We estimate several monetary policy rules for Russia for the period 2004–2017. We find that traditional Taylor rule is reasonably good description of the conduct of monetary policy in Russia, both when coefficients are restricted to be the same over the sample period and when they are allowed to change. We find that Bank of Russia has often overshot its inflation target, and large overshootings are associated with large depreciations of the rouble, which testifies to the importance of exchange rate in conduct of monetary policy in Russia.

Key words: monetary policy rule; Taylor rule; McCallum rule; Russia; inflation.

JEL E31, E43, E52, P33

1. Introduction and motivation

In this paper we estimate several standard 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 an area where we make our contribution. As one of the G20 countries, Russia is one of the largest emerging markets, and its financial markets are relatively advanced. Moreover, Russia remains to a large extent dependent on exports of hydrocarbons, as approximately two thirds of its export revenue comes 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. This paper is an extension of Korhonen and Nuutilainen (2016) with longer dataset, and we see that our main results remain the same.

Using data from 2004 to 2017 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 care about stability of both inflation and output gap and respond to these with interest rate. However, results are somewhat sensitive to whether exchange rate or both exchange rate and oil price are included in the empirical specification. On the other hand, McCallum rule does not seem to fit the data very well. This is in contrast to some earlier studies on the topic, indicating a change in the conduct of monetary policy in Russia.

We must also highlight the role of exchange rate and 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 conduct of monetary policy in Russia during our sample period as well as 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 2004 to 2017. During this time the Bank of Russia has had several goals for its policy, although the whole period has been marked by a gradual shift towards more full-fledged inflation targeting, which was officially introduced from the beginning of 2015. At the same time, exchange rate stability has been explicitly mentioned as one of the key targets for the central bank for almost the whole sample period, and exchange rate target was only given up in November 2014, although the Bank of Russia 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 (consisting of the US dollar and the euro, reflecting both Russia’s foreign trade orientation and the dollar’s traditionally large role in the Russian econo-
my). Moreover, the targeted exchange rate was also allowed to change to reflect underlying market pressures, especially after 2008.

The CBR 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 to the gradual move towards inflation targeting in Russia.

Figure 1 shows inflation targets (or target ranges) of Bank of Russia as well as the realized inflation from 2003 to 2015. (It should be noted that especially during earlier periods it was sometimes difficult to discern inflation targets from inflation 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 has overshot inflation targets on several occasions, and that the largest deviations from inflation target have happened in the aftermath of large currency depreciations, for example in 2008 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. Moreover, the official role of exchange rate basket also speaks for the importance of it.

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. (2006) estimate several monetary policy rules for Russia for the period starting in 1993 or 1994 and ending in 2002. For large part of this data sample Russia had a fixed exchange rate target. The authors find that McCallum rule with monetary base fits the data best. In their estimation the US dollar exchange rate is also used as a control variable. 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 rouble was officially pegged to the US 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. Also they find that McCallum rule with monetary base seems to reflect the underlying data reasonably well, but only when exchange rate is included as well.

Drobyshshevskiy 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 McCallum rule for Russia.

As was noted before, Korhonen and Nuutilainen (2016) estimate similar monetary policy rules for Russia for period 2003–2015, and conclude that augmented Taylor rule provides a reasonably good approximation to 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 the rule during crisis and non-crisis periods in 2003–2015. They show that the estimated Taylor rule does not work during the crisis period and augment the rule to also include a financial stress indicator.

One can also note that a somewhat stable link between monetary aggregates and other economic variables, i.e. money demand function, is needed for McCallum rule to be a viable strategy for a central bank to follow. For Russia e.g. Korhonen and Mehrtra (2010) find such a stable money demand function, but again 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 behaviour in 2004–2017. We utilise the literature on monetary policy rules to formulate the reaction functions. To be able to timely capture 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 Appendix.

The estimated interest rate rule is a version of the famous Taylor (1993) rule, where the central bank reacts to output gap and inflation deviation 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 exchange rate in Russia. It is reasonable to assume that the Bank of Russia takes oil prices directly into account when making monetary policy decisions. Therefore oil prices are added to the policy rule as one of the macroeconomic variables the central bank may directly react when setting its policy.

Taylor (1993, 2001) assumes that the central bank reacts to output deviations from a potential level of output. Determining the potential output in practice, however, is very difficult even for the developed countries with long time series available, not to mention emerging economies like Russia, where structural changes are present. Following Orphanides and Williams (2007), we estimate the so called ‘difference rule’ that considers changes in output growth from the long run trend growth. There is much less controversy in determining the trend growth rate rather than the potential output for an economy. Following the empirical literature, policy smoothing is added to the estimated rules to increase their empirical fit.

We estimate the Taylor interest rate rule of a form:

$$i_t = \alpha_0 + \alpha_1(\pi - \pi^*)_{t-1} + \alpha_2\Delta Y_{t-1} + \alpha_3\Delta\pi_{t-1} + \alpha_4\Delta\pi_{t-2} + \alpha_5\Delta\pi_{t-3} + \epsilon_t,$$

(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 \(i\) from February 2011 onwards, when the central bank adopts this instrument and starts to publish the data. Prior to that refinancing rate is selected as the policy interest rate. Inflation deviation term \((\pi - \pi^*)_{t-1}\) is determined as the y-o-y growth in consumer prices over the annual CPI growth target determined by the central bank for the year. 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. In some occasions Bank of Russia has changed the target towards the end of the year.

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1 Majority of the empirical studies include policy smoothing in the estimated policy rules. Examples of these include Clarida, Gali and Gertler (1998), who estimate such a 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.

2 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 policy rate.

3 For a robustness check, also a HP-filtered inflation deviation series is considered. There is not much difference between using the official inflation target or the HP-filtering to determine the trend inflation rate, however.
if it has become obvious that original target can’t be reached. We do not take these changes into account.

Output growth deviation \( \Delta y_{t-1} \) is calculated by removing the Hodrick-Prescott filtered trend from the estimated monthly GDP y-o-y growth series published by the Economy Ministry.1 Similarly, the exchange rate deviation \( \text{reER}_{t-1} \) and oil price deviation \( \text{oil}_{t-1} \) are calculated by removing the HP-trend from the real effective exchange rate (REER) index, and the index for Urals oil prices, respectively. In Eq. (1) \( \alpha_i \) is a constant term and \( \varepsilon \) stands for the estimation error. Parameters \( \alpha_i \) to \( \alpha_5 \) are the estimated policy reaction coefficients and \( \alpha_5 \) 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 \( \alpha_4 > 0 \).

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 the central bank has a full control over. 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:

\[
\Delta bm_t = \beta_0 + \beta_1 \Delta x_{t-1} + \beta_2 \text{reER}_{t-1} + \beta_3 \text{oil}_{t-1} + \\
+ \beta_4 \text{oil}_{t-2} + \beta_5 \Delta bm_{t-1} + \varepsilon_t.
\]

(2)

The nominal base money growth \( \Delta bm \) is the y-o-y change in M0 money aggregate. Fortunately, the Ministry of Finance in Russia publishes a monthly estimate for the GDP in rubles.2 We use this series to calculate the y-o-y nominal GDP growth rate and use the HP-filter to get the nominal output growth deviation \( \Delta x \). The exchange rate gap and oil price gap are calculated similarly to (1), but here the nominal effective exchange rate (NEER) index is used. Again, \( \beta_i \) is a constant term, \( \beta_1 - \beta_3 \) measure the strength of policy reactions in base money supply to the macroeconomic variables and \( \beta_5 \) measures policy inertia. Error term \( \varepsilon_t \) captures elements of random behavior that might be present at time \( t \) and potential omitted variables and specification errors. Increases in the base money supply indicate policy easing. Therefore the signs in countercyclical policy reaction are the opposite from the Taylor rule: \( \beta_1 < 0, \beta_2 > 0 \) and \( \beta_4, \beta_5 > 0 \). To be able to adequately account for the policy reactions to oil prices, also the second lag of the oil price deviation need to be added to the policy rules.3

The estimated policy rules are formulated to retain rules’ operationality. Policy is assumed to react to the macroeconomic variables prevailed in the previous period and thus are available at time \( t \). Another possibility would be to allow the central bank take into account expectations about the 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 & Haldane 1999, Levin et al. 2003, and Rudebusch & Svensson 1999). Traditionally, however, 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 on expectation formation. Earlier literature for Russia (Esanov et al. 2006, Vdovichenko & Voronina 2006, and Drobyshhevsky et al. 2008) adopts this approach and is also the one we follow here.

Figure A4 in the Appendix depicts the data series used in the empirical estimations. All the variables used in the estimations can be considered to be stationary in levels.4

### 4. Estimation results

The policy reaction functions are empirically estimated using the general methods of moments (GMM) estimator. The use of 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 from January 2003 until April 2017. The McCallum rule is estimated using data from May 2003.5 The Taylor rule is estimated from 2004 onwards. Prior to 2004 the Taylor rule residuals are not well behaved and suffer from non-normality and autocorrelation. As robustness check, the policy reactions are also estimated for a more recent time period starting from 2007, during a time period 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 as well as Vdovichenko and Voronina, 2006) does not take into account the 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.

The estimated policy reactions of the Taylor rule (Eq. 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. There is little differ-

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1 The Hodrick-Prescott filtering is a standard method for removing trend and calculating the output gap. It, however, has an obvious shortcoming of unreliability at the beginning and end of the data sample. In calculating the de-trended series we have used data starting in 01/1999, when 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 November 2015, and results were almost identical. This gives us confidence that our results do not depend on the very last observations.

2 The monthly GDP estimate can deviate few percentage points from the final rouble GDP value by Rosstat in annual terms. The monthly estimate by the Ministry of Finance, however, is available for the central bank for its policy decisions much sooner than the Rosstat’s official quarterly GDP.

3 We assume that monetary policy reacts only to deviations of output growth as well as exchange rate and oil prices from a long-run trend level. Following the earlier literature, the HP-filtering of the variables is done for the full sample. The disadvantage of the method is that, in practice, the estimated rule may not be fully operational. However, the HP-filtered trend values of the variables remain close to constant, so we can assume that the CBR assumption of the trend or target values of the variables made at the time of monetary policy decisions do not deviate much from our trend level. The HP filtering results are available from the authors.

4 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. Also 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 5% level of significance in the basis of both the ADF and the KPSS tests. These results are available from the authors upon request.

5 Data availability partly limits the selection of the estimation period, as the base money aggregate is available from 2003 onwards.
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 exchange rate and oil prices are harder to interpret, as these two variables are largely interrelated. The instrument lags selection is based on the autocorrelation behavior of the dependent variable. Standard errors and covariances are computed using Newey-West weighting matrix.

Estimated McCallum rule policy reactions are presented in Table 2. In this specification, Russian monetary policy reacts only to oil prices. Coefficient on nominal output growth deviation is not statistically significant, unlike in Korhonen and Nuutilainen (2016). Therefore the McCallum rule does not describe the Bank of Russia policy during the decade and a half.

Oil prices are important among the variables the Bank of Russia considers in making its policy decisions. Policy rules accounting for oil prices perform better than the ones that do not in terms of the strength and significance of the estimated policy reactions to output growth and inflation deviations. In general, policy smoothing behavior is strong in the estimated rules. This is common in the empirical estimations of policy rules, especially when using a higher frequency monthly data (see, for example, Clarida et al. 1998, Mehrata and Sánchez-Fung 2011, Vdovichenko and Voronina 2006 as well as Esanov et al. 2005).

5. Concluding remarks
We have estimated different monetary policy rules for Russia for the period 2004–2017. As there are no recent papers undertaking similar exercise, our contribution illustrates the challenges faced by the Russian policy-makers during both calm and very turbulent periods. We can see that traditional Taylor rule seems to describe monetary policy in Russia reasonably well, even if 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 experience of many other central banks in the world. Moreover, monetary authorities have clearly also tried to dampen output fluctuations. It is noteworthy that earlier papers on Russia’s monetary policy rules emphasized the role of monetary aggregates. Low level of development in Russia’s financial markets was often cited as the reason for this. Our results with more recent data suggest that Russian monetary policy has changed, and the observed move towards inflation-targeting tells us also that Russia’s financial markets have become more mature.
References / Список литературы

Appendix

Table A1. Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measure</th>
<th>Source*</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interest rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refinancing rate</td>
<td>% (end of period)</td>
<td>CBR</td>
<td>01/2000–11/2015</td>
</tr>
<tr>
<td>Central Bank Policy Rate</td>
<td>% (end of period)</td>
<td>CBR</td>
<td>02/2011–04/2017</td>
</tr>
<tr>
<td><strong>Monetary aggregate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monetary base growth</td>
<td>y-o-y change (%) in RUB monetary base (broad def.)</td>
<td>CBR</td>
<td>12/2002–04/2017</td>
</tr>
<tr>
<td><strong>Inflation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer price inflation deviation</td>
<td>CPI y-o-y inflation (%), less the average of the annual target range for CPI inflation</td>
<td>FSSS, CBR</td>
<td>01/2000–04/2017</td>
</tr>
<tr>
<td><strong>Output gap</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real GDP growth gap</td>
<td>Real y-o-y GDP growth (estimate), less HP-trend*</td>
<td>EM</td>
<td>01/2001–04/2017</td>
</tr>
<tr>
<td>Nominal GDP growth gap</td>
<td>y-o-y change (%) in GDP in RUB, less HP-trend*</td>
<td>MF</td>
<td>01/2000–04/2017</td>
</tr>
<tr>
<td><strong>Exchange gap</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real effective exchange rate gap</td>
<td>REER index (2010=100), less HP-trend*</td>
<td>BIS</td>
<td>01/2000–04/2017</td>
</tr>
<tr>
<td>Nominal effective exchange rate gap</td>
<td>NEER index (2010=100), less HP-trend*</td>
<td>BIS</td>
<td>01/2000–04/2017</td>
</tr>
<tr>
<td><strong>Oil gap</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude oil price gap</td>
<td>Urals oil price in USD, monthly average (index 2010=1.00), less HP-trend*</td>
<td>OPEC</td>
<td>01/2000–04/2017</td>
</tr>
</tbody>
</table>

* Hodrick-Prescott filter applied to data series starting from 01/1999, when data available. Smoothing parameter λ.
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.

Figure A1. Data used in policy rule analysis