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A monetary policy rule for Russia, or is it rules?

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Abstract

We estimate several monetary policy rules for Russia for the period 2003–2015. We find that the traditional Taylor rule describes the conduct of monetary policy in Russia reasonably well, whether coefficients are restricted to being the same or allowed to change over the sample period. We find that the Bank of Russia often overshot its inflation target and that extensive overshooting is associated with large depreciations of the ruble, testifying to the importance of the exchange rate in the conduct of monetary policy in Russia.

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1 Introduction

In this paper, we estimate several monetary policy rules for Russia. Such estimations are standard for most OECD countries and are often used in policy debates. However, estimates of monetary policy rules for emerging markets are much less common, and this is where we make a contribution.

As one of the G-20 countries, Russia is one of the largest emerging markets, and its financial markets are relatively advanced.[1] Russia remains to a large extent dependent on exports of hydrocarbons, with approximately two-thirds of its export revenue coming from sales of crude oil, oil products and natural gas. This feature of the Russian economy obviously has implications also for the conduct of monetary policy.

Using data from 2003 to 2015, we estimate several different specifications for monetary policy rules in Russia. For the whole period, we find that an augmented Taylor rule seems to depict the data reasonably well. Russian monetary authorities seem to focus on maintaining the stability of both inflation and the output gap and respond to changes in these aggregates by adjusting the interest rate. However, the results are somewhat sensitive to whether the exchange rate or both the exchange rate and the oil price are included in the empirical specification. In contrast to earlier studies, however, the McCallum rule does not seem to fit the data very well, indicating a change in the conduct of monetary policy in Russia.

The Taylor rule seems to be in congruence with the data also when we allow the coefficients of monetary policy rule to change over time. It is noteworthy that at the very end of our sample, the Bank of Russia seems to have placed much greater weight on output stabilization. This is perhaps understandable given the fall in output in 2014 and 2015. Also, one must note that the Bank of Russia moved officially into full-fledged inflation targeting only in 2015 and that exchange rate targeting was officially abandoned in November 2014. In 2014, the Bank of Russia stated that “Starting from 2015, the monetary policy will be conducted under the inflation targeting regime” (Bank of Russia, 2014). At that time the central bank supposed a 4% inflation rate at the end of 2017. While Russia’s exchange rate targeting was already very flexible, this change could affect our results at the very end of the sample.

[1] For example, by 2014, domestic credit provided by the financial sector reached 52% of GDP, higher than e.g. in Romania (38%), an EU country, or Kazakhstan (37%), a large former Soviet republic.

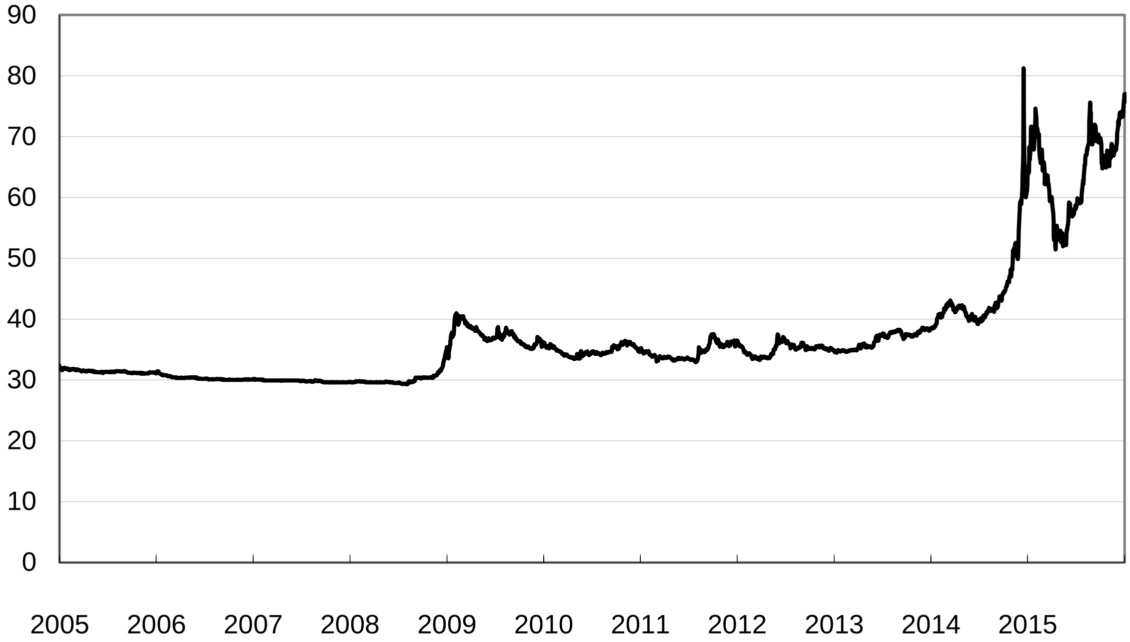
We must highlight the role of the exchange rate and the oil price in our estimates. Including them in the estimated policy functions sometimes leads to counterintuitive results, which may be explained by some of the idiosyncratic features of Russian economic policy. The study is structured as follows. In the second section, we describe the conduct of monetary policy in Russia during our sample period and present a short literature survey. The third section introduces the monetary policy rules to be estimated as well as the data. The fourth section discusses the empirical estimates, and the fifth section concludes.

2 Monetary policy rules for Russia

Our data sample runs from 2003 to 2015. During this time, the Bank of Russia had several goals for its policy, although the whole period was marked by a gradual shift toward more full-fledged inflation targeting, which was officially introduced from the beginning of 2015. At the same time, the central bank explicitly pursued exchange rate stability as one of its key targets for almost the whole sample period. The Bank of Russia gave up the exchange rate target only in November 2014, although it announced then that it would stand ready to intervene in the foreign exchange markets 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, which consists of the U.S. dollar and the euro to reflect both Russia's foreign trade orientation and the dollar's traditionally large role in the Russian economy. Moreover, the targeted exchange rate was also allowed to change to reflect underlying market pressures, especially after 2008, as is evidenced in chart 1.[2]

[2] The value of the Bank of Russia's dual-currency basket is calculated as a weighted sum of the ruble values in U.S. dollars and euro at official exchange rates. The weights varied in 2005–2007 after the dual-currency basket was adopted. An initial weight of USD 0.90/EUR 0.10 was used in February 2005, and the weight of the euro was gradually increased to the current USD 0.55/EUR 0.45 in February 2007. This weighting remains in place to this day, but the currency basket lost its relevance for exchange rate policy in November 2014.

Chart 1 Dual currency basket

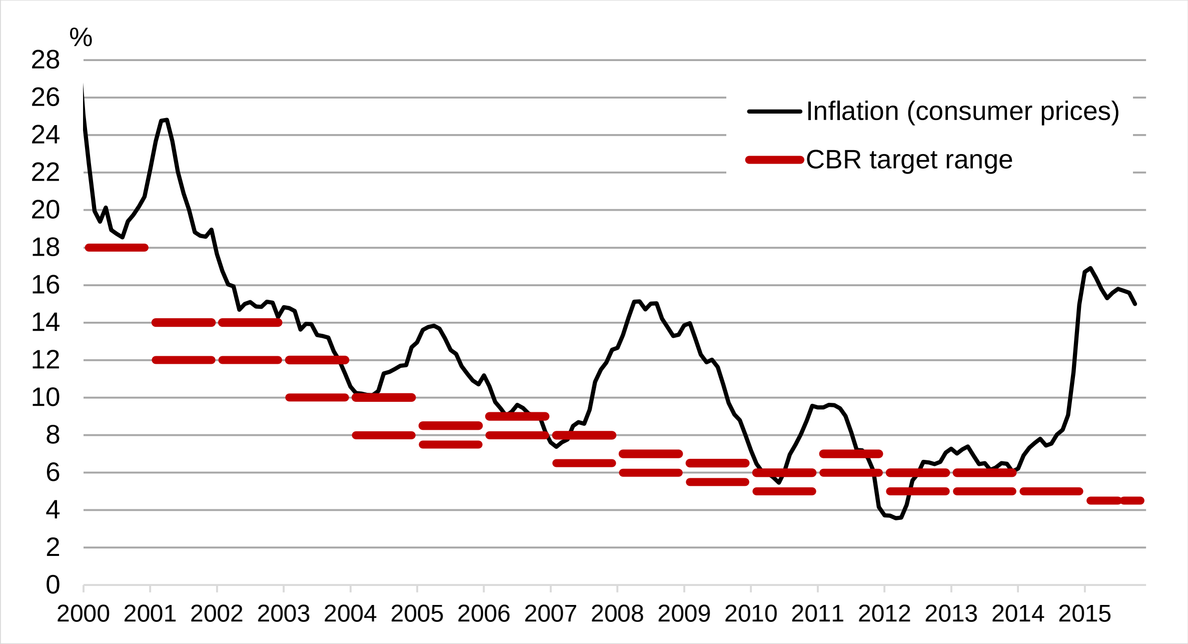


Source: Bank of Russia.

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

Chart 2 shows inflation targets (or target ranges) of Bank of Russia as well as actual inflation from 2000 to 2015. Note that especially during earlier periods, it was sometimes difficult to discern inflation targets from inflation forecasts, although the ranges were called inflation targets in the Bank of Russia's annual monetary policy guidelines. One can see that actual inflation overshot inflation targets on several occasions, and that the greatest deviations from inflation targets happened in the aftermath of large currency depreciations, for example in 2009 and 2015. This empirical regularity can be used to justify inclusion of an exchange rate variable in the empirical estimates of Russia's monetary policy rules, which is further corroborated by the official role of the exchange rate basket.

Chart 2 Inflation and annual inflation targets



Sources: IMF, Bank of Russia and Rosstat.

While empirical estimates of different monetary policy rules are relatively common in advanced OECD countries, similar exercises for emerging market countries are still quite rare. Moreover, there are only a handful of published papers on monetary policy rules in Russia, and their data samples usually end more than a decade before our data. Esanov et al. (2005) estimate several monetary policy rules for Russia for the period starting in 1993 or 1994 and ending in 2002. For a large part of this data sample, Russia had a fixed exchange rate target. The authors find that the McCallum rule with the monetary base as a target fits the data best. In their estimation, the U.S. 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 much of this period. However, there is a structural break in the data in 1995, when the ruble was officially pegged to the U.S. dollar. This reminds us of the importance of the exchange rate for the conduct of Russian monetary policy.

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

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

One may also note that a somewhat stable link between monetary aggregates and other economic variables, i.e. the money demand function, is needed for the McCallum rule to be a viable strategy for a central bank to follow. For Russia, e.g. Korhonen and Mehrotra (2010) find such a stable money demand function, but again, the exchange rate needs to be 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 in 2003–2015. We utilize the literature on monetary policy rules to formulate the reaction functions. For a timely capture of the recent policy changes, we use monthly data in the estimations. This section introduces the policy rules estimated and the data used in the empirical analysis. Data and their original sources are listed in table A1 in the annex.

The estimated interest rate rule is a version of the famous rule proposed by John Taylor (1993), according to which a central bank reacts to output gaps and deviations of inflation from a target rate. Following Taylor (2001), we select an open economy version of the rule, accounting also for exchange rate developments, because of the strong emphasis on exchange rate stabilization in the monetary policy of the Bank of Russia. In addition, oil prices strongly impact the behavior of output, inflation and the exchange rate in Russia. It is reasonable to assume that the Bank of Russia takes oil prices directly into account in monetary policy decisions. Therefore, oil prices are added to the policy rule as one of the macroeconomic variables to which the central bank may directly react when setting its policy.

Taylor (1993, 2001) assumes that the central bank reacts to deviations of output from a potential level. Determining potential output in practice, however, is very difficult even for developed countries that have long time series, much less for emerging economies like Russia that display structural changes. Following Orphanides and Williams (2007), we estimate the so-called "difference rule" that considers changes in output growth from long-run trend growth. There is much less controversy in determining the trend growth rate than potential output for an economy. Following the empirical literature, policy smoothing is added to the estimated rules to increase their empirical fit.[3]

We estimate the Taylor interest rate rule of a 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 key policy rate (the one-week repo credit rate) as the policy interest rate i_t from February 2011 onward, when the central bank adopted this instrument and started to publish the data. We select the refinancing rate as the policy interest rate prior to that date.[4] The inflation deviation term $(\pi - \pi^*)_{t-1}$ is determined as the year-on-year growth of consumer prices over the annual CPI growth target determined by the central bank for the year.[5] We use the inflation target observed at the beginning of the year in question, as this should be the most relevant e.g. for formulating expectations for monetary policy. On some occasions when it became obvious that original target could not be reached, the Bank of Russia changed the target toward the end of the year. We do not take these changes into account.

Output growth deviation $\widehat{\Delta y}_{t-1}$ is calculated by removing the Hodrick-Prescott (HP) filtered trend from the estimated monthly GDP year-on-year growth series published by the Russian 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 index for Urals oil prices, respectively. In equation (1), α_0 is a constant term and ε_t stands for the estimation error. Parameters $\alpha_1$to α_5

[3] The majority of the empirical studies include policy smoothing in the estimated policy rules. Examples include Clarida et al. (1998), who estimate such rules 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.

[4] The level of the policy rate is shifted up to match the refinancing rate in February 2011, so that only true policy changes affect the interest rate variable (see the upper left panel in chart A4).

[5] For a robustness check, an HP-filtered inflation deviation series is also considered. There is not much difference, except at the very end of our sample, between using the official inflation target or HP filtering to determine the trend inflation rate (see middle left panel in chart A4).

[6] Hodrick-Prescott filtering is a standard method for removing trend level and calculating the output gap. However, it has an obvious shortcoming of unreliability at the beginning and end of the data sample. In calculating the de-trended series, we used data starting in January 1999, wherever available. Our HP-filtered data may still suffer from the endpoint problem at the end of our sample. However, in an earlier version of the paper, we used data only up to February 2015, and results were almost identical. This makes us confident that our results do not depend on the very last observations. We use the year-on-year GDP growth data, as month-on-month data are not available. By using only the cycle component of year-on-year growth, the output growth deviation variable is better able to capture the sudden changes than the year-on-year growth rate itself.

are the estimated policy reaction coefficients and α_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 a 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 deviation from the target rate. This way, the policy would not be biased in the short run to the 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 the policy instrument, because it is the monetary aggregate over which the central bank has full control. The estimated McCallum rule is also formulated to take into account 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 Δbm_t is the year-on-year change in the monetary aggregate M0. Fortunately, the Russian Ministry of Finance publishes a monthly GDP estimate in rubles.[7] We use this series to calculate the year-on-year nominal GDP growth rate and use the HP filter to get the nominal output growth deviation $\widehat{\Delta x}_{t-1}$. The exchange rate gap and oil price gap are calculated similarly to (1), but using the nominal effective exchange rate (NEER) index. Again, β_0 is a constant term, β_1–β_4 measure the strength of policy reactions in base money to the macroeconomic variables and β_5 measures policy inertia. The error term ε_t captures elements of random behavior that might be present at time *t* and potential omitted variables and specification errors. Increases in base money indicate policy easing. Therefore, the signs in the countercyclical policy reaction are the opposite of those in the Taylor rule: $\beta_1 < 0$, $\beta_2 > 0$ and $\beta_3, \beta_4 > 0$.

The estimated policy rules are formulated to retain the rules' operationality. Policy is assumed to react to the macroeconomic variables prevailing in the previous period and thus are available at time *t*. Traditionally, Taylor rules have been estimated with realized data, which is also one of the strengths of the approach, as one does not need to take a stand

[7] The monthly GDP estimate can deviate a few percentage points from Rosstat's final ruble GDP value in annual terms. But the monthly estimate by the Ministry of Finance is available to the central bank for its policy decisions much sooner than Rosstat's official quarterly GDP.

on expectation formation. This is also the approach we follow here. Also, HP filtering is performed using data available until the time of estimation. To adequately account for policy reactions to oil prices, the second lag of the oil price deviation also needs to be added to the policy rules.

Chart A4 in the annex depicts the data series used in the empirical estimations. All variables used in the estimations can be considered to be stationary in levels.[8] Descriptive statistics and unit root test statistics of the variables are presented in table A2. Last, correlations between the variables are presented in table A3.

4 Estimation results

The policy reaction functions are empirically estimated using the generalized method of moments (GMM) estimator. The use of the GMM is fairly standard in estimating policy reaction functions with inertia and possible measurement errors in the variables. Estimation results are presented in table 1 and table 2. Our data sample spans January 2002 to November 2015. In addition, we have the December 2015 values for the policy variables, which enables us to estimate the monetary policy rules until end-2015. The McCallum rule is estimated using data from January 2003.[9] The Taylor rule is estimated from 2004 onward. Prior to 2004, the Taylor rule residuals are not well-behaved and suffer from non-normality and autocorrelation. As a robustness check, the policy reactions are also estimated for a more recent time period starting from 2007, when inflation targeting was initiated as the main policy goal of the Bank of Russia. The previous literature on estimating monetary policy rules for Russia (Esanov et al., 2005; Vdovichenko and Voronina, 2006) does not take into account central bank policy reactions to oil prices. To maintain comparability with these earlier results, the Taylor and McCallum rules are estimated also without the oil price variable.

[8] An augmented Dickey-Fuller (ADF) unit root test cannot reject the null hypothesis of a unit root in the inflation deviation variable, but the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test does not reject the null for stationarity either. Moreover, in the case of the reference policy rate, although the null hypothesis of unit root is rejected by the ADF test, the null for stationarity cannot be rejected by the KPSS test. All other variables are stationary at least at the 5% level of significance on the basis of both the ADF and the KPSS tests.

[9] Data availability partly limits the selection of the estimation period, as the base money aggregate is available only from 2003 onward.

4.1 Time-invariant policy rules

The estimated policy reactions of the Taylor rule (equation 1) 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 estimation results differ little whether we use the time period starting in 2004 or the more recent period from 2007 onward.

The policy reactions to exchange rate developments and oil prices are harder to interpret, as these two variables are largely interrelated. The interest rate reactions to the exchange rate and oil prices are statistically significant, but the signs of the estimated reactions are the opposite of those assumed beforehand. In the policy rules literature, policy easing is assumed to follow exchange rate appreciation. Here, we find the opposite. Also, an increase in oil prices is assumed to lead to policy tightening, as it boosts future output growth and increases inflation. When disregarding the effect of oil prices, the estimated policy reactions to inflation and output gaps are smaller and statistically less significant in some instances. In addition, the reaction to exchange rate changes remains positive. Our results may be explained by the fact that a rise in the oil price also leads to exchange rate appreciation. We might not be able to completely disentangle these two effects in our estimation, which may lead to the observation that exchange rate appreciation is followed by monetary policy tightening, even if the oil price increase is the original cause of the appreciation.[10]

[10] In our data set, the correlation between the REER gap and the oil price gap is 0.55 (and the correlation between the NEER gap and the oil price gap is 0.58). Also, the lagged oil price gap correlates strongly with the REER and NEER gaps (see table A3 in the annex). As a robustness check, we have also estimated the Taylor rule using the nominal effective exchange rate (NEER). The results are largely similar to the ones using the REER. In our estimation period, there is no considerable difference between the REER and NEER gap series (see lower left panel in chart A4).

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	$J-stat.$
Taylor rule 2004/01–2015/12									
i_t	0.399***	0.026**	0.023**	0.025***	-3.120***	2.709***	0.949***	78.90	14.13
	(0.140)	(0.010)	(0.009)	(0.007)	(0.586)	(0.672)	(0.015)		(0.7)
i_t	0.249**	0.018**	0.020**	0.022***			0.965***	79.51	9.10
	(0.124)	(0.009)	(0.008)	(0.006)			(0.013)		(0.91)
Taylor rule 2007/01–2015/12									
i_t	0.590***	0.029**	0.028***	0.023***	-3.033***	2.577***	0.929***	73.01	11.57
	(0.172)	(0.013)	(0.008)	(0.007)	(0.518)	(0.551)	(0.021)		(0.87)
i_t	0.260*	0.013	0.024***	0.019***			0.965***	73.90	7.74
	(0.144)	(0.012)	(0.008)	(0.005)			(0.018)		(0.96)

Notes: The table presents GMM estimates. Standard errors are given in parentheses. ***, ** and *denote the 1%, 5% and 10% level of significance, respectively. The instrument list includes a constant and second, third, fourth, fifth and sixth lags of the 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.

Estimated McCallum rule policy reactions are presented in table 2. Russian monetary policy reacts countercyclically to nominal output growth deviation. The nominal output gap reaction parameter is statistically significant only in the period starting from 2003 and when including oil prices in the estimated policy rule. After 2007, the reactions to nominal output as well as all other macroeconomic variables except the exchange rate become statistically insignificant. Therefore, the McCallum rule does not describe the Bank of Russia's policy in the more recent period.

Table 2 McCallum rule estimation results

	c	$\widehat{\Delta x}_{t-1}$	$\widehat{neer}_{t-1}$	$\widehat{oil}_{t-1}$	$\widehat{oil}_{t-2}$	Δbm_{t-1}	SSR	$J-stat.$
McCallum rule 2003/05–2015/12								
Δbm_t	0.683	-0.285*	0.037	-8.931	17.801	0.949***	4387.6	4.54
	(0.572)	(0.163)	(0.136)	(16.073)	(13.595)	(0.031)		(0.92)
Δbm_t	1.049*	-0.192	0.161*			0.927***	4331.8	4.17
	(0.564)	(0.141)	(0.090)			(0.028)		(0.90)
McCallum rule 2007/01–2015/12								
Δbm_t	-0.252	-0.181	-0.195*	8.750	9.595	1.002***	3231.8	7.23
	(0.540)	(0.133)	(0.107)	(10.937)	(11.370)	(0.045)		(0.70)

Notes: The table presents GMM estimates. Standard errors are given in parentheses. ***, ** and *denote the 1%, 5% and 10% level of significance, respectively. The instrument list includes a constant and second, third, fourth and fifth lags of the 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.

Oil prices are important among the variables the Bank of Russia considers in making its policy decisions. In terms of the strength and significance of the estimated policy reactions to output growth and inflation deviations, policy rules that do account for oil prices perform better than those that do not. Policy inertia as measured by the autoregressive (AR) lag coefficient is also less pronounced in the Taylor rule when oil prices are added to the estimated equation. In general, policy smoothing behavior is strong in the estimated rules. This is common in the empirical estimations of policy rules, especially when using higher-frequency monthly data (see, for example, Clarida et al., 1998, Mehrotra and Sánchez-Fung, 2011, Vdovichenko and Voronina, 2006, as well as Esanov et al., 2005).

4.2 Time-varying policy reactions

In this section, the behavior of monetary policy reaction is allowed to vary over time. To this aim, the monetary policy rules (equations 1 and 2) are estimated in a rolling window. We select an eight-year rolling window (96 observations)[11] and use data starting from January 2002. The estimation window is moved one observation forward at each step, and the policy reactions parameters are re-estimated. Proceeding this way, the policy reactions are estimated for 73 subsamples. Hodrick-Prescott filtering is performed at each step prior to the estimation for time *t*, using data available until *t-1*, to ensure that the variables in the estimation do not depend on future releases of the data.

The Taylor rule rolling parameter estimates and their 90% confidence bounds are displayed in chart A1 in the annex. The confidence bounds are calculated based on the estimated standard errors computed using a Newey-West weighting matrix. The interest rate exhibits a statistically significant reaction to inflation deviation from the first subsample (January 2002–December 2009) to the subsample ending in February 2015. Reactions to the output gap are statistically significant for the entire estimation period, except during a short period at the beginning of the estimation sample. At end-2014, the Bank of Russia started to react very strongly to the output gap, and at the same time, reactions to inflation became less significant. Interest rate reactions to inflation remain insignificant until the end of our estimation sample, and the AR policy-smoothing parameter also shows values larger than one.

[11] The estimation window selection is subject to the tradeoff between estimation accuracy with a large enough sample size and the ability of the rolling estimates to detect policy changes occurring in the most recent data in a timely fashion. A seven-year (84 observations) and a nine-year (108 observations) window is also considered, and the results remain largely robust to the window selection.

One may of course interpret the strong reaction to the output gap as signifying that the Bank of Russia is reacting to the output gap, but eventually, the reaction will also have an effect on inflation via Phillips curve. During the turbulent times at end-2014 and in 2015, however, the Taylor rule does not seem to fit the Russian data as well as before end-2014.

McCallum time-varying estimates are depicted in chart A2. Base money does not seem to react to oil prices; therefore, chart A3 presents the time-varying parameters for the McCallum rule without oil prices. The McCallum rule fits the Russian data until the 2004–2011 sample. Reactions in base money to nominal output growth deviation are negative and statistically significant at the 10% level. Reactions to the exchange rate are also significant and positive, as is assumed in the literature. The time-varying estimation confirms our earlier finding. After around 2012, the McCallum rule performs very poorly in describing Russian monetary policy.

To illustrate the difference between the Bank of Russia's inflation and output objectives, chart 3 shows the Taylor rule time-varying long run responses.[12] The chart presents long-run parameters only for the subperiods they are statistically significantly different from zero. In addition, it omits the most recent periods during which the Taylor rule does not describe monetary policy in Russia well and during which the value of the policy-smoothing AR parameter in the rolling Taylor rule estimation is equal to or above one. The long-run estimated coefficients for inflation are not very far from 1.5, the value Taylor (1993) selected to describe U.S. monetary policy from the late 1980s to the early 1990s. In 2010–2014, the long-run inflation coefficient is larger than one, thus fulfilling the "Taylor principle." The Bank of Russia's interest rate policy seems to place a relatively large weight on output stabilization, however, as the long-run output gap reaction parameter is higher than the 0.5 suggested by Taylor (1993). Interestingly, chart 3 indicates a change in the tradeoff between the two policy objectives. Prior to 2014, monetary policy was more concerned with price stability, but since then, output growth stability has become relatively more important.

The long-run policy response to nominal output in the McCallum rule without oil prices is displayed in chart 4. Again, the response coefficient is depicted only for the subperiods in which the short-run parameter is statistically significant (parameter ρ is always significant). Quantitatively, the strength of the policy response is stronger than the value of 0.5 suggested by McCallum (2000) for the growth-type policy rules.

[12] The long-run response parameters are calculated as $\beta^{LR} = \frac{\beta}{1-\rho}$, where β is the estimated short-run reaction and ρ is the estimated policy smoothing parameter.

Chart 3 Taylor rule long-run responses over time

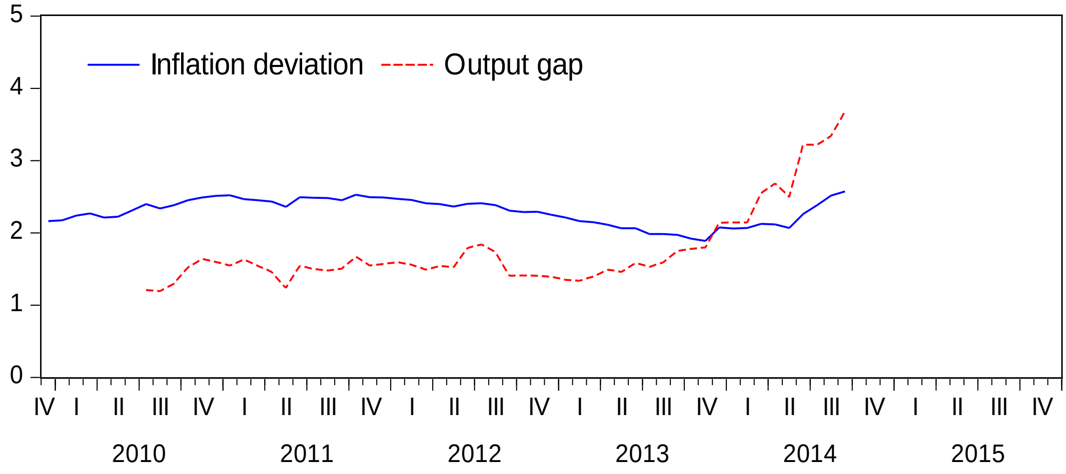
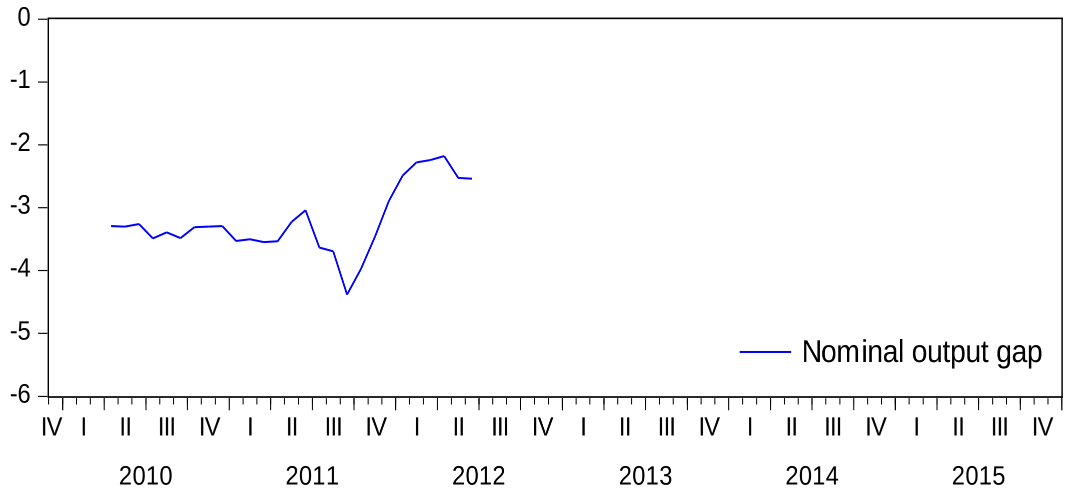


Chart 4 McCallum rule long-run response over time



5 Concluding remarks

We have estimated different monetary policy rules for Russia for the period 2003–2015. As no recent papers have undertaken a similar exercise, our contribution is able to illustrate the challenges Russian policymakers faced during both calm and very turbulent periods. We can see that the traditional Taylor rule seems to describe monetary policy in Russia reasonably well, even though the Bank of Russia has moved to full-fledged inflation targeting only recently. Even if exchange rate stability has also been important, the Bank of Russia has stabilized inflation in a manner consistent with the experience of many other central banks in the world. Moreover, monetary authorities have clearly also tried to dampen output fluctuations, and the weight of the output gap in the central bank's objective function seems to have increased during the very turbulent period of 2014 and 2015. For this reason, central bank interest rate policy seems to have stopped reacting statistically significantly to inflation in 2015, so that the traditional Taylor rule does not provide as good a description of Russian monetary policy as prior to 2015.

It is noteworthy that earlier papers on Russia's monetary policy rules emphasized the role of monetary aggregates. The low level of development in Russia's financial markets was often cited as the reason for this monetary policy choice. Our results with more recent data suggest that Russian monetary policy has changed, and the observed move toward inflation targeting also tells us that Russia's financial markets have become more mature.

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Annex

Chart A1 Rolling Taylor rule parameter estimates

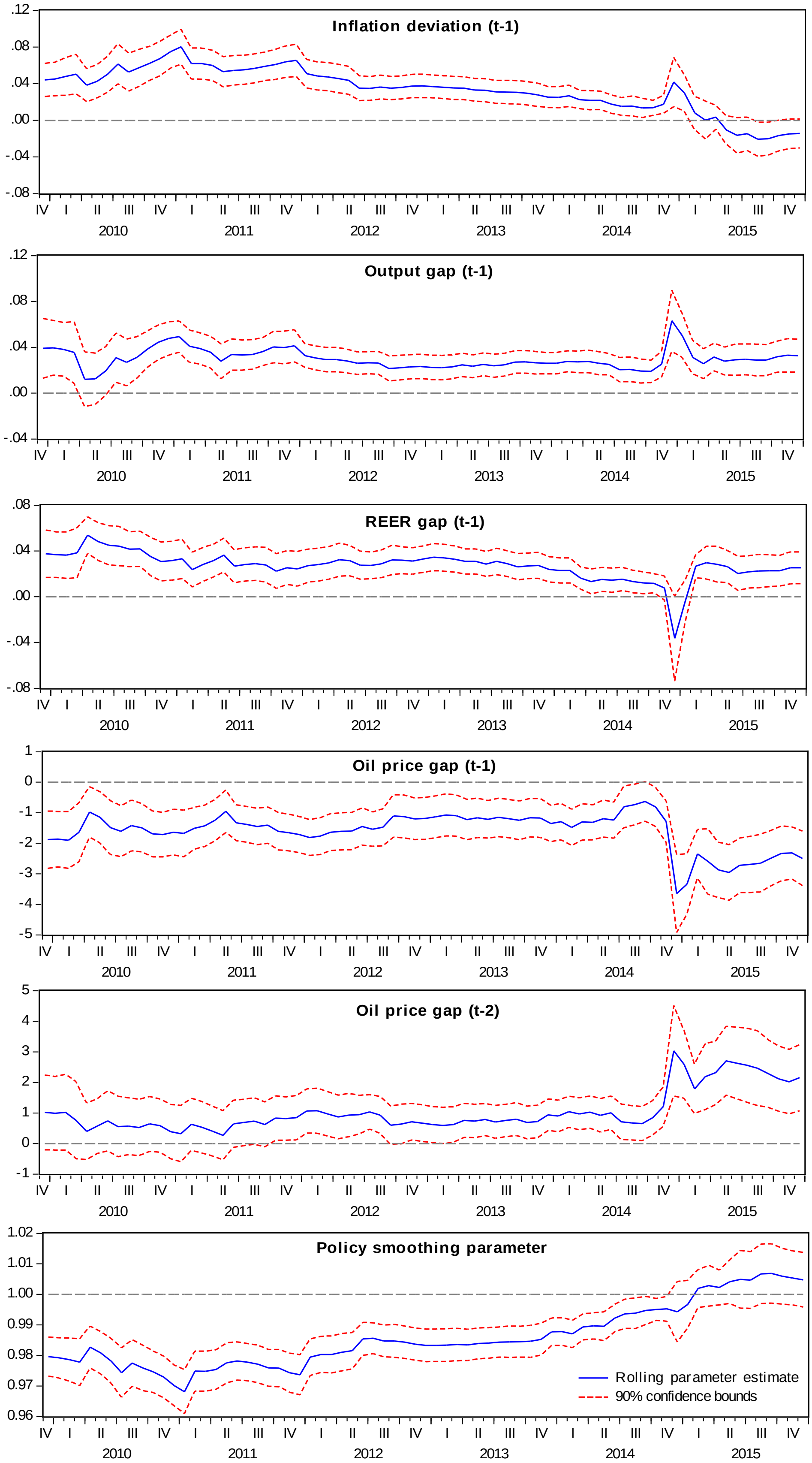

Chart A2 Rolling McCallum rule parameter estimates

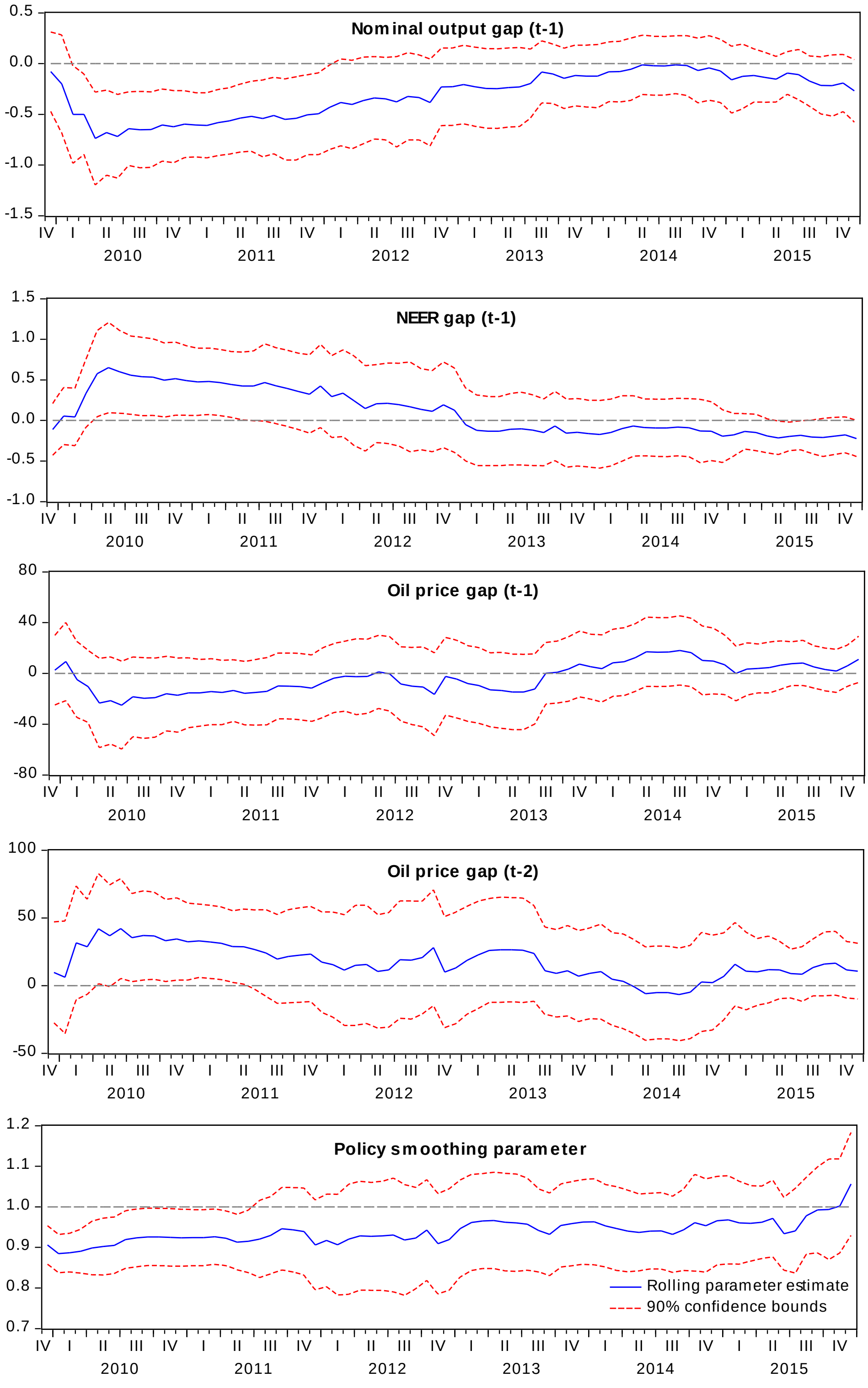

Chart A3 Rolling McCallum rule parameter estimates without oil prices

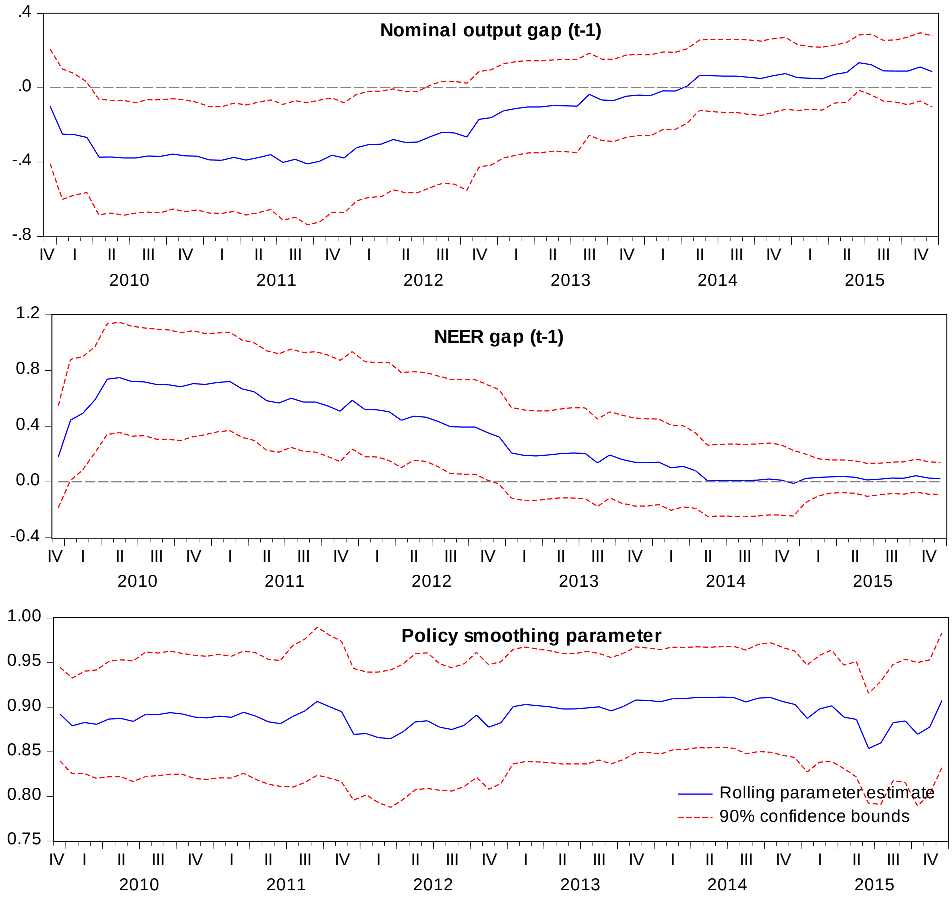

Table A1 Variables

Variable	Measure	Source[a]	Availability
Interest rate			
Refinancing rate	% pa (end of period)	*CBR*	01/2000–11/2015
Central Bank Policy Rate	% pa (end of period)	*CBR*	02/2011–12/2015
Monetary aggregate			
Monetary base growth	y-o-y change (%) in RUB monetary base (broad def.)	*CBR*	12/2002–12/2015
Inflation			
Consumer price inflation deviation	CPI y-o-y inflation (%), less the average of the annual target range for CPI inflation[c]	*FSSS, CBR*	01/2000–11/2015
Output gap			
Real GDP growth gap	Real y-o-y GDP growth (estimate), less HP-trend[b]	*EM*	01/2001–11/2015
Nominal GDP growth gap	y-o-y change (%) in GDP in RUB, less HP-trend[b]	*MF*	01/2000–11/2015
Exchange gap			
Real effective exchange rate gap	REER index (2010=100), less HP-trend[b]	*BIS*	01/2000–11/2015
Nominal effective exchange rate gap	NEER index (2010=100), less HP-trend[b]	*BIS*	01/2000–11/2015
Oil gap			
Crude oil price gap	Urals oil price in USD, monthly average (index 2010=1.00), less HP-trend[b]	*OPEC*	01/2000–11/2015

[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] Hodrick-Prescott filter applied to data series starting from 01/1999, when data available. Smoothing parameter λ=14 400.
[c] 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.

Table A2 Descriptive statistics

Variable	Obs.	Mean	Min	Max	Std.dev.	Skew.	Kurt.	ADF *t*-stat.[a]	KPSS *LM*-stat.[b]
Interest rate									
Reference policy rate	167	12.04	7.75	25.00	4.17	1.30	4.22	–3.288**	0.288***
Monetary aggregates									
Base money growth	156	17.78	–13.45	54.77	15.28	0.14	2.16	–2.028**	0.044
Inflation									
CPI inflation deviation	167	3.28	–1.93	12.42	3.12	1.15	3.83	–1.095	0.125
Output									
Real GDP growth gap	167	–0.02	–12.22	5.47	3.13	–1.83	7.52	–2.939***	0.035
Nom. GDP growth gap	167	–0.22	–36.90	35.77	7.80	–0.45	8.35	–4.900***	0.043
Exchange rate									
REER gap	167	–0.09	–20.32	9.93	4.29	–1.25	7.18	–7.897***	0.058
NEER gap	167	–0.21	–18.32	9.08	4.70	–1.07	4.95	–6.609***	0.083
Oil price									
Oil price gap	167	–0.00	–0.37	0.53	0.13	0.68	6.68	–4.589***	0.035

Data for 01/2002–11/2015. [a] The table presents the Augmented Dickey-Fuller unit root test statistic with a maximum of 13 lags. Intercept is included in the test equation if it is statistically significant. [b] The Kwiatkowski-Phillips-Schmidt-Shin Lagrange Multiplier test statistic evaluates the null-hypothesis that the series is stationary. Trend term is included in the test equation if it is statistically significant. ***1%, **5% and *10% level of significance.

Chart A4 Data used in the policy rule analysis

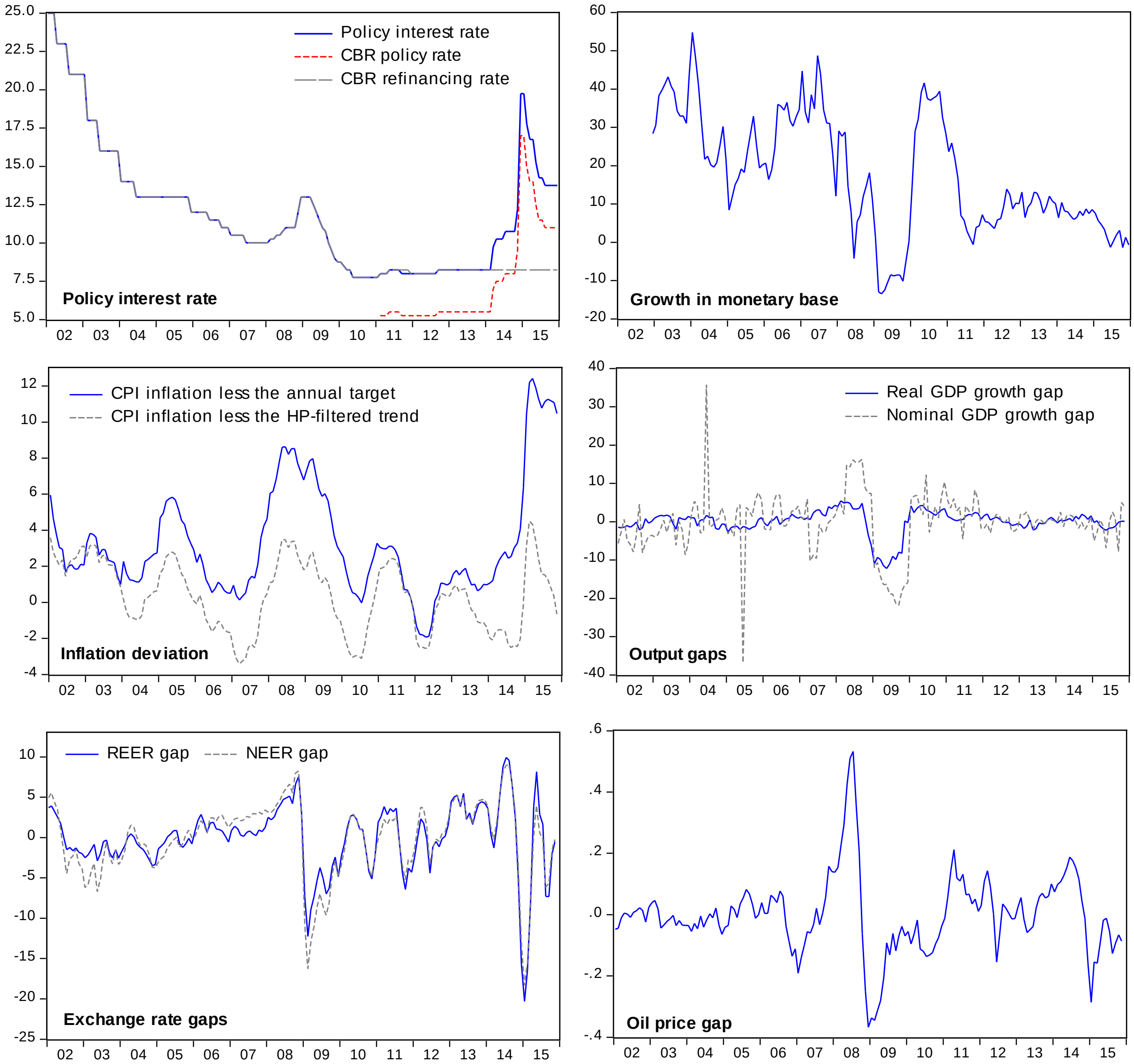

Table A3 Correlations between the variables (individual samples, 01/2002–11/2015)

Correlation [t-stat.]	i_t	Δbm_t	$(\pi-\pi^*)_t$	$\Delta\hat{y}_t$	$\Delta\hat{x}_t$	$\widehat{reer}_t$	$\widehat{neer}_t$	$\widehat{oil}_t$	i_{t-1}	Δbm_{t-1}	$(\pi-\pi^*)_{t-1}$	$\Delta\hat{y}_{t-1}$	$\Delta\hat{x}_{t-1}$	$\widehat{reer}_{t-1}$	$\widehat{neer}_{t-1}$	$\widehat{oil}_{t-1}$
i_t	1.00 []								0.97*** [47.42]	0.18** [2.23]	0.46*** [6.49]	-0.15* [-1.93]	-0.10 [-1.26]	-0.37*** [-4.85]	-0.43*** [-5.82]	-0.19** [-2.45]
Δbm_t	0.18** [2.27]	1.00 []							0.19** [2.39]	0.94*** [33.49]	-0.42*** [-5.69]	0.52*** [7.45]	0.21***. [2.71]	0.13 [1.63]	0.18** [2.25]	-0.02 [-0.23]
$(\pi-\pi^*)_t$	0.47*** [6.66]	-0.40*** [-5.38]	1.00 []						0.49*** [6.97]	-0.37*** [-4.85]	0.98*** [57.98]	-0.23*** [-2.92]	-0.04 [-0.52]	-0.27*** [-3.48]	-0.33*** [-4.26]	-0.06 [-0.70]
$\Delta\hat{y}_t$	-0.17** [-2.20]	0.50*** [7.18]	-0.27*** [-3.51]	1.00 []					-0.20** [-2.47]	0.46*** [6.43]	-0.32*** [-4.11]	0.90*** [26.27]	0.45*** [6.18]	0.30*** [3.93]	0.45*** [6.32]	0.55*** [8.19]
$\Delta\hat{x}_t$	-0.13 [-1.64]	0.25*** [3.23]	-0.05 [-0.61]	0.59*** [9.08]	1.00 []				-0.15* [-1.83]	0.26*** [3.36]	-0.06 [-0.76]	0.64*** [10.18]	0.51*** [7.33]	0.32*** [4.23]	0.42*** [5.78]	0.47*** [6.59]
$\widehat{reer}_t$	-0.39*** [-5.22]	0.14* [1.73]	-0.23*** [-2.91]	0.33*** [4.36]	0.34*** [4.49]	1.00 []			-0.36*** [-4.77]	0.14* [1.71]	-0.16** [-2.05]	0.36*** [4.80]	0.31*** [4.10]	0.82*** [17.65]	0.77*** [15.13]	0.55*** [8.06]
$\widehat{neer}_t$	-0.47*** [-6.52]	0.19** [2.36]	-0.31*** [-4.01]	0.49*** [6.92]	0.43*** [5.93]	0.95*** [36.10]	1.00 []		-0.46*** [-6.36]	0.19** [2.40]	-0.26*** [-3.40]	0.51*** [7.36]	0.39*** [5.29]	0.82*** [17.58]	0.87*** [21.36]	0.62*** [9.66]
$\widehat{oil}_t$	-0.22*** [-2.84]	-0.03 [-0.35]	-0.06 [-0.75]	0.52*** [7.50]	0.38*** [5.08]	0.55*** [8.07]	0.58*** [8.82]	1.00 []	-0.23*** [-2.93]	-0.02 [-0.31]	-0.06 [-0.69]	0.46*** [6.45]	0.30*** [3.89]	0.46*** [6.34]	0.47*** [6.61]	0.90*** [25.40]

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