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MONETARY STABILISATION: MODELING AND ESTIMATION FOR THE RUSSIAN ECONOMY

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ABSTRACT

The paper analyses Russian monetary policy in 2004 – 2012. We present a model that describes short run nonlinear monetary dynamics induced by balance of payments and policy shocks. We consider Central Bank's international reserves volume as the key factor of monetary and exchange rate stabilization using "ad hoc" monetary rule. Empirical analysis of the model is carried out with Bayesian techniques. Estimation measures the difference in Central Bank's preferences in crisis and no crisis dynamics.

JEL: E52, E58

KEYWORDS: monetary stabilization, monetary rule, Bayesian estimation.

INTRODUCTION

The global financial crisis of 2008 - 2009 has shown that Russian economy depends a lot on external shocks. Losses of Russian economy during financial crisis were one the most significant in the group of developing countries. In particular, the ruble was devalued by 30%, inflation accelerated in 2008 to 13.3% per year, there was a decline in GDP growth by 13%[1] and a drop in share prices of Russian corporations for 64%[2].

Among the external factors that determine the macroeconomic cycle, experts usually emphasize oil prices [8] and the outflow of capital from the country [7]. Considering this issues,

[1] http://www.gks.ru

[2] http://moex.com/

it is interesting to analyze how, in the last decade, the Central Bank of Russia responded to external challenges.

Exchange rate policy has always been in the focus of Russian monetary authorities. For the last decade, the Central Bank used crawling peg regime. Crawling peg is an exchange rate regime usually seen as a part of fixed or intermediate exchange rate regimes which allows depreciation or appreciation in an exchange rate gradually. Till the recent financial crisis this meant limiting the real appreciation of the ruble. However, in autumn 2008, a rapid fall in oil prices and the rapid outflow of investments from developing countries forced the Bank of Russia to defend the ruble from weakening. As a result, devaluation has been postponed for several months. The process of smoothing devaluation is questionable. Experts debate whether the policy of the Bank of Russia in crisis period was discretionary or they operated within the monetary rule they used before. This paper aims to find evidence of deviations from traditional monetary rule during crisis.

For the purpose of identifying changes in the policy preferences, we offer a new simple short run dynamic monetary model for Russian economy. Thus the main objectives are: (a) construction of a dynamic model of the monetary sphere with the monetary policy rule for intermediate exchange rate regime; (b) estimation of the model on the basis of macroeconomic statistics of Russia in 2004 – 2012; (d) comparing the estimated parameters of monetary policy in crisis and in a stable macroeconomic environment. Recent policy changes associated with the transition to inflation targeting are not considered.

The paper includes introduction, two parts and conclusion. The first part involves the description and analysis of the monetary sphere model for a small open economy and the analysis of monetary policy rule. The second part presents the results of calibration and estimation of the model using the data of the Russian economy from 2004 to 2012. Discussion of the results is in conclusion.

THEORETICAL ANALYSIS OF MONETARY SPHERE OF RUSSIAN ECONOMY

The model takes into account the following features of Russian economy:

a) dependence on external factors: fluctuations in the price of oil and gas, the behavior of international investors in the capital market;

b) a significant role of the international reserves in conducting monetary policy;

c) the risk of a liquidity crisis in the banking sector.

The role of each factors is discussed below.

Trade balance and the capital account had a positive trend in the pre-crisis period. In particular, the balance of trade has grown from U.S. $ 85 billion in 2004 to $ 150 billion in the first three quarters of 2008. The trade surplus was achieved due to the export of oil, as the middle 2000s are associated with a period of high oil prices. The capital account also had a positive trend, which has been associated with the policy of the authorities of attracting short-term foreign investments. Capital inflow consisted of borrowings of the banking sector and commercial enterprises. Before the crisis, this trend has been seen as a positive factor, however, it made the economy extremely vulnerable. In crisis many professional and private investors have closed their positions on the Russian financial market. All this changes have made the devaluation of the national currency inevitable.

Secondly, it is worth noting that Russia met the crisis with the world's third largest international reserves (546,035 million in June 2008)[3]. It was considered as a rescue reserve for unexpected situations as intermediate exchange rate regime implies currency interventions for exchange rate adjustment. However during financial crises the amount of reserves decreased by about a one third by 2009 compared to the pre-crisis level.

Finally, the risk of a liquidity crisis in the banking sector was induced by significant capital outflows from the country. In a short period of time banking sector was forced to repay its debt in foreign currency (about $ 150 billion in three month). In such circumstances, it was difficult to avoid a liquidity crisis accompanied by the bank run. Only an active government anti-crisis program helped to avoid the banking crisis.

Thus the baseline of the model is associated with the justification of changes in monetary policy under the listed above restrictions.

The model is based on a model of optimal devaluation in the condition of twin crisis [7], model of currency crisis for the Russian economy [2], as well as models of the second generation of currency crisis [1], [3], [4], [5].

1.1 The Model

We assume a simple dynamic model of monetary and financial sector which is subject to external shocks.

[3] http://cbr.ru

$$\overline{W}_t = NPFA_t + H_t \tag{1}$$

$$NPFA_t = -k \cdot \mathrm{E}_t \cdot id_{t+1} \tag{2}$$

$$id_t = i_{t-1} - i^*_{t-1} - \frac{\Delta S_t}{S_{t-1}} \cdot (1 + i_{t-1}) \tag{3}$$

$$i_t^* - \bar{i}^* = \rho_i \cdot (i^*_{t-1} - \bar{i}^*) \tag{4}$$

$$H_t = IC_t + IR_t \tag{5}$$

$$\Delta IC_t = -\theta \cdot \Delta IR_t + U_t^{IC} \tag{6}$$

$$U_t^{IC} = \rho_{IC} \cdot U_{t-1}^{IC} + \varepsilon_t^{IC} \tag{7}$$

$$-\Delta NPFA_t + a \cdot \ln Q_t + U_{BP} - \Delta IR_t = 0 \tag{8}$$

$$\ln Q_t = \ln S_t + \ln RP_t \tag{9}$$

$$\ln RP_t = \rho_p \cdot \ln RP_{t-1} + (1 - \rho_p) \cdot \ln \overline{RP} + \varepsilon_t^p \tag{10}$$

$$U_t^{BP} = \rho_{BP} \cdot U_{t-1}^{BP} + \varepsilon_t^{BP} \tag{11}$$

Equation (1) defines the structure of the wealth of society ($\overline{W}_t$), which is distributed on the ruble-denominated assets (H_t - monetary base) and foreign assets ($NPFA_t$ - net foreign assets of the private domestic agents). In this model we assume that the amount of wealth is constant and agents make their decision on its allocation subject to the restrictions of the model. Net private foreign assets depend on the expectations of the interest rate differential (id_{t+1}) with a coefficient k, here E_t is the expectation operator. Equations (1) along with (2) define the demand for money. Equation (3) describes the premium of domestic investors, arising due to the failure of uncovered interest parity, here S_t - the nominal exchange rate of foreign currency, i_t, i_t^* - the nominal interest rates in the country and abroad (respectively). Equation (4) specifies an adjustment rule for foreign nominal interest rates with a coefficient of adjustment $\rho_i > 0$, here $\bar{i}^*$ is a steady state level

Equation (5) determines the money supply. The monetary base H_t^s is under the control of the Central Bank and is created by the operations with international reserves IR_t and in the process of refinancing of commercial banks in the domestic currency IC_t. Equation (6) defines sterilization rule for currency operations with the parameter of sterilization $\theta < 1$. The exogenous function U_t^{IC} represents the autoregressive process with coefficient $\rho_{IC} \in (0, 1)$ and shock ε_t^{IC}.

Equation (8) defines in a simplified manner the dynamics of the balance of payment. Capital account KA_t is represented by the net foreign private assets. $NPFA_t > 0$ means the purchase of foreign assets by household. Similarly, $NPFA_t < 0$ means the borrowings in foreign currency. The current account CA_t is represented by the logarithm of the real exchange rate (Q_t) with a coefficient a. The real exchange rate is related to the nominal exchange rate by the relative price level (RP_t). The dynamics of the relative price level is determined by the steady state level of the variable $\overline{RP_t}$ adjusted by the ratio $\rho_p \in (0,1)$ and shock ε_t^p.

Balance of payment have an exogenous component U_{BP}. This process includes dynamics of both capital account and current account. The dynamics of capital account implies inflow or outflow of capital, the dynamics of the current account means export earnings fluctuations. Function follows AR(1) – process with an autoregression factor $\rho_{BP} \in (0,1)$ and shock ε_t^{BP}. Equation (9) determines the equilibrium in the foreign exchange market: balance of payments in case of intermediate exchange rate regime is balanced by the operations with international reserves ΔIR_t.

In the equations (1) - (11) the components of the model are specified in terms of the domestic currency. The system of equations describes the interaction of tools and operational goals of monetary policy, this framework allows to analyze the process of monetary stabilization. The model is based on monetary and financial sectors, the connection with the real sector is provided by real exchange rate variable and relative price level which reflects the dynamics of inflation in the country. We assume that other indicators of economic activity do not affect the process of monetary stabilization substantially. This simplification limits the usage of the model and don't allow to assess the optimal monetary policy with respect to the welfare of society.

1.2 The Monetary Rule

In order to formulate the monetary rule for Central Bank we carried out a qualitative analysis of Russian monetary policy in 2002 - 2012 years. Pre-crisis policy is associated with ruble appreciation during years of high oil and gas prices. Central Bank stimulated demand for foreign currency and accumulated huge international reserves aiming at stimulating the inflow of short international investment. The exact formula of exchange rate adjustment is not disclosed to the public, but empirical tests show that the decision of monetary authorities is based on information about the volume of accumulated international reserves and the dynamics of the

USD/Euro basket [6]. So, in this paper to analyze changes in monetary policy we use a monetary rule that reflect the stabilization of the exchange rate in the intermediate regime.

As a basis we use the rule for adjusting the exchange rate band, depending on the amount of currency intervention: $\Delta S_t = -\mu \cdot \Delta IR_t$,

In terms of deviations from the steady state, we obtain:

$$\frac{S_t - \overline{S}}{\overline{S}} = -\mu \cdot \frac{(IR_t - \overline{IR})}{I\overline{R}} + U^S \qquad (12),$$

where $\overline{S}$ - the steady state value of the nominal exchange rate and $\overline{IR}$ - steady state value of international reserves.

$$U_t^S = \rho_s \cdot U_{t-1}^S + \varepsilon_t^S \qquad (13)$$

The rule means that monetary authorities target both: the nominal exchange rate and the value of international reserves. If the value of exchange rate is close to the long-term equilibrium level, the intervention in the monetary sphere is minimal. If speculative fluctuations in foreign financial markets or changes in the terms of trade caused the demand for ruble (or reduced), Central Bank will use reserves to smooth out fluctuations. Adjustments are complete, if the value of the policy coefficient (μ) is close to one, it corresponds to more strict regime. In more floating regimes, the policy coefficient will have a value close to zero. We assume that framework can describe the process of gradual devaluation of 2008-2009 with changing the policy coefficient. By estimating the policy coefficient in crisis period we aim to track the change of priorities of Bank of Russia. The coefficient should decrease with an increase in exchange rate flexibility and increases for policy tightening.

So we have thirteen equations that define thirteen endogenous variables: H, i, IR, IC, S, Q, $NPFA$, i^*, id, RP, U^{BP}, U^{IC}, U^S. The model assumes shock changes for the following exogenous variables: $\underset{4\times1}{\vec{\vec{S}}} \equiv [U_{BP}, U_{IC}, U_S, RP]'$ - column vector of variables subject to shocks. The next part of the paper implies empirical analysis of the model using data of the Russian Economy from 2004 to 2012 years.

EMPIRICAL ANALYSIS OF MONETARY STABILIZATION IN RUSSIA

Empirical part of the paper presents the results of calibration of the model and estimation for crisis and non-crisis periods. Next, we analyze effects of monetary policy, outlined in the first part of the paper.

2.1 Data

The research is based on the statistical data for Russian economy for the period from January 2004 to September 2012. The number of observations is large, it is important to improve the quality of empirical estimations. The period under consideration includes the crisis stage from August 15, 2008 to March 6, 2009. We chose the beginning of the crisis period by date of oil prices lowering, the end of the crisis period corresponds to the period of stabilization of the ruble around the level of 41 rubles for currency basket.

The analysis uses weekly data for Russia. We use four observable variables to make Bayesian estimation of the model.

The dynamics of international reserves is published by the Bank of Russia in a weekly format. As interest rate we used the actual rate on ruble loans 1 day-MIACR[4]. We used the nominal exchange rate of the currency basket of the Central Bank, which at the time of writing this paper is 0,45 EUR and 0,55 USD (note that in the period under consideration the composition of the basket was changed[5].) The calculation of the real exchange rate is made using data on the nominal exchange rate of the currency basket of the Central Bank and the CPI for the Euro area countries, the USA and Russia.

Descriptive statistics of the variables is presented in Table 1.

Table 1: Descriptive statistics of the observal variables

Variables	Sample	
	2004 – 2012	2008 –2009
International reserves, billions of U.S. dollars	360.92 [158.58]	470.28 [72.24]
The interest rate MIACR,%	4.23 [2.62]	8.89 [3.11]
The real exchange rate of the currency basket	26.76 [4.28]	25.21 [2.24]
The nominal exchange rate of the currency basket	32.16 [3.09]	33.32 [1.86]
Number of observations	453	30

Source: The Bank of Russia, OECD statistics, authors' calculations.
Note: This table shows the average values of the variables. The numbers in square brackets are standard deviations.

Trends in time series data are removed using the Hodrick-Prescott filter. We used deviations from the steady-state level variables in estimation (see Table 2).

In the steady state model takes the following values:

[4] Moscow InterBank Actual Credit Rate

[5] We assume that during the month in which there was a change in the currency basket weights the ruble value of the basket did not change.

Table 2: Steady state values of endogenous variables

Variables	Values	Variables	Values
$\overline{H}$	1.000	$\overline{NPFA}$	0.000
$\bar{i}$	0.003	$\overline{i^*}$	0.003
$\overline{IR}$	0.850	$\overline{id}$	0.000
$\overline{IC}$	0.150	$\overline{U^{BP}}$	0.000
$\overline{S}$	1.000	$\overline{U^{IC}}$	0.000
$\overline{Q}$	1.000	$\overline{U^{S}}$	0.000
$\overline{RP}$	1.000		

We assume that in the steady state all the wealth of domestic agents (W) amounts one and is represented by the domestic currency, which means agents do not have foreign assets. The supply of money is under the control of the Central Bank, the distribution between international reserves and internal credit is based on the average ratio of international reserves to the monetary base in the Bank of Russia balance sheet from 2004 to 2012 (0.85:1) [6] . The value of the real exchange rate is derived from the balance of payments equation in the steady state with a constant value of international reserves and foreign assets. The relative price level equals one, the nominal exchange rate equals real exchange rate. We use LIBOR[7] rate for the foreign weekly interest rate.

2.2 Econometric estimation of the model

In our tests we used a Bayesian approach that allows to estimate the distribution of the estimated parameters. We built posterior distribution for the parameters and shocks acting in the model. The system was linearized around the steady state. For the four shocks - the balance of payments shock, sterilization shock, monetary rules shock and relative price level shock - we use four observable variables. Prior distributions are specified using a standard gamma distribution. The coefficient of the exchange rate from the equation of balance of payments and the policy AR-coefficient have an average value of 1. Autoregression coefficients in the equations for other shocks have an average at 0.2. Shocks in the model have a mean equal to one.

Maximizing the likelihood function yields the following results (Table 3).

We got a significant parameter estimates. The preference parameter of the Central Bank (μ) is positive. It does not contradict to the idea that the rule implies depreciation of the exchange rate in replay to negative deviations of international reserves. Thus, the estimation results confirm the role of this factor in the dynamics of monetary variables. Estimates for the

[6] http://www.cbr.ru/statistics/

[7] 12-Month London Interbank Offered Rate

crisis and non-crisis periods suggest that there is some deviation in the preference parameter. But with standard errors the difference is not high. The estimation results do not give a clear answer whether the policy of the Central Bank during the crisis was discretionary, but a tightening of monetary policy is observed.

Table 3. Estimation results

Parameter	Estimates with full sample		Estimates with crisis sample	
	Mode	St. Errors	Mode	St. Errors
a	8.8848	(1.6250)	7.0858	(1.2870)
μ	0.5138	(0.0729)	0.6109	(0.0355)
ρ_{BP}	0.7214	(0.0647)	0.7516	(0.0618)
ρ_{IC}	0.1166	(0.0548)	0.0990	(0.0487)
ρ_{S}	0.1500	(0.0866)	0.1500	(0.0866)
ρ_{P}	0.9454	(0.0256)	0.9195	(0.0232)
ε_{BP}	0.1873	(0.0309)	0.1092	(0.0180)
ε_{IC}	0.0645	(0.0045)	0.0394	(0.0028)
ε_{S}	0.0695	(0.0102)	0.0250	(0.0022)
ε_{P}	0.0079	(0.0006)	0.0068	(0.0005)

Thus, the exchange rate adjustment can be explained by the same rule that works in non-crisis periods, but the speed of adjustment varies due to internal constraints of the Central Bank, the exchange rate response to deviations of international reserves in crisis is higher on its average than non-crisis response.

Autoregression coefficient values for the balance of payments shocks and the real exchange rate are close to one. One can interpret these estimates as an indicator of long-term impact of these shocks on the monetary sphere of the country. Autoregression coefficient for sterilization mechanism and monetary policy assessment is low enough, which means quick resection on shocks, but their impact in the long run is minimal.

CONCLUSION

In this paper we constructed, solved and estimated the model which allows to analyse the peculiarities of monetary policy of the Central Bank. The model involves the monetary rule of exchange rate adjustment, which describes the relationship of the nominal exchange rate and the dynamics of international reserves. The rule is presented in the form of deviations from the

steady state values of variables. This framework implies minimal interventions in the case of stable economic situation and active adjustment to shocks.

The model takes into account the main features of the Russian economy, such as high dependence on export earnings and capital market. The role of international reserves in an intermediate exchange rate regime is emphasized by including it in the monetary rule. Do, the dynamics of international reserves provides an additional source of exchange rate dynamics in the model.

The econometric part of the paper focuses on the calibration and estimation of the model for the Russian economy using data from 2004 - 2012 years. Estimation is carried out with the Bayesian technique. The estimated coefficient that shows the relation between nominal exchange rate and international reserves in the Central Bank rule is significant and positive (as theoretically predicted) for the entire period and for the crisis period. Thus the monetary policy rule of the Central Bank in the form proposed in the paper allows to describe the current and stabilization policy of the regulator. There is some difference in estimated policy parameters for crisis and non-crisis period, but the figures do not allow to claim that anti-crisis policy was discretionary. We do not discuss the question of the optimality of this policy in this paper, it requires using the methodology of dynamic stochastic general equilibrium model which we assume as the most promising framework for further developments.

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