inflation targeting strategies. However, with the exchange rate and thus prices of imported goods held constant, consumer prices are stronger affected by the higher volatility of the domestic price level.

Since shocks to foreign capital flows can be fully neutralized by central bank interventions, the effects of the disturbance in combination with a simultaneous oil price shock correspond exactly to the latter occurring independently. Relative to the outcome under alternative strategies, in which import prices drop following an even stronger appreciation to curb the total price level, consumer price inflation is even more affected under the peg regime, as higher wages push the domestic price level and monetary policy cannot be tightened to counter this development.

5.5 Ruble price of oil targeting

Finally, we analyze the alternative strategy of the CBR targeting the ruble price of oil, so that it intervenes to match the rate of exchange rate appreciation (depreciation) to the change in the price of oil on the world market. This policy alternative is motivated by Frankel (2005), who argues that countries that are specialized in exporting one particular commodity should fix its price in terms of the local currency since this would automatically accommodate shocks to the terms of trade. The strategy should provide a credible nominal anchor to monetary policy and be based on reliable 'now data', reducing problems associated with time-inconsistency. We implement the policy strategy by including the domestic currency price of oil in the intervention rule and setting the respective reaction coefficient to infinity.

As in the case of an exchange rate peg, foreign capital shocks are completely offset by the monetary policy, so that domestic variables remain unaffected.

Following a positive shock to the oil price, the central bank amplifies the exchange rate appreciation via foreign exchange interventions. Prices for imported goods drop sharply, causing the total price level to decrease. Imports soar against the background of the strong real appreciation, whereas demand for exports declines. Higher income fuels consumption expenditures and wage growth that subsequently translates to higher domestic prices. This consequently leads to an increase of the overall price index, since import prices recover in the light of the domestic currency's depreciation caused by the gradual return of the oil price to its pre-shock level. Even though the economy is hit much stronger by the shock in the short-term than under any other strategy, the long-run effects only slightly exceed those under the policy in place. However, this holds true only for temporary shocks to the oil price and consequently temporary real exchange rate misvaluations. As a strategy to primarily fend off short-term fluctuations, ruble price of oil targeting proves ineffective and even rather destabilizing. Herz et al. (2015) come to a similar conclusion.

Again, as in the case of exchange rate pegs, shocks to foreign capital flows can be fully neutralized by central bank interventions so that the effects of oil price shocks on the economy are the same independent of a contemporaneous capital flow shock.

Also, relative effects compared to the policy in place and other alternatives do not differ substantially.

5.6 Alternative policy forecast error variance decomposition

After the analysis of the effects of shocks to oil prices and capital flows under different policy regimes, we turn our attention to how domestic variables are affected from all modeled disturbances under possible policy alternatives. Therefore, we simulate the model for the strategies presented in the preceding sections and compare the forecast error variance decompositions at different time horizons to the estimated policy in place. For reasons of consistency, we exclude the two monetary policy shocks in the model and adjust the deviations in the alternative scenarios respectively. Results are presented in the Tables 3, 9, 10, 11 and 12.

Compared to the monetary policy strategy in place, the relative impact of oil price shocks on the volatility of inflation and output can only be reduced at all horizons when adapting hybrid targeting. In addition, it most strongly increases the relative importance of technology shocks in describing the behavior of real variables, to comply with the theory of real business cycles. Also in line with theory, hybrid targeting of inflation and output leads to a tradeoff for the central bank in the presence of supply shocks and consequently a higher relative impact of these disturbance on the inflation rate compared to the current strategy.

As already proposed by the consideration of single capital flow shocks, the relative importance of these disturbances to fluctuations of nearly all domestic variables can substantially be reduced at all horizons by adapting any of the proposed policy alternatives. Analogously, however, in all of the three proposed inflation targeting regimes real GDP is affected stronger on impact.

Under a fixed exchange rate regime, capital flow shocks would be fully compensated by respective foreign exchange interventions and thus have no effect on domestic variables. However, oil price shocks would result in an amplification of their inherent impact on the exchange rate, imported prices and total inflation that the central bank cannot mitigate due to the abandonment of an independent monetary policy.

Ruble price of oil targeting proves inferior to the policy in place as well as the other alternatives. Whereas it offsets the impact on nominal exchange rate dynamics caused by non-fundamental capital flows, it induces exchange rate fluctuations according to movements in oil prices that affect the domestic economy via an increased volatility of absolute and relative prices.

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.9	-21.1	24.4	2.2	-8.1	-5.1	-16.8	4.7	-1.8	0.5
Consumption	-3.0	-2.6	0.0	-3.2	1.2	1.8	0.2	1.2	-1.1	0.0
Investment	0.0	-0.4	-0.6	1.7	-0.3	1.0	0.0	-2.1	0.3	0.0
Exports	-0.2	-18.0	-3.8	-6.6	25.7	-13.3	1.2	0.2	-3.0	-0.3
Imports	-4.0	-14.0	1.9	0.9	3.0	-7.0	-0.1	1.0	0.1	0.2
Real wages	-13.3	-11.9	-10.8	17.7	-24.4	-1.7	0.1	18.1	1.1	-0.1
Inflation	-15.3	-28.8	-23.2	20.2	-21.2	1.0	0.4	21.3	1.7	-0.1
Dom. Prices	-13.3	-11.9	-10.8	17.7	-24.4	-1.7	0.1	18.1	1.1	-0.1
Real ER	-0.3	-83.2	13.4	-2.5	3.8	-18.5	1.0	5.6	-3.6	0.8
4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-0.7	-7.6	1.4	4.1	-6.3	1.6	-3.5	3.5	-0.9	0.1
Consumption	-1.3	-6.3	-7.0	16.9	2.4	-11.9	-0.4	-3.0	2.9	0.1
Investment	-0.4	-0.2	-0.4	2.7	-1.0	0.9	0.0	-2.6	0.5	0.0
Exports	-3.5	-7.2	-8.2	-7.1	30.2	-12.1	1.3	-1.2	-2.8	-0.1
Imports	-2.9	-13.0	-14.8	11.6	-12.6	-0.8	0.1	14.5	2.1	0.0
Real wages	-3.5	-3.2	-3.6	0.0	-1.8	2.1	0.2	2.9	0.3	0.1
Inflation	-14.7	-29.5	-26.5	21.2	-19.7	-0.6	0.6	24.0	1.4	-0.4
Dom. Prices	-12.3	-12.9	-12.4	18.4	-23.8	-3.3	0.3	20.1	0.8	-0.2
Real ER	-1.6	-35.0	9.5	-4.2	8.6	-16.2	1.2	3.7	-3.3	0.8
8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.5	-3.8	0.8	4.0	-6.5	1.8	-1.6	1.8	-0.2	0.0
Consumption	-3.9	-4.6	-4.7	20.2	-2.0	-11.7	-0.3	-4.2	2.8	-0.1
Investment	-1.2	-0.2	-0.1	3.5	-2.3	0.5	0.0	-2.0	0.5	-0.1
Exports	-9.5	-3.8	-2.7	-7.8	25.0	-8.7	1.2	-4.7	-2.2	-0.2
Imports	-8.7	-7.1	-7.2	11.7	-24.1	3.5	0.1	14.5	1.9	-0.4
Real wages	-5.3	-2.8	-2.6	5.4	-3.8	0.6	0.1	0.6	-0.3	0.0
Inflation	-14.8	-29.0	-26.0	21.4	-19.7	-1.7	0.6	25.0	1.2	-0.7
Dom. Prices	-12.1	-12.6	-12.3	18.7	-23.5	-4.8	0.3	21.3	0.6	-0.4
Real ER	-6.6	-24.1	10.8	-5.2	6.7	-12.0	1.2	0.8	-2.7	0.4
∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-2.7	-3.8	-1.1	4.4	-6.2	0.6	-0.9	3.3	0.0	-0.2
Consumption	-6.8	-6.0	-6.5	14.3	-3.1	-6.4	-0.1	1.2	1.0	-0.3
Investment	-2.9	-1.7	-1.9	4.7	-3.5	0.1	0.0	0.3	0.6	-0.2
Exports	-12.5	-8.9	-8.9	-6.6	29.0	-4.8	1.0	-7.9	-1.3	-0.5
Imports	-13.1	-11.2	-12.4	11.8	-19.3	3.6	0.2	15.4	1.7	-0.8
Real wages	-7.1	-4.6	-4.8	4.9	-3.5	0.0	0.1	3.9	-0.4	-0.2
Inflation	-15.1	-29.0	-26.4	21.7	-19.7	-1.7	0.6	25.2	1.1	-0.8
Dom. Prices	-12.5	-12.8	-12.6	18.9	-23.6	-4.6	0.3	21.5	0.5	-0.6
Real ER	-9.4	-22.4	4.8	-5.2	12.4	-8.3	1.1	-2.9	-1.9	0.0

Table 3: Forecast error variance decomposition at different horizons under hybrid inflation targeting, in percentage point deviations from the current policy, adjusted for absence of monetary policy shocks

6 Conclusion

Russian monetary policy has been challenged by large and continuous private capital outflows and a sharp drop in oil prices during 2014, with both ongoings having put a significant depreciation pressure on the ruble. In order to mitigate the impact on its currency, the central bank repeatedly raised its key policy rate and directly intervened on the foreign exchange market. However, its policy measures could not prevent a strong depreciation of the ruble, while raised interest rates might have posed an additional obstacle for the already weak economy. This work estimates a small open economy model for Russia, featuring an oil price sector and extended by a specification of the foreign exchange market to correctly account for systematic central bank interventions. We find that shocks to the oil price and private capital flows substantially affect domestic variables, such as inflation, output and the exchange rate. Simulations of the model for the estimated actual strategy and five alternative regimes suggest that the vulnerability of the Russian economy to external shocks can be substantially lowered by adopting some form of inflation targeting strategy. Foreign exchange intervention-based policy strategies to target the nominal exchange rate or the ruble price of oil, on the other hand, prove inferior to the policy in place, in particular because of the lacking ability of conducting independent monetary policy via the interest rate. However, in the presence of non-fundamental capital flow shocks, interventions may be helpful to offset destabilizing effects from their impact on the exchange rate. Although these implications do not qualitatively differ from the ones argued for in comparable studies in the past, the analysis in this work has been conducted by properly accounting for foreign exchange interventions of the central bank and also by introducing non-fundamental capital flows that have a direct impact on the exchange rate and thus on potential policy strategies that aim at a stabilization of the latter. Even though capital flows are regarded as non-fundamental in the sense that their dynamics are not explained by other model variables, large and continuous capital outflows are not random in reality. Since our analysis finds them to strongly affect the domestic economy, any political arbitrariness as well as legal and political uncertainty that might cause them should be regarded as obstacles to a sound economic development.

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Appendix A: Log-linearized model equations

Marginal utility of consumption:

$$\lambda_t = \left(-\left(\frac{\sigma_c}{1-h}\right)\right)\,(c_t - h\,c_{t-1}) + \varepsilon_t^b \tag{66}$$

Marginal utility of savings:

$$\lambda_t = r_t + \lambda_{t+1} - \pi_{t+1} - \xi\,b_t \tag{67}$$

Wage dynamics:

$$\begin{aligned} w_t = \quad & \tfrac{\beta}{1+\beta}\,w_{t+1} + \tfrac{1}{1+\beta}\,w_{t-1} + \pi_{t+1}\,\tfrac{\beta}{1+\beta} + \tfrac{1+\beta\,\delta^w}{1+\beta}\,\pi_t + \tfrac{\delta^w}{1+\beta}\,\pi_{t-1} - \tfrac{1}{1+\beta}\,\tfrac{(1-\beta\,\theta^w)\,(1-\theta^w)}{\theta^w\,\left(1+\frac{(1+\lambda^w)\,\varphi}{\lambda^w}\right)} \\ & \times\left(w_t - \varphi\,l_t - \tfrac{\sigma}{1-h}\,(c_t - h\,c_{t-1}) - \varepsilon_t^l\right) \end{aligned} \tag{68}$$

Shadow price of capital:

$$t_t = \xi\,b_t + \pi_{t+1} - r_t + \beta\,\left(\bar{r}^k\,r_{t+1}^k + (1-\delta)\,t_{t+1}\right) \tag{69}$$

Investment Euler equation:

$$i_t = f_t\,\frac{1}{(1+\beta)\,\varkappa} + \frac{1}{1+\beta}\,i_{t-1} + \frac{\beta}{1+\beta}\,i_{t+1} + \frac{1}{1+\beta}\,\left(\beta\,\varepsilon_{t+1}^i - \varepsilon_t^i\right) \tag{70}$$

Capital law of motion:

$$k_t = (1-\delta)\,k_{t-1} + \delta\,i_t \tag{71}$$

Labor demand:

$$l_t = k_{t-1} + (1+\omega)\,r_t^k - w_t \tag{72}$$

Marginal cost:

$$mc_t = w_t\,(1-\psi) + r_t^k\,\psi - a_t \tag{73}$$

Marginal cost exported goods:

$$mc_t^x = mc_t - q_t - p_t^x \tag{74}$$

Marginal cost imported goods:

$$mc_t^m = q_t - p_t^m \tag{75}$$

Domestic goods inflation:

$$\pi_t^h - \delta^h\,\pi_{t-1}^h = \kappa_h\,\left(mc_t - p_t^h\right) + \beta\,\left(\pi_{t+1}^h - \pi_t^h\,\delta^h\right) \tag{76}$$

with:

$$\kappa_h = \frac{\left(1-\theta^h\right)\,\left(1-\theta^h\,\beta\right)}{\theta^h} \tag{77}$$

Exported goods inflation:

$$\pi_t^x - \delta^x\,\pi_{t-1}^x = mc_t^x\,\kappa_x + \beta\,\left(\pi_{t+1}^x - \pi_t^x\,\delta^x\right) \tag{78}$$

with:

$$\kappa_x = \frac{(1-\theta^x)\,(1-\beta\,\theta^x)}{\theta^x} \tag{79}$$

Imported goods inflation:

$$\pi_t^m - \delta^m \pi_{t-1}^m = mc_t^m \kappa_m + \beta \left(\pi_{t+1}^m - \pi_t^m \delta^m\right) \tag{80}$$

with:

$$\kappa_m = \frac{(1-\theta^m)\,(1-\beta\,\theta^m)}{\theta^m} \tag{81}$$

Consumer price inflation:

$$\pi_t = \alpha\,\pi_t^h + (1-\alpha)\,\pi_t^m \tag{82}$$

Price level domestic goods:

$$p_t^h = p_t^m \left(-\left(\frac{1-\alpha}{\alpha}\right)\right) \tag{83}$$

Price level exported goods:

$$p_t^x = \pi_t^x + p_{t-1}^x - \pi_t^* \tag{84}$$

Price level imported goods:

$$p_t^m = \pi_t^m + p_{t-1}^m - \pi_t \tag{85}$$

GDP deflator:

$$p_t^y = \phi_x\,(q_t + p_t^x) + \phi_o\,\left(q_t + p_t^O\right) - p_t^m\,\phi_m \tag{86}$$

Domestic production:

$$y_t = a_t + k_{t-1}\,\psi + r_t^k\,\omega\,\psi + l_t\,(1-\psi) \tag{87}$$

Demand for domestic goods:

$$y_t^h = (-\eta)\,p_t^h + \left(\frac{\phi_c}{\phi_c+\phi_i}\right) c_t + \left(\frac{\phi_i}{\phi_c+\phi_i}\right) i_t \tag{88}$$

Demand for exported goods:

$$x_t = (-\eta^x)\,p_t^x + y_t^* \tag{89}$$

Demand for imported goods:

$$m_t = (-\eta)\,p_t^m + \left(\frac{\phi_c}{\phi_c+\phi_i}\right) c_t + \left(\frac{\phi_i}{\phi_c+\phi_i}\right) i_t \tag{90}$$

Non-oil GDP:

$$y_t = \frac{1}{1-\phi_o}\,(\phi_c c_t + \phi_i i_t + \phi_x\,x_t - \phi_m\,m_t) + \varepsilon_t^g \tag{91}$$

Total GDP:

$$gdp_t = \phi_o\,(q_t + p_t^o) + (1-\phi_o)\,\left(y_t + p_t^h\right) - p_t^y \tag{92}$$

Total economy budget constraint:

$$\phi_b\left(b_t - \frac{1}{\beta}\,b_{t-1}\right) = \phi_o\,\left(q_t + p_t^O\right) + \phi_x\,(q_t + p_t^x + x_t) - \phi_m\,(p_t^m + m_t) + \frac{\phi_b}{\beta}\,(r_{t-1} - \pi_t) \tag{93}$$

Real exchange rate:

$$q_t = \pi_t^* + q_{t-1} + \Delta e_t - \pi_t \tag{94}$$

Uncovered interest parity condition:

$$\Delta e_{t+1} = r_t - r_t^* + \gamma\sigma_{\Delta e}^2\left(\omega_t^* + \omega_t^{*,CB}\right) \tag{95}$$

Monetary policy rule:

$$r_t = r_{t-1}\,\rho_r + (1-\rho_r)\,\left(\pi_t\,\phi_\pi + \Delta e_t\,\phi_{\Delta e}\right) + \eta_t^m \tag{96}$$

Central bank intervention rule:

$$\omega_t^{*,CB} = \phi_{\Delta e,int}\Delta e_t + \eta_t^{int} \tag{97}$$

Foreign capital flows:

$$\omega_t^* = \rho_{\omega^*}\,\omega_{t-1}^* + \eta_t^{\omega^*} \tag{98}$$

Oil price:

$$p_t^o = \rho_o\,p_{t-1}^o + \eta_t^o \tag{99}$$

Technology shock

$$a_t = \rho_a\,a_{t-1} + \eta_t^a \tag{100}$$

Preference shock:

$$\varepsilon_t^b = \rho_b\,\varepsilon_{t-1}^b + \eta_t^b \tag{101}$$

Government spending shock:

$$\varepsilon_t^g = \rho_g\,\varepsilon_{t-1}^g + \eta_t^g \tag{102}$$

Investment shock:

$$\varepsilon_t^i = \rho_i\,\varepsilon_{t-1}^i + \eta_t^i \tag{103}$$

Labor supply shock:

$$\varepsilon_t^l = \rho_l\,\varepsilon_{t-1}^l + \eta_t^l \tag{104}$$

And the variables of the foreign block outlined in (57).

Appendix B: Tables and figures

Parameter		Value
Discount parameter	β	0.9900
Depreciation rate	δ	0.0250
Share of capital in production	ψ	1/3
Net wage markup	λ^w	0.1500
Share of foreign goods in consumption	α	0.2300
Nominal ER depreciation variance	$\sigma^2_{\Delta e}$	0.0065
Risk aversion parameter	γ	200.00
Portfolio adjustment cost	ψ^b	0.1000
Steady-state consumption to GDP	ϕ_c	0.5000
Steady-state investment to GDP	ϕ_i	0.2000
Steady-state non-fuel exports to GDP	ϕ_x	0.1200
Steady-state imports to GDP	ϕ_m	0.1600
Steady-state fuel exports to GDP	ϕ_o	0.1700
Steady-state reserves to GDP	ϕ_b	0.9000

Table 4: Calibrated parameter and steady state values

Parameter		Distribution	Mean	St. Dev.
Relative risk aversion	σ	Gamma	1.20	0.40
Inverse labor supply elasticity	ϕ	Gamma	1.50	0.75
Habit persistence	h	Beta	0.50	0.25
Fixed cost	φ	Gamma	1.45	0.25
Capital utilization adj. Cost	ω	Gamma	0.20	0.08
Investment adj. Cost	$\varkappa$	Gamma	4.00	0.75
Elasticity home/foreign goods	η	Gamma	1.00	0.75
Elasticity foreign/home goods abroad	η^x	Gamma	1.00	0.75
Calvo domestic goods	θ^h	Beta	0.50	0.10
Calvo exported goods	θ^x	Beta	0.50	0.10
Calvo imported goods	θ^m	Beta	0.50	0.10
Calvo wages	θ^w	Beta	0.50	0.10
Indexation domestic goods	δ^h	Beta	0.50	0.25
Indexation exported goods	δ^x	Beta	0.50	0.25
Indexation imported goods	δ^m	Beta	0.50	0.25
Indexation wages	δ^w	Beta	0.50	0.25
Interest rate smoothing	ρ_r	Beta	0.80	0.10
Taylor coefficient inflation	ϕ_π	Gamma	1.50	0.30
Taylor coefficient exch. Rate	$\phi_{\Delta e}$	Gamma	0.50	0.13
Intervention coefficient exch. Rate	$\phi_{\Delta e,int}$	Gamma	0.50	0.13
AR(1) parameter oil price	ρ_{po}	Beta	0.20	0.15
AR(1) parameter capital flows	ρ_{ω^*}	Beta	0.40	0.15
AR(1) parameter technology	ρ_a	Beta	0.80	0.10
AR(1) parameter gov. Spending	ρ_g	Beta	0.80	0.10
AR(1) parameter preferences	ρ_b	Beta	0.80	0.10
AR(1) parameter labor supply	ρ_l	Beta	0.80	0.10
AR(1) parameter investment	ρ_i	Beta	0.80	0.10
S.d. monetary policy shock	η^m	Inv. Gamma	0.01	2.00
S.d. capital flow shock	η^{ω^*}	Inv. Gamma	0.05	2.00
S.d. intervention shock	η^{int}	Inv. Gamma	0.15	2.00
S.d. oil price shock	η^{po}	Inv. Gamma	0.15	2.00
S.d. technology shock	η^a	Inv. Gamma	0.01	2.00
S.d. gov. spending shock	η^g	Inv. Gamma	0.01	2.00
S.d. preference shock	η^b	Inv. Gamma	0.01	2.00
S.d. labor supply shock	η^l	Inv. Gamma	0.01	2.00
S.d. investment shock	η^i	Inv. Gamma	0.01	2.00
S.d. foreign output shock	η^{y^*}	Inv. Gamma	0.01	2.00
S.d. foreign inflation shock	η^{π^*}	Inv. Gamma	0.01	2.00
S.d. foreign interest shock	η^{r^*}	Inv. Gamma	0.01	2.00

Table 5: Prior means and standard deviations

Parameter		Mean	90% Prob.	
Relative risk aversion	σ	1.0349	0.7147	1.3539
Inverse labor supply elasticity	ϕ	0.0711	0.0116	0.1280
Habit persistence	h	0.3953	0.2335	0.5521
Fixed cost	φ	1.4509	1.0455	1.8472
Capital utilization adj. Cost	ω	0.1707	0.0617	0.2755
Investment adj. Cost	$\varkappa$	6.2959	4.8374	7.6526
Elasticity home/foreign goods	η	0.4222	0.1424	0.6852
Elasticity foreign/home goods abroad	η^x	0.8754	0.4704	1.2660
Calvo domestic goods	θ^h	0.2236	0.1471	0.2984
Calvo exported goods	θ^x	0.6667	0.5673	0.7684
Calvo imported goods	θ^m	0.3886	0.2695	0.5030
Calvo wages	θ^w	0.1196	0.0658	0.1728
Indexation domestic goods	δ^h	0.2584	0.0030	0.5105
Indexation exported goods	δ^x	0.1760	0.0008	0.3743
Indexation imported goods	δ^m	0.5602	0.1793	0.9702
Indexation wages	δ^w	0.1379	0.0005	0.2952
Interest rate smoothing	ρ_r	0.9324	0.9078	0.9566
Taylor coefficient inflation	ϕ_π	1.4436	0.9737	1.8873
Taylor coefficient exch. Rate	$\phi_{\Delta e}$	0.5017	0.3108	0.6859
Intervention coefficient exch. Rate	$\phi_{\Delta e,int}$	0.8957	0.7217	1.0689
AR(1) parameter oil price	ρ_{po}	0.7943	0.7289	0.8581
AR(1) parameter capital flows	ρ_{ω^*}	0.2354	0.1248	0.3470
AR(1) parameter technology	ρ_a	0.8959	0.8389	0.9542
AR(1) parameter gov. Spending	ρ_g	0.7591	0.6309	0.8890
AR(1) parameter preferences	ρ_b	0.7937	0.7341	0.8563
AR(1) parameter labor supply	ρ_l	0.7338	0.5826	0.8853
AR(1) parameter investment	ρ_i	0.7777	0.6938	0.8618
S.d. monetary policy shock	η^m	0.0066	0.0054	0.0078
S.d. capital flow shock	η^{ω^*}	0.0615	0.0524	0.0707
S.d. intervention shock	η^{int}	0.0841	0.0706	0.0973
S.d. oil price shock	η^{po}	0.1446	0.1232	0.1657
S.d. technology shock	η^a	0.0184	0.0142	0.0224
S.d. gov. spending shock	η^g	0.0120	0.0102	0.0139
S.d. preference shock	η^b	0.0837	0.0683	0.0978
S.d. labor supply shock	η^l	0.0307	0.0222	0.0388
S.d. investment shock	η^i	0.0802	0.0561	0.1037
S.d. foreign output shock	η^{y^*}	0.0041	0.0035	0.0047
S.d. foreign inflation shock	η^{π^*}	0.0039	0.0033	0.0044
S.d. foreign interest shock	η^{r^*}	0.0012	0.0011	0.0014

Table 6: Posterior means and probability distributions

1 Quarter	IT	SIT	HIT	FIX	ROIL
Real GDP	1.41	2.28	0.43	1.33	11.06
Consumption	1.16	0.81	1.11	1.42	2.20
Investment	0.74	1.21	1.05	0.73	2.45
Exports	1.07	1.87	1.46	0.88	4.73
Imports	1.16	1.20	1.24	1.21	3.39
Real wages	1.19	0.47	0.78	1.48	0.64
Inflation	1.17	0.00	0.21	1.77	1.13
Dom. prices	1.20	0.10	0.42	1.61	0.05
Real ER	1.68	5.04	3.20	1.07	26.01
4 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.93	1.79	0.37	0.91	5.86
Consumption	0.93	1.61	1.38	0.94	3.65
Investment	0.64	1.20	1.00	0.61	1.76
Exports	0.91	1.57	1.23	0.74	2.63
Imports	0.91	1.55	1.27	0.82	3.26
Real wages	1.09	1.21	1.10	1.08	2.36
Inflation	1.22	0.00	0.20	1.78	1.22
Dom. prices	1.22	0.13	0.42	1.59	0.05
Real ER	1.05	2.11	1.56	0.82	6.48
8 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.68	1.29	0.38	0.70	2.96
Consumption	0.76	1.32	1.15	0.75	1.95
Investment	0.60	1.08	0.92	0.58	1.02
Exports	0.82	1.39	1.08	0.67	1.50
Imports	0.76	1.30	1.07	0.68	1.75
Real wages	0.94	1.22	1.04	0.87	1.70
Inflation	1.18	0.00	0.22	1.76	1.24
Dom. prices	1.19	0.13	0.44	1.58	0.05
Real ER	0.87	1.63	1.23	0.69	3.48
∞	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.70	1.18	0.67	0.75	1.57
Consumption	0.85	1.39	1.26	0.84	1.08
Investment	0.67	1.10	0.99	0.65	0.57
Exports	0.88	1.44	1.12	0.72	1.00
Imports	0.80	1.32	1.11	0.73	1.11
Real wages	0.99	1.41	1.15	0.88	1.12
Inflation	1.14	0.00	0.31	1.75	1.21
Dom. prices	1.14	0.13	0.50	1.55	0.05
Real ER	0.89	1.58	1.20	0.71	2.61

Table 7: Variances following a shock to oil prices under inflation targeting (IT), strict inflation targeting (SIT), hybrid inflation targeting (HIT), a fixed exchange rate (FIX) and ruble price of oil targeting (ROIL), relative to current policy

1 Quarter	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	3.08	2.51	5.96	0.00	0.00
Consumption	1.05	4.67	0.98	0.00	0.00
Investment	0.04	0.01	0.03	0.00	0.00
Exports	0.71	0.07	0.70	0.00	0.00
Imports	1.37	1.67	1.34	0.00	0.00
Real wages	2.08	102.65	2.17	0.00	0.00
Inflation	0.72	0.00	0.69	0.00	0.00
Dom. prices	0.51	0.08	0.48	0.00	0.00
Real ER	3.20	1.41	3.19	0.00	0.00
4 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	1.03	0.94	1.97	0.00	0.00
Consumption	0.18	0.44	0.17	0.00	0.00
Investment	0.05	0.96	0.07	0.00	0.00
Exports	0.15	0.61	0.15	0.00	0.00
Imports	0.24	0.45	0.23	0.00	0.00
Real wages	0.21	1.15	0.21	0.00	0.00
Inflation	0.60	0.00	0.59	0.00	0.00
Dom. prices	0.41	0.17	0.39	0.00	0.00
Real ER	1.63	0.93	1.62	0.00	0.00
8 Quarters	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	1.04	1.11	1.96	0.00	0.00
Consumption	0.26	0.92	0.27	0.00	0.00
Investment	0.51	3.99	0.60	0.00	0.00
Exports	0.36	2.31	0.36	0.00	0.00
Imports	0.36	1.21	0.37	0.00	0.00
Real wages	0.35	1.90	0.35	0.00	0.00
Inflation	0.60	0.00	0.59	0.00	0.00
Dom. prices	0.41	0.17	0.38	0.00	0.00
Real ER	1.60	1.15	1.60	0.00	0.00
∞	**IT**	**SIT**	**HIT**	**FIX**	**ROIL**
Real GDP	0.67	0.86	1.23	0.00	0.00
Consumption	0.19	0.79	0.21	0.00	0.00
Investment	0.14	0.81	0.16	0.00	0.00
Exports	0.17	0.97	0.16	0.00	0.00
Imports	0.20	0.78	0.21	0.00	0.00
Real wages	0.23	1.23	0.22	0.00	0.00
Inflation	0.58	0.00	0.58	0.00	0.00
Dom. prices	0.39	0.16	0.37	0.00	0.00
Real ER	1.16	0.93	1.15	0.00	0.00

Table 8: Variances following a shock to foreign capital flows under inflation targeting (IT), strict inflation targeting (SIT), hybrid inflation targeting (HIT), a fixed exchange rate (FIX) and ruble price of oil targeting (ROIL), relative to current policy

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.9	-21.1	18.9	-4.1	0.7	-0.7	-9.2	-4.1	-1.9	0.4
Consumption	-3.0	-2.6	0.1	-1.4	1.7	-0.1	0.0	0.3	-0.6	0.0
Investment	0.0	-0.4	-0.5	0.2	-0.6	1.1	0.0	-0.2	0.1	0.0
Exports	-0.2	-18.0	-4.9	0.9	4.4	-0.8	0.0	0.9	-0.1	-0.4
Imports	-4.0	-14.0	2.9	-1.3	2.4	-1.8	0.0	-2.1	-0.3	0.2
Real wages	-13.3	-11.9	-6.7	0.1	3.6	2.3	0.0	-0.1	0.5	0.4
Inflation	-15.3	-28.8	-8.6	0.1	3.1	3.9	0.0	-0.2	0.7	1.0
Dom. Prices	-13.3	-11.9	-6.7	0.1	3.6	2.3	0.0	-0.1	0.5	0.4
Real ER	-0.3	-83.2	17.8	-1.6	-4.8	-10.4	-0.1	0.1	-1.9	0.8
4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-0.7	-7.6	0.1	0.1	-0.7	1.3	-0.3	-1.2	0.5	0.2
Consumption	-1.3	-6.3	-6.6	3.1	0.2	-0.1	0.1	0.8	2.4	0.1
Investment	-0.4	-0.2	-0.4	0.3	-1.4	1.4	0.0	-0.1	0.2	0.0
Exports	-3.5	-7.2	-8.3	1.1	6.0	-0.3	0.0	1.3	0.0	0.2
Imports	-2.9	-13.0	-12.1	1.9	4.9	1.1	0.0	2.4	1.4	0.4
Real wages	-3.5	-3.2	-3.5	-0.4	2.3	0.7	0.0	0.6	0.2	0.1
Inflation	-14.7	-29.5	-12.0	0.3	5.6	4.4	0.0	-0.1	0.8	0.9
Dom. Prices	-12.3	-12.9	-8.6	0.3	5.2	2.4	0.0	-0.1	0.5	0.3
Real ER	-1.6	-35.0	10.8	-0.5	-5.2	-5.2	0.0	0.4	-0.9	0.7
8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.5	-3.8	0.1	0.9	-2.8	1.7	-0.3	0.0	0.5	0.0
Consumption	-3.9	-4.6	-4.2	5.4	-3.8	-0.5	0.1	0.5	2.6	-0.1
Investment	-1.2	-0.2	-0.1	0.6	-2.7	1.5	0.0	0.7	0.2	-0.1
Exports	-9.5	-3.8	-2.7	0.6	1.6	-0.5	0.0	1.1	-0.1	-0.1
Imports	-8.7	-7.1	-5.1	2.7	-5.6	2.5	0.0	4.4	1.1	-0.1
Real wages	-5.3	-2.8	-2.4	1.6	-0.6	0.7	0.0	0.5	0.2	0.0
Inflation	-14.8	-29.0	-11.6	0.3	5.2	4.5	0.0	0.1	0.8	0.6
Dom. Prices	-12.1	-12.6	-8.5	0.3	4.9	2.5	0.0	0.1	0.5	0.2
Real ER	-6.6	-24.1	11.9	-0.6	-8.5	-2.7	0.0	0.0	-0.5	0.4
∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-2.7	-3.8	-1.4	1.5	-3.2	0.9	-0.1	2.2	0.4	-0.1
Consumption	-6.8	-6.0	-6.0	4.8	-1.1	-0.3	0.1	1.1	1.6	-0.2
Investment	-2.9	-1.7	-1.8	1.0	-3.7	1.3	0.0	3.3	0.2	-0.2
Exports	-12.5	-8.9	-9.0	1.9	5.2	0.3	0.0	2.2	0.1	-0.5
Imports	-13.1	-11.2	-10.6	2.8	0.0	2.0	0.0	5.6	0.8	-0.5
Real wages	-7.1	-4.6	-4.4	1.9	1.7	0.3	0.0	0.4	0.2	-0.1
Inflation	-15.1	-29.0	-11.8	0.4	4.8	5.0	0.0	0.2	0.9	0.6
Dom. Prices	-12.5	-12.8	-8.8	0.4	4.2	3.4	0.0	0.1	0.6	0.1
Real ER	-9.4	-22.4	4.7	0.3	-3.7	-0.9	0.0	-0.2	-0.2	-0.1

Table 9: Forecast error variance decomposition at different horizons under inflation targeting, in percentage point deviations from the current policy, adjusted for absence of monetary policy shocks

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.9	-21.1	12.6	-6.1	7.2	3.1	-8.9	-4.9	-3.3	0.2
Consumption	-3.0	-2.6	7.4	8.7	-2.6	-20.8	0.3	-0.2	7.2	0.1
Investment	0.0	-0.4	-0.6	-0.3	0.6	-0.8	0.0	1.2	-0.1	0.0
Exports	-0.2	-18.0	-17.4	3.1	2.6	12.4	0.1	0.3	2.4	-3.5
Imports	-4.0	-14.0	5.9	-0.5	3.4	-6.9	0.0	-2.4	0.3	0.2
Real wages	-13.3	-11.9	-1.7	0.9	3.7	-2.8	0.0	0.5	-0.3	-0.3
Inflation	-15.3	-28.8	2.6	6.8	-19.7	8.4	0.3	-0.4	2.5	-0.7
Dom. Prices	-13.3	-11.9	-1.7	0.9	3.7	-2.8	0.0	0.5	-0.3	-0.3
Real ER	-0.3	-83.2	-31.7	4.2	8.8	15.0	0.1	0.6	3.0	0.0

4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-0.7	-7.6	-0.2	-3.7	6.8	-0.2	1.0	-2.0	-1.7	0.0
Consumption	-1.3	-6.3	-4.7	-5.9	8.0	3.8	-0.1	1.2	-2.2	-0.1
Investment	-0.4	-0.2	0.0	-0.6	1.1	-2.9	0.0	2.8	-0.3	-0.1
Exports	-3.5	-7.2	-6.7	2.2	-7.0	11.5	0.1	-0.4	2.2	-1.9
Imports	-2.9	-13.0	-10.4	-5.1	17.2	6.8	-0.1	-5.9	-2.2	-0.3
Real wages	-3.5	-3.2	0.4	-5.9	3.4	1.0	-0.1	0.7	0.5	-0.1
Inflation	-14.7	-29.5	-0.7	10.7	-18.3	6.4	0.4	-0.2	2.5	-0.9
Dom. Prices	-12.3	-12.9	6.6	0.1	2.9	-8.2	0.0	0.5	-1.3	-0.5
Real ER	-1.6	-35.0	-18.6	3.1	0.0	12.9	0.1	0.2	2.5	-0.2

8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.5	-3.8	0.7	-1.9	2.9	-1.2	0.7	0.0	-1.0	-0.1
Consumption	-3.9	-4.6	-0.9	-7.6	5.5	5.3	-0.1	0.9	-2.8	-0.3
Investment	-1.2	-0.2	0.8	-0.7	1.0	-4.1	0.0	3.6	-0.4	-0.1
Exports	-9.5	-3.8	1.6	1.6	-13.6	11.1	0.1	-1.8	2.1	-1.2
Imports	-8.7	-7.1	0.7	-4.2	9.0	1.1	0.0	-4.4	-1.6	-0.6
Real wages	-5.3	-2.8	2.5	-8.8	2.6	2.9	-0.1	0.2	0.8	-0.1
Inflation	-14.8	-29.0	-0.2	10.8	-18.3	6.2	0.4	-0.2	2.5	-1.2
Dom. Prices	-12.1	-12.6	6.1	0.1	2.7	-7.5	0.0	0.4	-1.2	-0.6
Real ER	-6.6	-24.1	-9.3	2.4	-7.5	12.9	0.1	-0.8	2.5	-0.3

∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-2.7	-3.8	-0.3	-1.3	2.8	-3.5	0.6	2.6	-0.8	-0.1
Consumption	-6.8	-6.0	-1.7	-6.3	10.3	-0.2	-0.1	-0.3	-1.6	-0.2
Investment	-2.9	-1.7	-0.3	-0.9	2.1	-5.7	0.0	5.3	-0.3	-0.2
Exports	-12.5	-8.9	-4.4	2.1	-5.0	10.7	0.1	-4.4	2.2	-1.1
Imports	-13.1	-11.2	-3.8	-3.6	13.9	-3.6	0.0	-1.4	-0.8	-0.6
Real wages	-7.1	-4.6	0.9	-7.8	9.7	-2.1	-0.1	-1.3	0.8	0.0
Inflation	-15.1	-29.0	-0.4	10.9	-18.8	6.8	0.4	-0.2	2.6	-1.3
Dom. Prices	-12.5	-12.8	5.5	0.2	2.6	-6.9	0.0	0.4	-1.1	-0.7
Real ER	-9.4	-22.4	-10.7	2.5	-3.9	13.1	0.1	-3.1	2.6	-0.6

Table 10: Forecast error variance decomposition at different horizons under strict inflation targeting, in percentage point deviations from the current policy, adjusted for absence of monetary policy shocks

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.9	-21.1	-14.1	0.3	5.2	2.0	5.7	0.4	0.4	0.1
Consumption	-3.0	-2.6	-2.1	-3.6	4.3	2.9	-0.1	0.5	-2.0	0.0
Investment	0.0	-0.4	-0.6	0.2	-0.6	0.8	0.0	0.1	0.1	0.0
Exports	-0.2	-18.0	-18.1	1.6	9.1	3.4	0.0	0.7	0.7	2.4
Imports	-4.0	-14.0	-11.7	-0.9	10.6	3.4	0.0	-1.2	-0.3	0.0
Real wages	-13.3	-11.9	-12.9	1.4	10.4	0.3	0.0	0.7	0.2	-0.3
Inflation	-15.3	-28.8	-28.9	3.0	16.4	7.4	0.0	0.9	1.6	-0.4
Dom. Prices	-13.3	-11.9	-12.9	1.4	10.4	0.3	0.0	0.7	0.2	-0.3
Real ER	-0.3	-83.2	-56.2	5.6	23.2	21.8	0.1	1.1	4.2	0.2

4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-0.7	-7.6	-8.2	2.3	-0.2	1.7	0.9	2.5	1.2	-0.1
Consumption	-1.3	-6.3	-8.2	3.8	0.4	1.4	0.1	0.4	2.2	-0.1
Investment	-0.4	-0.2	-0.4	0.4	-1.5	1.3	0.0	0.2	0.2	-0.1
Exports	-3.5	-7.2	-10.2	0.9	6.5	0.5	0.0	0.8	0.1	1.4
Imports	-2.9	-13.0	-17.1	4.0	3.2	1.9	0.1	6.4	2.0	-0.3
Real wages	-3.5	-3.2	-4.4	0.5	2.2	1.0	0.0	0.5	0.2	0.0
Inflation	-14.7	-29.5	-32.0	3.0	17.4	9.4	0.1	1.0	1.9	-0.6
Dom. Prices	-12.3	-12.9	-14.4	1.5	10.5	1.6	0.0	0.7	0.4	-0.4
Real ER	-1.6	-35.0	-33.3	2.9	19.1	8.5	0.1	1.1	1.7	-0.1

8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.5	-3.8	-4.1	1.9	-2.4	2.0	0.0	2.2	0.7	-0.2
Consumption	-3.9	-4.6	-6.0	6.6	-3.6	0.5	0.1	0.1	2.6	-0.3
Investment	-1.2	-0.2	-0.2	0.7	-2.9	1.4	0.0	1.0	0.2	-0.1
Exports	-9.5	-3.8	-4.9	0.5	3.3	-0.2	0.0	0.9	0.0	0.3
Imports	-8.7	-7.1	-9.1	4.6	-8.3	3.6	0.0	8.1	1.6	-0.6
Real wages	-5.3	-2.8	-3.7	4.2	-2.2	1.3	0.0	0.3	0.3	-0.1
Inflation	-14.8	-29.0	-31.4	2.9	17.0	9.4	0.1	1.0	1.9	-0.9
Dom. Prices	-12.1	-12.6	-14.2	1.5	10.4	1.7	0.0	0.8	0.5	-0.6
Real ER	-6.6	-24.1	-22.9	2.1	14.0	4.9	0.0	1.3	1.0	-0.3

∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-2.7	-3.8	-4.2	2.1	-2.6	1.2	0.0	3.3	0.4	-0.3
Consumption	-6.8	-6.0	-7.6	5.8	-1.1	0.7	0.1	0.9	1.7	-0.4
Investment	-2.9	-1.7	-2.1	1.1	-4.0	1.4	0.0	3.6	0.2	-0.3
Exports	-12.5	-8.9	-11.4	2.1	6.4	0.3	0.0	3.1	0.1	-0.6
Imports	-13.1	-11.2	-14.2	4.5	-2.4	3.5	0.0	8.5	1.1	-1.0
Real wages	-7.1	-4.6	-5.8	4.5	-1.1	1.2	0.0	1.1	0.3	-0.3
Inflation	-15.1	-29.0	-31.6	2.9	17.4	9.2	0.1	1.1	1.8	-1.0
Dom. Prices	-12.5	-12.8	-14.5	1.5	10.4	2.0	0.0	0.8	0.5	-0.7
Real ER	-9.4	-22.4	-23.1	2.9	13.3	3.4	0.0	3.4	0.7	-0.8

Table 11: Forecast error variance decomposition at different horizons under a fixed exchange rate, in percentage point deviations from the current policy, adjusted for absence of monetary policy shocks

1 Quarter	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.9	-21.1	-14.1	-6.3	49.9	-2.1	-18.0	-6.0	-3.4	0.0
Consumption	-3.0	-2.6	-2.1	-5.6	11.3	-0.5	-0.1	0.3	-3.3	0.0
Investment	0.0	-0.4	-0.6	0.1	3.1	0.0	0.0	-2.6	0.0	0.0
Exports	-0.2	-18.0	-18.1	-4.0	43.9	-14.3	-0.1	-1.0	-2.8	-3.8
Imports	-4.0	-14.0	-11.7	-3.4	33.7	-11.9	0.0	-5.3	-1.4	0.0
Real wages	-13.3	-11.9	-12.9	7.4	-26.7	25.5	0.2	1.7	5.0	-0.1
Inflation	-15.3	-28.8	-28.9	4.6	6.4	14.1	0.1	1.2	2.8	-0.3
Dom. Prices	-13.3	-11.9	-12.9	7.4	-26.7	25.5	0.2	1.7	5.0	-0.1
Real ER	-0.3	-83.2	-56.2	-3.2	78.2	-15.4	-0.1	-0.4	-2.9	-0.1
4 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-0.7	-7.6	-8.2	-4.8	27.1	-0.3	-3.7	-8.0	-2.0	-0.2
Consumption	-1.3	-6.3	-8.2	-7.2	26.4	-6.1	-0.1	-0.9	-3.8	-0.1
Investment	-0.4	-0.2	-0.4	0.3	2.5	0.3	0.0	-2.7	0.1	-0.1
Exports	-3.5	-7.2	-10.2	-4.0	29.3	-10.0	0.0	-1.6	-2.0	-1.5
Imports	-2.9	-13.0	-17.1	-2.8	32.5	-2.7	0.0	-8.6	-1.0	-0.4
Real wages	-3.5	-3.2	-4.4	-7.1	19.7	-5.7	-0.1	-0.5	-1.9	-0.1
Inflation	-14.7	-29.5	-32.0	4.2	9.0	15.2	0.1	1.2	2.9	-0.6
Dom. Prices	-12.3	-12.9	-14.4	6.9	-26.2	26.9	0.2	1.7	5.2	-0.3
Real ER	-1.6	-35.0	-33.3	-3.6	54.4	-13.8	-0.1	-0.9	-2.6	-0.2
8 Quarters	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-1.5	-3.8	-4.1	-1.9	12.7	-0.1	-1.2	-4.6	-0.6	-0.2
Consumption	-3.9	-4.6	-6.0	-3.0	16.2	-4.3	0.0	-1.2	-1.3	-0.3
Investment	-1.2	-0.2	-0.2	0.6	-0.3	0.7	0.0	-0.8	0.2	-0.1
Exports	-9.5	-3.8	-4.9	-3.3	17.2	-5.0	0.0	-2.1	-1.1	-0.6
Imports	-8.7	-7.1	-9.1	-0.2	13.7	-0.2	0.0	-3.7	0.0	-0.7
Real wages	-5.3	-2.8	-3.7	-3.8	13.3	-3.6	0.0	-0.8	-1.3	-0.1
Inflation	-14.8	-29.0	-31.4	4.0	9.3	14.8	0.1	1.2	2.8	-0.9
Dom. Prices	-12.1	-12.6	-14.2	6.7	-25.9	26.9	0.2	1.7	5.1	-0.4
Real ER	-6.6	-24.1	-22.9	-3.8	40.1	-9.1	0.0	-1.9	-1.9	-0.4
∞	η^m	η^{int}	η^{ω^*}	η^a	η^{po}	η^b	η^g	η^i	η^l	η^*
Real GDP	-2.7	-3.8	-4.2	0.1	4.7	-0.1	-0.4	0.1	0.0	-0.3
Consumption	-6.8	-6.0	-7.6	3.5	4.2	-0.7	0.0	0.0	1.0	-0.4
Investment	-2.9	-1.7	-2.1	1.2	-4.8	1.7	0.0	4.2	0.2	-0.3
Exports	-12.5	-8.9	-11.4	-0.1	13.7	-1.0	0.0	-0.2	-0.2	-0.9
Imports	-13.1	-11.2	-14.2	2.3	7.7	1.0	0.0	3.7	0.6	-1.1
Real wages	-7.1	-4.6	-5.8	2.1	4.3	-0.4	0.0	0.2	-0.1	-0.3
Inflation	-15.1	-29.0	-31.6	4.1	8.9	15.1	0.1	1.4	2.9	-0.9
Dom. Prices	-12.5	-12.8	-14.5	6.9	-26.7	27.6	0.2	1.9	5.2	-0.5
Real ER	-9.4	-22.4	-23.1	-3.1	37.4	-5.2	0.0	-3.9	-1.1	-0.9

Table 12: Forecast error variance decomposition at different horizons under ruble price of oil targeting, in percentage point deviations from the current policy, adjusted for absence of monetary policy shocks

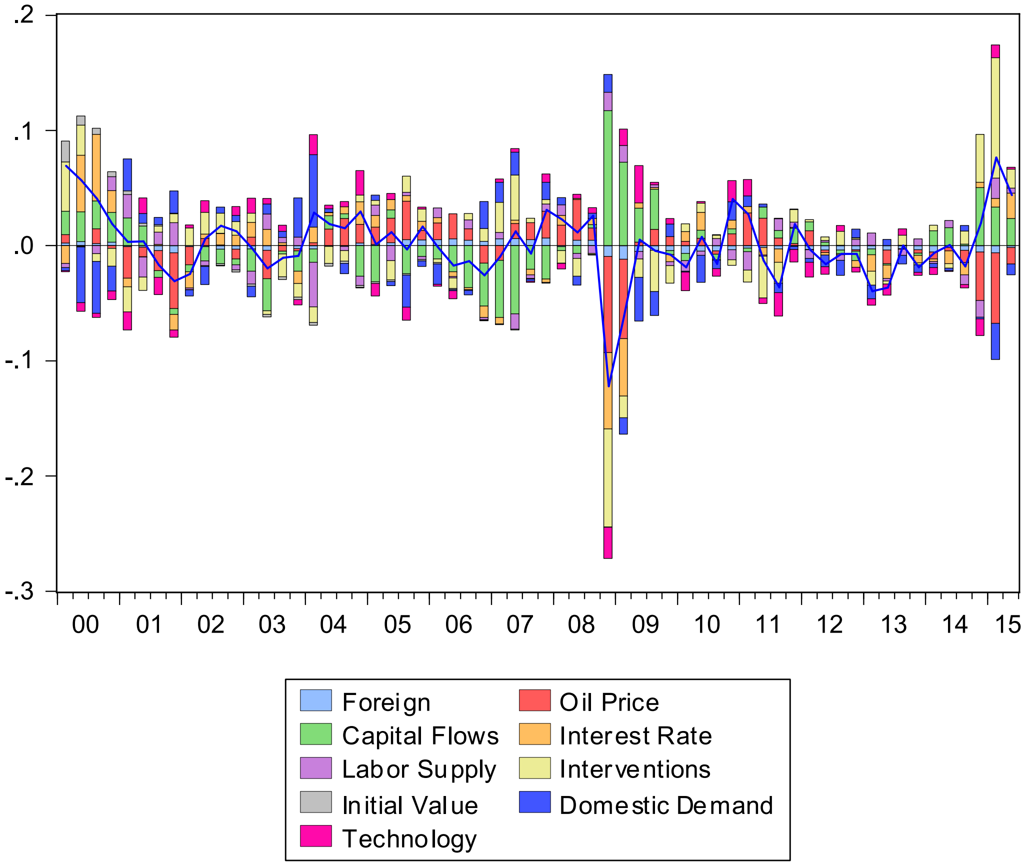

Figure 5: Historical decomposition of consumer price inflation (solid line)

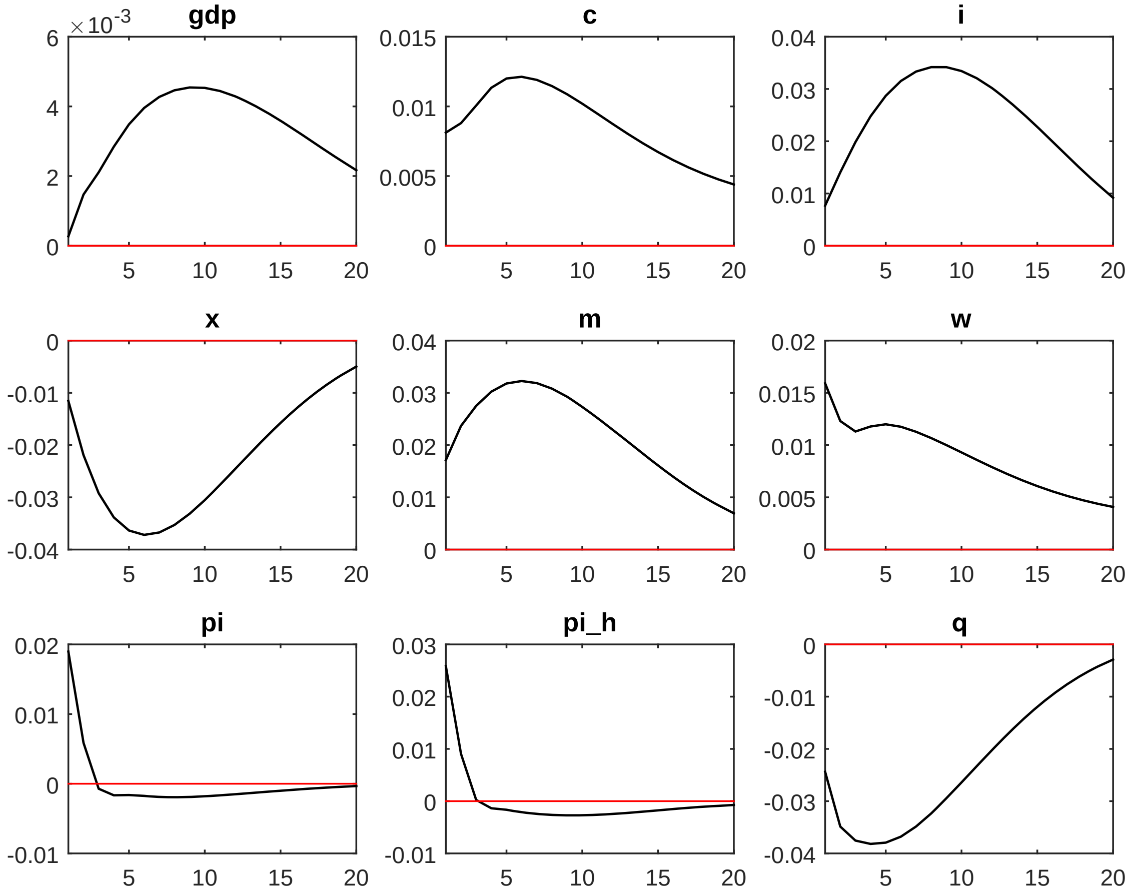

Figure 6: Impulse response functions following a 1 s.d. shock to the oil price

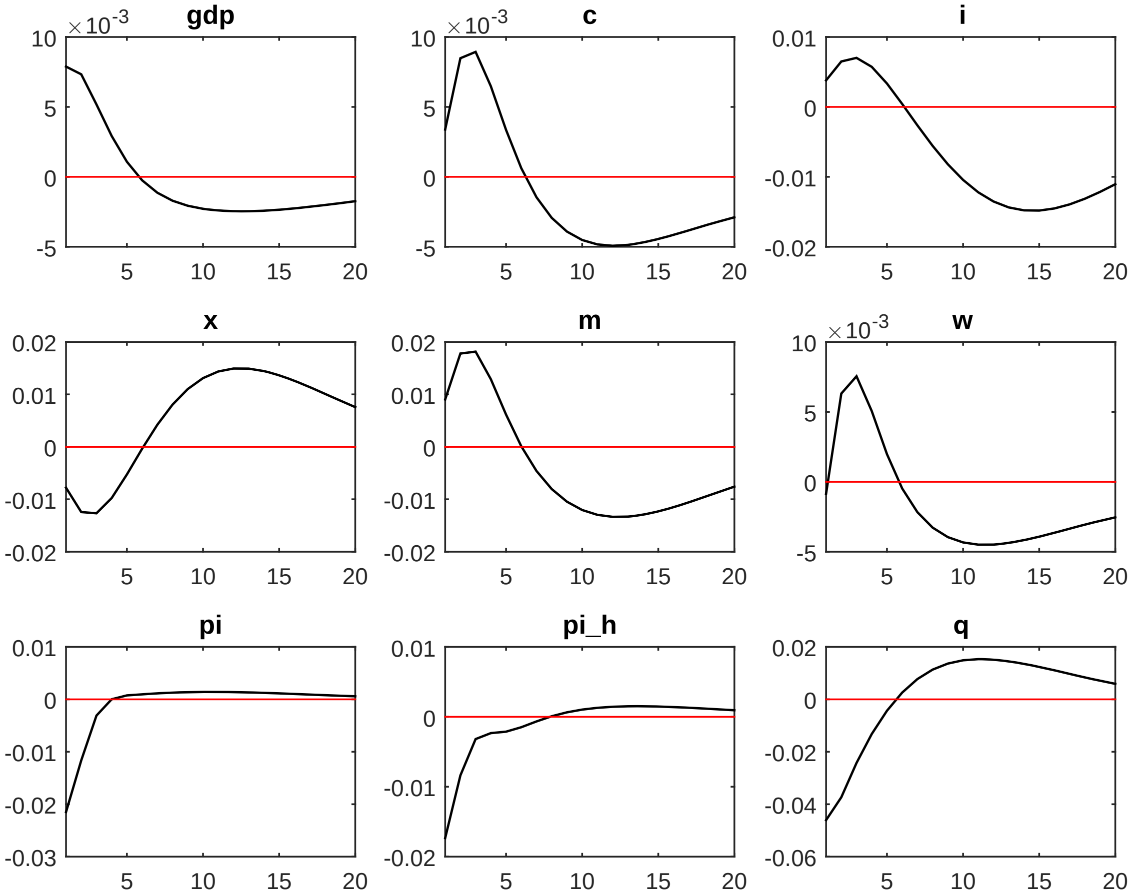

Figure 7: Impulse response functions following a 1 s.d. shock to capital flows

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