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FACULTY of SOCIAL SCIENCES

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2014 **Petr Vystropov**

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Monetary Policy in Russia: Description of Central Bank's Policies in the Post-2008 Crisis Period

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Abstrakt

V této bakalářské práci jsou aplikovány dva základní přístupy k empirickému vyhodnocování monetární politiky. Monetární politika Ruské centrální banky v letech 2000 až 2014 je analyzována jak pomocí modifikovaných pravidel pro úrokovou míru, tak i pravidel pro peněžní agregáty. Zvláštní pozornost je věnována období v průběhu a po skončení finanční krize z roku 2008. Nalezená evidence podporuje hypotézu, že CBR postupně udílí větší pozornost inflačnímu cílování.

Klasifikace JEL: E52; E61; F33; F41

Klíčová slova: Rusko, monetární politika, inflace

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Abstract

In this bachelor thesis two approaches to empirical evaluation of monetary policy are applied. Monetary policy conducted by the Central bank of Russia in years 2000 – 2014 is analyzed by means of modifications of interest – rate rules and monetary aggregates rules. Special attention is devoted to the period during and after the 2008 financial crisis. Significant evidence supporting the hypothesis that the CBR is gradually shifting its attention towards inflation targeting was found.

JEL Classification: E52; E61; F33; F41

Keywords: Russia, monetary policy, inflation

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Declaration of Authorship

I hereby proclaim that I wrote my bachelor thesis on my own under the leadership of my supervisor and that the references include all resources and literature I have used.

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Prague, July 30, 2014

Signature

Bachelor Thesis Proposal

Author of the bachelor thesis: **Petr Vystropov**

Supervisor of the bachelor thesis: **Ing. Vladimír Dlouhý, CSc.**

Theme: **Monetary Policy in Russia: Description of Central Bank's Policies in the Post-2008 Crisis Period**

Goals of the thesis:

My aim is to study the monetary policies the Bank of Russia (CBR) has implemented from the beginning of the world financial crisis in 2008 up to date.

Since the Russian default in 1998 there has been a rather complex development in the goals the CBR has pursued. Taking into account the high inflow of foreign direct investment, rising oil prices, and economic growth that took place in the first decade of the 2000s, it is obvious that there must have been an uneasy trade-off for the CBR authorities between exchange rate and inflation targeting in the period before the world financial crisis broke out. The consequence of such a dilemma, coupled with an underdevelopment of the domestic financial sector, heavy focus on exports of natural resources, and low competitiveness of most domestic industries contributed to the failure of achieving a significant drop of inflation in the pre-

crisis period, even though this was an officially declared policy goal of the CBR (Granville and Mallick, 2009).

In my thesis I will review available literature on CBR's monetary policy between 1995 and 2009 (e.g. Vdovichenko and Voronina, 2005 or Granville and Mallick, 2009) and then analyze the anti-inflationary measures the CBR has undertaken in the following years. Of particular interest to me is whether the officially declared goal of lowering the inflation was perceived as the main task or whether exchange rate smoothing continued to have priority as in the period before the financial crisis and during its first year (Granville and Mallick, 2009). My hypothesis is that since 2009 the CBR has primarily concentrated on lowering the high levels of inflation in accordance with its officially stated goals.

I will use data provided by the Rosstat, the CBR and such international organizations as the International Monetary Fund (IMF), the World Bank (WB), and the Organization for Economic Cooperation and Development (OECD). I will base my research on the standard text of Taylor (1993) in order to gain necessary theoretical background of the functioning of a central bank in general.

Outline:

1. Introduction

2. Literature review

3. Monetary policy in Russia

4. Methodology

5. Data

6. Estimation

7. Conclusion

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Supervisor

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1 Introduction

A successful conduct of monetary policy in times of a crisis is always a difficult task. Danger of capital flows' reversals, threats to the banking system and highly probable slow-down of real economy are only few of the aspects that many central bankers have to consider. The Central Bank of Russia (CBR)[1] faced not only those effects of the last financial crisis but also entered it with a rather poor track of inflation fighting. As many other emerging market economies, also the Russian economy experienced strong economic growth, rise in foreign capital inflows and, mostly thanks to favorable prices on energy resources, also large current account surpluses during the most of the first decade of the 2000s. Furthermore, rapid credit boom (financed to a large extent from abroad) contributed to both exchange rate and inflation pressures. In a situation when most of the domestic export-substituting industries were substantially less efficient than foreign producers, there was a fear that should the Russian ruble be let to freely float, consequent appreciation would seriously threaten many of domestic producers. Therefore, in its aim to stabilize the fluctuations of the Ruble, the CBR massively intervened by purchaseing currency in the foreign exchange market in order to prevent strengthening of the ruble.

A rise in foreign reserves was not the only outcome of these interventions. The other side of the coin was also a rise in the rubble money stock in the Russian economy that led to persistently high levels of inflation. Even though the CBR had on numerous occasion declared that its main priority was low inflation, announced inflation target were frequently missed without any consequences. Unlike many other emerging market economies, the CBR did not join the group of central banks that adopted inflation targeting regime, nor did it seem to devote a particularly strong attention to changes

[1] In numerous articles several names are used for the monetary authority in Russia. Generally, also the term Bank of Russia can be used. Nonetheless, consistent with more recent literature, I am going to use the term Central Bank of Russia (CBR).

of price levels compared to other variables. On the contrary, for a rather long period the CBR reportedly sticked to exchange rate stabilization. Several authors evaluated monetary policy conduct in Russia in roughly the period preceding the 2008 financial crisis that severely hit Russian economy. Granville and Mallick (2005, 2010), Esanov et al. (2005) or, for instance, Vdovichenko and Voronina (2006) documented that poor record of the CBR on restricting inflation for more or less the whole period between the 1998 Russian default and the 2008 financial crisis was mainly due to prioritizing the exchange rate stabilization by the CBR. On numerous occasions the CBR even attempted to change the equilibrium level of the exchange rate (Vdovichenko and Voronina, 2006).

On the outset of the 2008 financial crisis the CBR, however, confirmed its determination to further loosen its exchange rate policy with an ultimate goal of adopting inflation targeting in 2011. As this final date was subsequently again and again postponed, the question remains how far the CBR in fact did shift to inflation targeting since that time. The financial crisis has doubtless forced the CBR to consider other more acute issues than inflation stabilization. Interventions in the financial sector and massive injections of liquidity are representative for the months following the Lehman Brothers collapse. An unstable level of dollarization of Russian economy together with a danger of further propagation of the crisis led the CBR to intervene in the currency market. At this time the direction of interventions was opposite to pre-crisis period, and the CBR carried out substantive purchases of domestic currency with an aim of slowing down depreciation. Nevertheless, the question how the CBR assigned weights to inflation and the exchange rate during and after the 2008 crisis remains unanswered.

A broad scope of literature on both theoretical and empirical research of monetary policy rules has been accumulated in the last two decades. The basic idea is that no matter how complicated deliberations of policymakers may stand behind decisions on policy instruments, responses of a central bank

to changes in macroeconomic environment can be approximated by a simple (linear) equation where the dependent variable is the corresponding monetary policy instrument, and set of independent variables contains primarily measures of gross domestic product growth and movements of price level. Other variations are possible by means of including additional explanatory variables and (or) modifying present ones. The most famous contribution in this field has been made by Taylor (1993) in his seminal paper on the US Federal reserve interest rate policy. Should the central bank in question rely on monetary aggregates as policy instrument, other type of rules, based on McCallum's (1994) contribution, is available.

In order to evaluate reaction of the CBR to changes in price level, gross domestic product (GDP) and the exchange rate, a set of models based on Esanov et al. (2005) is proposed. Their aim is to evaluate the strength of the reaction of the CBR to changes in different policy variables. As the inflation targeting requires the central bank interest rates to be the main policy instrument, and the CBR has rather relied on monetary aggregates targeting, rules based on changes of interest rate are evaluated together with rules using monetary aggregates as response variable. Outcomes of both types of models are compared so that it could be possible to determine whether the CBR reacted to the exchange rate fluctuation more than to changes in the price level, and what monetary policy instrument the CBR used preferrably. Based on obtained results, it will be possible to assess how much the policy of the CBR has changed in response to the global financial crisis and adopted priority of inflation targeting.

Three different approaches are applied to estimate monetary policy rules. Firstly, a usual ordinary least squares estimator is used. Later an OLS estimator is adjusted to be able to deal with processes with permanent effects of shocks. Secondly, to allow for endogeneity of variables, estimates are obtained by means of a generalized method of moments (GMM) estimator. Finally, and a bit unusually for the traditional policy rules literature, an

autoregressive distributed lag model is estimated.

Results of estimations indicate significant evidence in favor of an increasing importance of inflation in monetary policy rules of the CBR. Furthermore, interest rates as policy instrument were found to be of an increasing importance as a monetary policy instrument in the post-2008 period. Both these findings provide an evidence in support of the planned shift towards an inflation targeting regime announced by the CBR.

The rest of this thesis is organized as follows: The next chapter reviews the theoretical background behind monetary policy rules and discussion of the exchange rate policy. In Chapter 3 development of monetary policy in Russia is briefly outlined with focus on the first decade of the 2000s, financial crisis and post-crisis period and also on several specific features of the Russian monetary policy environment. Further, hypotheses are presented as well as models with which they can be tested. Chapter 5 discusses the data used, and in Chapter 6 estimation methods and results are presented. The last chapter then concludes the thesis.

2 Literature review

Since the topic of this thesis in fact concerns estimation of the policy rule of the CBR, larger part of this chapter is devoted to discussion of monetary policy rules. Two basic approaches have to be commented on so that it is further possible to correctly design a suitable model for testing hypotheses. As the Russian economy is broadly considered an open one, the role of the exchange rate cannot be neglected. Hence the second section of this chapter deals with various aspects of exchange rate policies as well as with some features of the financial crisis that might affect the exchange rate fluctuations. In the first section attention is similarly given to the role of the exchange rate in monetary policy rules and its incorporation into them.

2.1 Monetary policy rules

Several approaches have been developed in order to describe functioning of a central bank's monetary policy. Generally, a monetary policy rule can be defined as a "description, expressed algebraically, numerically or graphically of how the instruments of policy, such as the monetary base or the federal funds rate, change in response to economic variables" (Taylor, 1999a, p. 319). An important feature of most of proposed rules is that not only do they provide a theoretical background for empirical description and evaluation of a monetary policy conduct of a central bank but they can also function as a prescription for a policy maker to respond to fluctuations in several key variables of his preference, such as inflation, (real) output, the exchange rate *vis-à-vis* one or more currencies, or the level of monetary aggregates in the economy. In other words, monetary policy rules can be used both for normative purposes, i.e. to provide a "recommendation of a good way to conduct a monetary policy," and for positive purposes, i.e. as a "description of how the central bank actually does set policy"[2] (Taylor, 2000,

[2]Put differently, it is possible to observe a "rule-like behavior"(McCallum, 1997) of a central bank based in fact on a *contingency formula* determining policy maker's responses

p. 8). One monetary policy rule can be considered better than another if its application results in better economic performance, mostly in terms of inflation or the variability of inflation and output or the exchange rate movements (Taylor, 1999a, 2000). Based on the estimation of the past monetary policy a rule can be obtained, with which it is then possible to examine the real economy performance in order to assess whether the rule worked well or poorly (Taylor, 2000). The policymaker can then choose such a rule that brings the best economic performance.

Knut Wicksell's approach can be considered the first attempt to prescribe a specified form of behavior to the central bank. He suggested an interest rate to be set in response merely to inflation without considering a real-economy activity (Orphanides, 2007). Another famous approach is connected with Milton Friedman and his constant k-rule of money supply growth stemming from the 1960s.

In practice, however, two relatively more recent approaches can be distinguished from the monetary policy rules literature. The first one, sometimes called an "R-rules," puts interest rates set by the monetary authority as a response variable in the equation describing a monetary policy rule. The other one, sometimes referred to as "M-rules," uses on the contrary monetary aggregates such as monetary base, M1 or M2, as an indicator of a monetary policy. The former is connected with the famous Taylor rule. Although this approach has been largely modified and further extended since the seminal paper by John Taylor (1993) had been published, a common name Taylor rule is still used in literature. The latter approach was proposed and applied by McCallum (1993, 1997). Several other rules based on interest rates setting have been proposed to be used by central bankers as well as for the purpose of empirical evaluation of monetary policy conduct. These rules modified for a (small) open economy were developed for instance by Ball (1999), Batini et al. (2001) or Svensson (1998, 2000).[3] A comparison of

to fluctuations of target variables or macroeconomic shocks in general.

[3]Svensson directly designs a rule for a central bank following a policy of inflation

several monetary policy rules for a big open economy in terms of efficiency and robustness can be found in Taylor (1999b). Since the identification issue for the monetary policy followed by the CBR is a rather complicated matter and both basic approaches (and some other methods as well) have been used to empirically evaluate it, it is necessary to discuss them both in the following subsections.

In emerging market economies in general the situation is more complicated than in matured economies. The underdevelopment of financial markets, often different institutional setting, and, especially in the earlier periods of transition, the often doubtful reliability of availible data together with a complicated specification of the models make implementation of a rule-based monetary policy, in particular "R-rules," much more difficult, and hence using a monetary policy rule to describe a behavior of the central bank may not have brought the best results although in advanced economies an open-economy version of Taylor rule is capable of explaining a high share of variation in short-term interest rates (Esanov et al., 2005).

The relative underdevelopment of financial markets stands frequently behind an absence of highly liquid longer maturity markets, and hence short-term interest rate responses of the central bank have to be faster and in larger amounts than in advanced economies. While in advanced economies expectations of future interest rates changes may affect financial markets operations and thus the real economy activity, and expected future short-term interest rates often have an immediate effect on long-term interest rates via the term structure of interest rates, in emerging market economies expectations matter not only for the term structure but, in spite of not entirely developed financial markets, expectation channel of monetary policy may influence, for instance, movements in the exchange rate, price of land or wages. Additionally, real interest rate measurement may prove to be difficult due to high inflation, and risk premia are often highly variable. Unlike in advanced

targeting.

economies, the exchange rate may require to be assigned a greater role in the monetary policy rule. Conducting a successful interest rate policy is further complicated in a high real economy growth environment. This all can cause over-night interest rates not to be a good monetary policy instrument, and such an overall uncertainty is likely to translate into policy errors. That is why monetary base may happen to be a more efficient instrument for achieving an inflation target and thus it can be used as an instrument in the central bank's rule although there are opposite opinions claiming that inflation targeting and monetary aggregates targeting are in fact alternatives (Taylor, 2000). As the only two clear alternatives Taylor(2000), however, distinguishes merely inflation targeting and fixed or managed exchange rate regimes. Esanov et al. (2005) even suggest that the specific features of emerging market economies may bring about that neither interest rates, nor the money base but rather the exchange rate can prove to be a more adequate policy instrument.

2.1.1 McCallum rules

McCallum rule, as designed and applied by McCallum (1993, 1997), assumes the setting of monetary base in a way that keeps levels of nominal GNP or GDP close to their target values in order to ensure their smooth growth at a rate that does not accelerate inflation. Hence, it is apt to apply for the description of central banks using monetary aggregates as their intermediary instrument as opposed to those monetary authorities that use interest rates as their primary instruments. Standardly it is expressed in the following form:

$$\Delta b_t = \Delta x^* - \Delta v_t + \beta(\Delta x^* - \Delta x_{t-1}) + u_t, \tag{1}$$

where Δb_t is a logarithm of an adjusted monetary base rate of change, in other words its growth rate between periods $t-1$ and t, which is controlled by the monetary authority. Δx^* is a target growth rate of nominal GDP or

GNP[4] in percentages per year. Analogically Δx_{t-1} is a logarithm of change of nominal GDP or GNP, again interpreted as annual percentage change. In this case values of target nominal growth rates of GDP (GNP) are calculated as the sum of the desired inflation rate and the long-run average rates of growth of real GDP (GNP), i.e. $\Delta x^* = \pi^* + \Delta y^*$. v_t is an annual growth rate of base velocity in percentages(sometimes taken in average values) that should reflect long-lasting changes in domestic residents' demand for monetary base determined by regulatory requirements or technological developments (Vdovichenko and Voronina, 2006). While the difference between desired and actual growth rates of nominal output reflects the cyclical conditions of the studied economy, the base velocity growth rate should not capture cyclical fluctuations. McCallum (1993) uses an extended variant of the rule with both lags of monetary base and nominal GNP (on a quarterly basis) included together with an intercept. This rule, according to his simulations produces a more desirable performance of monetary policy conducted by Bank of Japan than interest rate instruments rules. For an estimation of coefficients a standard vector -autoregressive (VAR) framework is used.

Similarly to Taylor rule, also McCallum rule is easy to interpret, as far as the coefficient β is concerned. Should the nominal output growth rate be lower than the target one, the monetary base is enlarged in proportion to the gap and the corresponding coefficient (assuming $\beta > 0$).[5] The opposite effect takes place when the actual nominal growth rate is higher than the projected optimal one.

As noted in McCallum (1997), the choice of target variables, be it inflation or growth rates of nominal GDP (GNP), is made presuming that the central bank in question does not have an exchange rate target. Considera-

[4]Although McCallum (1993) originally uses logarithms of Japanese nominal GNP, in later applications of his rule nominal GDP occurs more frequently.

[5]Esanov et al. (2005, p. 489) puts $\beta = 0.5$ directly. He also uses monetary aggregate M1 for the case of Russia for a Granger causality test indicated that in the short run implication goes from monetary aggregates to prices and not vice versa.

tions involved in choosing an appropriate exchange rate target differ to those when other macroeconomic variables are targeted, e.g. inflation or nominal spending growth (McCallum, 1997).

2.1.2 Taylor rule and its modifications

Unlike McCallum rule, the group of monetary policy rules known as Taylor rules concerns reactive rules expressing the adjustments in the interest rate policy instrument in form of a, usually, linear function of changes in inflation and economic activity. The most famous manifestation of this approach was presented by Taylor (1993). His contribution was to develop a "hypothetical but representative policy rule" that closely approximated the Federal Reserve's policy in the previous periods. General form of Taylor rule can be expressed in the following way:

$$i_t = \pi_t + \delta(\pi_t - \pi_t^*) + \gamma y_t + r^* \tag{2}$$

The dependent variable i_t represents the short-term nominal interest rate set by the policymaker,[6] π_t stands for rate of inflation and π_t^* for the targeted level of inflation. Output gap, expressed as the percentage difference between the actual real GDP and its linear trend, is represented by the variable y_t, and r^* is the real interest rate equilibrium level.

As follows directly from equation (2) (for $\delta > 0$), the policymaker raises interest rates whenever the measured inflation exceeds its target levels. Analogically for the output gap, and positive γ, interest rates are increased to prevent the economy from exceeding its potential output and subsequent overheating. Target level of inflation is positive because undershooting a target of zero inflation might lead to deflation. On the contrary, the targeted rate for output gap is put at zero due to the natural rate hypothesis

[6] In some cases, i_t can be replaced by the target for the nominal short-term interest rate, i_t^*. The target is, nevertheless, assumed to be achieved within one period (Molodtsova et al., 2008) and there is thus no distinction between the targeted and actually set policy rate

stating that output cannot stay higher than its potential for longer period (Molodtsova et al., 2008). The rule Taylor estimated for the FED policy was as follows:

$$i_t = \pi_t + 0.5y_t + 0.5(\pi_t - 2) + 2 \tag{3}$$

Taylor put both inflation target and equilibrium real interest rate equal to 2% assuming them to be constant over time. Since both response coefficients are equally set to one half, policy maker is implicitly assumed to care equally about the price stability and economic growth. This rule, as expressed in equation (3) fitted the actual FED policy conduct and is known as the classic Taylor rule (Orphanides, 2007). An interesting feature of the equation (3) is that, should the weight put by the policy maker on output deviations be empirically proved to be zero, than the central bank in question can be said to follow the so called strict inflation targeting, i.e. authorities are concerned only about "keeping inflation as close to a given inflation target as possible, and nothing else."(Svensson, 1997, p. 5)

To show an interesting aspect of the classic Taylor rule, let us put, according to Molodtsova et al. (2008), $\mu = r^* - \delta\pi_t^*$ and $\lambda = 1 + \delta$. Then the equation (1) can be expressed as:

$$i_t = \mu + \lambda\pi_t + \gamma y_t \tag{4}$$

The fact that $\lambda = 1 + \delta > 1$ is usually referred to as Taylor principle (Molodtsova et al., 2008, p. 586), which states that for any increase of inflation over its target level the correspondent increase in the policy rates should be higher so that also the real interest rate is raised, which is required to keep the economy stable.

Generally, rules of the above-mentioned type can be expressed as (Orphanides, 2007):

$$i - i^* = \theta_\pi(\pi - \pi^*) + \theta_q(q - q^*), \tag{5}$$

where there is a difference of the short-term nominal interest rate and its baseline path i^* on the left hand-side. The right hand-side variables again

represent deviations of real output and inflation. In fact, as it is showed hereafter, right hand-side variable can be generally thought of as any observable economic variable that the policy maker intends to keep as closely to its target value as possible, for example the exchange rate. The corresponding response coefficient then represents the intensity with which the monetary authority reacts to deviations from the target in terms of adjusting the interest rates.

A generalization of (3), which then becomes a special case of a generalized Taylor rule, can be considered in the following form (Orphanides, 2007):

$$i = (1-\theta_i)(r^*+\pi^*)+\theta_\pi(\pi-\pi^*)+\theta_\pi(\pi-\pi^*)+\theta_q(q-q^*)+\theta_{\Delta q}(\Delta q-\Delta q^*) \quad (6)$$

The rule (4) is obtained by rearranging the right hand-side of the rule (3) by using Fisher identity for optimal interest rates and by adding two further elements. Firstly, control for inertial behavior of the process of setting interest rates (for $\theta_i > 0$) is allowed and, secondly, the interest rate instrument is enabled to respond to the deviations of output growth from its potential growth rates, $(\Delta q - \Delta q^*)$.[7] The former feature is particularly important for models empathizing expectations. Orphanides (2007) proposes another special case by putting $\theta_i = 1$ and $\theta_g = 0$, which then allows for considerations of a family of so called difference rules.

While discussing the usefulness of monetary policy rules, it is important to distinguish between changes in instruments due to "shifts" in the policy rule, and due to "movements along" the policy rule (Taylor, 1999a). As Taylor (1999a) concludes in his historical analysis of monetary policy rules applied in the United States, macroeconomic performance in terms of volatility of output and inflation did differ under different monetary policy rules. It is also important to capture the difference between a discretionary behavior of the central bank and a transition between policy rules (Taylor, 1993).

[7] Adding lagged nominal interest rate can allow the rule to control for interest rate smoothing (Batini et al., 2001).

Another potential complication is connected with the use of real-time data available at the given moment to policy makers and those used in the *ex-post* policy analysis. While the descriptive models use already revised data for their inputs, the monetary authority decision is based on the information known at the time t, i.e. on either data from previous period $t-1$ (Molodtsova et al., 2008) or forecasts of key variables (Orphanides, 2007). In both cases the evaluation of policy is equally questionable.[8]

2.1.3 Exchange rate in Taylor rules

Even though Taylor (1993) did not include the exchange rate into his estimated rule, there is still much to be said about the inclusion of the exchange rate into interest rate rules in general. In fact, as Taylor (2001, p. 12) notes, the omission of the exchange rate from the rule for FED in Taylor (1993) was based on simulations that showed that if the central bank had exercised a strong reaction to the exchange rate movements, macroeconomic performance would have worsened. Nevertheless, Taylor (1993) model still assigns a big role to the exchange rate (Taylor, 2001).

Any central bank has, according to Taylor (2000, 2001), only two effective alternatives for its monetary policy. Either it follows a policy of permanently fixed exchange rate, or it has to formulate its policy based on a "trinity" consisting of the flexible exchange rate regime (in wide range of modifications), inflation target and a monetary policy rule. This is the so called "bipolar view". As inflation targeting and exchange rate policy are discussed later in this text, solely inclusion of the exchange rate into monetary policy rules will be focused on in this subsection. An important notice should be also taken of the fact that once the exchange rate has been completely fixed via for instance a pegged exchange rate regime, a currency board or a monetary union, there is no space for central bank's instruments

[8]Molodtsova et al. (2008) compare the results of Taylor rules for the Fed and Bundesbank policy using both real-time and revised data.

to be used on domestic economy conditions. On the contrary, if a central bank follows a flexible exchange rate regime, monetary policy instruments can be aimed at domestic economy conditions, with inflation and output growth being usually the priority.

The exchange rate channel plays an important role in the monetary policy transmission mechanism, also allowing for additional channels of transmission (Svensson, 2000), and is present in several forms in any basic model for monetary policy that considers not only an output target but also the effect of the exchange rate on inflation. In most cases a perfect mobility of capital flows is assumed, which holds both on theoretical and empirical levels also for Russian economy in the evaluated period.

The discussion about the pass-through effects of the exchange rate changes to prices of goods sold at home and in another country is a necessary part of considerations included in open-economy models. Therefore Taylor (2000) suggests that an inclusion of the exchange rate into the reaction function of the central bank in a country where exchange rate stabilization is an essential part of output stabilization and controlling inflation. Consequently, there is a need to include the exchange rate (possibly with lags) into a model describing central bank's behavior in order to improve its explanatory power. Paez-Farrel (2012), however, demonstrates on a two small open economy models that once policy makers are stabilizing the exchange rate without making it clear to public, i.e. a situation described by Calvo and Reinhardt (2000) as "fear of floating," current estimated models may not be enough descriptive to provide information about the central bank's behavior. If the monetary authority is concerned about the exchange rate but would like to conceal it, simple policy rules will not distinguish this policy from a floating exchange rate regime. Thus "fear of floating" can be mistakenly considered a pure inflation targeting (Paez-Farrel, 2012, p. 19).

A natural extension of the rule in equations (2) or (5) can be considered in simplified form of a linear relationship in which policy rates respond to,

apart from inflation and deviations of real GDP from its potential, also to current and lagged real exchange rates.[9] Taylor (2001) considers a rule of the following shape for three distinct models presented in Svensson (2000), Ball (1999) and Taylor (1999b):

$$i_t = f\pi_t + gy_t + h_0 e_t + h_1 e_{t-1} \tag{7}$$

The absence of an intercept indicates that the central banks aims at zero inflation, and that interest rate and exchange rates are measured relative to their long-run steady state values. An overall discussion on the need of including the exchange rate into monetary policy rules is provided in Taylor (2001). The general conclusion, however, is that rules reacting both directly to the exchange rate and to inflation and GDP at the same time "do not work much better in stabilizing inflation and real output and sometimes work worse" compared to models that do not allow for a direct reaction of interest rates (i.e. coefficients h_o and h_1 in rule (7) are set to zero). Indirect exchange rate effects are still present even in equation (2) or (5) type rules via a combination of inertia and rational expectations. A flexible exchange rate regime does not necessarily mean that exchange rate effects do not play any role, either direct or indirect, in considerations of the policy makers (Taylor, 2000), of which an account must be taken of also for designing monetary policy rules for descriptive purposes. Furthermore, Detken and Gaspar (2003) found that for a small open economy with fully free movements of capital the exchange rate may appear as if it were managed (or even fixed) by the central bank even though it follows a free floating regime. For even the monetary authority that is not directly targeting the exchange rate may happen to react to its fluctuations as long as deviations of price level matter for the authority. In other words, an observational equivalence may occur between free floating and managed exchange rate regimes. Especially in a response to shocks coming from the international capital markets the

[9]The model can be further extended by adding lags of interest rate, inflation or deviations of GDP as well as by including longer lags of the exchange rate.

exchange rate may seem to be *quasi-fixed*.

2.1.4 Ball rule

Ball (1999) objects, however, that in an open economy the policymaker has to react via both the interest rate and the exchange rate channel to affect economy. In that cause he proposes a model consisting of an open-economy IS curve, open-economy Phillips curve and a link between the interest rate and the exchange rate described in the subsection above. By rearranging the equations, following model is obtained (Ball, 1999, 131):

$$wr + (1 - w)e = ay + b(\pi + \gamma e_{-1}) \tag{8}$$

Where the left hand-side policy variable now consists of a weighted average of interest rate and exchange rate instruments, called a "monetary conditions index" (MCI). Inflation was replaced by a combination of inflation and lagged exchange rate. This can be interpreted as a long-run forecast of inflation with output being at its natural level. Coefficients a and b are obtained by calibration of the model, and γ represents a response of inflation to fluctuations of the exchange rate.

Batini et al. (2001), nevertheless, argues that MCI based rules can perform poorly facing several exchange rate shocks and are thus unsuitable for every day monetary policy conduct. They propose a rule based on inflation forecasts (IFB) that, contrary to other models, reacts to deviations of the expected inflation from target. Such a rule is then more robust to different shocks compared to simple Taylor rules or Ball rule.

2.2 Exchange rate

In this part several aspects of exchange rate policy are discussed. For the exchange rate by all means plays an essential role in the analysis of behavior of the central bank in a small open economy. As most of the monetary authorities in other emerging markets economies, also the CBR devoted a

great attention to movements of the exchange rate. Its fluctuations can not only affect a real economy activity or the level of inflation, but can also be a part of the contagion spreading process during a period of a crisis as the exchange rate may in some instances serve as an additional channel of transmission of foreign disturbances (Svensson, 2000). The exchange rate, like a price of any other asset, is by its character forward-looking and prone to being affected by expectations (Svensson, 2000). Monetary policy can also from its side affect the volatility of the exchange rate channel. By influencing the fundamentals of an economy, the central bank can affect the base volatility of the exchange rate. And, similarly, changes in central bank credibility have an effect on the excess exchange rate volatility (Bauer and Herz, 2007).

The exchange rate enters monetary policy models prevailingly as a part of an *ex-ante* interest rate parity (e.g. in Svensson, 2000) or in a reduced-form relationship between the real interest rate and the real exchange rate (e.g. in Ball, 1999). In a relationship similar to reduced form equations (Ball, 1999), $e = \theta r + \nu$, exchange rate e responds to the policy rate r set by the central bank and other factors such as investor confidence or expectations, or foreign interest rates. Generally, a rise in domestic interest rates makes home currency, ceteris paribus, more attractive for foreign investors, which consequently leads to appreciation pressures. Analogically, an appreciation of domestic currency forces the central bank to lower its rates to offset contractionary effects of currency appreciation. Nevertheless, as lowered interest rates are likely to cause a rise in inflation, an offsetting rise in the interest rate can be expected in the next period. Another transmission channel leads from movements of the exchange rate and consequent changes in terms of trade to the price and quantity of imports and exports. A direct exchange rate channel of monetary policy has typically shorter lags than an aggregate demand channel as it enters the domestic currency prices of imported final goods, whose changes are in turn reflected in changes of the

consumer price index (CPI), i.e. in other words inflation (Svensson, 1999). Hence, by influencing the exchange, rate policymaker can affect inflation faster. Svensson (1999) identifies and additional channel from the exchange rate to inflation. This channel stems from the domestic currency prices of imported inputs for intermediate production. Through the effect of inflation on wage setting, nominal wages are consequently increased, which raises the price of domestically produced goods and thus also the domestic inflation.

Unlike numerous developed economies, many emerging market economies in the last decade managed to accumulate large reserves of foreign currencies as they kept moving towards greater capital account openness, exchange rate flexibility and monetary independence (Sokolov, 2012). This is partly true also for Russia for at least the period from the beginning of the 2000s to the start of the "post-Lehman" phase of the financial crisis in 2008. According to Aizenman et al. (2008), who estimated a so called "trilemma index" measuring the degree of the exchange rate flexibility, monetary independence and capital account openness, Russia has made some progress towards the exchange rate flexibility and monetary independence since 2005.

Levy-Yeati and Sturzenegger (2005) provide simple definitions of both of the border exchange rate regimes in terms of changes of the nominal exchange rate, their volatility and volatility of international reserves. The fixed exchange rate means that changes in international reserves reduce volatility of the nominal exchange rate, and the flexible exchange rate is associated with substantial variations in the nominal exchange rate and with relatively stable reserves. Furthermore, under managed exchange rate regimes conditional volatility of the exchange rate is low as the exchange rate is stabilized by currency market interventions and (or) exchange rate oriented interest rate policy of the central bank (Bauer and Herz, 2007). For the same reasons, conditional volatility of the floating exchange rate is likely to be high. But should the fixed exchange rate be subject to speculative attacks, it is likely to exercise a rather high volatility as well, depending on the credibility

of central banks, its international reserves etc.

Contrary to previous studies, Aghion et al. (2009) found evidence of a significant impact of volatility of the real exchange rate on productivity growth. This effect is, however, related to the level of financial development of an economy that plays an important role in the interaction between the exchange rate volatility and macroeconomic shocks. Most importantly, on a cross-country sample panel it was proved that higher levels of exchange rate volatility can hinder growth in particular for countries with thin capital markets and financial shocks being the main source of macroeconomic volatility (Aghion et al., 2009), which are conditions similar to those faced by the CBR. In developing countries, attempts to stabilize the exchange rate may increase the volatility of output that can be in turn mitigated by a greater accumulation of foreign reserves. This holds especially for economies with not fully developed financial sectors (Aizenman et al., 2008). Indeed, as country's financial markets become more developed, flexible exchange rate policies seem to be rather beneficial for the economy (Aghion et al., 2009). Yet, in countries for which high volumes of imports and exports and international capital inflows represent a significant part of their economy (such as many emerging market economies) large fluctuations in the exchange rate can cause substantial deviations in the real economy sector growth even though the central bank in question follows (*de facto*) a free floating regime. This is caused by a large level of foreign currency denominated commercial debts that are likely to get out of control and injure the financial system during substantial depreciations (Calvo and Mishkin, 2003). Higher levels of dollarization of the economy tend to intensify the negative impact of large depreciations on the inflation pass-through (Carranza et al., 2009). This means that a real depreciation (in particular a large one) may not bring about higher inflation through higher internal demand and imported inflation. These effects can be ruled out or mitigated by larger financial costs and balance sheet effect. Balance sheet effects are in particular severe for

countries with fixed exchange rate. Carranza et al. (2009) conclude that balance sheet effects of exchange rate changes in dollarized economies go against the implications of models with origins in Mundel-Flemming model. That is why attention must be given to the varying level of dollarization of the Russian economy when the policy of the CBR is assessed.

As it emerged during a series of crises in the 1990s, the fixed exchange rate may be too costly to defend against speculative attacks and can, in the end, lead to further propagation of a crisis. And yet, not always did the monetary authorities, who announced a move to the floating exchange rate (often as a reaction to a previous crisis), in fact float their currencies (Calvo and Reinhardt, 2000). Often exchange rate regimes officially classified as free or managed floats rather resemble a non-credible pegs. Hence, as Calvo and Reinhardt (2000) claimed, the "demise of fixed exchange rates", which was supposed to take place partly as a reaction to the currency crises in the 1990s, was a myth, and the "fear of floating" occurred instead. Furthermore, if banks lend their foreign exchange deposits, the "liability dollarization" may cause the government to be rather anxious to float the currency (Mishkin, 2004). The lack of central bank credibility can make sustaining the fixed exchange rate a very costly affair (Obstfeld and Rogoff, 1995). Thus the central bank should primarily focus on inflation keeping the exchange rate as a mere indicator and not the target, which is not far from the recommendations given in Calvo and Mishkin (2003). Insufficient credibility of the central bank to sustain low levels of inflation increases the probability that the depreciation of domestic currency will substantially increase inflation due to a bigger pass-through effect from higher prices of imports and higher foreign demand for domestic exports. This, together with "liability dollarization", may trigger a financial crisis (Mishkin, 2004). Mishkin (2004) hence argues that it is impossible to neglect entirely the exchange rate fluctuations even in case of an inflation targeting central bank. But if an inflation targeting central bank in its efforts to prevent sharp depreci-

ations smoothers the exchange rate too strongly, its monetary policy may rather start approaching the "fear of floating" stance. Therefore, the policy maker should, according to Mishkin (2004) aim at increasing transparency of foreign exchange market interventions without aspiring to "prevent the exchange rate form reaching its market determined level over longer horizon"(Mishkin, 2004, p. 26).

Further insight into the problematic is provided by Levy-Yeati and Sturzenegger (2005), who also carry out a cluster analysis of different exchange rate arrangements of many countries according to their performance that is compared to theoretical features of given exchange rate regimes. They document that there are often inconsistencies between the exchange rate regime country announces and that is then recorded by the IMF (i.e. a *de jure* classification), and the actually conducted exchange rate policy (a *de facto* classification). Their results show that as the number of the *de jure* floats increased, so did the number the of *de facto* dirty floats. *De facto* floats are often associated with low variability of the exchange rate because many countries having declared to float their currencies still intervene regularly to stabilize the exchange rate. This supports the findings of Calvo and Reinhardt (2000). Analogically, many countries did not explicitly announce to peg their currencies although they did so in reality ("hidden pegs"), which can partly explain why, despite the arguments of Obstfeld and Rogoff (1995) of likely speculative attacks on fixed regimes, many countries still kept their exchange rates *de facto* fixed. Nevertheless, the argument of "hidden pegs" did not concern countries that could not entirely freely access the international capital markets. In an assessment of credibility of exchange rate policies of Russia, Ukraine, Belarus and Kazakhstan based on financial markets' views, Bauer and Herz (2007) demonstrated that all these countries manage their *de facto* exchange rate policies relatively credibly according to financial traders' assessment. Excess volatility of these respective exchange rates is low, and technical traders' reactions to trend signals are weaker in

expectation of "trend breaking interventions" of policymakers.

The reaction of the central bank to exchange rate fluctuations can take form of either a standard operation with policy rates, the movements of which affect (via the interest rate parity or any other relationship between the exchange rate and interest rates) the exchange rate, or an intervention in the foreign exchange market. The former approach has several limitations in altering the exchange market conditions (Levy-Yeati and Sturzenegger, 2005). The latter approach consists of a sale of foreign reserves (in cases when central bankers support the domestic currency), and, in order to avoid contractionary effects of such operation on domestic money base, the central bank simultaneously buys equal amounts of domestic currency denominated bonds thus conducting the so called "sterilization" (Obstfeld and Rogoff, 1995). An unsterilized intervention would include only the first part of the process. Sterilized interventions do not affect relative supply of money therefore their effect on interest rates and on the exchange rate can be only modest. A foreign exchange intervention can be aimed not only at reversing the process of devaluation/appreciation but can be also used to make any of these processes smoother.

A more flexible alternative to the fixed exchange rate, which, nonetheless, does not deprive the central bank of the opportunity to influence the exchange rate, is targeting the zones of the exchange rate fluctuations. Such an approach towards originally the US dollar and consequently the euro-dollar bi-currency baskets was also exercised by the CBR. Keeping the exchange rate inside certain bounds has several benefits. For instance it reduces opportunities for speculative attacks while offsetting extreme exchange rate fluctuations. Once the monetary authority has acted persuasively enough for some period, investors are bound to expect an intervention in the foreign exchange market as the exchange rate approaches any of the two bounds. This enables also the movements within bands to be sufficiently stable. For the central bank that on the one hand faces high fluctuations of the exchange

rate potentially endangering the real economy sector, and on the other hand cannot commit itself to a fully-fledged fixed exchange rate regime leaving no options for policymakers to control domestic variables such as inflation or output, a zone targeting can pose a reasonable balance. Widening the bounds gives the monetary authority further space for an active use of monetary policy instruments (Obstfeld and Rogoff, 1995). Therefore, in the process of transition towards an inflation targeting regime the CBR widened the fluctuation bounds and regulated the rules for interventions in the foreign exchange rate market consequently approaching a free-floating regime. Contrary to abovementioned benefits, Obstfeld and Rogoff (1995) also mention numerous cons of zone targeting. Even a broad band still represents a commitment of the central bank to defend it in case of different macroeconomic shocks or speculative attacks. Hence, a band can at maximum postpone a speculative attack but cannot entirely rule it out (Obstfeld and Rogoff, 1995, p. 19). Maintaining the bounds, once the exchange rate has reached them, is then the same problem for the central bank as maintaining the fixed exchange rate, which is why zones should not be used as a monetary anchor but rather as a device for limiting the exchange rate fluctuations in the short-term as well as sharp medium term movements in the real exchange rate (Obstfeld and Rogoff, 1995).

For countries who still choose to peg or manage their currencies and whose trade is primarily carried out in more than one principal currency (like the euro or the US dollar) it is sometimes more beneficial to target two (or even more) currencies in their exchange rate policies. Targeting a basket of currencies loosens dependence of domestic interest rates on the monetary cycle of one economy and links them to a synthetic interest rate that is likely to respond to monetary conditions of all countries whose currencies are in the targeted basket (Sokolov, 2012). After the 1997 Asian crisis a debate was led on the benefits of basket targeting. Several countries, e.g. China or Malaysia (or Kuwait since 2007), afterwards switched to basket

targeting and, instead of managing their currencies merely towards the US dollar, they set their national currencies towards an undisclosed basket of currencies (Sokolov, 2012). The CBR started targeting both the US dollar and the euro in 2005 describing it as a step towards higher exchange rate flexibility and monetary independence. Another reason for it may have been a declining level of dollarization of Russian economy in that period, and expected rise of importance of trade with the Euro-area (Bauer and Herz, 2007). Unlike other basket-targeters, the CBR discloses composition of the basket. Bi-currency targeting formally means that the central bank in question chooses two feedback parameters λ and θ from the interval $(0, 1)$ in the following model for the combination of the euro and the US dollar (Bauer and Herz, 2007).

$$m = \frac{1-\lambda}{\lambda}[(1-\theta)(e_{eur} - e^*_{eur}) + (e_{usd} - e^*_{usd})] \tag{9}$$

In this case m is the policy instrument set by the central bank (money supply or interest rate), e the exchange rate *vis-a-vis* the euro and the US dollar respectively, and e^* is the respective exchange rate target. Parameter λ implies to what extent the monetary authority under consideration cares about the exchange rate movements. θ is the weight of respective currency in the targeted basket. For $\lambda \leftarrow 0$ the central bank exercises a strong reaction to exchange rate movements (up to fixed exchange rate in the limit case). $\theta = 0$ means a peg towards the euro and, conversely, $\theta = 1$ signals that the central bank fixes currency towards the US dollar.

Calvo and Mishkin (2003) point out, however, to the weaknesses of the debate of the choice of the exchange rate regime, particularly as far as the emerging market countries were concerned. According to them the choice of the exchange rate regime is of second order of importance, only following the development of good fiscal, financial and monetary institutions. These are considered to be essential for successful macroeconomic policies. Thus institutional reforms are also crucial for prevention of a financial crisis in emerging market economies. Decision to float exchange rate regime then only

rules out the possibility to peg the domestic currency towards some other currency (currencies) but it says nothing about conduct of the monetary policy, and different strategies from inflation or money aggregates targeting to a purely discretionary, "just-do-it"(Bernanke et al., 1999) approach can be applied to achieve the monetary policy goals. Nominal anchor becomes then implicitly set by the monetary policy regime in contrast to the explicitly set exchange rate target.

Another question of interest is the behavior of the exchange rate during crisis and role of the exchange rate in propagation of crisis. Obviously, during a crisis the exchange rate by definition tends to perform greater than normal fluctuations as it is, especially in emerging market countries, often influenced by rapid capital outflows. Investors tend to withdraw from emerging markets to obtain liquidity they suddenly become short of due to a fall in advanced economies. This brings about shortage of accessible sources of lending in emerging markets. Foreign borrowing by banks can become a serious problem during a financial turmoil. Similarly, once a crisis has struck in one country, the conditional probability that its trade partners will also be hit increases.

In the last financial crisis spillovers from advanced financial markets into emerging economies were exacerbated and in period between July 2007 and September 2009 the exchange rate volatility rose strongly (Coudert et al., 2011). This surge was not, however, always associated with depreciation. As Coudert et al. (2011) report, the Brazil real recorded an appreciation afterwards. A more than proportional increase of exchange rates was recorded as a result of global financial stress. Currencies of emerging market economies were hit by regional contagion. Volatile exchange rates were also more associated with the US dollar linked economies, many of which consequently loosened the link of their currencies to the US dollar. In particular this concerned Brazil, India, Korea, Mexico and Russia (Coudert et al., 2011). This loosening occurred as a result of market pressures caused by speculators' at-

tacking respective currencies. Coudert et al. (2011) explain it by contagion effects stemming from the contractionary reaction of investors who lacked liquidity in advanced markets and rapid sales of their emerging markets' assets then exercised pressure on currencies of emerging market economies. Thus, spillovers of contagion from advanced economies were behind the loosening of exchange rate policies. Feldkirecher et al. (2014) contribute to the debate about exchange rates' behavior during the last financial crisis by examining the influence of country's leading economic indicators on pressures on the exchange rate and its volatility. Apparently, price stability seemed to be an important determinant of exchange market pressures. Currencies in countries with higher pre-crisis levels of inflation were more seriously affected once the crisis has struck. On the other hand, higher domestic savings tended to stabilize exchange market pressures for countries with low levels of pre-crisis inflation. On the contrary, in countries with pre-crisis inflation of more than 5% "hoarding of domestic savings might constitute a waste of economic resources" (Feldkircher et al., 2014, p. 32). Foreign reserves seemed to lessen volatility of exchange rate pressures serving thus as a buffer. An important conclusion for the purposes of this text is that pre-crisis price stability "reduced vulnerability to adverse financial shocks" (Feldkircher et al., 2014).

3 Monetary policy in Russia

In this section development of the Russian monetary policy with a particular focus on the 2008 crisis period is briefly reviewed. Important results of research are also presented.

3.1 Evolution of monetary policy in Russia

At the beginning of the 1990s the CBR had to overcome the legacy of a centrally planned economy. Standard institutional environment of market economies was only beginning to develop as well as the, till that time nonexistent, financial markets that could provide sources for financing of the government deficit. As a heritage of a centrally administered economy a border between budget and credit financing of government and government owned enterprises was missing. Similarly, role of the CBR in the economy was not well defined (Granville and Mallick, 2005). At the beginning of the restructuralization process, as well as for some period following the 1998 default, domestic and foreign funds for deficit financing were largely unavailable. Initially, the CBR acted as banker of the government providing credits directly to the government budget, state enterprises, or other republics in the rubble area disregarding the evolving financial markets. Between 1992 and 1993 the CBR provided "monetary financing" both for the government and government owned enterprises. Monetary financing of the government, who had to conduct a painful restructuralization of economy, led to a surge in inflation. Only later these flows began to be reduced and the CBR started using indirect monetary instruments as its main policy tool (IMF, 1997). In 1995, as the government T-bills replaced seignorage as the main source of deficit financing, the independence of the CBR could be increased. In other periods the CBR on the contrary provided funds to financial markets or restricted its policy with respect to them.

Granville and Mallick (2005) identify two basic monetary policy regimes

that the CBR conducted in the years 1992 to 2005. In the periods 1992-1995 and 1998-2005 the CBR led a money based program. From July 1995 to August 1998 the CBR conducted a program aimed at exchange rate stability. Results in Esanov et al. (2005) also indicate that between the years 1993 and 1995 the CBR was likely more concerned with inflation but since 1995 the CBR was mainly oriented towards the exchange rate stability.

During almost whole of the 1990s the policy rates were largely disconnected from inflation (Granville and Mallick, 2005). In July 1995 the exchange rate *vis-à-vis* the US dollar was adopted as the nominal anchor for price stability. Esanov et al. (2005) find also an evidence of a structural break in 1995, after which the CBR seemed to be concerned more with the exchange rate than with inflation. In the financial crisis in August 1998 expectations of the exchange rate played a role of a catalyst of the crisis (Basdevant and Hall, 2001). And, consequently, on August 17th 1998 the exchange rate peg was abandoned with successive devaluation of 60% and a rapid rise in inflation. In the following period restrictive fiscal policy as well as a number of reforms were adopted in order to stabilize financial situation of the government and make the country attractive for foreign investors. In order to rebuild its credibility, the CBR introduced a new simple and transparent intermediary target with the US dollar exchange rate being set up as the nominal anchor (Bauer and Herz, 2007). According to Juurikkala et al. (2011), since 1998 (to 2005) the exchange rate *vis-à-vis* the US dollar was a *de facto* target of the CBR. [10]

In consequence of the Russian default in August 1998 the Russian government was forced to substantially tighten its fiscal policy as well as to introduce a number of reforms in several areas, including the tax reform (in 2001) or reform of financial markets. These led to lower interest rates that enabled a rise of investment and consumption (Guriev and Tsyvinski,

[10]Broader and more detailed description of the monetary policy conduct in Russia in the 1990s and beginning of the 2000s can be found e.g. in Granville and Mallick (2005, 2010) or Vdovichenko and Voronina (2006).

2010). Since 2000 the Russian government has been able to accumulate budget surpluses. Their origin laid not only in rising prices of oil and energy sources in general but also in prudent fiscal policy of the government, which may have had a more important role (Granville and Mallick, 2005). Altogether, in the period 2000 - 2008 Russian economy grew in average by 7% a year. Its annual capital account surpluses amounted to 10% and fiscal surpluses to 4% in average terms (Granville and Mallick, 2010). Persistently high prices of energy resources and inflows of foreign capital attracted by comparatively higher interest rates created significant balance of payments surpluses throughout the whole period. Before proceeding to discussion of the reaction of the CBR to these circumstances, it is, nonetheless, necessary to consider several other features typical for the Russian economy that may have seriously influenced the ability of the CBR to conduct monetary policy. In particular, question of monetary policy transmission channels is considered.

3.2 Specifics of Russian monetary policy

The level of dollarization of the Russian economy is without doubt an important factor affecting the monetary policy and CBR's decision making. Moreover, if the dollarization and currency substitution in the Russian economy is considered within a framework of the managed exchange rate regime, rapid economic growth and underdeveloped banking sector, it becomes apparent that this factor often did enter the decisions of the policymakers. Periods of hyperinflation in the 1990s and substantial depreciation during the currency crisis in 1998 led to a significant increase in currency substitution and demand for foreign currency (in this case the US dollar) for holding savings (Ponomarenko et al., 2011). In a model of a representative transition economy designed by Papazoglou and Pentecost (2004) demand for foreign currency reacts to expected depreciation of domestic currency as well as to transaction and precautionary purposes of domestic residents optimizing

their portfolio given the presence of high domestic inflation, against which they hedge. Other motives to hold foreign currency are linked to instability and uncertainty during the transition process. Thinness of capital markets and currency substitution are thus the most distinct features of the financial markets (Papazoglou and Pentecost, 2004).

This situation rather closely resembles Russia where the motives for currency substitution at the beginning of the 2000s were further intensified by the currency crisis and subsequent sharp depreciation in 1998. In such a context it makes sense to consider Cagan style demand for money during hyperinflation. Taylor (1991, p. 342) shows that to correctly specify the demand for money during hyperinflation (in this case in interwar Germany), it is necessary to consider substitution "between domestic money and foreign nominal assets, as well as between domestic money and real assets." Foreign nominal assets then appear to be closer substitutes for domestic money than domestic real assets (Taylor, 1991). Therefore expected rate of depreciation of the domestic currency has to be included into the money demand specification. Choudhry (1998) also finds that the high sensitivity of the demand for money to the exchange rate fluctuations in Russia may indicate currency substitution. Oomes and Ohnsorge (2005) estimated that in 2003 up to 40% of the effective broad money aggregate consisted of foreign currency either in circulation or in a form of deposits. They conclude that it is necessary to include estimates of foreign cash holdings into the definition of broad money holdings in order to obtain a stationary money demand function, which in dollarized economies tends to be rather unstable and hence complicates forecasts and control of inflation. Growth of effective broad money aggregate including an estimate of foreign cash holdings then has "the strongest and most persistent effect on short run inflation" as it leads to an increas in inflation. On the contrary, changes in other money aggregates do not have a significant effect on price level (Oomes and Ohnsorge,

2005).[11] Nonetheless, in the 1990s the influence of changes of broad money growth on inflation appeared to be decreasing with higher stability of the Russian economy (Nikolič, 1999). High levels of foreign currency in use in Russia also amplify Russian reliance on foreign money markets that stands behind a large volume of foreign currency liabilities. Changes in preferences of economic agents also tend to amplify the exchange rate fluctuations (Ponomarenko et al., 2011).

In the post 1998 crisis period (1999-2003) the CBR could not use its rather restricted and inefficient interest rate policy to influence the economy. The financial markets and banking sector were not yet sufficiently developed and efficient to enable a smooth transition of the interest rate channel, and likewise the CBR lacked available monetary policy tools. Its reference rate had originally a mere nominal status (Vodvichenko and Voronina, 2006) as the money market rates were substantially lower, and there was a permanent excess of liquidity in the money markets. Only after reduction to 18% on over-night credits and currency swaps in 2003, the reference rate became an applicable monetary policy instrument. Hence during the post-crisis period the CBR relied mostly on targeting of monetary aggregates (Vdovichenko and Voronina, 2006). Yet, their results obtained by estimation of the monetary policy rule with different independent and response variables within a GMM framework show that both the money base and the interest rates were used as instruments by the CBR. Interest rate policy bore a rather accommodative pattern, and the management of money base was conducted with stabilizing aims, which corresponded to officially declared policy of the CBR (Vdovichenko and Voronina, 2006, p. 159).

Similarly, Esanov et al. (2005, p. 489) claim that (especially in the 1990s) due to shallow financial markets, frequent shocks to investments and exports, and uncertainty in measuring the real expected interest rate, the

[11] A more recent text on money demand in Russia can be found in Krupkina and Ponomarenko (2013) who review numerous models of money demand for different monetary aggregates.

interest rate was not an optimal and the most important policy instrument. On the contrary, monetary aggregates were more optimal as policy instruments. Therefore, the CBR chose to control the money supply to overcome post-default inflation in the years 1999-2004 while simultaneously influencing the foreign exchange market to stabilize the exchange rate (Vymyatnina, 2006). Monetary aggregate M2 was adopted as an intermediate anchor in the years 2004-2005, and deposit auctions then became the main instrument of the CBR. That is why, Taylor rules in Esanov et al. (2005) produce results inferior to McCallum rules in case of the CBR, and only after 1998 they provide significant coefficients. On the other hand, McCallum rules for monetary aggregates fit the data for the period 1993-2004 much better with coefficients significant and mostly unchanged throughout the whole period, which means that the CBR used monetary aggregates as its main policy instrument.

Contrary to these conclusions Sokolov (2012) claims that shallow domestic debt market did not allow the CBR to freely conduct open-market operations with the aim of influencing the money supply. Starr (2005) in a research on the effects of monetary policy on output and inflation also finds that results for Russia tend to resemble advanced economies in linking adjustments in the interest rates of the CBR to statistically significant changes of output, and in the ability of monetary policy variables to explain changes in prices. Though this research is, so to say, done from the other way round than that in Esanov et al. (2005), i.e. reaction of the economy to changes in monetary policy variables is observed. On the other hand, Ono (2013), within a VAR framework, finds that monetary policy shocks in the form of money supply disturbances (exogenous to the monetary policy) had in the period 1999 - 2010 a persistent effect on real output, and a substantial part in volatility of real output can be explained by money supply changes. Changes in money supply had, according to Ono (2013), a more significant impact on the real economy than interest rates, exchange

rate or stock prices and disturbances to bank loans. Interest rates, again as in Esanov al. (2005), did not pose an efficient monetary policy instrument. Yet Esanov et al. (2005) propose that with improving institutional framework of the Russian economy, particularly with increasing credibility of the CBR, along with an evolution of forward-looking behavior of Russian economic agents, and deepening financial markets, the CBR may become able to operate an effective interest rate policy.

Still, it is a matter of discussion whether the money supply in Russia is exogenous or endogenous because it is of a particular importance for the effectiveness of the monetary policy conduct. In Vymyatnina (2006) money supply is found to have an endogenous nature with two principal sources of endogeneity; one stemming from the credit demand of the "new" corporate sector of the economy, and the other one coming from the enterprises of an old type with origins in the centrally planned economy. Granger causality also supports this view by going from inflation to money supply in the period 1995 - 2004. Given the restricted ability of the CBR to control the money base in the presence of endogenous money supply, it seemed, hence, that interest rate operations could be a more suitable policy instrument for the CBR than regulation of the money supply. Moreover, since the growth of money supply is a consequence of a rise of inflation (and not its cause), disinflationary policy based on money supply targeting might lead to real economy slowdown via the reduction of bank credits (Vymyatnina, 2006).

Apart from the interest rate channel or money supply channel, other possible monetary policy transmission channels have been studied within the framework of Russia. At the beginning of the 2000s credit channel was the most active transmission channel (Vdovichenko and Voronina, 2006). The exchange rate channel is present in Russia but has its own specific features. CBR's interventions in the foreign exchange market did though affect initially the exchange rate, nevertheless consequent monetary expansion was rather a by-product of the exchange rate policy (Vdovichenko and Voronina,

2006).

Juurikkala et al. (2011) found an evidence of existing bank lending channel in Russia, which is important for considerations of an optimal monetary policy stance, especially with long-term goal of shifting the monetary policy to inflation targeting. This transmission channel has, nonetheless, again slightly different characteristics than that of the advanced economies, given the specifics of the Russian banking sector and financial system in general.
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For some time, financial markets in Russia were rather shallow. And the financial system itself is to a substantial part based on banks with several large dominant monetary institutions that have relatively low capital ratios (Juurikkala et al., 2011, p. 119). The most important banks are state controlled. These are, nevertheless, not less efficient than domestic private banks, but less efficient than foreign banks, whose penetration is still low mainly due to the legacy of the 1998 crisis (Fungáčová and Solanko, 2009). Even before the 2008 financial crisis Russian banks had a little trust in their counterparts, particularly in the interbank market (Fungáčová and Solanko, 2009), and before the last financial crisis in 2008 only the 15 largest banks could access unsecured interbank lending (IMF, 2011b). Russian banking sector recorded a rapid growth of credits to domestic corporate and household sector of 400% annually in the four years prior to the 2008 financial crisis. Bank loans are typically short-term, which often accelerates the transmission process (Juurikkala et al., 2011). Middle sized banks also used to link substantial parts of their assets to stock markets. Russian corporate sector and commercial banks are dependent on borrowing from abroad, either in a form of direct loans, or via IPOs, issuance of Eurobonds and syndicated bank loans. This is a heritage of post 1998 crisis growth period when nominal value of the ruble was kept relatively stable, and domestic interest rates were above the international level, which made foreign borrowing rather attractive option for Russian banks. Ponomarenko et al. (2011) find evidence

of a significant vulnerability to currency risk also in the non-banking private sector. Interbank lending was likewise highly dependent on foreign sources of cash with 60% of interbank loans in 2008 involving a foreign counterparty. This is also consistent with the IMF (2011b) report assessing causes and origins of the 2008 crisis, according to which excessive lending was channeled mainly to construction and real-estate sectors. Another strong source of demand for credits that exceeded the lending capacity of Russian banking sector came from companies in oil, gas and metal industries (Fungáčová and Solanko, 2009).

Although foreign borrowing was not particularly large in international comparison, it was growing rather quickly, mainly regarding the short-term loans (Fungáčová and Solanko, 2009). This openness of the banking sector and dependence on the risk taking preferences of foreign investors made it rather prone to financial contagion. Contrary to other markets, the size and liquidity effects are missing in the Russian banking sector. Russian banks are also forced to hold large liquidity buffers (due to the abovementioned features). During the last financial crisis loan dollarization in Russia proved to be positively dependent on the depreciation rate of the ruble while the exchange rate effect on dollarization was smaller than the effect of mechanical revaluation in response to overall decrease in foreign currency denominated loans. Since large part of claims of Russian banks are credits to domestic unhedged borrowers, banking sector (and non-banking sector too) are rather vulnerable to currency risk than to exchange rate risk (Ponomarenko et *al.*, 2011).

All in all, even though the bank lending channel of monetary policy does exist in Russia, its effect hinges on bank's characteristics. In reaction to monetary policy changes banks change their loan supply (changes in the interest rate policy affect the demand of banks for loans), which potentially amplifies the effect of monetary policy. The strength of the bank lending channel depends on bank's capitalization, and better capitalized banks are

less prone to limit or expand their lending after a change in monetary policy stance as they have smaller informational frictions and can easier access other sources of financing (Juurikkala et al., 2011). Perhaps therefore stock prices tend to be not only a more significant monetary policy transmission channel than bank loans but are also more important than interest rate or exchange rate channels (Ono, 2013).

3.3 Pre-crisis monetary policy

After the beginning of the 2000s prudent macroeconomic policy and rising oil prices brought about a rise in levels of foreign investment and foreign currency inflows into Russia. The resulting appreciation pressures meant a serious problem for the CBR. For the period 2000-2008 the CBR declared that its main priority was the anti-inflationary policy. Nevertheless, numerous studies give a different picture. Despite the priority of lowering inflation, the CBR seemed to be more concerned with the appreciation of the exchange rate and was thus intervening in the foreign exchange market in order to affect smoothness of the exchange rate fluctuations or its level (Vdovichenko and Voronina, 2006). Although targets for both the managed exchange rate and inflation (given as change in 12 months CPI) had been announced, inflation targets were often missed without any consequences (Granville and Mallick, 2010). Likewise as central banks in many other commodity exporting economies, the CBR, which adopted the US dollar as an operating target for its exchange rate policy in 1998, used foreign exchange interventions to smooth movements of the exchange rate of the ruble *vis-à-vis* the US dollar, and thus to ensure favorable terms of trade for commodity exports (Sokolov, 2012) and prevent current account deterioration (Granville and Mallick, 2010).

In practice, the monetary operations of the CBR were aimed at affecting the exchange rate and had a form of sterilized or unsterilized interventions in the foreign exchange market. But the CBR lacked sufficient sterilization

tools, and the financial markets were not enough developed to be able to quickly absorb large volumes of liquidity. This forced the CBR to face the trade-off between appreciation and inflation as the excess liquidity was partly poured into the banking sector, which in turn increased lending, and partly into the government Stability fund, which was filled thanks to oil price related variations of taxes on oil sector (Granville and Mallick, 2010). The consequent money expansion was, along with rising food and energy prices, was one of the reasons for high inflation (Juurikkala et al., 2011). Such a trend was even strengthened after the full convertibility of the ruble had been introduced in 2006, and all the restrictions on capital account had been abolished. Sokolov (2012) estimates that a 1% rise in CBR's foreign reserves in the pre-crisis period led to an increase in the dollar-ruble exchange rate by 4.3% as the excess supply of US dollars from export proceeds weakened the US dollar against the ruble and was therefore absorbed by the CBR that added it to its reserves.

In 2005 the CBR introduced a change into its exchange rate policy. Instead of targeting the exchange rate *vis-à-vis* the US dollar, it started targeting the "bi-currency" basket consisting of the US dollar and the euro. The proportions of the currencies were initially set at 90% for the US dollar and 10% for the euro. The weight of the euro was later increased to 45% reflecting rise of its importance. Such a step was reasonable from point of view of the Russian economy for the US dollar was the main invoicing currency for exports whereas the euro served as the main invoicing currency for imports (Sokolov, 2012). It allowed not only to increase flexibility of the exchange rate policy, which is necessary precondition for a shift to inflation targeting (unlike other countries that implemented basket targeting the CBR was not motivated by concerns about competitiveness of domestic producers but mostly by monetary policy considerations) but also to disconnect Russian interest rates from those denominated in US dollars, and to link them to synthetic interest rate reflecting the weights of both currencies in the basket

(Sokolov, 2012). Greater flexibility of the Russian ruble was enabled thanks to the so called "triangular arbitrage", which in fact meant that exchange rate of the ruble *vis-à-vis* the euro and the dollar was determined only by the euro-dollar exchange rate.[12]

The main reason for policymakers' concern about the appreciation may have been to avoid the danger of Dutch disease (Ono, 2013), especially in a situation when strong appreciation could negatively affect the competitiveness of (natural resources) exports, and the competiveness of most of the domestic import substituting industries (major employers) would be threatened likewise (Granville and Mallick, 2010; Vdovichenko and Voronina, 2006). In order to ensure employment and enhance output growth, the CBR considered exchange rate stability as its principal goal. In that cause, the CBR preferred to slow down appreciation of the real exchange rate and conduct the so called "weak ruble policy" (Granville and Mallick, 2010, p. 434) by buying and subsequently accumulating large volumes of excess foreign currency, which led to an expansion of the money supply and higher levels of inflation as proxied by the CPI (Granville and Mallick, 2005, 2010). Granville and Mallick (2005) even consider tensions between the exchange rate and inflation as a result of macroeconomic policy being used by authorities "as a direct instrument of social welfare provision" and recommend the CBR to move towards inflation targeting, which would enable the CBR to control prices more efficiently whilst lowering the need to intervene in the foreign exchange markets.

Contrary to Russia, many transition and emerging market economies in consequence of the currency crises in the second half of the 1990s adopted inflation targeting, which is associated with a highly independent central bank and a floating exchange rate regime. Carare and Stone (2006) distinguish monetary framework of inflation targeting countries into full-fledged inflation targeting, implicit price stability anchor and inflation targeting lite. Prefer-

[12]For a detailed explanation see e.g. Sokolov (2012).

ences to one for these regimes are related to structural differences in economic and financial development across countries. Discussion of this topic for particular developing, emerging markets and transition economies can be found for instance in Fruga (2000) for Brazil, in Geršl and Holub (2006) for the experience of the Czech national bank with foreign exchange interventions under inflation targeting, or in Jonáš and Mishkin (2005), who also review experience of Central and Eastern European economies with their shift to inflation targeting. On a similar basis Golinelli and Rovelli (2001) evaluate the experience of interest rate and inflation targeting in Poland, Hungary and the Czech Republic. An overall evaluation of the more or less first decade experience with inflation targeting (mostly in advanced economies) can be found in Bernanke et al. (1999) or Bernanke and Woodford (2005).

The situation of the CBR differs from that of other central banks in advanced and emerging market economies due to the abovementioned stress on the exchange rate, impact of dollarization and presence of sovereign wealth funds, which accumulate part of the money stock in the economy (Ponomarenko et al., 2012). Even though already in 2005 the CBR announced in its annual monetary policy outlook that the shift towards inflation targeting was its medium-term policy objective, the actual state of the monetary policy conduct continued to resemble a managed exchange rate regime, in which inflation was often of second order of importance after the appreciating real exchange rate. Analogically, in a report on Principal monetary policy guidelines for 2009 and period 2010-11 the CBR announced in 2008 that it was going to complete its shift towards the inflation targeting by 2011 as lowering inflation had to be CBR's priority. In the post crisis period, the shift to inflation targeting has been further postponed till 2015.

Esanov et al. (2005) conclude that rising balance of payments surpluses together with reluctance of the CBR to allow depreciation of the ruble real exchange rate led to significant strains on the monetary policy. In monetary policy considerations the exchange rate played a more important role than

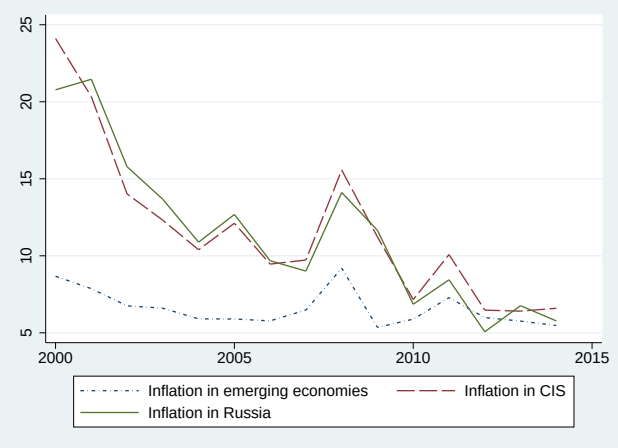

Figure 1: *Annual inflation in Russia, CIS and emerging markets economies (in %).*

inflation, and from 2003 the CBR seemed to accept any level of inflation.

Although inflation was lowering in this period, pace of disinflation was bellow official targets.[13]. Not only was the level of inflation comparatively high in Russia, but it was also relatively higher in comparison to a peer group of countries in the post-soviet space (Granville and Mallick, 2010) or other emerging market economies. Nevertheless, since approximately the second half of 2000s Russian annual inflation, expressed as average change of CPI, followed the level of other countries in the Commonwwelth of Independent States (CIS) or even was bellow it. Also in the post 2008 crisis period Russian inflation fell for a short time bellow average levels of inflation in emerging market economies. As Figure 1 indicates, after 2006 inflation in Russia appeared to have similar trend as inflation in other emerging market economies.

Furthermore, as it was unclear whether appreciation of the ruble is an effect of previous undershooting or whether ruble was indeed surpassing its long-term equilibrium levels, reaction of the CBR was rather questionable (Esanov et al., 2005). Similarly, in a monetary policy feedback rule in Granville and Mallick (2005) central bank's interest rates responds more to

[13]See, please, Figure 2 in Chapter Data

the movements of the exchange rate than to inflation.

Granville and Mallick (2010) derive a reaction function of the CBR and test a hypothesis that policy rates are mainly reacting to exchange rate shock stemming from a policy decision. They prove that the exchange rate was the main factor behind inflationary pressures, and that monetary policy expansion was mostly based on international reserves given the limited capacity of the CBR to sterilize money inflows coming from its interventions. Contrary to theoretical predictions of short inflation persistence after a monetary shock, inflation in Russia appears to be rather persistent primarily because of the policymakers' preference to the exchange rate stability almost without regard of inflation. Indeed, the CBR seems to face a different trade-off than monetary authorities in advanced economies with developed financial markets. Inflation in Russia increases after an exchange rate shock only to die out after a new monetary shock (Granville and Mallick, 2010, p. 422). In presence of high oil prices that consistently forced the CBR to intervene to delay or event reverse appreciation of the ruble, and to ensure short-run rise of output, inflation became "entrenched" in the long-run. Granville and Mallick (2010) argue, however, that such an exchange rate policy was in a sense "futile". For the consequent rise of price levels increased the real trade-weighted value of the ruble and negatively affected Russian competitiveness anyway. In their view a pre-announced inflation target could stabilize inflation expectations and, in effect, inflation as well.

On the contrary, Drobyshevski and Trunin (2012, p. 24), based on their estimation of the monetary policy rule for the period 1999-2007, conclude that "price stability can be considered a strategic goal" of the CBR. Rules based on forecast values of economic indicators proved to be consistent with empirical data. Authors could not reject the hypothesis that the bi-currency basket did not respond to forecast values of CBR's strategic goals even though it was an announced operational guideline of the CBR. This indicates that the CBR did not use the values of the basket as its intermediary

target, which nevertheless does not contradict the option that bi-currency basket was an important indicator. In this sense, an expected appreciation of the ruble implied a relaxation of monetary policy. On the other hand, at higher levels of inflation the CBR seemed, according to Drobyshevski and Trunin (2012), to be less constrained with an appreciation of the ruble and relaxed its foreign exchange interventions so that inflation could be lowered. An interesting conclusion concerns volatility of Russian financial markets that caused intermediary targets of the CBR to have a low inertia. Therefore quick adjustments to the CBR policy stance were needed to react to developing market conditions (Drobyshevski and Trunin, 2012).

3.4 2008 financial crisis

Unlike many advanced economies, Russian economy did not record any serious contractions in the "pre-Lehman" phase of the crisis (summer 2007-August 2008). On the contrary, Russia was in a group of emerging market economies that went through a period of the so called "decoupling". In this time, the Russian ruble became also an "investment currency" in the global carry trade (Sokolov, 2012, pp. 717-718). Russian economy also boasted good macroeconomic indicators at the beginning of the crisis (Kudrin, 2009). This was, however, to change soon as the impacts of the August 2008 financial crisis hit Russia.

After the collapse on world financial markets liquidity began to evaporate from Russia because of the so called "flight to security" of international investors, who, furthermore, lacked available liquidity for their operations in developed markets (Fungáčová and Solanko, 2009). This led to a sharp decline in confidence in ruble and rise in depreciation pressures as the interest rate differential was widening due to increasing credit risk (Sokolov, 2012). Even a large stock of foreign currency reserves could not prevent Russia from being significantly hit by the financial crisis.

Given the high level of dollarization of the economy that found itself in

a deep financial turmoil, highly probable reversals of capital inflows,[14] and increasing depreciation pressures, there was a real threat to financial and macroeconomic stability in Russia. Ponomarenko et al. (2011) presume, therefore, that these considerations were behind costly measures that the CBR implemented to conduct the "controlled depreciation". Till October 2008 government required the CBR to keep the exchange rate above market determined levels. Only in the middle of November 2008 the CBR started to smoothly weaken the ruble exchange rate by widening the bounds of allowed fluctuations. But in order to defend the ruble against strong depreciation pressures, large amount of CBR's foreign reserves were used. Such a gradual depreciation of the ruble was probably more expensive in terms of foreign reserves (Kudrin, 2009). Amount of CBR's reserves declined consequently by about 200 billion US dollars, which equaled to about one third of the whole reserves (Guriev and Tsyvinski, 2010). Most of it was nevertheless transferred to private sector. And hence gradual depreciation was in practice an "implicit bailout" of the Russian financial sector (Guriev and Tsyvinski, 2010, 22).

Due to the uncertainty of expectations of the future exchange rate, banks were not willing to lend in rubles while borrowers were reluctant to take credits in foreign currencies, which effectively paralyzed financial markets (Fungáčová and Solanko, 2009). The "step-by-step" devaluation of the ruble (of about 30% towards the bi-currency basket) enabled Russian economic agents to lower costs of depreciation. Only in January 2009 a new credible ruble exchange rate was established. Faster devaluation of about two a three percent a week instead of a one percent decline of ruble value per week might have been riskier although gradual depreciation had had to come sooner and be faster (Guriev and Tsyvinski, 2010).

As a consequence of these interventions, CBR's foreign currency reserves

[14]Which then indeed occurred, and after many years Russian economy recorded a net outflow of foreign capital (Kudrin, 2009, p. 16).

decreased during the crisis and ceased to be the main source of money supply. Liquidity inflows from the CBR to banks, and generally rise of aggregate credit then began to be primary source of money supply providing enough short-term liquidity but no long-run liquidity sources to banks (Kudrin, 2009). This also meant that the CBR might implement its interest rates policy more effectively, by, in a sense, beginning to use its interest rate channel. In the end of 2008 the monetary aggregate M2 began to contract (Fungáčová and Solanko, 2009). Decreasing volume of operations of the CBR in the internal markets also enabled bigger exchange rate flexibility and made possible transmission to floating exchange rate regime.

Fall of asset prices and liquidity crunch seriously affected depositors' confidence and led to a run on deposits in autumn 2008. Most likely memories of the 1998 crisis played an important role in the behavior of depositors (IMF, 2011b). As a result system-wide liquidity crisis was only deepened. Large part of domestic savings (and liquidity in general) was also converted into foreign currencies. The decline in ruble deposits in banks was another sign in low confidence in the exchange rate.

The CBR together with the government was also forced to conduct fast massive measures to support the financial system finding itself on the brink of financial collapse at the end 2008. These measures proved to be sufficient (Kudrin, 2009; Fungáčová and Solanko, 2009), and no major bank declared a bankrupt.[15] This conclusion is also shared by Guriev and Tsyvinski (2010).

Interestingly enough, despite the global deflationary environment, the pace of Russian disinflation was slower than in other economies (Granville and Mallick, 20010). Interest rates in Russia are primarily determined by the level of inflation and risk. Throughout the whole period negative real interest rates rather put off domestic households from depositing money for a long-term (Fungáčová and Solanko, 2009). Low interest rates needed for financing development of key sectors of industry could be achieved only

[15] A survey of these measures can be found for instance in IMF (2011b).

through a decline of inflation, which made it the most important task of the CBR. That is why, increasing policy rates by the CBR can be justified (Kudrin, 2009, p. 20).

The impact of the financial crisis on Russia was stronger than in other G20 countries, and only in 2009 Russian GDP fell by 8%. Behind the severity of the impact were, according to Fungáčová and Solanko (2009), two main reasons; In the first place it was the high dependence of Russian economy and its financial sector on the price of oil and global financial markets providing liquidity,[16] and, secondly, fragmentation of Russian banking sector, which also suffered from insufficient supervision and low trust in counterparty. Together with relatively small penetration of foreign banks, it led to further worsening of the situation. Rapid fall of oil prices meant also decline in stock prices of Russian companies. Guriev and Tsyvinski (2010) also add that poorly designed economic policies in 2009 contributed to the size of the fall.

Sokolov (2012, p. 718) demonstrates that between September 2008 and November 2009 exchange rate policy of the CBR was perceived as a pure managed float against the US dollar, although *de jure* the CBR still was to maintain an "adjustable basket pegging."

3.5 Post-crisis development

In the post crisis period (i.e. after 2009) prices of commodities began to rebound and with them also Russian macroeconomic indicators. As a further step towards inflation targeting the CBR could narrow its spread between deposit and refinancing rates outlining thus a floor and a ceiling on the Moscow Interbank Offered Rate (MosIBOR)[17] and allowed wider fluctuations of the basket.

[16] Same conclusion can be found in Guriev and Tsyvinski (2010).

[17] In February 2009 the CBR narrowed the spread between over-night and deposit rates by 1%. Further narrowing of 0.25% was conducted in December 2010 and Mai 2011 (Sokolov, 2012).

For the first time, in August 2008 the CBR introduced a monetary policy outline that did not contain any specific limits on the ruble appreciation, which indicated easing out of foreign exchange interventions as a necessary precondition for a shift towards inflation targeting. Acceleration of domestic inflation also necessitated easing of the exchange rate policy and active use of the interest rate policy. In Principal monetary policy guidelines for 2009 and period 2010-11 (as of 17th of October 2008) the CBR, nevertheless, confirmed that for the then nearest perspective features of previous periods were to be maintained. Simultaneously, the CBR claimed to apply measure to convert the interest rate into its main policy instrument for influencing inflation expectations.

Yet, in 2011 the inflation still did not decrease to the targeted range of the CBR of six to seven percent (IMF, 2011a). The transmission lag for this period was estimated by the IMF (2011a) to be around seven to twelve months. Growth of the aggregate M2 had to be restricted along with limiting interventions in the foreign exchange market, and increasing policy rates (IMF, 2011a). Nevertheless, crucial for decline of inflation was stabilization of food prices. Prices of food products continued to be the most important component of the increase in inflation (CPI) also at the beginning of 2013. Their rise was also based on increase in excise duties (Luksha, 2013). For a successful implementation of inflation targeting functioning yield curve is required (Guriev and Tsyvinski, 2010) too. The CBR was also recommended in the 2011 IMF Staff Country Reports to start publishing its inflation forecasts, improve its credibility and communication with the public.

Stress on improving credibility and independence of monetary authority has both theoretical and empirical background. Barro and Gordon (1983) show that as a result of repeated interaction between the monetary authority and agents in the economy, formal rules for the CBR can be substituted by the reputational forces. In a model in Clarida et al. (1999, p. 1663) commit-

ment of the central bank can bring additional gains "if current price setting depends on expectations of the future." Having credibly committed to fight inflation, central bank can make the standard trade-off between inflation and GDP more favorable. Mishkin's (2004) conclusion of the applicability of inflation targeting in emerging market economies also stresses the importance of institutional development, without which inflation targeting cannot produce superior results. Analogically, implementation of inflation targeting is also a political question of increasing and guaranteeing the independence of the CBR.

4 Methodology

In accordance with the above mentioned characteristics of the development of monetary policy and economy generally in Russia, it is possible to propose two following hypotheses.

First: *Monetary policy changed its orientation from mainly focusing on exchange rate movements to lowering inflation in the post-crisis period.*

Such a proposal is consistent with proclamations of the policymakers' and their intention to adopt inflation targeting. Refutation of this hypothesis would (in an appropriate model setting) mean that the exchange rate remained the main policy target. Although a change of weights of coefficients of the estimated equation over specific time periods can provide a reasonably accurate picture of the reaction of the CBR or a possible shift in its priorities.

Second: *Monetary aggregates ceased to play the role of the main policy instrument, and the interest rate was prevailingly used to respond to fluctuations in the economy.*

Again, this allows to consider to what extent the progress towards the adoption of inflation targeting was made after the outburst of the financial crisis in Russia.

In order to test both hypotheses, several models based on Esanov et al. (2005) are estimated, and results obtained are compared so that the model with superior characteristics in terms of its explanatory power, statistical and economic significance of coefficients and their robustness may be considered the most appropriate estimate of the CBR's response function. Not only is the fact whether an "R-rule" or an "M-rule" is superior, important but also hypothetical change of coefficients of different time sub-periods is of interest.

Firstly, as an example of an "R-rule" a modified Taylor rule (Taylor, 2001) is estimated. Such a rule is applicable for countries where determination of stable long-run target levels of inflation and real interest rate is

complicated.

$$i_t = \beta_0 + \beta_1 \pi_t + \beta_2 y_t + \beta_3 xr_t + \beta_4 xr_{t-1} + \beta_5 i_{t-1} + u_t \tag{10}$$

In this rule, i_t is again a short-term interest rate set by the CBR. Its lagged value on the right hand-side allows considering interest rate smoothing behavior of the central bank. π_t is a measure of inflation (either a plain y-o-y quarterly change of CPI or their deviations from targeted values). Term y_t captures either deviations of real GDP from its targeted levels or a plain y-o-y quarterly change of GDP, i.e. GDP growth rate. To model the reaction of the CBR to exchange rate fluctuations, variable xr_t and its one-period lagged values are added representing growth of the real effective exchange rate (REER) or growth rates of respective nominal exchange rates. u_t is a white-noise error term assumed to be identically independently distributed with zero mean and finite variance.[18]

Expected coefficients are as follows: Intercept term, β_0, is positive implying that the long-term value of the interest rate instrument of the CBR is positive. The coefficient on inflation is expected to be positive since rising inflation should lead to an increase in policy rates. $\beta_2 > 0$ means that as GDP exceeds its trend growth levels, the CBR responds with raising the interest rate to prevent a rise in inflation. β_5 is set greater than zero in accordance with interest rate smoothing hypothesis. Coefficients $\beta_3, \beta_4 < 0$. because an increased growth of the REER likely forces the CBR to counteract by easing its monetary policy and allowing lower interest rates leading to a depreciation pressures and vice versa. Additionally, long-run response to inflation, put as $\beta^{LR} = \frac{\beta_1}{1-\beta_5}$ is expected to be greater than 1 in accordance with Taylor principle. Model (10) can be augmented by adding dummy variables with corresponding interaction terms to capture various periods (crisis, post-crisis), so that potential change of behavior of the CBR during these

[18] Assuming independent and identical distribution of error term may prove to be a too strong assumption. Therefore during estimation procedures appropriate tests are applied to check this assumption.

periods can be captured, as well as by adding control dummies to account for time trend and quarterly effects.

To assess whether monetary aggregates remained the main policy instrument of the CBR, modification to McCallum rule in equation (1) is estimated. In this case, however, the response variables are changes of logarithms of real money aggregate and M2 respectively (i.e. their percentage changes). The right hand-side of the rule remains mostly unchanged with respect to rule (10) with the exception of lagged interest rate, which is replaced by lagged values of changes of logarithms of respective money aggregates. Such an approach is prevailingly based on Esanov et al. (2005), application of whose method seems as the best way to test abovementioned hypothesis.

$$gM2 = \beta_0 + \beta_1\pi_t + \beta_2 y_t + \beta_3 xr_t + \beta_4 xr_{t-1} + +\beta_7 gM2_{t-1} + u_t \qquad (11)$$

In (11) the term $gM2$ stands for percentage growth rate of monetary aggregate M2. Obviously, the excepted signs of coefficients are now opposite to rule (10). For an excessive growth of price level or GDP should imply the CBR to slow down growth of its money aggregates. Opposite reaction compared to interest rate instrument is now also expected for coefficients measuring the response to exchange rate fluctuations. Dummy variables for periods 2008 crisis and post-crisis periods will be included along with relevant interaction terms so that it may be possible to see whether there was any change in the use of money aggregates during the financial crisis.

Alltogether by evaluating which of the models (10) and (11) it will be possible to judge which monetary policy instrument the CBR has preferred during and after the 2008 financial crisis. Analogically, influence of the exchange rate on the decisions of the CBR in this period can be likewise assessed by comparing relevant coefficients in models.

5 Data

For the purpose of estimation of various versions of monetary policy rules quarterly data for the period between the first quarter of 2000 and the first quarter of 2014 were used. Given the fact that the accessibility of Russian data from Russian databases was often rather complicated, databases of international organizations had to be used as well. The sources of data are hence the Russian Statistical office, the Central Bank of Russia and Organization for Economic Cooperation and Development (OECD). Also the databases of Eurostat and the Federal Reserve of St. Luis were used mainly for the data of Russian exchange rates.

Seasonally adjusted data for quarterly growth rates of real gross domestic product (GDP) with respect to the same quarter of previous year were chosen to enter the output gap computation. As it is likely that should the CBR react to changes of output gap, the measure of this gap would be the targeted rate of GDP growth declared by the CBR in its annual Principal monetary policy guidelines for the forthcoming periods, targeted annual rate of growth of output was selected as an indicator of the output gap.

Analogically, as an indicator of inflation, percentage changes over the same quarter of previous year of the consumer price index (CPI) were chosen. Inflation targets were taken from the Principal monetary policy guidelines of the CBR. These, however, often indicate a range of possible fluctuations of inflation rather than a specific target. Because inflation in Russia stayed above the targeted upper bound of accessible fluctuations for the most of the period, the upper bound of the targeted range was conventionally used in this analysis instead of the middle point. This has also an economic interpretation since the CBR did not seem to face a danger of undershooting inflation targets and would be more likely to operate in a way to push inflation below the upper bound, if it chose to react to high inflation. Furthermore, periods when inflation was below the upper bound were quickly followed by periods when inflation again increased above the upper bound

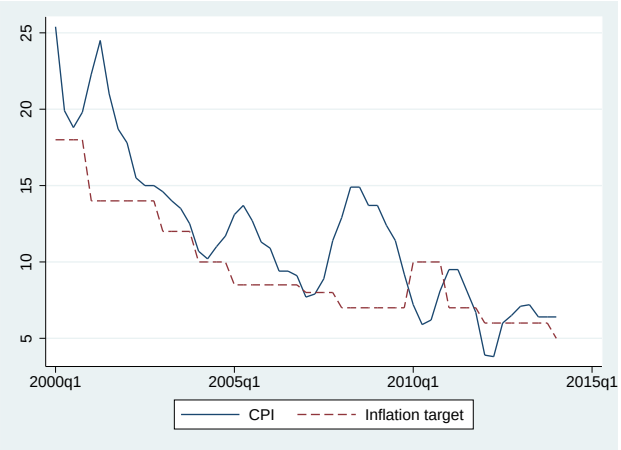

Figure 2: *Quarterly CPI and inflation targets (in %).*

of targeted range as can be seen from the Figure 2.

Both the targets for annual GDP growth and annual inflation were extrapolated for quarters of corresponding year. Output gap was the computed as difference between actual output growth in the respective quarter and extrapolated annual targeted growth rate. The same approach was applied for deviations of quarterly inflation from extrapolated annual targets.

An attempt to infer trend values of GDP and inflation was made using a Hodrick-Prescott. Nevertheless, estimated long-run values were not in the least bit plausible as they often had sings opposite to an observable trend and magnitudes largely bellow any level that could have been reasonably expected given the recorded values of variables. This could be caused by a small sample size as well as by a rather unstable development of these variables over time (rebounding, growth and sharp fall with consequent stabilization) that could not be sufficiently smoothed due to the small number of observations. Hence, target values reported by the CBR were rather used instead. Again, an economic interpretation might be that monetary authorities would rather care about the level of inflation above their objectives than about deviations of inflation from certain trend. The percentage growth rates of monetary aggregate M2 were obtained as a quarterly average of monthly growth rates of M2 computed as $(log(\frac{M2_t}{M2_{t-1}})) \times 100$

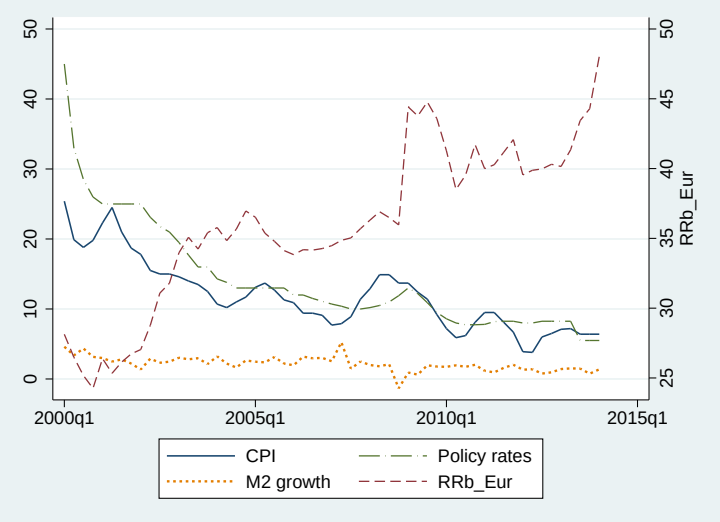

Figure 3: *Quarterly CPI, M2 growth rate, policy rates (in %) and RRb-Eur exchange rate.*

where the terms $M2_t$ and $M2_{t-1}$ stand for seasonally adjusted volumes of monetary aggregate M2 for corresponding months. Growth rates of the real effective exchange rate (REER) were computed again in nearly the same way as above, i.e. as $(log(\frac{REER_t}{REER_{t-1}})) \times 100$. This time the terms $REER_t$ and $REER_{t-1}$ nevertheless indicate values for corresponding quarters. Growth rates of nominal exchange rates of ruble to euro and US dollar were computed in an analogical way.

The policy rate of the CBR was obtained from the official CBR database. As of September 16th of 2013 the one-week auction repo rate functions as the official policy rate. Before this period, the refinancing rate of the CBR served as the main policy rate. Hence values of both indicators were included for respective periods. Since the CBR changes its policy rates with various frequencies depending on the economic situation, values of the policy rate for corresponding quarters were computed as weighted average of actual values of policy rates that occurred in the given quarter. Although this approach may seem as a too rough approximation, it was considered the best way to extrapolate the data such that they match relevant quarters.

Inspecting closer the dynamics of inflation, it is possible to observe sev-

eral trends that have already been highlighted by previous research. Firstly, as Figure 2 indicates, inflation, as approximated by growth of the CPI, stayed for the most of the period above the upper bound of inflation targeting range. And despite occasional periods when inflation got very close to the target or even fell below it, we can very often observe inflation spikes in subsequent periods. Additionally, two of the three periods when inflation fell below the upper bound, i.e. it was within the targeted range of fluctuations, occurred in the post 2008 crisis period and during economic slowdown, which would rather suggest that real economy linked deflationary pressures forced inflation to fall. Furthermore, as Figure 3 would suggest, the CBR did not seem to conduct its interest rates operations too aggressively with respect to lower inflation and kept policy rates stable, while maintaining them on higher levels possibly due to reasons discussed above, i.e. lower inflation was basically considered to be more important for economic recovery than easily accessible money. The growth of interest rates in the periods shortly after the second quarter 2008 may have been caused by attempts of the CBR to slow down depreciation of the ruble. The decrease in the interest rates at the beginning of 2014 may have been motivated by an effort to stimulate economic recovery. Nevertheless, in the nearest future, the CBR is not be likely to further decrease its interest rates for a possible fear of stagflation and possibly also because of the planned transmission to a standard inflation targeting regime. Another interesting aspect stemming from graphical analysis of Russian macroeconomic indicators can be gained by plotting annual current account (in percent of GDP) and annual inflation in Figure 4. These two variables seem to exercise similar trend through most of the sample size. Increasing current account is often associated with rising inflation, and these two variables have a coefficient of correlation equal to 0.81. This observation indeed supports conclusion made in several studies discussed above, namely that increasing current account forced the CBR to ease its monetary policy in order to avoid possible appreciation of the ruble,

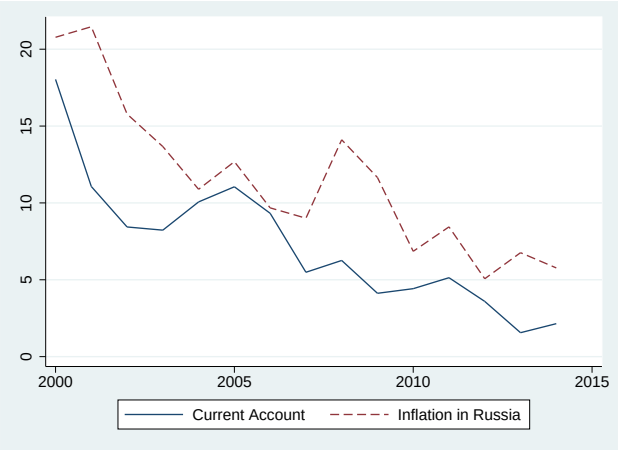

Figure 4: *Annual current account (in %) and annual inflation (in %).*

which consequently inflated the price level.

Figure 3 indicates a relatively strong positive correlation between the rate of inflation and policy rates of the CBR. On the other hand, the growth of money aggregate M2 does not seem to be strongly correlated with any of other variables. Interestingly, the average level of money growth declines after 2008, which may be an indication of an economic slow-down. The ruble-euro exchange rate in Figure 3 records a trend that corresponds well to above described dynamics. After an original depreciation at the beginning of the 2000s it was kept at a relatively stable level till the CBR relaxed its policy of slowing depreciation down during the 2008 crisis and the exchange rate depreciated rather sharply to a level of almost 45 rubles for euro. After that it returned to lower, though not pre-crisis, level and again sharply increased as a result of expectations of reversal of the Federal Reserve policy and political events in Ukraine at the beginning of 2014. Also the policy rate may be said to respond to the exchange rate dynamics, at least during the crisis. For there was an increase in the policy rates in the last two quarters of 2008, which rather contradicts conclusions of macroeconomic theory. On the other hand, increased interest rates may be also a response to rising inflation in this period (the lag is clearly visible), which would then correspond to a need for lower and stable price levels expected to encourage investment and

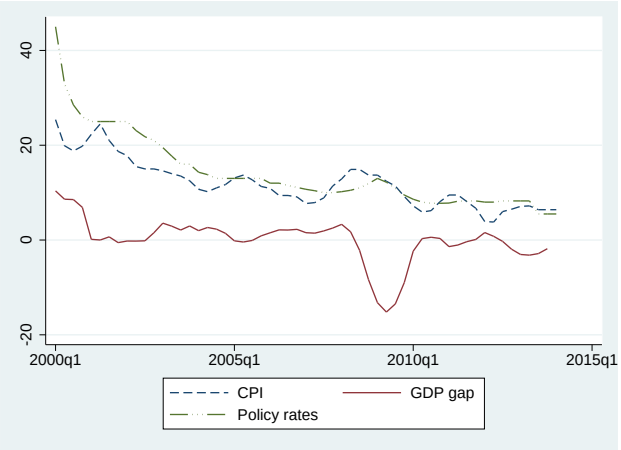

Figure 5: *Quarterly GDP gap, inflation and policy rate (in %).*

economic growth in Russia, as it was mentioned in subsection 3.4. After 2008 the interest rates seem to be much less responding to the exchange rate movements and indeed the coefficient of correlation in the post crisis period is only 0.075. A decline in money growth in 2008 could be associated with reinforced purchases of domestic currency by the CBR in an effort to smooth depreciation.

Inspecting Figure 5 yields a picture of development of the GDP gap and inflation and reaction of the policy rates. The deviation of GDP growth from its projections was mostly modest in the pre-crisis period with the exception at the beginning of the sample period when the Russian economy was recovering from the 1998 crisis with a faster pace than the policymakers would expect. Both the interest rate and inflation were slightly positively correlated with GDP gap before the third quarter of 2008. As the 2008 crisis hit the economy and the GDP gap fell to its minimum of approximately -15.2%, correlations became negative and much stronger with respect to GDP deviations whereas inflation and policy rates remained strongly positively correlated. Nevertheless, such a correlation analysis cannot take into account likely time lags between the development of real economy and monetary policy decisions and should not thus be taken per-ce. Figure 6 depicts development of exchange rates the two most important foreign currencies for

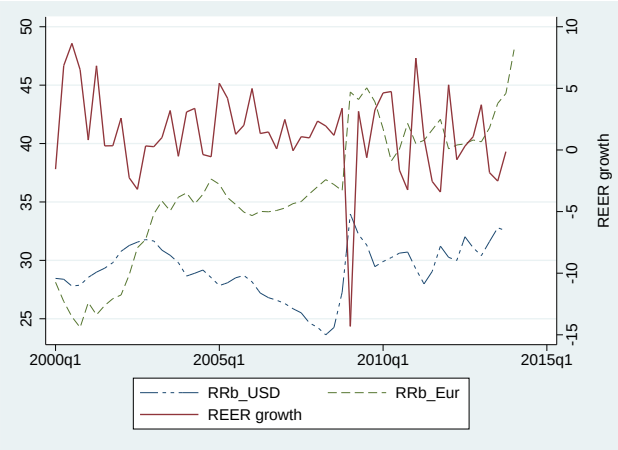

Figure 6: *Exchange rate of ruble to Euro and Dollar (in RRb) and growth rates of REER (in %).*

the Russian economy, i.e. the US dollar and the euro, and the growth of the real exchange rate (REER). In the pre-2008 crisis period US exchange rates of ruble to dollar and euro exercise a rather different pattern as the exchange rate *vis-à-vis* euro was kept rather stable for a considerable amount of time whereas rubble was allowed to slightly appreciate towards US dollar. However, once the CBR had ceased to intervene against depreciation in the late 2008, both exchange rates rose sharply in order to get relatively stabilized on higher level compared to the pre-crisis period. The steep depreciation in 2008 is also well depicted in movements of the REER growth, which, despite of being rather volatile, was kept within certain bounds for the whole sample period except for the 2008 depreciation when it recorded a sharp decline.

Tables 1 and 2 present correlation coefficients for the majority of variables of interest for periods before the 2008 crisis and during and afterwards (correlation table for the whole period can be found in Appendix). Strong negative correlation between policy rates and the ruble-euro exchange rate can be explained by large differences at the beginning of the sample period. In the second part of the sample period, the correlation is almost negligible and positive. On the other hand, the correlation between the ruble-dollar exchange rate and policy rates changes its sign and magnitude between the

Table 1: *Cross-correlation table, 2000Q1 - 2008Q2*

Variables	GDP gap	CPI	Policy rates	RRb_Eur	RRb_USD	M2 growth	REER
GDP gap	1.000						
CPI	0.312	1.000					
Policy rates	0.534	0.883	1.000				
RRb_Eur	-0.285	-0.827	-0.827	1.000			
RRb_USD	-0.140	0.322	0.442	-0.334	1.000		
M2 growth	0.505	0.189	0.377	-0.249	-0.038	1.000	
REER	0.299	0.197	0.085	-0.272	-0.214	0.053	1.000

Table 2: *Cross-correlation table, 2008Q3 - 2014Q1*

Variables	GDP gap	CPI	Policy rates	RRb_Eur	RRb_USD	M2 growth	REER
GDP gap	1.000						
CPI	-0.706	1.000					
Policy rates	-0.764	0.799	1.000				
RRb_Eur	-0.479	-0.089	-0.216	1.000			
RRb_USD	-0.239	-0.340	-0.176	0.742	1.000		
M2 growth	0.306	-0.298	-0.295	0.212	0.015	1.000	
REER	0.219	-0.184	-0.200	-0.435	-0.457	-0.099	1.000

periods before the third quarter of 2008 and afterwards. The same can be observed for the real exchange rate. Here, however, the correlation rises, although again with an opposite sign compared to the pre-crisis period. A strong and positive coefficient of correlation between policy rates and inflation in both sub-periods only confirms conclusion drawn from the graphical analysis. In general there is a change of sign and magnitude of coefficients of correlation between many variables in two sub-periods. This may indicate that the Russian economy was hit rather severely by the 2008 crisis and consequent Great Recession. This observation is also supported by summary statistics of all variables of interest provided in Appendix A where mean values of all variables substantially differ between sub-samples. Rather interesting is the slowing of the money growth from an average of 2.70% in period before the third quarter 2008 to 1.28% after the third quarter 2008. In fact M2 growth recorded a negative level of -1.34% in the fourth quarter of 2008, which may be both a clear indication of an economic crisis or a sign of strong foreign-exchange intervention aiming at stabilizing depreciation pressures. Nevertheless, the money growth did not accelerate in the post-crisis period. Standard deviations of variables of interest seem to be surprisingly in general lower in the post 2008 crisis period. This can be explained by the effects of the 1998 currency and economic crisis that caused many of the variables to depart from their standard levels and subsequently return to more moderate values during the period of rebounding in the early 2000s. Hence many variables in the first sub-period are likely to suffer from contamination (as for instance the interest rate that did not in fact present any important monetary policy instrument until the second half of the 2000s), which would cause their volatility to be higher than after the 2008 crisis.

As the Figures in this section indicate, most of the variables tend to follow certain time trend. Mostly a decreasing linear time trend would fit the development of variables. On the other hand, the ruble-euro exchange rate can be rather approximated by an increasing time trend. But in general

inclusion of a time trend into the estimation and testing procedures appears to be justified by graphical analysis.

6 Estimation

In order to estimate rules proposed above, several approaches has been chosen. First, an ordinary least squares (OLS) regression was run with appropriate testing. After that, in accordance with other studies on monetary policy rules, a generalized method of moments (GMM) was applied to allow for endogenous errors that are, however orthogonal to a set of instruments. As a slightly unusual step for the framework of money stock and interest rates rules, an autoregressive distributed lag model (ARDL) was estimated in order to obtain certain insight into the possible length of reaction of monetary authorities.

6.1 OLS regression

Originally, simple regressions of models (10) and (11) were run with interest rates and M2 growth rate, respectively, as response variables and with lagged interest rate (or lagged M2 growth respectively), real effective exchange rate (REER) together with its lagged values and a combination of a GDP gap or a real GDP growth with CPI growth rates or deviations of inflation from its target values as explanatory variables. The aim of this was to find an optimal combination of variables according to which the CBR would set its policy rates. Results are reported in Table 3. In general, for the interest rate rules, only significant coefficients were those in front of lagged interest rate and measures of inflation, be it a narrow CPI growth or deviations of CPI growth from targeted rates. Coefficients for inflation have negative signs as expected. The Taylor principle does not hold for any of those combinations, i.e. the CBR reacted always with a less-than one percent increase of its policy rates to one percent rise of inflation or one percent deviation of inflation from its target levels. In spite of the inclusion of a linear time trend, the coefficient of determination remained high. The time trend is highly significant with a negative coefficient, which corresponds to the pre-

vious graphical analysis where the interest rates are also decreasing linearly over time. Money-growth rules performed much poorer in this original setting. For most of possible combinations of variables, only measures of GDP fluctuations had statistically significant coefficients. Only in one case, CPI significantly entered the model in combination with GDP gap. In this case the CPI had an expected negative coefficient as the CBR would react to a growing inflation with slowing the growth of money supply. Coefficients on measures of GDP growth were positive, which would rather contradict theoretical conclusions about a stabilizing pattern of monetary policy in a matured economy. Esanov et al. (2005) argue that by increasing money supply after a rise in output the CBR may expect that this output growth was likely caused by a positive technological shock. Esanov et al. (2005) predict that after a permanent growth of output caused by a technological improvement the interest rates should not change contrary to an increasing money growth that should level-out the shock to the real economy. However, in all cases of money growth rules, coefficients were economically negligible, and coefficients of determination were much lower than those for interest rate rules. In both cases, also replacement of the REER with a growth rate of nominal exchange rate of US dollar and euro, respectively, *vis-à-vis* the rubble was attempted. No significant improvement of model was, however, achieved, and therefore these statistics are not reported here. Addition of quarterly dummies and a dummy for the 2008 financial crisis did not significantly improve nor change any of the models, and the dummies themselves were not significant, as opposed to the time trend. Hence these results are not reported here either. In general, all the estimations above do not serve as any benchmark for further estimation and should only present an initial picture. Clearly, issues related to the order of integration of data as well as nature of errors must be discussed further.

To control for potential unit roots of variables indicating that shocks to those variables have permanent effects, a Dickey-Fuller Generalized least

Table 3: *OLS - R-Rules*

	(1)	(2)	(3)	(4)
	Policy rates	Policy rates	Policy rates	Policy rates
L.Policy rates	0.626***	0.692***	0.620***	0.677***
CPI	0.235***		0.223***	
GDP gap	-0.0183	-0.0399		
REER	-0.0628	-0.0584	-0.0568	-0.0523
L.REER	0.0300	0.0518	0.0353	0.0556
Time	-0.0570**	-0.0802***	-0.0645**	-0.0890***
Inflation deviations		0.133*		0.126*
GDP			-0.0405	-0.0641
Constant	12.70**	18.52***	14.52**	20.72***
Observations	55	55	55	55
Adjusted R^2	0.982	0.978	0.982	0.979

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: *OLS - M-Rules*

	(1)	(2)	(3)	(4)
	M2 growth	M2 growth	M2 growth	M2 growth
L.M2 growth	-0.114	-0.0945	-0.140	-0.156
CPI	-0.0794		-0.0701	
GDP gap	0.0752*	0.0762*		
REER	-0.00672	-0.0116	-0.00226	-0.00509
L.REER	0.0244	0.0211	0.0231	0.0180
Time	-0.0517**	-0.0352***	-0.0491**	-0.0363***
Inflation deviations		-0.0543		-0.0625
GDP			0.0882*	0.0946*
Constant	13.01***	9.072***	12.04**	8.952***
Observations	55	55	55	55
Adjusted R^2	0.470	0.452	0.478	0.480

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

squares (DF-GLS) test proposed by Elliott et al. (1996) was run for it generally has greater power in small samples than an Augmented Dickey-Fuller test for unit root.[19]. Selection of an optimal lag was conducted according to the Modified Akaike Information Criterion (MAIC) proposed by Ng and Peron (2001). MAIC was preferred to other criteria such as Schwarz-Bayes Information Criterion (SBIC) since it provides substantially better size properties of DF-GLS tests for variables with roots of their respective moving average polynomials approaching one (Ng and Peron, 2001). Under MAIC the hypothesis of unit root presence was not rejected for all variables at 99% confidence level. Only for the REER and growth of M2 aggregate unit root could be rejected at90% and 95% levels respectively.[20] Hence, further estimations were made under the condition that all variables are integrated of order one ($I(1)$).[21]

First-differencing all variables may be potentially problematic in two cases. If some variables are only approaching the unit root, then regressing their differences would lead to a misspecified regression. Here, this issue has been dealt with by using the DF-GSL test with MAIC providing better size properties for coefficients approaching unity. Another problem may arise if, in spite of being both individually $I(1)$, response and explanatory variables enter a so-called cointegrating relationship (which is by definition $I(0)$ in this case). Then again, a matter of model misspecification would arise, if response and explanatory variables were merely differenced. This topic would involve an estimation of a vector error correction model, which is beyond the scope of this text.

Bearing in mind topics outlined above, a simple OLS regression of mone-

[19]An in-depth discussion of theory concerning unit root tests can be found e.g. in Hamilton (1994).

[20]Under SBIC unit root was rejected at 99% confidence level for GDP gap, REER, inflation deviations and growth rates of euro and dollar exchange rates. Unit root hypothesis for M2 growth was rejected also at 95% confidence level.

[21]Integration of higher order as well as fractional integration were not considered here as being so far irrelevant in this part of empirical research.

tary policy rules was run using a solution "combined" of two of the three approaches described above. Again, a set of equations with different measures of fluctuations of GDP and inflation was estimated. This time, however, first differences of variables were included. In cases of the lagged policy rate and lagged M2 growth respectively, these variables were left untouched, as being in fact proposed by the first option for curing for non-stationarity of errors. The same was applied for the REER since all equations already contained its lag thus controlling for unit root process in this case. As it would be most unusual in monetary policy rules literature, instead of adding lagged measures of inflation and GDP, these regressors were included in their first-differenced form. At this stage, such an approach was considered sufficient to deal with a possibility of unit-root processes.

This time only equations with GDP gap and CPI or deviations of inflation and GDP growth were estimated. The estimation results are reported

Table 5: *OLS Stationarity-adjusted models*

	(1)	(2)	(3)	(4)
	Policy rates	Policy rates	M2 growth	M2 growth
L.Policy rates	0.626***	0.692***		
CPI	0.235***		-0.0794	
GDP gap	-0.0183	-0.0399	0.0752*	0.0762*
REER	-0.0628	-0.0584	-0.00672	-0.0116
L.REER	0.0300	0.0518	0.0244	0.0211
Time	-0.0570**	-0.0802***	-0.0517**	-0.0352***
Inflation deviations		0.133*		-0.0543
L.M2 growth			-0.114	-0.0945
Constant	12.70**	18.52***	13.01***	9.072***
Observations	55	55	55	55
Adjusted R^2	0.982	0.978	0.470	0.452

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

in Table 5. As far as interest rules are concerned, a statistically significant coefficient for lagged interest rates was estimated. A plain CPI growth rate appears to be both statistically and economically more significant than deviations of inflation from target. Time trend is still significant and negative, although rather negligible compared to the coefficient at lagged interest rate. All coefficients have expected signs except for coefficients at lagged REER which are negative contrary to contemporaneous values of REER. Nevertheless, REER does not enter significantly any of estimated rules. The adjusted R^2 remains high in spite of including the time trend.

In various combinations of money growth rules only measures of GDP gap and time trend enter corresponding rules significantly. Other variables remain insignificant, among them also lagged values of M2 growth. R^2 is substantially lower for these types of models than for interest rates rules. Including quarterly dummies or a dummy for the financial crisis in general only worsens results for both types of rules, which is why these regressions are not reported here.

To test for serial correlation of errors alternative Durbin test and Breusch-Godfrey test (for higher order serial correlation) were used, neither of which require exogenous regressors. In case of money growth rules none of those tests rejected the null hypothesis of no serial correlation. However, no serial correlation hypothesis was rejected in all cases of interest rate rules. This implies that $t - statistics$ in interest rate rules are not valid, and those rules have to be estimated using a Prais-Winston feasible generalized least squares estimator (FGLS). The effect of FGLS estimation with robust standard errors on interest rate rules was such that all coefficients except for lagged interest rate and time trend became insignificant, and the coefficient of determination also decreased. These results are reported in Appendix B. However, as long as it is not possible to assure a strict endogeneity of regressors, estimates obtained by FGLS method are not consistent. Therefore, a GMM estimation conducted in the next section is required to allow

for endogeneity of regressors and disturbances.

6.2 GMM regression

In order to deal with potential endogeneity of explanatory variables, a Generalized Method of Moments estimator (GMM) was applied. Such an estimation technique requires also set of instruments that are assumed to be orthogonal to the error term. As instruments, response variables were used along with their one-period lags.

For interest rate models statistically significant coefficients were obtained in both of the estimated options for measures of inflation, lagged interest rate term and contemporaneous values of REER as well as for time trend. Economically most significant coefficient is associated with the interest-rate smoothing term. A 1% growth of plain CPI is associated with an increase of interest rates that is by about 0.1% bigger than that associated with 1% deviation of inflation from its target. This could suggest that while affecting the price level, the CBR preferred to react in an ad-hoc manner rather than to strictly follow its objectives. A one-percent appreciation of REER is associated with statistically significant but economically negligible lowering of interest rates by about 0.05%. An interesting feature is absence of any statistically significant coefficient associated with GDP growth or deviations of GDP from its target.

Money aggregate model gives a different picture in terms of reaction of M2 growth to changes in macroeconomic variables. Whereas positive increases of GDP gap statistically significantly cause an acceleration of money growth, acceleration of inflation imply statistically significant slowing down of money growth of approximately the same magnitude as the increases of money supply growth after a rise of GDP gap. This observation is in accordance with the interpretation provided for simple OLS models and is further supported by insignificant coefficient at GDP terms in interest rate model. As Esanov et al. (2005) confirm, this is the customary reaction of the CBR

to GDP growth associated with technological progress, i.e. interest rates are kept unchanged whereas the money growth is accelerated. An insignificant coefficient at lagged M2 growth term suggest that the money growth was regulated rather disregarding its past values. A more or less stable path of M2 growth rate over time supports this view. Surprisingly, no significant reaction of the money growth to changes in REER was recorded, which may contradict conclusions made in previous studies.

Table 6: *GMM - R-Rule (1)*

GDP gap	
	-0.0177
Inflation deviations	
	0.145***
L.Policy rates	
	0.752***
Time	
	-0.0593*
REER	
	-0.0631*
L.REER	
	0.0364
Constant	
	13.79*
Observations	55

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Several variations of explanatory variables were tested in order to find out whether other factor influenced the monetary policy instruments setting process. Nonetheless, including growth rates of nominal euro and dollar exchange rates both as instruments and as explanatory variables did not bring about any significant improvement of any of the models. On the contrary,

the coefficients under these terms were insignificant themselves and overall statistical and economic significance of other variables only worsened. The same result was obtained after controlling for quarterly effects and effects of the 2008 crisis, i.e. the respective coefficients were statistically insignificant and overall significance of the model only worsened either. Hence neither of these extended models is reported here.

Table 7: *GMM - R-Rule (2)*

GDP gap	
	-0.0115
CPI	
	0.231***
L.Policy rates	
	0.641***
Time	
	-0.0521*
REER	
	-0.0625*
L.REER	
Constant	0.0259
Constant	
	11.61**
Observations	55

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To assess behavior of the CBR during and after the 2008 financial crisis, a new dummy for the whole period from the third quarter of 2008 to the first quarter of 2014 was created. Such a dummy was supposed to capture any effects of this whole period on instrument setting behavior of monetary authorities. This time, nonetheless, only values of GDP gap and deviations of inflation from target were applied. As instruments, again a full set of

Table 8: *GMM - M-Rule*

GDP gap	
	0.0752
CPI	
	-0.0794*
L.M2 growth	
	-0.114
REER	
	-0.00672
L.REER	
	0.0244
Time	
	-0.0517***
Constant	
	13.01***
Observations	55

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

explanatory variables with their one-period lagged values, and a linear time trend was used for both equations. Results of estimation of models for interest rate and money growth are reported in Table .

Table 9: *GMM - R-Rule for crisis*

GDP gap	
	0.0191
Inflation deviations	
	0.163***
L.Policy rates	
	0.882***
REER	
	-0.0648*
L.REER	
	0.00732
AfterCrisis	
	-0.0155
Constant	
	0.929*
Observations	55

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In the interest rate model, values of coefficients in front of inflation deviations and interest rate remain highly significant but both coefficients slightly increased in magnitude compared to the situation without a dummy for crisis and after crisis period. On the other hand, contemporaneous values of REER have roughly the same small negative effect as in the previous estimations. Other variables, including the *AfterCrisis* dummy itself are insignificant at any acceptable level. The increase in magnitudes of coefficients at inflation deviations and interest rate smoothing might imply that in the relevant period the CBR both assigned higher attention to interest rate policy itself and

to levels of inflation, which would jointly suggest a possible move towards an inflation targeting regime.

Table 10: *GMM - M-Rule for crisis*

GDP gap	
	0.0191
Inflation deviations	
	0.163***
L.Policy rates	
	0.882***
REER	
	-0.0648*
L.REER	
	0.00732
After2008	
Constant	-0.0155
Constant	
	0.929*
Observations	55

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model for money growth presents a moderately different picture of Russian monetary policy during and after the financial crisis. GDP gap is no more significant contrary to previous money growth models for the whole period. Coefficients for inflation deviations that are larger in absolute value than those in models for the whole period are obtained from a money growth rule. Analogically, lagged values of REER became significant once an independent dummy for financial crisis and periods afterwards is included. Coefficient at lagged values of REER is, nevertheless, positive as expected. Most importantly, the very dummy *AfterCrisis* is associated with a strong and statistically significant decline of money growth rate of about 1.41%. This

is consistent with the literature review and observations made in Chapter 4. Reasons for such a deceleration of money growth may be various but most likely efforts to prevent sharp depreciation by buying foreign currency at the outset of crisis, subsequent policy shift towards inflation targeting associated with limited monetary policy interventions, and a general influence of economic slow-down on money growth were behind the decline of money growth rate after 2008. Consistent with this view is also a, of magnitude smaller, coefficient at one-period lagged REER, which would suggest a rather limited effort of the CBR to further influence the exchange rate.

Based on this evidence, it is possible to conclude that indeed during the financial crisis in 2008 and in the years after, the CBR devoted higher attention and effort to the interest rate policy and inflation dynamics although partly inconclusive results may suggest that still certain role was assigned to exchange rate operations conducted via foreign exchange interventions in the open market that influenced the money supply. Such operations, nevertheless, became less frequent compared to the pre-crisis period.

6.3 ARDL regression

In this section, a slightly nonstandard approach is tested to find an optimal monetary policy rule. Although using an autoregressive distributed lag model (ARDL)[22] is not common within the policy rules literature, resemblance of monetary policy rules to an ARDL model can be utilized along with tools enabling for an optimal selection of number of lag. Even though, in such a case, a deviation from the originally proposed rule may occur, applying an ARDL model can help to discover a potential length of the lag with which the CBR reacted to changes in exogenous variables. The principle of an ARDL model is to augment a univariate autoregressive model by including (lagged) exogenous variables. A potential problem with this model

[22]ARDL model is also known as Lagged endogenous regressors or Dynamic regression model.

again arises with serially correlated errors. These may cause least squares estimators not to be consistent. An ARDL model for an interest rate rule is generally, in this case, of the following form:

$$i_t = \beta_0 + \sum_{h=1}^{m} \beta_h i_{t-h} + \sum_{i=0}^{n} \beta_i \pi_{t-i} + \sum_{j=0}^{p} \beta_j y_{t-j} + \sum_{k=0}^{q} \beta_k REER_{t-k} + \epsilon_t \quad (12)$$

Where π stands for one of the measures of inflation, y symbolizes a measure of GDP fluctuations, and REER is as above growth rate of the real effective exchange rate. Time trend enters estimation as an exogenous variable but is not listed explicitly here. Number of lags of variables (i.e. values of m, n, p, q respectively) can be either preset manually or selected given some information criteria, such as Schwarz-Bayes (SBIC), which puts stronger penalty on additional regressors and hence chooses a more parsimonious model selection, or Akaike (AIC), which allows for a greater number of parameters.

Tables 16 and 17 in Appendix B report estimated results using AIC and SBIC respectively. As expected, AIC enabled to include a much broader scope of lags into policy rules. Up to four lags were included into the model under AIC. Interestingly, coefficients for interest rate were significant only in their first lag also in cases where more lags were incorporated into the model. Under both information criteria coefficient at lagged interest rate a close to one (or even above) and positive. Their magnitude compared to other variables may imply that a high role in the interest rate setting process is assigned to smooth transformation of interest rates. REER under SBIC is statistically significant in its first lag only in one specification (with GDP gap and deviations of inflation). However, its magnitude is of order smaller than that of other variables. Similar result is obtained for REER using AIC but now REER is significant also in combination with GDP growth and inflation deviations. GDP gap enters significantly policy rule only in its second lag under SBIC. Its coefficient is positive as expected. A plain measure of GDP growth is under SBIC, nevertheless, significant in its first lag (in specification with inflation deviations), and in its second lag (in combination with a

plain CPI growth). In the latter case the coefficient is slightly large in magnitude. Under AIC GDP gap is positive in the second lag in combination with CPI, being smaller than coefficient at CPI, and negative in its forth lag in combination with inflation deviations that are also negative in their forth lag. GDP growth under AIC is associated with a rise in interest rates after two periods if also CPI enters the decision making process two periods later. Contrary to inflation deviations, which are negative and statistically significant only for quarters later under AIC, CPI has positive and statistically significant effect on interest rates after two lags under both criteria. Under SBIC deviations of inflation are statistically significant and positive in their second lag only in combination with GDP gap. In general, absence of any significant contemporaneous values might imply that reaction of monetary authorities is manifested only with some delay (usually after two quarters). Apart from interest rate, GDP in specification with inflation deviations is also statistically significant in its first lag. Interestingly enough, time trend is insignificant for any specification under both of the information criteria used here. Adjusted R^2 is rather high in all cases, being approximately 98%. Mostly, a reaction of the CBR to a one-percent increase of inflation or GDP (or an analogical change of deviations of inflation or a GDP gap) would be on average an 0.13% to 0.20% increase of interest rates two periods later. Such a prolonged period may be explained by some degree of rigidity of the monetary policy board of the CBR or by attempts to rule out sharp changes in economic environment. Other possible explanation might be that the CBR reacted to real-time data instead. Investigation such an option is, however, not within the scope of this work.

The very same approach has been used also for money growth rules, where the only difference are values of M2 growth instead of interest rates.

$$\begin{aligned} M2growth_t = \beta_0 + \sum_{h=1}^{m} \beta_h M2growth_{t-h} + \sum_{i=0}^{n} \beta_i \pi_{t-i} + \\ + \sum_{j=0}^{p} \beta_j y_{t-j} + \sum_{k=0}^{q} \beta_k REER_{t-k} + \epsilon_t \end{aligned} \tag{13}$$

Results of these regressions are reported in Table 18 and 19 in Appendix B. For SBIC, the only significant coefficients are those for either GDP growth or GDP gap, mostly for contemporaneous values and first lags. Coefficients at contemporaneous values are positive and larger in absolute value than those at first lags that are negative. This could suggest that, analogically to OLS estimates, the CBR responds to GDP increase with an acceleration of M2 growth and slows it down after one period while keeping interest rates constant. Lagged values of M2 growth are insignificant. Coefficient of determination is again lower than that for interest rate rule. But in this case exogenous time trend becomes significantly negative. Results under AIC are very similar to those under SBIC this time. Adding an exogenous dummy variable for a crisis period only worsens results in all cases and the coefficient for such a variable is insignificant in all specifications suggesting that neither the interest rates nor the money growth were driven by a reaction to the world financial crisis in 2008 under the ARDL setting.

7 Conclusion

The aim of this bachelor thesis was to estimate monetary policy that was conducted by the Central Bank of Russia in the period 2000-2014 with special attention to the 2008 crisis and subsequent post crisis period. Two main hypotheses were considered. First, whether the CBR started attaining more value to its interest rate instruments as opposed to money supply operations. And second, whether the rate of inflation became more important in instrument setting behavior of the CBR. These hypotheses aim at assessing the fact whether the announced shift of the CBR policy towards an inflation targeting regime indeed occurred. To evaluate them, two basic theoretical approaches to monetary policy rules were applied; interest rate rules based on Taylor rule, and money supply rule based on McCallum rule. Various adaptations of these rules were estimated for Russian economy in the given period.

General findings can be summarized as follows: Significant evidence in favor of an increasing importance of inflation in monetary policy rules was found. Along with it, evidence points out to a growing role of interest rates as policy instrument in the post-2008 crisis period. Therefore it is possible to consider efforts of the CBR to adopt inflation targeting regime the next couple of years as reasonably credible.

It was also discovered that different results both in terms of statistical and economic significance are obtained if different measures of key policy variables are used in estimation. Thus, in some rules the CBR reacts stronger to movements of a plain growth rate of CPI, or of a GDP growth rate, compared to deviations of those variables from their targeted levels. In such a case, the CBR is suspected to react in a rather ad hoc way bearing in mind only a general aim of, say, restricting inflation but without a stronger attention to announced targets. The abovementioned fact, however, does not apply to changes of nominal exchange rates of euro and US dollar *vis-à-vis* ruble. These remain insignificant across various model specifications.

This can be evidence in support of the notion that the CBR on average reacted rather to a basket of currencies than to movements of individual exchange rates throughout the sample period. Generally, effect of changes of REER on monetary policy is of magnitude smaller than that of other key variables. In particular, a big part of interest rate movements can be explained by interest rate smoothing behavior of the CBR. A high economic and statistical significance of lagged interest rates in the crisis and post-crisis period rather supports the proposition that the CBR attempted to set policy rates in consistence with its previous decisions.

Rather surprisingly, a dummy variable for the period from the third quarter of 2008 to the first quarter of 2009 proved to be statistically insignificant across all tested specifications. On the other hand, variable capturing the period after the start of the 2008 crisis till the first quarter of 2014 significantly influenced several models. It is hence possible to conclude that an overall change of behavior of the CBR took place 2008 and was maintained afterwards.

Contrary to matured economies, acceleration of GDP growth is not associated with decreasing the growth rate of monetary aggregate M2 in Russia. As long as the CBR considers a rise of GDP to be an effect of technological improvement, it is willing to further stimulate the economy by rising money supply. Nevertheless, no significant reaction of interest rates to changes of GDP was captured, which is typical for this kind of behavior. These observations are similar to those made by Esanov et al. (2005). Analogically, the Taylor principle did not hold for any specification of an interest rate rule where measures of inflation entered significantly the interest rate equation. This means that the CBR reacted with less than one-percent increase of interest rate to a one-percent increase of inflation (or one-percent deviation of inflation from its target levels). This can be understood as another piece of evidence that the CBR is so far only moving towards a standard role of the central bank in a matured economy.

ARDL estimation revealed that decisions of monetary policy authorities in response to changes in key macroeconomic variables often come only with a considerable lag. This may be caused by either rigidity of decision makers or by the fact that authorities base their decisions on real-time data instead of the ex-post data used in this research. Nevertheless, even the latter option would hardly explain the lag length of two (or even four) periods that frequently occurs.

In conclusion of this text, it can be said that the CBR in fact made a considerable progress in the transition process towards a model of central bank of a matured market economy as inflation is gradually becoming CBR's main policy objective, and policy rates seem to become the main policy instrument of the CBR. This thesis provides certain evidence of change of behavior of the CBR in recent years. Such an evidence can be used for instance in further research on operations of central banks in emerging market economies during the last financial crisis as well as for purposes of forecasting reactions of the CBR to changes in macroeconomic environment.

Applying a vector error correction model to check for possibility of cointegrating relationships among variables, or estimating monetary policy rules with real-time data available at the moment when decisions were made can be discussed as possible extensions of this text.

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Appendix

A

Table 11: *Summary statistics, whole period*

Variable	Mean	Std. Dev.	Min.	Max.	N
CPI	11.849	5.052	3.8	25.4	57
Inflation deviations	2.218	3.094	-4.1	10.5	57
GDP	4.884	4.301	-9.497	11.869	56
GDP gap	0.005	4.659	-15.197	10.369	56
Policy rates	14.135	7.776	5.5	45	57
M2 growth	2.156	1.049	-1.343	5.259	57
REER	1.309	3.556	-14.311	8.654	56
RRb_Eur	35.97	5.713	24.253	48.042	57
RRb_USD	29.159	2.287	23.627	33.966	56

Appendix B

Table 12: *Summary statistics, 2000Q1-2008Q2*

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
CPI	14.271	4.696	7.7	25.4	34
Inflation deviations	2.918	2.755	-0.3	10.5	34
GDP	7.261	1.8	4.278	11.869	34
GDP gap	2.243	2.657	-0.545	10.369	34
Policy rates	17.856	8.037	10	45	34
M2 growth	2.724	0.828	1.357	5.259	34
REER	1.92	2.713	-3.195	8.654	34
RRb_Eur	32.346	4.098	24.253	36.962	34
RRb_USD	28.374	2.088	23.627	31.779	34

Table 13: *Summary statistics, 2008Q3-20014Q1*

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
CPI	8.27	3.072	3.8	14.9	23
Inflation deviations	1.183	3.332	-4.1	7.9	23
GDP	1.209	4.478	-9.497	5.123	22
GDP gap	-3.454	5.012	-15.197	1.577	22
Policy rates	8.635	1.999	5.5	13	23
M2 growth	1.317	0.733	-1.343	2.119	23
REER	0.365	4.474	-14.311	7.459	22
RRb_Eur	41.326	2.757	35.965	48.042	23
rrb_USD	30.372	2.074	24.255	33.966	22

Table 14: *Cross-correlation table, whole period*

Variables	GDP gap	CPI	Policy rates	RRb_Eur	RRb_USD	M2 growth	REER
GDP gap	1.000						
CPI	0.269	1.000					
Policy rates	0.459	0.894	1.000				
RRb_Eur	-0.624	-0.793	-0.828	1.000			
RRb_USD	-0.392	-0.157	-0.012	0.308	1.000		
M2 growth	0.623	0.422	0.550	-0.571	-0.297	1.000	
REER	0.321	0.154	0.141	-0.349	-0.381	0.127	1.000

Table 15: *FGLS for R-Rules*

	(1)	(2)	(3)	(4)
	Policy rates	Policy rates	Policy rates	Policy rates
L.Policy rates	0.430***	0.407***	0.428***	0.398***
D.CPI	0.0663		0.0596	
D.GDP gap	0.0233	0.0232		
REER	-0.0211	-0.0239	-0.0183	-0.0209
L.REER	0.0113	0.00910	0.0133	0.0104
Time	-0.200***	-0.211***	-0.200***	-0.214***
D.Inflation deviations		0.0148		-0.00168
D.GDP			-0.00793	-0.0175
Constant	45.46***	47.96***	45.39***	48.48***
Observations	55	55	55	55
Adjusted R^2	0.881	0.873	0.882	0.873

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: *ARDL - R-Rules, AIC*

	(1)	(2)	(3)	(4)
	Policy rates	Policy rates	Policy rates	Policy rates
L.Policy rates	1.019***	0.955***	0.964***	0.866***
L2.Policy rates	-0.180			
GDP gap	0.0795	0.0645		
L.GDP gap	-0.136	-0.180		
L2.GDP gap	0.149*	0.141		
L3.GDP gap		0.149		
L4.GDP gap		-0.143*		
CPI	0.165			0.136
L.CPI	-0.165			-0.122
L2.CPI	0.211*			0.186*
REER	-0.00237	0.00587	0.0103	0.00582
L.REER	0.0362	0.0564	0.0581*	0.0387
Time	0.0178	0.00939	0.0128	0.0294
Inflation deviations		0.146	0.123	
L.Inflation deviations		-0.143	-0.0824	
L2.Inflation deviations		0.0926	0.0524	
L3.Inflation deviations		0.169	0.159	
L4.Inflation deviations		-0.146	-0.133*	
GDP			0.106	0.0804
L.GDP			-0.296	-0.179
L2.GDP			0.233	0.201*
L3.GDP			0.167	
L4.GDP			-0.185*	
Constant	-3.992	-1.859	-2.771	-7.072
Observations	52	52	52	52
Adjusted R^2	0.990	0.989	0.990	0.990

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: *ARDL - R-Rules, SBIC*

	(1)	(2)	(3)	(4)
	Policy rates	Policy rates	Policy rates	Policy rates
L.Policy rates	0.824***	0.922***	0.939***	0.866***
GDP gap	0.0645	0.0799		
L.GDP gap	-0.129	-0.181		
L2.GDP gap	0.159*	0.200*		
CPI	0.132			0.136
L.CPI	-0.108			-0.122
L2.CPI	0.196*			0.186*
REER	-0.00545	0.00253	-0.00659	0.00582
L.REER	0.0308	0.0481	0.0348	0.0387
Time	0.0188	0.0103	0.00517	0.0294
Inflation deviations		0.0865	0.0399	
L.Inflation deviations		-0.0955	0.0582	
L2.Inflation deviations		0.150		
GDP			-0.0954	0.0804
L.GDP			0.136*	-0.179
L2.GDP				0.201*
Constant	-4.184	-1.671	-1.007	-7.072
Observations	52	52	52	52
Adjusted R^2	0.989	0.988	0.988	0.990

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: *ARDL - M-Rules, AIC*

	(1)	(2)	(3)	(4)
	M2 growth	M2 growth	M2 growth	M2 growth
L.M2 growth	-0.104	-0.0490	-0.152	-0.166
GDP gap	0.136*	0.184*		
L.GDP gap	-0.110	-0.128		
CPI	-0.0645			-0.00459
L.CPI	0.00166			-0.0459
L2.CPI	0.0414			
L3.CPI	-0.141			
REER	-0.0433	-0.0400	-0.0472	-0.0384
L.REER	0.0114	0.0207	0.00292	0.00631
Time	-0.0786***	-0.0346**	-0.0310**	-0.0442*
Inflation deviations		0.0592	0.0471	
L.Inflation deviations		-0.0875	-0.0536	
GDP			0.264**	0.221**
L.GDP			-0.170*	-0.137*
Constant	19.14***	8.838***	7.883***	11.02**
Observations	52	52	52	52
Adjusted R^2	0.430	0.391	0.460	0.464

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: *ARDL - M-Rules, SBIC*

	(1)	(2)	(3)	(4)
	M2 growth	M2 growth	M2 growth	M2 growth
L.M2 growth	-0.0835	-0.0490	-0.152	-0.166
GDP gap	0.137*	0.184*		
L.GDP gap	-0.0864	-0.128		
CPI	-0.00511			-0.00459
L.CPI	-0.0743			-0.0459
REER	-0.0297	-0.0400	-0.0472	-0.0384
L.REER	0.0213	0.0207	0.00292	0.00631
Time	-0.0530**	-0.0346**	-0.0310**	-0.0442*
Inflation deviations		0.0592	0.0471	
L.Inflation deviations		-0.0875	-0.0536	
GDP			0.264**	0.221**
L.GDP			-0.170*	-0.137*
Constant	13.23**	8.838***	7.883***	11.02**
Observations	52	52	52	52
Adjusted R^2	0.404	0.391	0.460	0.464

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$