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# Breaking monetary policy rules in Russia

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**Abstract**

This study estimates whether the monetary policy rules of Bank of Russia have changed recently. Russia has moved towards inflation targeting over the past years, which is reflected in our empirical estimations. We start by estimating various monetary policy rules for Russia, concluding that a variant of the Taylor rule depicts Bank of Russia's monetary policy over the past decade well. Moreover, there have been two clear breaks in the coefficients of the estimated monetary policy rule, possibly signifying a shift towards traditional inflation targeting and also the current recent economic turbulence.


*JEL classification:* E31, E43, E52, P33.
*Keywords:* monetary policy rule, Taylor rule, McCallum rule, Russia, inflation.

## 1. Introduction and motivation

In this paper, we analyze whether the monetary policy rules of the Bank of Russia have changed over the past years. This could be possible a priori, given the changes in the explicit monetary policy framework, as well as the further development of Russia's financial system.

Broadly, previous studies (see section 2 for a brief literature review) determined that, in recent years, Russia's monetary policy can be described in terms of the Taylor rule, where the central bank's steering of the interest rate responds to deviations from its inflation target as well as the output gap. The central bank's aim is to stabilize inflation around its target and output around the level of potential output. In Russia, as in numerous other open economies, the exchange rate is often included in estimations.

We find that estimated monetary policy rules do indeed contain breaks, or at least a break. We observe a break in the estimated Taylor rule in February 2015, broadly

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coinciding with the formal start of inflation targeting. It is also interesting that before the summer of 2006, the Taylor rule did not explain Bank of Russia's interest rate policy. This would hint that the changes in Russia's monetary policy have been gradual, and the central bank perhaps behaved differently in earlier periods.

This paper is structured as follows. The subsequent section offers a short introduction to Russia's monetary policy, as well as a review of the literature on the estimated monetary policy rules in Russia. Section 3 introduces the data and the estimated monetary policy rules. In the fourth and fifth sections, we estimate different versions of monetary policy rules, with and without breaks. Section 6 concludes the paper.

## 2. Evolution of monetary policy in Russia

Our data sample runs from the beginning of 2004 to August 2017.[1] During this time, the Bank of Russia has had several goals for its policy, although the entire period has been marked by a gradual shift towards fully-fledged inflation targeting, which was officially introduced from the beginning of 2015. At the same time, exchange rate stability has been explicitly mentioned as a key target of the central bank for almost the entire sample period. Moreover, the exchange rate target was only given up in November 2014, although the Bank of Russia announced then it would stand ready to intervene on the foreign exchange market to dampen undue volatility. However, it should be noted that the Bank of Russia had continuously widened the allowed fluctuation band around the central parity of its exchange rate basket (consisting of the US dollar and the euro, and reflecting both Russia's foreign trade orientation and the dollar's traditionally significant role in the Russian economy). Moreover, the targeted exchange rate was also allowed to change as to reflect underlying market pressures, especially after 2008.

The Bank of Russia first stated price stability as its primary policy objective in the 2007 monetary policy guidelines (Bank of Russia, 2006). This can be seen as the starting point for the gradual move towards inflation targeting in Russia.

Fig. 1 shows the inflation targets (or target ranges) of the Bank of Russia, as well as the realized inflation from 2000 to 2017. (It should be noted that, especially during earlier periods, it was sometimes difficult to discern inflation targets from forecasts, although these ranges were called inflation targets in the Bank of Russia's annual monetary policy guidelines.) One can see that the realized inflation overshot inflation targets on several occasions, and that the largest deviations from the inflation target have happened in the aftermath of large currency depreciations, such as in 2008 and 2015. This empirical regularity can be used to justify the inclusion of an exchange rate variable in the empirical estimates of Russia's monetary policy rules. Moreover, the official role of the exchange rate basket shows the importance of this variable.

While empirical estimates of different monetary policy rules are relatively common in advanced OECD countries, similar exercises for emerging market countries are still rare. Moreover, there are only a handful of published papers

[1] Our sample starts from 2004, as inflation had decelerated close to 10% by that time. At the same time, our current data sample contains several different monetary and exchange rate policy regimes, which allows us to search for breaks.

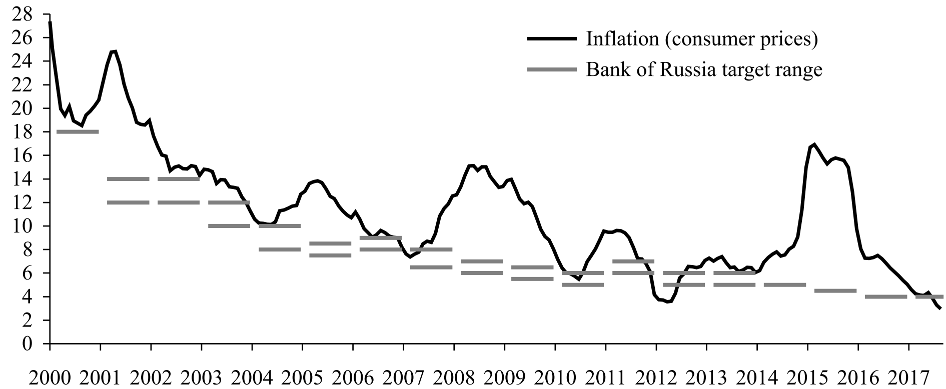


**Fig. 1.** Inflation and annual inflation targets (%).

*Sources:* IMF, Bank of Russia, and Rosstat.

on monetary policy rules in Russia, and their data samples typically end more than a decade before our data. For instance, Esanov et al. (2005) estimate several monetary policy rules for Russia from 1993 or 1994 to 2002. For a large part of this data sample, Russia had a fixed exchange rate target. The authors find that the McCallum rule with monetary base fits the data best. In their estimation, the US dollar exchange rate is also used as a control variable. The results are plausible in the sense that monetary aggregates were explicitly used as intermediate targets during most of the period. However, there is a structural break in the data in 1995, when the rouble was officially pegged to the US dollar. This reminds us of the importance of the exchange rate for conducting the Russian monetary policy.

Vdovichenko and Voronina (2006) estimate monetary policy rules for the period after the crisis of 1998, but their sample is very short, from 2000 to 2003. They find that the McCallum rule with monetary base seems to reflect the underlying data reasonably well, but only when the exchange rate is included in the analysis as well.

Drobyshevskiy et al. (2008) look at the conduct of monetary policy in Russia between 1999 and 2007, and find that commercial banks' correspondent accounts in the central bank seem to be the instrument of choice for monetary policy. This would imply a variant of the McCallum rule for Russia.

Korhonen and Nuutilainen (2017) update their previous estimations of monetary policy rules for Russia for 2003–2017, and conclude that an augmented Taylor rule provides a good approximation of the actual conduct of monetary policy in Russia. Fedorova et al. (2016) extend the analysis of the Taylor rule in Russia by studying the behavior of this rule during crisis and non-crisis periods during 2003–2015. They show that the estimated Taylor rule does not work during crisis periods. They also augment the rule to include a financial stress indicator.

One can also note that a somewhat stable link between monetary aggregates and other economic variables — that is, a money demand function — is needed for the McCallum rule to be a viable strategy for a central bank to follow. For Russia, Korhonen and Mehrotra (2010) find, for instance, such a stable money demand function, but exchange rate needs to be again included in the estimated empirical relationship.

## 3. Methodology and data

We estimate two types of monetary policy reaction functions to evaluate the Bank of Russia's behavior from 2004 to August 2017. We utilize the literature on monetary policy rules to formulate the reaction functions. To timely capture the recent policy changes, we use monthly data in our estimations. This section introduces the estimated policy rules and the data used in the empirical analysis. Data and their original sources are listed in Appendix Table A1.

The estimated interest rate rule is a version of the famous Taylor (1993) rule, where the central bank reacts to the output gap and inflation deviation from a target rate. Following Taylor (2001), we select an open economy version of the rule, also accounting for exchange rate developments, because of the strong emphasis on exchange rate stabilization of the Bank of Russia's monetary policy. Additionally, oil prices strongly impact the behavior of output, inflation, and exchange rate in Russia. As such, it is reasonable to assume that the Bank of Russia considers oil prices directly when making monetary policy decisions. Therefore, oil prices are added to the policy rule as a macroeconomic variable the central bank may directly react to when setting its policy.

Taylor (1993, 2001) assumes the central bank reacts to output deviations from a potential level of output. However, determining potential output in practice is very difficult, even for developed countries with available long time series, not to mention emerging economies such as Russia where structural changes are present. Following Orphanides and Williams (2007), we estimate the so-called "difference rule," which considers changes in output growth from long-run growth trends. There is much less controversy in determining the trend growth rate over potential output for an economy. Following the empirical literature, policy smoothing is added to the estimated rules to increase empirical fit.[2]

We estimate the Taylor interest rate rule of the form:

$$i_t = \alpha_0 + \alpha_1(\pi - \pi^*)_{t-1} + \alpha_2 \widehat{\Delta y}_{t-1} + \alpha_3 \widehat{reer}_{t-1} + \alpha_4 \widehat{oil}_{t-1} + \alpha_5 \widehat{oil}_{t-2} + \\ + \alpha_6 i_{t-1} + \varepsilon_t. \quad (1)$$

In the empirical estimations, we use the Bank of Russia's key policy rate (the one week repo credit rate) as the policy interest rate $i_t$ from February 2011 onwards, when the central bank adopted this instrument and started to publish the data. Prior to that, the refinancing rate is selected as the policy interest rate.[3] Inflation deviation term $(\pi - \pi^*)_{t-1}$ is determined as y-o-y growth in consumer prices over the annual CPI growth target determined by the central bank for the analyzed year.[4] We use the inflation target observed at the beginning of the year in question, as this should be the most relevant for formulating the expectations of

[2] The majority of empirical studies include policy smoothing in the estimated policy rules. Examples of these include Clarida et al. (1998), who estimate such a rule for large developed countries, Mehrotra and Sánchez-Fung (2011) for 20 emerging countries, as well as Vdovichenko and Voronina (2006) and Esanov et al. (2005) for Russia.

[3] The level of the policy rate is increased to match the refinancing rate in February 2011, so that only true policy changes affect the interest rate variable.

[4] For a robustness check, a Hodrick-Prescott (HP)-filtered inflation deviation series is also considered. However, there is no significant difference between using the official inflation target or the Hodrick-Prescott filtering to determine the inflation rate trend.

monetary policy for instance. On some occasions, the Bank of Russia changed the target towards the end of the year, if it had become obvious that original target could not be reached. We do not take these changes into account.

We assume that monetary policy reacts only to deviations in output growth, as well as exchange rate and oil prices from the long-run trend level. Following the literature, we use HP filtering to calculate our deviation series.[5] Output growth deviation, $\widehat{\Delta y}_{t-1}$, is calculated by removing the HP-filtered trend from the estimated monthly GDP y-o-y growth series published by the RF Ministry of Economic Development.[6] Similarly, the exchange rate deviation, $\widehat{reer}_{t-1}$, and oil price deviation, $\widehat{oil}_{t-1}$, are calculated by removing the HP trend from the real effective exchange rate (REER) index and the Urals oil dollar prices, respectively. In Eq. (1), $\alpha_0$ is a constant term and $\varepsilon_t$ stands for the estimation error. Parameters $\alpha_1$–$\alpha_5$ are the estimated policy reaction coefficients, and $\alpha_6$ measures the strength of policy smoothing. For the policy to be countercyclical, we should observe that $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 < 0$, and $\alpha_4, \alpha_5 > 0$.

In addition to the interest rate rule, we also estimate the money supply rule introduced by McCallum (1988). The McCallum rule is defined in nominal terms. McCallum (1988, 2000) suggests that the central bank should react to nominal output growth deviations from the target rate. This way, the policy would not be biased in the short run to errors arising when separating the realized nominal output growth into real growth and inflation. We follow McCallum (1988, 2000), and use base money growth as a policy instrument, because it is the monetary aggregate the central bank has full control over. The estimated McCallum rule is also formulated to consider the possible policy reactions to exchange rate and oil price changes, as well as to account for policy smoothing.

The McCallum rule estimated is of the form:

$$\Delta bm_t = \beta_0 + \beta_1 \widehat{\Delta x}_{t-1} + \beta_2 \widehat{neer}_{t-1} + \beta_3 \widehat{oil}_{t-1} + \beta_4 \widehat{oil}_{t-2} + \beta_5 \Delta bm_{t-1} + \varepsilon_t. \qquad (2)$$

The nominal base money growth, $\Delta bm_t$, is the y-o-y change in the M0 money aggregate. Fortunately, the Ministry of Finance of Russia publishes a monthly GDP estimate in roubles. We use this series to calculate the y-o-y nominal GDP growth rate and the HP filter to obtain the nominal output growth deviation, $\widehat{\Delta x}_{t-1}$. The exchange rate and oil price gaps are calculated similarly to (1), but using the nominal effective exchange rate (NEER) index. Again, $\beta_0$ is a constant term, $\beta_1$–$\beta_4$ measure the strength of policy reactions in the base money supply to macroeconomic variables, and $\beta_5$ measures policy inertia. Error term $\varepsilon_t$ captures the elements of random behavior that might be present at time $t$, potential omitted variables, and specifica-

[5] HP filtering is a standard method for removing trend and calculating the output gap. However, the de-trended values may be unreliable at the beginning and the end of the data sample. In calculating the de-trended series, we have used data starting from January 1999, when available. To make the rules fully operational in practice, we also estimated the rules using deviation series (output gap, exchange rate gaps, and oil price gap), where the average value over the previous three years is used instead of the HP-filtered trend. The main findings do not differ between the different de-trending methods. The estimation results are available upon request.

[6] In 2017, the monthly GDP estimate has not been available at the time of the policy decisions, because of Rosstat's GDP data revisions. The estimates for March–July 2017 were published in August 2017, but the values for January and February were still missing. Therefore, for the real output growth in 2017, we use the growth in the Output Index for Key Economic Activities published by Rosstat. The correlation between the two series for the common sample of 2012–2016 is 0.94.

tion errors. Increases in the base money supply indicate policy easing. Therefore, the signs in countercyclical policy reactions are the opposite of the Taylor rule: $\beta_1 < 0, \beta_2 > 0$, and $\beta_3, \beta_4 > 0$. To adequately account for policy reactions to oil prices, the second lag of the oil price deviations also need to be added to the policy rules.

The estimated policy rules are formulated to retain operationality. Policy is assumed to react to macroeconomic variables prevailed in the previous period and, thus, are available at time *t*. Another possibility would be to allow the central bank consider expectations about future inflation and output when making policy decisions (see, for example, Clarida et al., 1998, 2000) or react to forecasts of future inflation (see, for example, Batini and Haldane, 1999; Levin et al., 2003; and Rudebusch and Svensson, 1999). Traditionally, however, the Taylor rules have been estimated with realized data, which is also a strengths of the approach, as one does not need to take a stand on expectation formation. Earlier literature on Russia (Esanov et al., 2005; Vdovichenko and Voronina, 2006; and Drobyshevskiy et al., 2008) also adopts this approach.

Appendix Fig. A2 depicts the data series used in the empirical estimations. Descriptive statistics are presented in Appendix Table A2. All variables used in the estimations can be considered level stationary.[7]

## 4. First estimation results

Here, we replicate the monetary policy rule estimations from Korhonen and Nuutilainen (2017) with a longer data sample. We can see that the Taylor rule continues to be a reasonable approximation of Russia's monetary policy during our sample period, but the McCallum rule does not find empirical support.

The policy reaction functions are empirically estimated using a general method of moments (GMM) estimator. The use of GMM is fairly standard in estimating policy reaction functions with inertia and possible measurement errors for variables. The estimation results are presented in Tables 1 and 2. Some papers estimating monetary policy rules for Russia (Esanov et al., 2005; and Vdovichenko and Voronina, 2006) do not consider the central bank's policy reactions to oil prices. To maintain comparability with these earlier results, the Taylor and McCallum rules are also estimated without the oil price variable.

The estimated policy reactions of the Taylor rule (1) for the full sample period are presented in Table 1. The policy reactions are generally in line with the theoretical assumptions, showing a stabilizing policy in terms of reactions to both inflation and output growth deviations. The reactions are also statistically significant.

The policy reactions to exchange rate developments and oil prices are more difficult to interpret, as these two variables are largely interrelated. The interest rate reactions to oil prices are statistically significant, but the sign of the estimated reactions to the first lag of the oil price are opposite from those expected. The increase in oil prices is assumed to lead to policy tightening, as it will boost future output growth and increase inflation. However, the second oil price lag has the opposite sign and counteracts the negative response to the first lag.

[7] The augmented Dickey-Fuller (ADF) unit root test cannot reject the null hypothesis of a unit root in the interest rate variable, but the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test does not reject the null for stationarity either. All other variables are stationary at least at the 10% significance level based on the ADF test.

**Table 1**
Taylor rule estimation results.

| | $c$ | $(\pi-\pi^*)_{t-1}$ | $\widehat{\Delta y}_{t-1}$ | $\widehat{reer}_{t-1}$ | $\widehat{oil}_{t-1}$ | $\widehat{oil}_{t-2}$ | $i_{t-1}$ | $SSR$ | $R^2$ | $j$-stat. |
|---|---|---|---|---|---|---|---|---|---|---|
| $i_t$ | 0.426** | 0.037** | 0.047*** | 0.014* | –0.035*** | 0.025*** | 0.947*** | 81.99 | 0.92 | 5.43 |
| | (0.187) | (0.015) | (0.015) | (0.008) | (0.008) | (0.009) | (0.018) | | | (0.71) |
| $i_t$ | 0.285** | 0.015 | 0.031*** | –0.001 | | | 0.962*** | 80.21 | 0.92 | 5.72 |
| | (0.129) | (0.012) | (0.009) | (0.006) | | | (0.012) | | | (0.68) |
| $i_t$ | 0.459** | 0.027** | 0.043*** | | –0.035*** | 0.028*** | 0.946*** | 81.54 | 0.92 | 5.93 |
| | (0.197) | (0.013) | (0.016) | | (0.009) | (0.008) | (0.019) | | | (0.43) |

*Notes:* This table presents the GMM estimates from January 2004 to August 2017. Standard errors are given between parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The instrument list includes a constant and the second, third, and fourth lags of the independent variables. The instrument lag selection is based on the autocorrelation behavior of the dependent variable. Standard errors and covariances are computed using a Newey-West weighting matrix.

**Table 2**
McCallum rule estimation results.

| | $c$ | $\widehat{\Delta x}_{t-1}$ | $\widehat{neer}_{t-1}$ | $\widehat{oil}_{t-1}$ | $\widehat{oil}_{t-2}$ | $\Delta bm_{t-1}$ | $SSR$ | $R^2$ | $j$-stat. |
|---|---|---|---|---|---|---|---|---|---|
| $\Delta bm_t$ | 0.883* | –0.124 | 0.017 | 0.217** | –0.128 | 0.944*** | 3647.2 | 0.89 | 8.00 |
| | (0.518) | (0.128) | (0.118) | (0.109) | (0.109) | (0.036) | | | (0.63) |
| $\Delta bm_t$ | 1.024* | –0.181 | 0.146* | | | 0.930*** | 3639.6 | 0.89 | 7.87 |
| | (0.620) | (0.144) | (0.076) | | | (0.034) | | | (0.55) |
| $\Delta bm_t$ | 0.643 | –0.155 | | 0.302** | –0.191 | 0.954*** | 3841.9 | 0.88 | 5.93 |
| | (0.531) | (0.148) | | (0.119) | (0.121) | (0.036) | | | (0.55) |

*Notes:* This table presents the GMM estimates from January 2004 to August 2017. Standard errors are given between parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The instrument list includes a constant and the second, third, fourth, and fifth lags of the independent variables. The instrument lag selection is based on the autocorrelation behavior of the dependent variable. Standard errors and covariances are computed using a Newey-West weighting matrix.

The sign of the estimated exchange rate reaction is opposite from the expected one. In the policy rules literature, policy easing is assumed to follow exchange rate appreciation. Here, we find the reverse. Oil prices and the exchange rate are closely interconnected and, in our estimation, we are perhaps unable to completely disentangle these two effects. When discarding the effect of oil prices, the exchange rate is not statistically significant.

The estimated McCallum rule policy reactions are presented in Table 2. In this specification, the Russian monetary policy reacts only to oil prices. The coefficient of the nominal output growth deviation is not statistically significant, unlike in Korhonen and Nuutilainen (2016). This finding holds even when oil prices or the exchange rate are omitted from the estimated rules. Therefore, the McCallum rule does not describe the Bank of Russia's policy, at least during the full sample period.

## 5. Breaks in the monetary policy rules

During our estimation period, the Bank of Russia's monetary policy framework has gone through several changes in terms of both policy instruments as well as policy objectives, as described in section 2. Therefore, a single monetary policy rule may not fit the Russian data well for the entire period, and presumably the policy rules are subject to structural breaks.

The existence of possible breaks in the estimated rules is studied using the Andrews-Fair Wald and LR-type tests suitable for GMM estimations. The test statistics show statistically significant breaks in the estimated rules. The most likely dates for the breaks are estimated by maximizing the value of the Andrews-Fair LR-type statistic. First, we estimate the date for the most likely break and, given the most likely first breakpoint, test the possible subsequent breaks.[8]

For the Taylor rule, the first breakpoint is February 2015, that is, when the rapid interest rate increases were followed by interest rate cuts (see Appendix Fig. A1). We can interpret this as the return to "normal times," given the extreme instability of the preceding months, large exchange rate swings, and interest rate hikes. Given this breakpoint, the second most likely and statistically significant break occurred in July 2006. Table 3 shows the Taylor rule estimation results for the three different subsamples. In the period prior to the first break of mid-2006, the Taylor rule does not fit the Russian data. This is in line with the literature, as well as the central bank's policy, where the central bank's interest rate was not yet used as the main policy instrument. Appendix Fig. A3 shows how allowing breaks decreased residuals in the estimations.

During 2006–2015, the monetary policy of Russia moved more towards price stabilization and started using the interest rate as a predominant policy instrument. During this period, the Taylor rule fits the data well. Coefficients on both inflation and output gap have the expected signs. Additionally, the effective exchange rate is statistically significant for Bank of Russia's interest rate formation. However, the sign of the estimated exchange rate reaction is opposite from the expected one. Our results may have the following explanation. When oil price increases, this also leads to an exchange rate appreciation and perhaps to expectations of further appreciation. In our estimation, we are unable to completely disentangle these two effects, which may lead to the observation that exchange rate appreciation is followed by a monetary policy tightening, even if an oil price increase is its ultimate cause. Table 4 presents the Taylor rule long-run coefficient for inflation deviation

**Table 3**
Taylor rule estimation results for different sub-periods.

| | $c$ | $(\pi - \pi^*)_{t-1}$ | $\widehat{\Delta y}_{t-1}$ | $\widehat{reer}_{t-1}$ | $\widehat{oil}_{t-1}$ | $\widehat{oil}_{t-2}$ | $i_{t-1}$ | $SSR$ | $R^2$ | $j$-stat. |
|---|---|---|---|---|---|---|---|---|---|---|
| 01/2004–06/2006 | | | | | | | | | | |
| $i_t$ | 3.100** | 0.022 | –0.053 | –0.030 | 0.011* | –0.014 | 0.745*** | 3.19 | 0.76 | 5.70 |
| | (1.260) | (0.027) | (0.048) | (0.029) | (0.006) | (0.009) | (0.103) | | | (0.68) |
| 07/2006–01/2015 | | | | | | | | | | |
| $i_t$ | 0.246 | 0.058** | 0.056*** | 0.032*** | –0.040*** | 0.025* | 0.963*** | 69.42 | 0.84 | 6.59 |
| | (0.252) | (0.024) | (0.015) | (0.009) | (0.014) | (0.014) | (0.029) | | | (0.58) |
| 02/2015–08/2017 | | | | | | | | | | |
| $i_t$ | 4.554*** | 0.066*** | 0.093* | –0.011 | 0.009 | –0.020*** | 0.622*** | 2.58 | 0.96 | 5.17 |
| | (0.249) | (0.021) | (0.053) | (0.015) | (0.010) | (0.005) | (0.023) | | | (0.74) |

*Notes:* This table presents the GMM estimates. Standard errors are given between parentheses; $^*p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The instrument list includes a constant and the second, third, and fourth lags of the independent variables. The instrument lag selection is based on the autocorrelation behavior of the dependent variable. Standard errors and covariances are computed using a Newey-West weighting matrix.

[8] We test the possible breaks for the monetary policy rules estimated from January 2004 to August 2017. In the estimations, we let the first possible breakpoint be June 2006 and the last one March 2015, allowing 31 observations in the subsamples before/after the breakpoint. The detailed breakpoint estimation results are available upon request.

and output gap for the periods when they are statistically significant. From 2006 until early 2015, the monetary policy rule fulfills the "Taylor principle," that is, the long-run reaction to inflation deviation is above 1. An interesting observation is that the long-run coefficient of the output gap is also above 1, indicating that the Bank of Russia places a relatively strong weight on output stabilization.

From the beginning of 2015, the Bank of Russia has been committed to full-fledged inflation targeting. Nonetheless, during this time, Russia has also been faced with a severe economic downturn as well as rapidly accelerating inflation due to the depreciation of the rouble. Consequently, the monetary policy had to balance between supporting the real economy and counteracting inflation. Our estimation results show that, after 2015, the interest rate policy has indeed followed the Taylor rule, and both reactions to inflation deviation and output gap are statistically significant. However, Table 4 shows that the strength of policy reactions has been much weaker than in the previous period. After 2015, the monetary policy seems to place more weight on output stabilization, relative to balancing inflation.

We can also identify two statistically significant breakpoints for the McCallum rule. The first breakpoint, maximizing the value of the Andrews-Fair LR-type statistic, is in March 2014. Given this break, the most likely second break is in January 2011. Table 5 presents the McCallum rule estimation results for the dif-

**Table 4**
Taylor rule long-run coefficients.

| Period | Inflation gap | Output gap |
|---|---|---|
| 01/2004–07/2017 | 0.70 | 0.89 |
| 01/2004–06/2006 | – | – |
| 07/2006–01/2015 | 1.57 | 1.51 |
| 02/2015–08/2017 | 0.17 | 0.25 |

*Notes:* The long-run coefficients are calculated as $\alpha^{LR} = \alpha/(1-\rho)$, where $\alpha$ is the short-run policy coefficient and $\rho$ is the policy smoothing parameter. The values presented in the table are for the Taylor rules, where both exchange rate and oil prices are included. The values presented for the long-run inflation gap and output gap are statistically significant at least at the 10% significance level.

**Table 5**
McCallum rule estimation results for different sub-periods.

| | $c$ | $\widehat{\Delta x}_{t-1}$ | $\widehat{neer}_{t-1}$ | $\widehat{oil}_{t-1}$ | $\widehat{oil}_{t-2}$ | $\Delta bm_{t-1}$ | $SSR$ | $R^2$ | $j$-stat. |
|---|---|---|---|---|---|---|---|---|---|
| 01/2004–12/2010 | | | | | | | | | |
| $\Delta bm_t$ | 2.930** | –0.439** | 0.480 | 0.254* | –0.118 | 0.905*** | 3330.4 | 0.85 | 6.62 |
| | (1.464) | (0.181) | (0.340) | (0.140) | (0.148) | (0.057) | | | (0.76) |
| 01/2011–02/2014 | | | | | | | | | |
| $\Delta bm_t$ | 2.296** | –0.217 | 0.038 | –0.340*** | 0.176** | 0.836*** | 290.6 | 0.71 | 8.82 |
| | (1.024) | (0.200) | (0.148) | (0.050) | (0.084) | (0.109) | | | (0.55) |
| 03/2014–08/2017 | | | | | | | | | |
| $\Delta bm_t$ | 2.088*** | 0.145** | 0.095 | –0.035 | 0.024 | 0.685*** | 387.7 | 0.55 | 6.48 |
| | (0.678) | (0.057) | (0.132) | (0.147) | (0.074) | (0.077) | | | (0.77) |

*Notes:* This table presents the GMM estimates. Standard errors are given between parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The instrument list includes a constant and the second, third, fourth, and fifth lags of the independent variables. The instrument lag selection is based on the autocorrelation behavior of the dependent variable. Standard errors and covariances are computed using a Newey-West weighting matrix.

ferent sub-samples. We find that, between 2004 and 2010, the McCallum rule fits the Russian data, confirming the earlier literature findings. During this period, the monetary policy reacts counter-cyclically to nominal output deviations and the exchange rate reaction has the expected sign, although it is not statistically significant.

After 2011 this is not the case anymore. From 2011 to early 2014, the central bank base money supply reaction is statistically significant only to oil prices. After March 2014, the nominal output growth deviation is statistically significant, but the sign of the policy reaction is positive, indicating pro-cyclical reactions in the money supply to nominal output growth. This is contrary to the theoretical assumptions in the monetary policy rules literature.

## 6. Concluding remarks

We have shown that Russia's monetary policy can be characterized by the Taylor rule at least since 2006. This seems to be also in consensus with more recent papers on this topic. We explicitly consider possible breaks in the estimated monetary policy rules. As some extant studies have found that Russia's monetary policy could be characterized by the McCallum rule in the late 1990s and early 2000s, our results may provide a way to link these older and the newer results on the topic.

When more data from the recent period of full inflation targeting become available, it will be interesting to observe whether the estimated coefficients on inflation and output variables would have changed. We leave this for future work.

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## Appendix

**Table A1**
Variables.

| Variable | Measure | Source[a] |
|---|---|---|
| *Interest rate* | | |
| Refinancing rate | % pa (end of period) until 01/2011 | *CBR* |
| Central Bank Policy Rate | % pa (end of period) available after 02/2011 | *CBR* |
| *Monetary aggregate* | | |
| Base money growth | y-o-y change (%) in RUB monetary base (broad def.) | *CBR* |
| *Inflation* | | |
| Consumer price inflation deviation | CPI y-o-y inflation (%), less the average of the annual target range for CPI inflation | *FSSS* *CBR* |
| *Output gap* | | |
| Real GDP growth gap | Real y-o-y GDP growth, less HP trend[b] (prior 2017, GDP growth is the EM monthly estimate and, in 2017, the FSSS key economic activity) | *EM, FSSS* |
| Nominal GDP growth gap | y-o-y change (%) in GDP in RUB, less HP trend[b] | *MF* |
| *Exchange gap* | | |
| Real effective exchange rate gap | REER index (2010=100), less HP trend[b] | *BIS* |
| Nominal effective exchange rate gap | NEER index (2010=100), less HP trend[b] | *BIS* |
| *Oil gap* | | |
| Crude oil price gap | Urals oil price in USD, monthly average, less HP-trend[b] | *OPEC* |

*Note:* Inflation target may be changed during the year. In calculating the inflation deviation series, we use the target inflation rate (range) available at the start of the year.
[a] BIS = Bank for International Settlements, CBR = Central Bank of the Russian Federation, EM = Ministry of Economic Development of the Russian Federation, FSSS = Russian Federal State Statistics Service (Rosstat), MF = Ministry of Finance of the Russian Federation, OPEC = Organization of the Petroleum Exporting Countries.
[b] HP filter applied to data series starting from 01/1999, when data available. Smoothing parameter $\lambda = 14{,}400$.

**Table A2**

Descriptive statistics.

| Variable | Obs. | Mean | Min | Max | Std. dev. | ADF $t$-stat.[a] | KPSS LM-stat.[b] |
|---|---|---|---|---|---|---|---|
| *Interest rate* | | | | | | | |
| $i$ | 164 | 11.00 | 7.75 | 19.75 | 2.50 | –2.707 | 0.279 |
| *Base money growth* | | | | | | | |
| $\Delta bm$ | 164 | 15.22 | –13.45 | 54.77 | 14.19 | $-3.482^{***}$ | $0.675^{**}$ |
| *Inflation deviation* | | | | | | | |
| $(\pi - \pi^*)$ | 163 | 3.25 | –1.93 | 12.42 | 3.23 | $-2.861^{*}$ | 0.079 |
| *Output gaps* | | | | | | | |
| $\widehat{\Delta y}$ | 163 | –0.01 | –12.24 | 5.46 | 3.25 | $-3.529^{***}$ | 0.036 |
| $\widehat{\Delta x}$ | 163 | 0.26 | –36.90 | 35.77 | 8.44 | $-5.337^{***}$ | 0.044 |
| *Exchange rate gaps* | | | | | | | |
| $\widehat{reer}$ | 163 | 0.00 | –19.53 | 11.68 | 5.35 | $-6.241^{***}$ | 0.050 |
| $\widehat{neer}$ | 163 | 0.06 | –18.03 | 10.06 | 5.40 | $-4.101^{***}$ | 0.052 |
| *Oil price gap* | | | | | | | |
| $\widehat{oil}$ | 163 | 0.03 | –36.78 | 53.22 | 13.83 | $-4.312^{***}$ | 0.037 |

*Note:* Data for 01/2004–07/2017, except for the policy instruments (interest rate and base money growth) for 01/2004–08/2017.

[a] The table presents the ADF unit root test statistic with a maximum of 13 lags. The intercept is included in the test equation.

[b] The Kwiatkowski-Phillips-Schmidt-Shin Lagrange multiplier test statistic evaluates the null hypothesis that the series is stationary. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

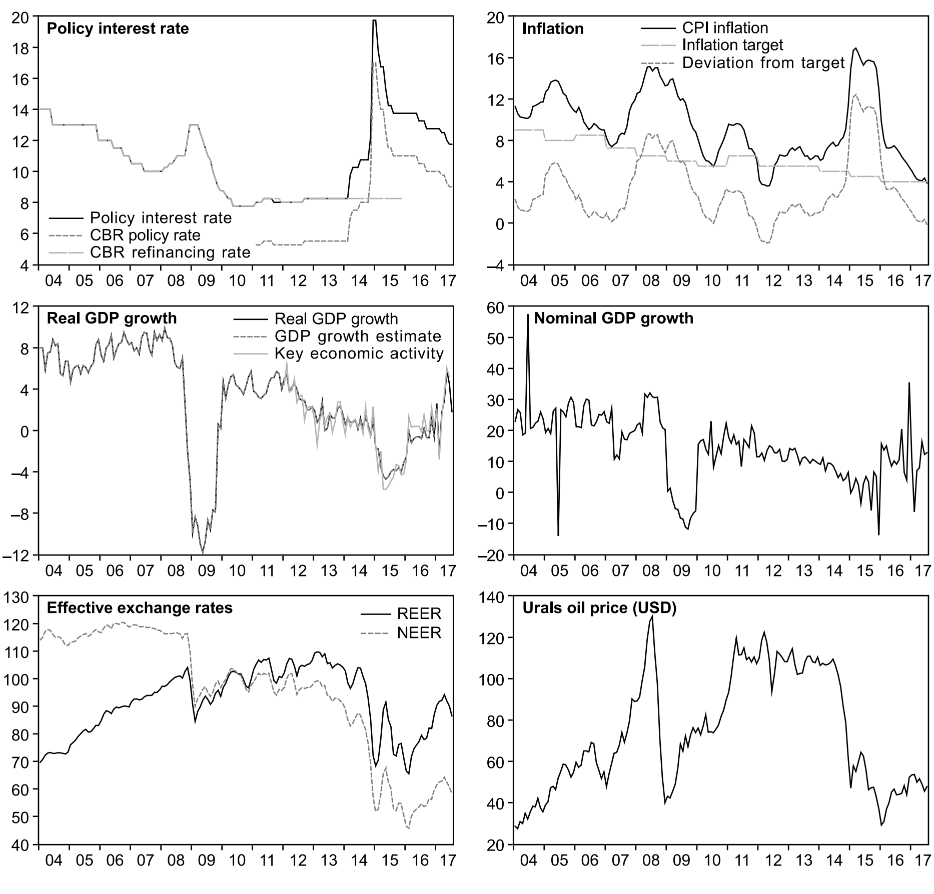


**Fig. A1.** Data by levels.

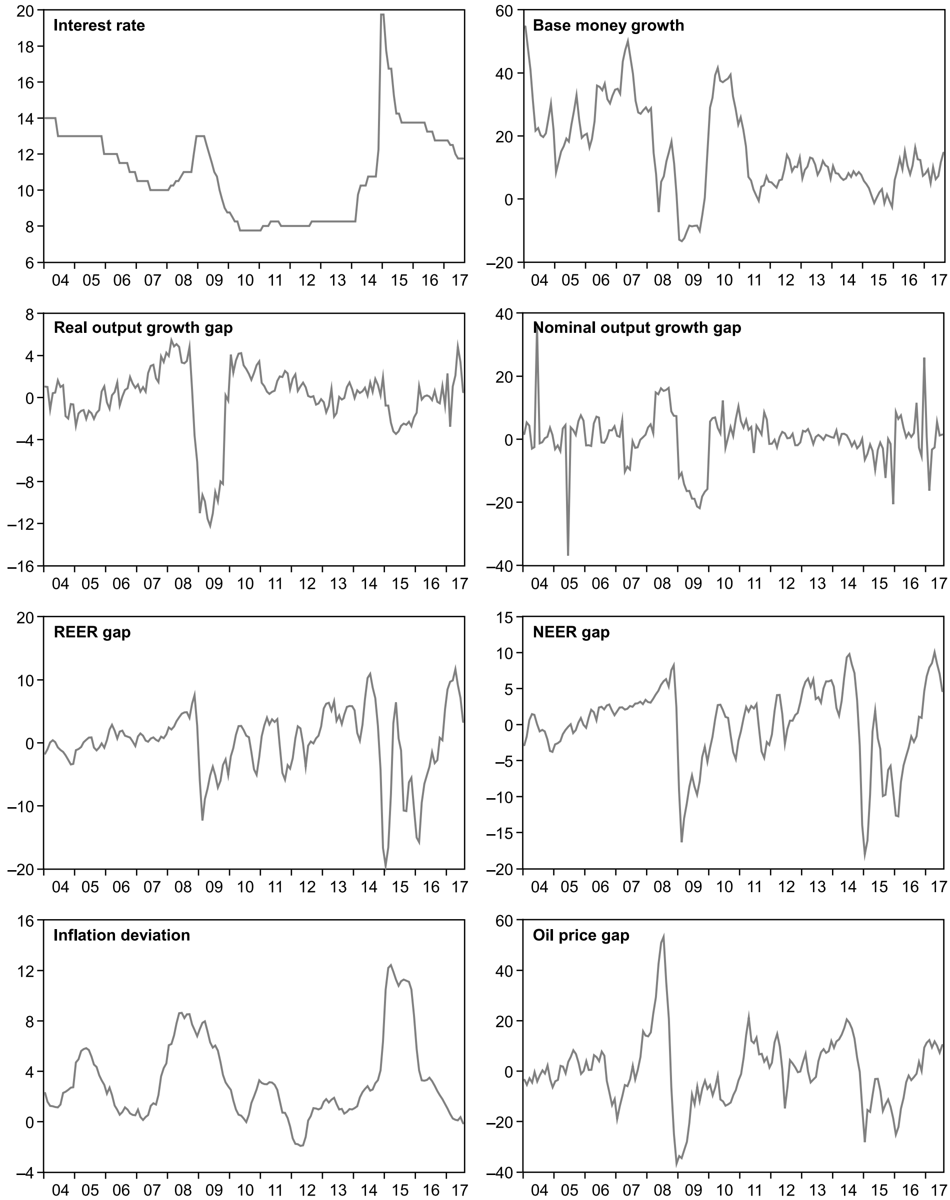


**Fig. A2.** Data used for policy rule analysis.

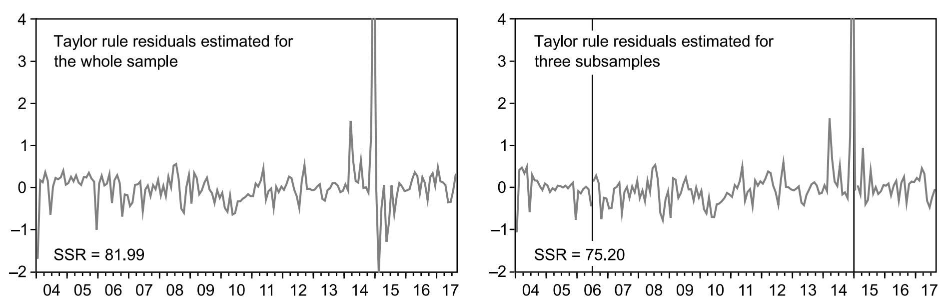


**Fig. A3.** Residuals of Taylor rules estimated for the full sample and three sub-periods.