BOFIT Discussion Papers
19 • 2017

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Should one follow movements in the oil price or in money supply? Forecasting quarterly GDP growth in Russia with higher-frequency indicators

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BOFIT Discussion Papers
Editor-in-Chief Zuzana Fungáčová

BOFIT Discussion Papers 19/2017
30.11.2017

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ISBN 978-952-323-200-6, online
ISSN 1456-5889, online

Suomen Pankki
Helsinki 2017

Contents

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Abstract

GDP forecasters face tough choices over which leading indicators to follow and which forecasting models to use. To help resolve these issues, we examine a range of monthly indicators to forecast quarterly GDP growth in a major emerging economy, Russia. Numerous useful indicators are identified and forecast pooling of three model classes (bridge models, MIDAS models and unrestricted mixed-frequency models) are shown to outperform simple benchmark models. We further separately examine forecast accuracy of each of the three model classes. Our results show that differences in performance of model classes are generally small, but for the period covering the Great Recession unrestricted mixed-frequency models and MIDAS models clearly outperform bridge models. Notably, the sets of top-performing indicators differ for our two subsample observation periods (2008Q1–2011Q4 and 2012Q1–2016Q4). The best indicators in the first period are traditional real-sector variables, while those in the second period consist largely of monetary, banking sector and financial market variables. This finding supports the notion that highly volatile periods of recession and subsequent recovery are driven by forces other than those that prevail in more normal times. The results further suggest that the driving forces of the Russian economy have changed since the global financial crisis.

JEL classifications: C53, E27

Keywords: Forecasting, mixed frequency data, Russia, GDP growth

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1 Introduction

Analysts and policymakers today commonly rely on nowcasts of quarterly GDP growth to understand the state of the economy before official GDP figures become available. Official GDP figures are typically only available at quarterly frequency and come with a considerable publication lag. Many other economic indicators, of course, are available sooner and at higher frequency (e.g. series on monthly industrial output), but this creates a new challenge of producing reliable estimates for GDP in the current and upcoming quarter with this fresher data. This paper presents a pseudo real-time forecast and nowcast exercise for quarterly Russian GDP growth over the subsample periods 2008-2011 and 2012-2016 using competing mixed-frequency forecasting models (bridge equations, mixed data sampling (MIDAS) models and unrestricted mixed-frequency models), a set of 247 monthly indicators and forecast pooling techniques.

Russia is the sixth largest economy in the world in terms of total GDP based on purchasing power parity exchange rates, yet there exists surprisingly little work on forecasting Russian GDP growth. Rautava (2013) employs a small structural error-correction macro model built for forecasting purposes and finds that the sharp contraction in Russian output in 2009 can be explained by oil prices and excess uncertainty. Porshakov et al. (2016) use the dynamic factor model framework developed by Gianonne et al. (2008) and a set of 116 indicators to short-term forecast and nowcast quarterly Russian GDP growth for the period 2012–2014. They find the model generally outperforms simple benchmark models in terms of predictive accuracy and that new statistical releases of monthly indicators tend to consistently improve the predictive accuracy at least for the nowcast horizon.[1] Departing from a forecast focus, Benedictow et al. (2013) study the Russian economy with a macroeconometric model and find that the oil price is quite important in shaping economic development in Russia in both the short and long run.

Forecasting studies typically struggle to beat a simple benchmark model (usually an autoregressive model or the in-sample mean). However, we identify a fairly large number of monthly indicators that significantly improve upon the benchmark in most evaluation periods. If nothing else, our results flag a number of indicators Russia-watchers might want to consider in forecasting and nowcasting Russian GDP growth.

As recent nowcasting literature suggests strong differences across European countries in predictability of GDP growth during and after the Great Recession (see e.g. Schumacher, 2016), we split our evaluation sample into two subsamples. The high volatility period of 2008Q1–2011Q4

[1] Porshakov et al. (2016) is published in Russian, but a working version of the paper is also available in English. Our literature review as a rule only deals with papers published in English.

covers the Great Recession and the subsequent recovery. The downward trend period of 2012Q1–2016Q4 brackets the transition to lower growth rates and the 2015 recession. Not surprisingly, we find that GDP growth was more difficult to predict across all indicators during the 2008–2011 period than during the 2012–2016 period relative to simple benchmark forecasts. We nevertheless identify certain indicators with high predictive power during the 2008–2011 period. Further, we observe that the best-performing indicators are distinctly different in each period. The best indicators in the 2008–2011 period include traditional real-sector variables, while in the 2012–2016 period the best indicators are mostly monetary, banking sector and financial markets variables.

We also find the differences in forecast performance of our three model classes (bridge, MIDAS and unrestricted mixed-frequency) are generally marginal. During the Great Recession, however, the unrestricted mixed-frequency models and MIDAS models fare considerably better than bridge models. Taken together, these findings support the view that the growth drivers of the Russian economy have changed since the Great Recession (see Rautava, 2013).

The next section provides a comparison between the three forecasting model classes. Section 3 describes the data used in the empirical exercise. Section 4 outlines the design of our forecast exercise. Section 5 summarizes the empirical findings and Section 6 concludes.

2 Mixed frequency forecasting models

The paper considers three model classes for forecasting with mixed-frequency data: bridge equations, mixed data sampling (MIDAS) models and unrestricted mixed-frequency models.[2]

Bridge equations are popular in policy institutions such as central banks. They are easy to implement and transparent. Literature applications include Ingenito and Trehan (1996), Baffigi et al. (2004), Golinelli and Parigi (2007), Diron (2008), Hahn and Skudelny (2008), Rünstler et al. (2009), Bulligan et al. (2010), Angelini et al. (2011), Camacho et al. (2013), Foroni and Marcellino (2014), Schumacher (2014) and Bulligan et al. (2015). This paper employs the classical bridge equations procedure as outlined in Schumacher (2016).

To briefly summarize the three-step procedure: First, a high-frequency (monthly or daily) indicator is forecasted using a simple iterated autoregressive (AR) model. Next, the high-frequency indicator is aggregated to a lower (quarterly) frequency. Following Chow and Lin (1971) and Stock and Watson (2002), the form of the time-aggregation function is determined by the stock or flow

[2] See, e.g., Foroni and Marcellino (2013) for a survey on econometric methods for forecasting with mixed-frequency data.

nature of the indicator and whether it comes in levels or growth rates. Finally, quarterly GDP growth is forecasted using the time-aggregated indicator and lagged GDP growth. As an alternative, quarterly GDP growth is forecasted using the time-aggregated indicator only, omitting lagged values of GDP growth.

Mixed data sampling (MIDAS) was developed by Eric Ghysels and his co-authors (e.g. Ghysels et al., 2007, Andreou et al., 2010, Andreou et al., 2011). Applications include Clements and Galvão (2008, 2009), Armesto et al. (2010), Kuzin et al. (2013), Drechsel and Scheufele (2012), Andreou et al. (2013), Duarte (2014) and Ferrara et al. (2014). MIDAS forecasts a low-frequency variable using a possibly large number of (lagged) observations of a high-frequency indicator where the lag coefficients are modelled as a possibly very flexible non-linear distributed lag function. The distributed lag function itself depends only on a small number of parameters needing to be estimated.

MIDAS attempts to balance two goals which are usually in a trade-off position to each other. The first is model flexibility, that is, allowing the relative importance of any lagged observation compared to any other lagged observation to be determined by the data and not pre-determined by the model itself. The second goal is a parsimoniously parameterized model that prevents parameter proliferation or overfitting. This paper implements the basic univariate MIDAS model and the autoregressive univariate MIDAS model as described in Clements and Galvão (2009) with one important difference. The non-exponential Almon lag polynomial of order 1, 2, 3 or 4 is used instead of the exponential Almon lag polynomial. This is because our preliminary analysis established that use of the former polynomial led to higher forecast accuracy than use of the latter polynomial or alternative non-linear polynomial schemes.[3]

Foroni et al. (2014) propose *unrestricted mixed-frequency regressions*. They call their approach “unrestricted MIDAS” (U-MIDAS). U-MIDAS forecasts a low-frequency variable using (lagged) observations of a high-frequency indicator where the lag coefficients are left unrestricted and, hence, can be estimated by ordinary least squares (OLS). While extremely flexible, the U-MIDAS model is not parsimonious when the number of indicator lags is large. Thus, the advantages of U-MIDAS are only superior to alternative weighting schemes when the number of lags is sufficiently small (see the evaluation in Foroni et al., 2014). Here, we treat the U-MIDAS approach as a separate model class to compare its forecast performance with the performance of MIDAS and bridge equations. A basic univariate unrestricted mixed-frequency model and an autoregressive univariate unrestricted mixed-frequency model is implemented.

[3] See also Mikosch and Zhang (2014).

3 Data

We forecast the year-on-year growth rate of Russian real GDP as published by the Russian Federal State Statistics Service (Rosstat). The GDP data is released at a quarterly frequency with the flash preliminary estimate published around the 45 days after the end of the quarter. The first official GDP estimate is released with a lag of two and a half months. We use data from 1996Q1 onwards as the data from earlier years of Russia's economic transition are not fully comparable. The forecast evaluation period is 2008Q1–2016Q4.[4]

In collecting the indicators for forecasting quarterly GDP growth, we include all available data series and make no prior judgements as to the perceived economic significance of a particular indicator. Russian statistics have evolved considerably over the past decade, and many new data series are available from the early or mid-2000s. To ensure a sufficiently long period for parametrization of the forecasting models, we only include series that start in 2001 or earlier.

The final dataset includes 247 macroeconomic and financial variables that can be grouped into three broad categories: 1) macroeconomic indicators for production and incomes, 2) financial market and banking sector data and 3) survey-based sentiment indicators. While most variables are available at a monthly frequency, we also include a small number of indicators that come at daily frequency (stock indices and foreign exchange rates) or weekly frequency (consumer price indices). Following Porshakov et al. (2016), these variables are included in monthly averages.

We employ most variables in levels (if stationary) and in year-on-year growth rates. Some variables are published in year-on-year growth rates or month-on-month growth rates only and, hence, are employed in growth rates only. The full list of individual variables with descriptions is provided in the Appendix 1. The data are publicly available and provided mainly by Rosstat or the Central Bank of the Russian Federation (CBR).

Having a big dataset is essential when using a forecast pooling strategy as we do here. Forecast pooling is a way of finding an optimal aggregation over many indicators, each of which reflects only a small part of the economy.

The data is final and not a real-time dataset. Thus, the role of revisions is not addressed. This is due to the fact that no real-time data for the Russian economy is available for the period we analyse. However, another important feature of the data, namely availability of the data due to varying publication lags is taken into account. We carefully trace publication lags for all the variables

[44] Rosstat has two consistent GDP series: SNA 2008 for the years 2012 to 2017 and the older SNA 1995, which covers the years 1996 to 2011. We make what we believe is a realistic assumption that real growth rates of the headline GDP figure are consistent over the data.

to make sure only observations actually available at each forecast date are used in the forecasting exercise.

4 Design of the forecast exercise

Our focus is on evaluating the forecast performance of various indicators and different model classes in forecasting quarterly Russian GDP growth over several forecast horizons. Specifically, GDP growth of quarter t is forecasted at the end of each month from 6 months before the end of t (= "sixth monthly forecast horizon") up to and including the last month of t (= "first monthly forecast horizon"). The 6 forecast horizons (= 6 months) allow us to track the evolutions of forecast errors as new data are released over time.

To establish pseudo-real time analysis and deal with the "ragged edge" problem (Wallis, 1986), the release dates of the indicators are carefully tracked to ensure that only data that were actually available at the respective forecast date are employed as inputs. The first estimate of the quarterly Russian GDP growth is usually released six to eight weeks after the end of a quarter. Hence, the forecast at the end of the last month a quarter is still six to eight weeks ahead of the GDP release for the quarter.

We conduct a pseudo real-time experiment with rolling estimation and forecasting (e.g. Kuzin et al., 2013). The out-of-sample range covers the period 2008Q1-2016Q4.[5] In the empirical forecast exercise we split the out-of-sample range in two parts. The high volatility period 2008Q1-2011Q4 covers the Great Recession and the subsequent recovery. The downward trend period 2012Q1-2016Q4 includes the transition to lower growth rates and the 2015 recession. As mentioned in the introduction, the sample split permits to study the differential performance of indicators and models at different times. A rolling re-estimation and forecast procedure is applied separately for all the 6 forecast horizons (= 6 months), i.e. with each forecast step, the estimation sample is shifted forward by one quarter and all models are re-estimated with the data available at the respective forecast horizon. This procedure results in a series of forecasts and forecast errors for each forecast horizon.

We pool forecasts stemming from univariate bridge equations, MIDAS and unrestricted mixed-frequency models using a forecast combinations approach (e.g., Hendry and Clements, 2004, Stock and Watson, 2004, Banerjee et al., 2005, Banerjee and Marcellino, 2006, and Timmermann,

[5] Stock and Watson (2012) recommend the out-of-sample range covering 10-15% of the total sample. Given the short time series here, our out-of-sample range covers roughly 40% of total sample.

2006). For each of the aforementioned model classes, a multitude of different model specifications are employed that differ w.r.t. lag length, polynomial order and/or autoregressive structure (see Appendix 2).

Each model specification generates a separate forecast. To pool the forecast, a two-step forecast combinations approach is adopted. First, forecasts stemming from all alternative specifications are pooled for each indicator, each model class and each forecast horizon separately. In the second step, the pooled forecasts stemming from all indicators are again pooled for each model class and each forecast horizon separately. Based on the two-step pooled forecasts, the forecast performance of the different model classes can be compared over all forecast horizons (see Section 5.4). As an alternative second step, the pooled forecasts stemming from all three model classes are pooled for each model class and each forecast horizon separately. This latter pooling is used when comparing the forecast performance of single indicators with each other at various forecast horizons (see Sections 5.1, 5.2 and 5.3). For building forecast combinations at either of the aforementioned pooling steps, the paper employs weighted averaging based on the mean square forecast error performance of the past four quarters as described in Kuzin et al. (2013) and Stock and Watson (2006).[6]

The root mean square forecast error (RMSFE) is employed for comparison of the forecasts with the GDP growth realizations. The result tables present RMSFEs relative to the RMSFE from a naive benchmark forecast, the rolling window in-sample mean of GDP growth. This benchmark has proved to be a strong competitor in earlier studies (e.g. Giannone et al., 2008). For means of robustness, the result tables also present comparisons with an alternative benchmark model, the AR model.[7]

[6] For each model specification, the rolling mean square forecast error (MSFE) is computed from the previous four forecasts for a particular forecast horizon. Each MSE is the divided by the sum of all MSE such that the MSE of all model specifications sum to one (normalization). Finally, the combination weight for each forecast is the inverse of the normalized MSE divided by the sum of all normalized inverted MSE.

[7] A multitude of AR model specifications are employed differing w.r.t. lag length and whether iterative or direct (see Appendix 2). The forecasts stemming from the alternative specifications are then pooled using the weighted averaging based on past forecast errors described above.

5 Empirical results

5.1 Performance of top-10 indicators

As a first step of the empirical analysis, we look for the best performing single indicators for forecasting Russian GDP growth in the two out-of-sample periods (2008–2011 and 2012–2016). Table 1 reports for each of the two evaluation periods the root mean squared forecast errors (RMSFEs) of the top-10 indicators relative to the RMSFE of the benchmark model (rolling window in-sample mean). Values smaller than one indicate performance better than the benchmark. Although GDP growth is forecasted at various monthly horizons as described in Section 4, we save space here by only reporting average RMSFEs for the nowcast horizon (= average RMSFEs over the first, the second and the third monthly horizon as described in Section 4) and average RMSFEs for the one-quarter-ahead forecast horizon (= average RMSFEs over the fourth, the fifth and the third sixth horizon as described in Section 4).[8]

A number of interesting observations emerge. First, many indicators easily beat our benchmark in forecasting quarterly GDP growth. For the nowcast horizon, a total of 153 variables in the 2008–2011 forecast period and 262 variables in the 2012–2016 forecast period have relative RMSFEs smaller than one. Second, the RMSFEs are clearly smaller in the latter forecast period, indicating that the single-indicator models have on average become better in nowcasting the Russian economy (or the Russian economy has become more predictable). This is not that surprising, given that the first period includes volatile times, i.e. a sudden drop in GDP in 2008Q4–2009Q4 and the rapid recovery thereafter.

A small number of indicators figure in the top-ten list consistently for both horizons (nowcast and one-quarter-ahead) and both forecast periods (2008–2011 and 2012–2016). These indicators are: the monthly key sectors economic output index published by Rosstat, the monthly composite leading indicator for Russia published by the OECD, as well as household banking deposits in Russian rubles and money supply M2, which are published by the CBR. These indicators are all released with a lag of less than a month, with the exception of the OECD leading indicator which is released with a lag of around six weeks.

The good forecast performance of these four indicators is hardly surprising. All rank among the most-watched macroeconomic indicators of the Russian economy (with the slight exception of household banking deposits). Still, two things are still noteworthy. First, Rosstat and the OECD seem to do a good job in tracking the Russian GDP on a monthly basis. Second, several indicators

[8] The separate RMSFEs for the monthly horizons are available on request.

typically followed by forecasters and analysts of the Russian business cycle, do not make it into the top-ten list. We explore the performance of these key variables further in Section 5.2.

A second striking observation is that, apart from the aforementioned four indicators, the set of best performing variables in the 2008–2011 forecast period differs markedly from the top-ten variables in the 2012–2016 forecast period. In the first period, the best indicators include very traditional real sector variables, namely industrial production, agricultural production, railway freight turnover, and ferrous metals freight turnover as well as price and survey variables related to real sector production, namely the producer price index for construction materials, the export price index for mineral fertilizers, and the diffusion index indicating enterprises with rising stocks published by the Institute of World Economy and International Relations. These indicators are published with a lag of less than one month, except for the price variables and the diffusion index which are with a lag of one and a half to two months.

Surprisingly, none of these indicators makes it to the set of best performing indicators in the latter period. In the 2012-2016 forecast period the best indicators include mostly monetary, banking sector and financial markets variables, namely money supply M0, the monetary base, foreign exchange reserves, the monthly average of the daily RTS stock market index, and the economic policy uncertainty index for Russia published by Baker, Bloom and Davis (2015). All these variables are available with a lag of less than one month.

The difference in the set of best performing indicators between the two forecast periods supports the notion that the factors supporting GDP growth in the volatile period of the Great Recession and in the subsequent period of declining growth rates differ from each other. This may partly reflect the fact that the causes of the economic crisis in 2009 were different in nature from those underlying the 2015 recession. Our findings for different sets of best-performing indicators in the two sub-periods gives further confirmation of what many researchers have noted as a structural change in the underlying dynamics of economic growth and the marked fall in potential growth rate after the Global Financial Crisis (see e.g. Rautava 2013).

Further, the swings in economic growth in 2008–2010 are often explained in terms of changes in oil prices and foreign exchange rates. These two variables, however, do not feature as particularly accurate predictors of GDP growth. The Urals crude oil price makes it into the top-ten only for the nowcast horizon of the 2012-2016 forecast period. The ruble foreign exchange rate never makes a particularly good forecast.

Table 1 Performance of top-ten monthly indicators for forecasting Russian quarterly GDP growth

Forecast period 2008–2011					
Nowcast horizon	Relative RMSFE	p value	One-quarter-ahead forecast horizon	Relative RMSFE	p value
Rosstat key sectors economic output index, yoy	0.35	0.02	OECD composite leading indicator, yoy	0.50	0.05
Railway freight turnover, yoy	0.38	0.08	Interbank loans, yoy	0.61	0.04
Producer price index for construction materials (cement), yoy	0.40	0.03	Producer price index for construction materials (cement), yoy	0.69	0.03
Industrial production, yoy	0.41	0.06	Money supply M2, yoy	0.72	0.07
OECD composite leading indicator, yoy	0.42	0.07	Rosstat key sectors economic output index, yoy	0.73	0.03
Manufacturing production, yoy	0.46	0.11	Export price index for mineral fertilizers, yoy	0.75	0.08
Household banking deposits, yoy	0.47	0.13	Industrial production, yoy	0.77	0.12
REB diffusion index: Enterprises with rising stocks over 1 month, yoy	0.47	0.09	Household banking deposits, yoy	0.77	0.10
Money supply M2, yoy	0.47	0.05	Household deposit rate for demand deposits in Russian rubles	0.79	0.18
Ferrous metals freight turnover, yoy	0.48	0.21	Agricultural production	0.79	0.04
Forecast period 2012-2016					
Nowcast horizon	Relative RMSFE	p value	One-quarter-ahead forecast horizon	Relative RMSFE	p value
Money supply M0 (cash), yoy	0.23	0.00	RTS stock market index, yoy	0.30	0.00
Rosstat key sectors economic output index, yoy	0.24	0.00	Money supply M0 (cash), yoy	0.33	0.00
RTS stock market index, yoy	0.25	0.02	Household banking deposits, yoy	0.34	0.01
Monetary base, level	0.27	0.01	Monetary base, level	0.36	0.00
CBR foreign exchange reserves, yoy	0.29	0.05	Money supply M2, yoy	0.36	0.03
Urals crude oil price in USD per barrel, yoy	0.29	0.07	Number of unemployed persons	0.40	0.02
Money supply M2, yoy	0.30	0.06	CBR foreign exchange reserves, yoy	0.41	0.05
Household banking deposits, yoy	0.30	0.07	Baker-Bloom-Davis economic policy uncertainty index, level	0.42	0.07
Baker-Bloom-Davis economic policy uncertainty index, level	0.31	0.10	OECD composite leading indicator, yoy	0.42	0.08
OECD composite leading indicator, yoy	0.31	0.11	Rosstat key sectors economic output index, yoy	0.46	0.02

Notes: All variables shown in the table are recorded at monthly frequency. The table reports RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). Forecast errors for each single indicator are pooled over all three model classes and all model class specifications as described in Section 4. The benchmark model and the forecast evaluation procedure are also described in Section 4. RMSFEs of the nowcast horizon = average RMSFEs over the first, the second and the third monthly horizon as described in Section 4. RMSFEs of the one-quarter-ahead horizon = average RMSFEs over the fourth, the fifth and the third sixth monthly horizon as described in Section 4 (= the first, the second and the third monthly horizon of the one-step ahead quarter). Improvements in forecast performance of the shown indicators over forecasts from the benchmark model turned out to be always statistically significant at conventional levels according to the Giacomini and White (2006) test of unconditional equal predictive ability. p values refer to the Giacomini-White test indicating whether improvements in forecast performance over forecasts from an alternative benchmark, the AR model class as specified in Section 4, is statistically significant. Abbreviations: CBR = Central Bank of the Russian Federation. REB = Russian Economic Barometer, compiled by the IMEMO Institute of the Russian Academy of Sciences, Moscow. Rosstat = Federal State Statistics Service.

Our observations point to noteworthy results. First, a large number of individual monthly indicators can apparently significantly improve on the benchmark forecast of Russian GDP growth. Second, contrary to the assumptions of many Russia-watchers, several indicators beat the crude oil price in nowcasting and short-term forecasting the Russian GDP growth.

5.2 Evolution of forecast accuracy of key macroeconomic variables

Besides the best performers, it may be worthwhile to take a closer look at some of the monthly indicators Russia-watchers typically track when assessing the current economic outlook. In particular, we ask how helpful such variables actually are in forecasting Russian GDP growth compared to the benchmark and other key variables. As the most recent performance of these indicators is of greatest interest for practitioners, we only report the relative performance of these indicators for the 2012–2016 forecast period.[9]

We define the set of key macroeconomic variables as a set of eight variables that includes the Urals crude oil price, the Rosstat monthly key sectors economic output index, as well as the six monthly variables in Rosstat's "Basic economic and social indicators" table that are consistently reported for the entire 1996–2016 period and published with reasonable lags. For comparison, Table 2 below also reports forecast performance of three common financial markets variables.

[9] The results for the forecast period 2008-2011 are available on request.

Table 2 Performance of key macroeconomic variables for forecasting Russian quarterly GDP growth in the 2012–2016 period

Nowcast horizon	RMSFE	p value	One-quarter-ahead horizon	RMSFE	p value
Rosstat key sectors economic output index	0.24	0.00	Money supply M2	0.36	0.03
Urals crude oil price in USD per barrel	0.29	0.07	Rosstat key sectors economic output index	0.46	0.02
Money supply M2	0.30	0.06	1-day MIACR interbank rate	0.47	0.07
1-day MIACR interbank rate	0.33	0.16	Urals crude oil price in USD per barrel	0.49	0.05
Industrial production index	0.33	0.07	Real wages	0.53	0.21
Real wages	0.33	0.11	Industrial production	0.55	0.22
Consumer price index	0.36	0.13	Consumer price index	0.58	0.22
Retail trade turnover	0.42	0.35	Retail trade turnover	0.68	0.69
Construction works (value)	0.47	0.81	Construction works (value)	0.71	0.81
Railway freight turnover	0.48	0.92	Railway freight turnover	0.73	0.95
Corporate bank loans	0.55	0.94	Corporate bank loans	0.87	0.96

Notes: All variables shown in the table are recorded at monthly frequency and come in year-on-year growth rates, except for the interbank rate which is in per cent. The table reports RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). Forecast errors for each single indicator are pooled over all three model classes and all model class specifications as described in Section 4. The benchmark model and the forecast evaluation procedure are also described in Section 4. RMSFEs of the nowcast horizon = average RMSFEs over the first, the second and the third monthly horizon as described in Section 4. RMSFEs of the one-quarter ahead horizon = average RMSFEs over the fourth, the fifth and the third sixth monthly horizon as described in Section 4 (= the first, the second and the third monthly horizon of the one-step-ahead quarter). Improvements in forecast performance of the shown indicators over forecasts from the benchmark model turn out to always be statistically significant at conventional levels according to the Giacomini and White (2006) test of unconditional equal predictive ability. p values refer to the Giacomini-White test indicating whether improvements in forecast performance over forecasts from an alternative benchmark, the AR model class as specified in Section 4, is statistically significant. Abbreviations: Rosstat = Federal State Statistics Service. MIACR = Moscow Interbank Actual Credit Rate.

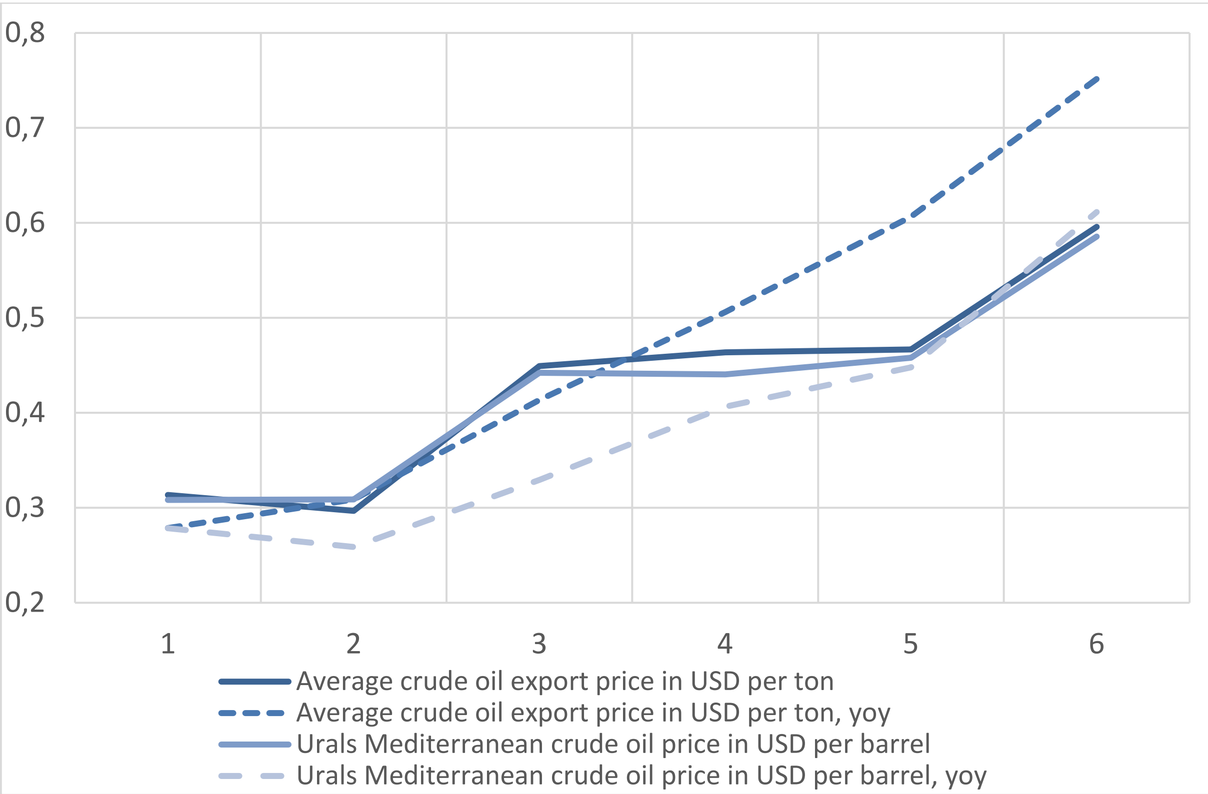
The results in Table 2 show that relative to our benchmark forecasts (rolling window in-sample mean of GDP growth), the year-on-year growth rates in the monthly Urals Mediterranean crude oil price (USD per barrel), in the Rosstat key sectors economic output index and in broad money supply (M2) deliver the best forecasts both for the nowcast horizon and for the one-quarter-ahead forecast horizon. Further, the p values from the Giacomini-White test indicate that these three variables also generate improvements in forecast performance for both horizons relative to forecasts from an alternative benchmark, the AR model as specified in Section 4. Some of the commonly used monthly indicators on the real side of the economy (retail trade, railway freight, industrial production, construction works all in year-on-year changes) beat our benchmark, but perform worse than the aforementioned top indicators.

We next have a closer look on the evolution of forecast performance for the three top-performing indicators and for the real wage indicator. We will compare the forecast evolution of these four variables as reported in the Table 2 with some complementary indicators often used by analysts who follow macroeconomic developments in the Russian economy.

Crude oil prices

There are two alternative oil price indicators that are of interest to Russia-watchers. First, the Urals Mediterranean crude oil price (in USD per barrel) is the major oil benchmark for Russian crude oil exports. Second, the CBR and Rosstat report the average crude oil export price (in USD per ton) based on realized exports and customs data. This export price, however, comes with a considerable lag that may render the indicator less useful in forecasting. We employ both indicators in levels and year-on-year growth rates.

Figure 1 Performance of alternative crude oil price measures for forecasting quarterly Russian GDP growth over forecast horizons from 1 to 6 months in the 2012–2016 period



Notes: The x-axis of the figure depicts the forecast horizons from month 1 to month 6 as described in Section 4. The y-axis of the figure shows RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the respective RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). The indicator models include either the average Russian crude oil export price (in USD per ton) in levels or in year-on-year growth rates or the Urals Mediterranean crude oil price (in USD per barrel) in levels or year-on-year growth rates. The indicator models, the benchmark model and the forecast evaluation procedure (generation of RMSFEs from pooled forecasts over different model specifications and different model classes) are described in Section 4.

As Figure 1 shows, the two indicators contain useful information in forecasting Russian GDP growth – in levels and in year-on-year growth rates. Specifically, at forecast horizons of one to four months (i.e. the nowcast horizon and the first part of the one-quarter-ahead forecast horizon) the Urals crude oil price in year-on-year growth outperforms the same series in levels and the crude oil export price in levels or year-on-year growth rates. In contrast, at forecast horizons from five to six months, the Urals crude oil price in levels or year-on-year growth rates and the crude oil export price in levels perform equally in terms of RMSFE.

GDP indicators

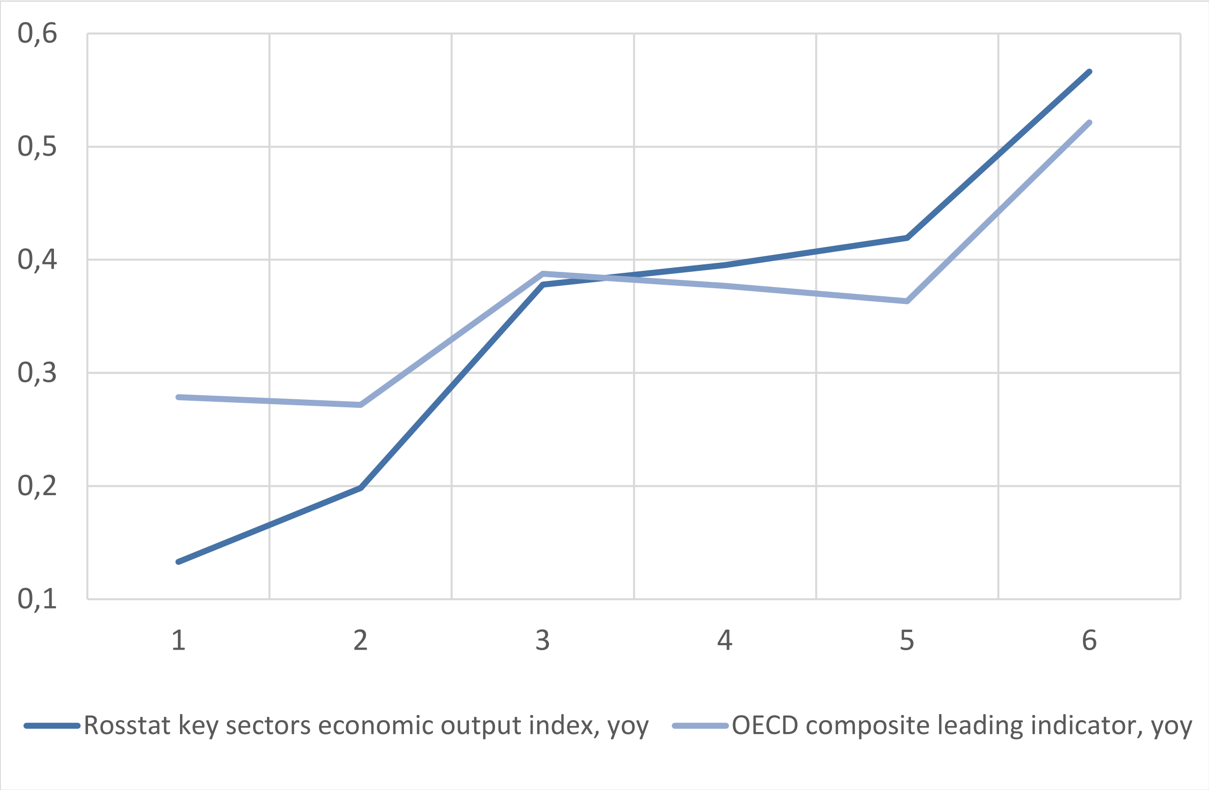
Rosstat publishes a monthly indicator that measures the level of output in five key sectors of the Russian economy (agriculture, industrial production, transportation, trade, communication and telecom industries). The review of the best-performing indicators in Section 5.1 revealed that the Rosstat indicator has relative RMSFEs much lower than any of its components. This indicator, however, is a bit of a black box because no additional information is available on how it is compiled. As Figure 2 shows, the Rosstat indicator delivers a strong improvement in forecasts performance relative to the benchmark for the first monthly forecast horizon (RMSFE reduction of 84%) and the second monthly forecast horizon (RMSFE reduction of 80%). However, the improvement in forecast performance relative to the benchmark decreases sharply for higher forecast horizons.

This finding meets our expectations. The Rosstat indicator for month 1 of quarter t is only available at the end of month 2 of quarter t, i.e. at the second monthly horizon (one month ahead of the end of quarter t and about two and a half months ahead of the GDP release for quarter t). In contrast, at end of month 1 of quarter t, i.e. at the first monthly horizon, no indicator observation on quarter t is yet available resulting in a lower forecast accuracy for nowcasting GDP growth of quarter t.

For comparison, we also show forecast evolution for the OECD composite leading indicator for Russia. The OECD compiles monthly composite leading indicators for member countries and a number of non-members, including Russia. The OECD indicator performs worse than the Rosstat indicator for the first monthly horizon and the second monthly horizon, but is better for higher forecast horizons. In conclusion, the Rosstat key sectors economic output index is most useful for nowcasting horizons and the OECD leading indicator is valuable for short-term forecasting horizons.[10]

[10] The limitation of these two indicators is that the methodologies used to compile the indicators has most likely been changed over the years, and therefore their forecast accuracy may not fully reflect reality.

Figure 2 Performance of monthly GDP indicators for forecasting quarterly Russian GDP growth over forecast horizons from 1 to 6 months in the 2012–2016 period



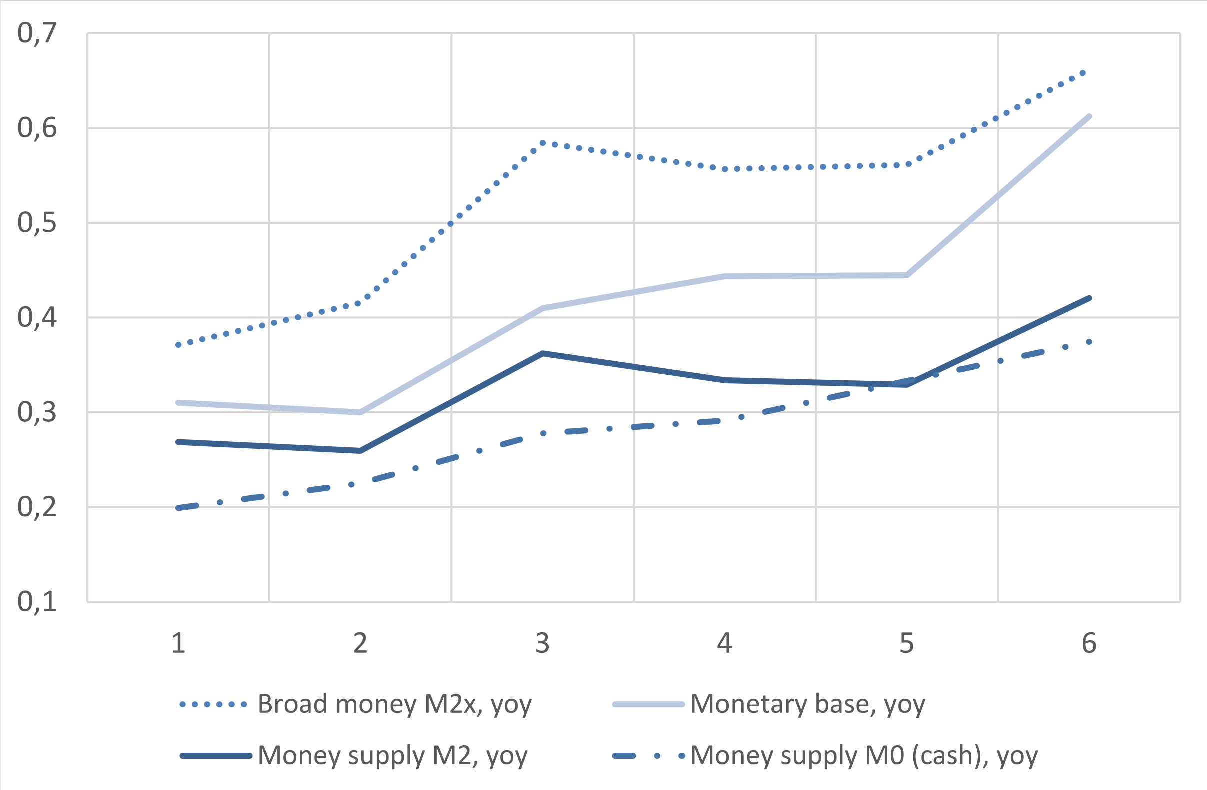
Notes: The x-axis of the figure depicts the forecast horizons from month 1 to month 6 as described in Section 4. The y-axis of the figure shows RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the respective RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). The indicator models include either the Rosstat key sectors economic output index in year-on-year growth rates or the OECD composite leading indicator year-on-year growth rates. The indicator models, the benchmark model and the forecast evaluation procedure (generation of RMSFEs from pooled forecasts over different model specifications and different model classes) are described in Section 4.

Monetary aggregates

The analysis of the best-performing indicators in Section 5.2 revealed that several money aggregates contain valuable information for forecasting Russian GDP in the 2012–2016 period. It is therefore of interest to examine how their forecast performance evolves over the different monthly forecast horizons. Figure 3 show the evolution of forecast accuracy for the monetary base, money supply M0 (cash), money supply M2, and a broad money aggregate (M2x).

The forecasts stemming from the year-on-year growth rates of M0 and M2 clearly beat the benchmark forecast over all forecast horizons. In contrast, the accuracy of models using the year-on-year growth in the monetary base or the broad money aggregate decline visibly after a forecast horizon of three months.

Figure 3 Forecast performance of monthly money aggregates for forecasting quarterly Russian GDP growth over forecast horizons from 1 to 6 months in the 2012–2016 period



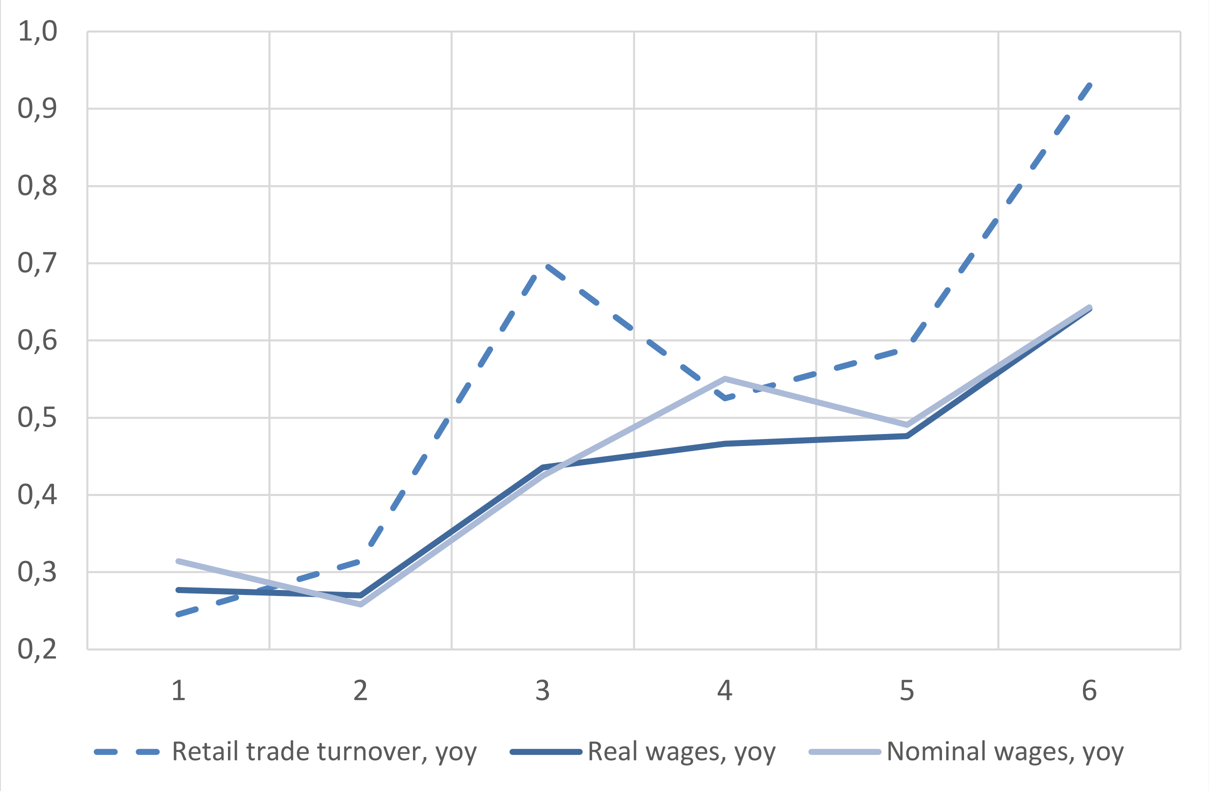
Notes: The x-axis of the figure depicts the forecast horizons from month 1 to month 6 as described in Section 4. The y-axis of the figure shows RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the respective RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). The indicator models include either the monetary base, money supply M0 (cash), money supply M2 or a broad money aggregate (M2x) each in year-on-year growth rates. The indicator models, the benchmark model and the forecast evaluation procedure (generation of RMSFEs from pooled forecasts over different model specifications and different model classes) are described in Section 4.

Wages

Wages are often used as a proxy for retail trade and considered an important indicator of changes in GDP. We thus focus on whether these variables are useful in forecasting GDP growth for at least some forecast horizons. Figure 4 below shows the relative forecast performance of real wages, nominal wages and retail trade turnover over the forecast horizons of one to six months.

Two interesting observations emerge. First, real wages are superior to retail trade turnover in improving upon the benchmark forecast model (= rolling-window in-sample mean of GDP growth). While the forecast performance of retail trade erodes rapidly, it appears that potentially there is a strong seasonal (quarterly) component to it. Second, real and nominal wages are equally good in improving upon the benchmark.

Figure 4 Forecast performance of monthly wage and retail trade data for forecasting quarterly Russian GDP growth over forecast horizons from 1 to 6 months in the 2012–2016 period



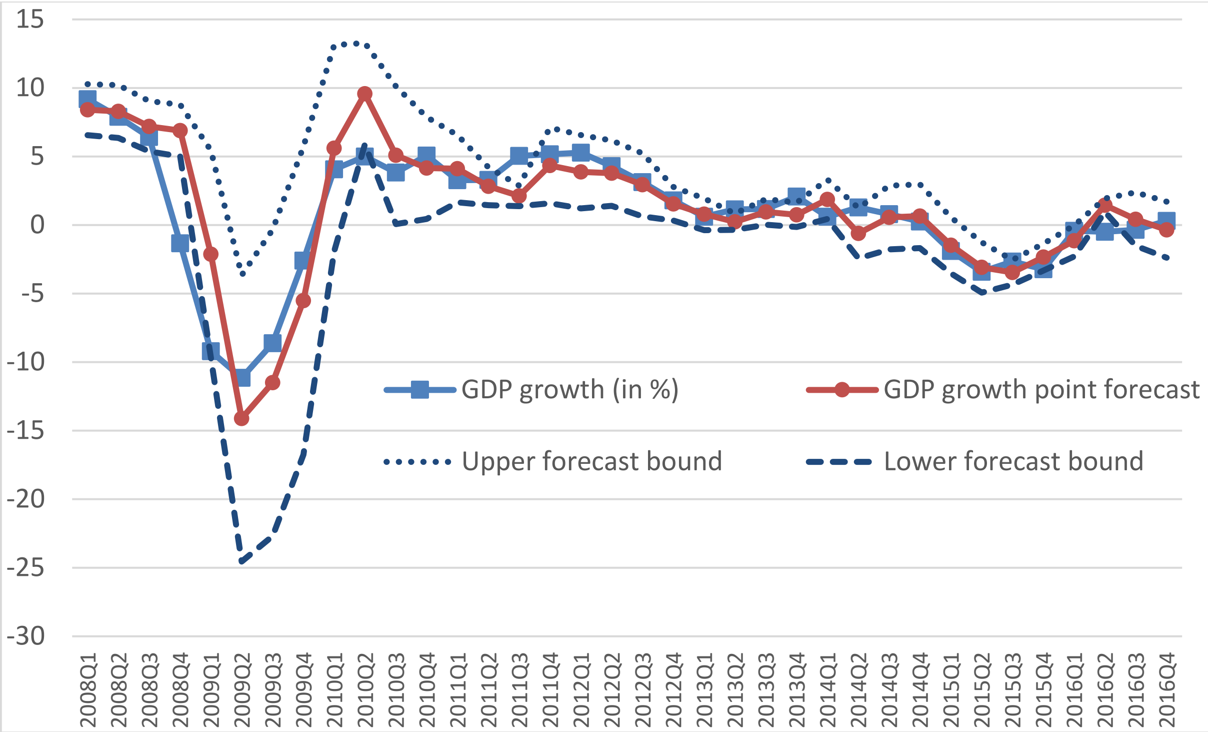
Notes: The x-axis of the figure depicts the forecast horizons from month 1 to month 6 as described in Section 4. The y-axis of the figure shows RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the respective RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). The indicator models include either retail trade turnover, real wages or nominal wages each in year-on-year growth rates. The indicator models, the benchmark model and the forecast evaluation procedure (generation of RMSFEs from pooled forecasts over different model specifications and different model classes) are described in Section 4.

Comparing the performance of our list of the key macroeconomic variables in this section to the top-ten list of best performers discussed in Section 5.1., we see that many of the key variables do not seem to be particularly good at beating the benchmark. The models using banking and financial markets data such as household deposits, money aggregates and stock market indices clearly perform better for the 2012–2016 forecast period.

5.3 Nowcast performance of top indicators over time

In the following section, we show how the nowcast performance of selected top indicators evolves over time. Figure 5 depicts the actual quarterly GDP growth series from 2008–2016 (blue line), as well as the GDP growth forecasts of the first monthly forecast horizon stemming from the forecast model with money supply M0 (cash) in year-on-year growth rates as a single indicator (orange line).[11] The choice is motivated by the fact that money supply M0 turned out to be the best single indicator for the nowcast horizon in forecast period 2012-2016. In addition, the figure shows the 90% forecast or prediction interval (black dotted lines). As can be seen from the figure the single monthly indicator money supply M0 fares extremely well in nowcasting GDP growth, especially since 2013.

Figure 5 Nowcast of quarterly Russian GDP growth using money supply M0 as a single indicator

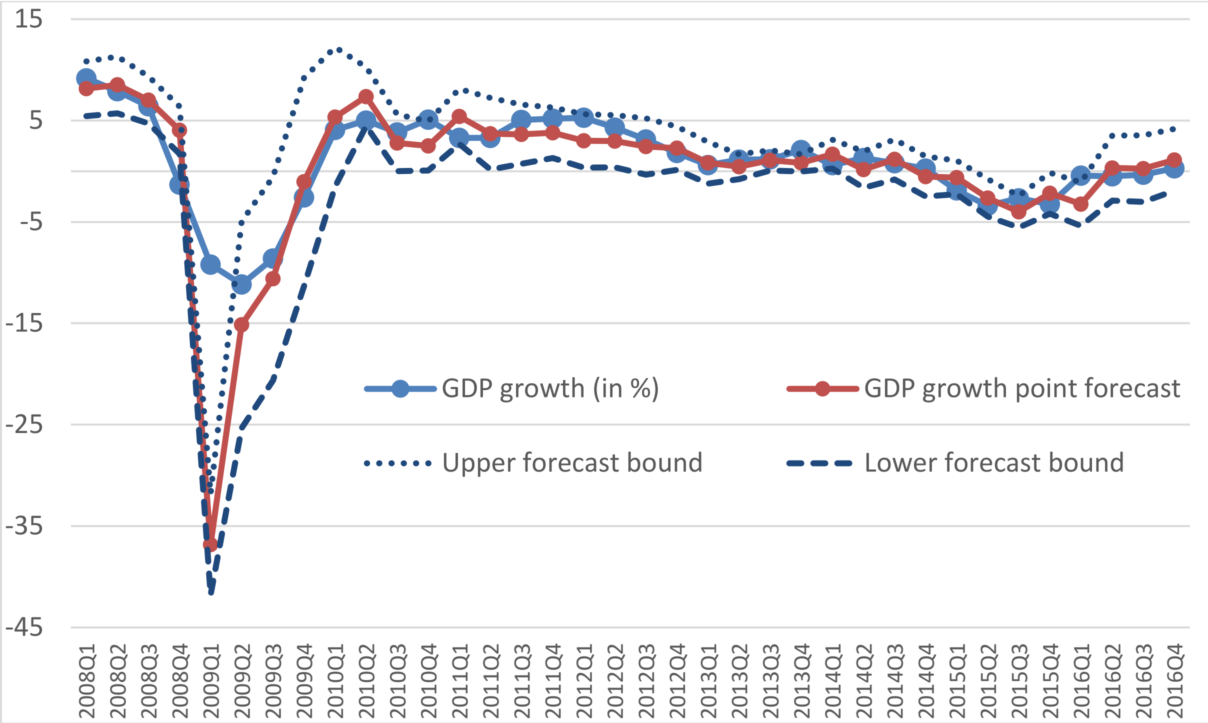


Notes: The figure shows realized quarterly Russian GDP growth (blue line) over the period 2008Q1–2016Q4, together with the GDP growth forecasts of the first monthly forecast horizon stemming from the pooled forecast with money supply M0 (cash) in year-on-year growth rates as a single indicator (orange line). The figure also shows the 90% forecast or prediction interval (black dotted lines). "First monthly forecast horizon" means that GDP growth of quarter t is forecasted at the end of the last of month of t (see Section 4). As quarterly Russian GDP growth is usually released six to eight weeks after the end of a quarter, the first monthly forecast horizon is still six to eight weeks ahead of the GDP release for the quarter. The pooled single indicator forecast is constructed in two steps (see Section 4). First, forecasts stemming from all alternative model class specifications are pooled for each indicator, each model class (MIDAS, unrestricted mixed-frequency, bridge) and each forecast horizon separately. Second, the (pooled) forecasts stemming from all three model classes are pooled for each model class and each forecast horizon separately. Only forecasts of the first monthly forecast horizon are shown in the figure.

[11] As detailed in Section 4. the single indicator forecast is actually a pooled forecast: In a first step, the forecasts stemming from all alternative model class specifications are pooled for each indicator, each model class (MIDAS, unrestricted mixed-frequency, bridge) and each forecast horizon separately. In a second step, the pooled forecasts stemming from all three model classes are pooled for each model class and each forecast horizon separately (although only forecasts of the first monthly forecast horizon are shown here). As described in Section 4, "first monthly forecast horizon" means that GDP growth of quarter t is forecasted at the end of the last of month of t. As quarterly Russian GDP growth is usually released six to eight weeks after the end of a quarter, the first monthly forecast horizon is still six to eight weeks ahead of the GDP release for the quarter.

Figure 6 repeats the exercise with the RTS stock market index in year-on-year growth as a single indicator instead of money supply M0. The US dollar-based stock market index was the third best single indicator for the nowcast horizon in the 2012-2016 forecast period and it was also clearly the best single indicator for the one-quarter ahead forecast horizon in the same forecast period. For practitioners, the potential advantage of this particular indicator is the publications being available at almost real time. The forecasts based on the stock market index are also relatively precise, but clearly overestimate the magnitude of the sudden slump in 2009Q1.

Figure 6 Nowcast of quarterly Russian GDP growth using the RTS stock market index as a single indicator.



Notes: The figure shows realized quarterly Russian GDP growth (blue line) over the 2008Q1–2016Q4 period, as well as the GDP growth forecasts of the first monthly forecast horizon stemming from the pooled forecast with the RTS stock market index in year-on-year growth rates as a single indicator (orange line). The figure also show the 90% forecast or prediction interval (black dotted lines). “First monthly forecast horizon” means that GDP growth of quarter t is forecasted at the end of the last of month of t (see Section 4). As quarterly Russian GDP growth is usually released six to eight weeks after the end of the quarter, the first monthly forecast horizon is still six to eight week ahead of the GDP release for the quarter. The pooled single indicator forecast is constructed in two steps (see Section 4). First, forecasts stemming from all alternative model class specifications are pooled for each indicator, each model class (MIDAS, unrestricted mixed-frequency, bridge) and each forecast horizon separately. Second, the pooled forecasts stemming from all three model classes are pooled for each model class and each forecast horizon separately. Only forecasts of the first monthly forecast horizon are shown in the figure.

5.4 Forecast accuracy of different model classes

In the last step of our empirical analysis, we compare the performance of the three model classes for nowcasting and short-term forecasting Russian GDP growth. Specifically, we ask whether the

MIDAS approach or the unrestricted MIDAS approach actually deliver higher forecast accuracy than the classical bridge equations approach (see descriptions of model classes in Section 2).

To compare the model classes based on the full set of 247 indicators, we build pooled forecasts over all indicators but for each model class and each monthly horizon separately as described in Section 4. This procedure ensures that our results are not driven by differential availability of information (each model class gets the same set of indicators) or by specific behaviours of individual indicators. Table 3 reports for each of the two evaluation periods the RMSFEs of the alternative model classes relative to the RMSFE of benchmark forecast model (rolling window in-sample mean of GDP growth). Values less than one indicate performance beating the benchmark. Again, we only report quarterly averages for the nowcasting horizon and the one-quarter ahead forecasting horizon to save space.[12]

Table 3 Performance of alternative forecast model classes in forecasting Russian quarterly GDP growth

		2008–2011		**2012–2016**	
		Nowcast horizon	One-quarter-ahead forecast horizon	Nowcast horizon	One-quarter-ahead forecast horizon
MIDAS model class	Relative RMSFE	0.54	0.89	0.33	0.49
	p value	0.01	0.01	0.00	0.00
Unrestricted mixed-frequency model class	Relative RMSFE	0.55	0.89	0.32	0.49
	p value	0.00	0.01	0.00	0.00
Bridge model class	Relative RMSFE	0.57	1.26	0.32	0.43
	p value	0.01	0.29	0.00	0.00
All model classes (MIDAS, unrestricted mixed-frequency, bridge)	Relative RMSFE	0.49	0.90	0.32	0.47
	p value	0.01	0.02	0.00	0.00
Autoregressive model class	Relative RMSFE	0.61	1.05	0.43	0.64

Notes: The table reports RMSFEs from forecasts of quarterly Russian GDP growth by indicator models relative to the RMSFE from forecasts of quarterly Russian GDP growth by a benchmark model (= rolling window in-sample mean of GDP growth). To get RMSFEs for each model class, forecast errors for each indicator and each model specification with a model class are first pooled over all model specifications within a model class and then over all indicators as described in Section 4. The benchmark model and the forecast evaluation procedure are also described in Section 4. RMSFEs of the nowcast horizon = average RMSFEs over the first, second and third monthly horizon as described in Section 4. RMSFEs of the one-quarter-ahead horizon = average RMSFEs over the fourth, fifth and sixth monthly horizon as described in Section 4 (= the first, the second and the third monthly horizon of the one-step-ahead quarter). Improvements in forecast performance of the shown indicators over forecasts from the benchmark model were always statistically significant at conventional levels with the Giacomini and White (2006) test of unconditional equal predictive ability. p values refer to the Giacomini-White test indicating whether improvements in forecast performance over forecasts from an alternative benchmark, the AR model class as specified in Section 4, are statistically significant.

[12] The RMSFEs for the monthly horizons are available on request.

All model classes clearly perform better relative to the benchmark in the 2012-2016 forecast period than in the 2008-2011 period. In this sense, the Russian economy has become more predictable. Further, in the first period, forecasts stemming from the MIDAS model class and forecasts from the unrestricted mixed-frequency model class perform significantly better than the benchmark forecasts and also better than the forecasts from the bridge model class. In the second period, the differences between the forecast model classes are very small. This indicates that, in relative terms, MIDAS forecast models and unrestricted mixed-frequency forecasts models are better in periods of high economic volatility.

6 Conclusions

A pseudo real-time forecast and nowcast exercise for quarterly Russian GDP growth was performed using a large set of indicators. Numerous variants of bridge models and mixed data sampling (MIDAS) models and unrestricted mixed-frequency models were employed for the purpose of mixed-frequency forecasting. A forecast combination approach was used to pool forecasts stemming from the different models. The set of indicators used consist of 247 monthly variables, including standard macroeconomic variables, financial markets and banking sector data, as well as a set of sentiment indicators. In order to identify the differential leading and coincident properties of the indicators the forecast and nowcast exercise was iterated for six different horizons: from a six-month-ahead horizon to a one-month-ahead horizon. The forecast evaluation period was split in two subsample periods. The 2008-2011 period captures the economic crisis of 2009 and the recovery thereafter. The 2012-2016 period covers the trend towards slower trend growth and the 2015 recession. The sample split allowed us to study the predictive accuracy of the employed indicators and models at different economic times.

With the notable exceptions of Rautava (2013) and Porshakov (2016), work on forecasting Russian GDP growth is surprisingly scarce. This paper adds to this research by employing a large set of monthly indicators, several established mixed-frequency forecasting models, six different forecast and nowcast horizons and a long evaluation period. We documented a large number of indicators that significantly improve upon simple benchmark models and we identified those indicators and models which are most useful for short-term forecasting and nowcasting of quarterly Russian GDP growth at different times and for different horizons. Russia-watchers may find it interesting that various indicators showed superior forecast performance relative to crude oil prices.

A small number of indicators consistently figured among the top indicators for both evaluation periods and all forecast/nowcast horizons: the monthly key sectors economic output index published by Rosstat, the monthly composite leading indicator for Russia published by the OECD, household banking deposits, and money supply M2, both published by the CBR. Notwithstanding this result, the top-performing indicators are distinctly different in each of the two evaluation periods. In the 2008-2011 period, the best indicators include traditional real-sector variables, while the best indicators in the 2012-2016 period are largely monetary, banking sector or financial markets variables. This finding suggests that economic recession and recovery periods are driven by forces other than those that prevail in more normal times.

The empirical findings highlight two important lessons for researchers nowcasting Russian GDP growth. First, one should seriously look beyond crude oil prices when searching for suitable indicators in nowcasting models. Second, the importance of monetary and banking variables has clearly increased in the more recent period. These insights might be taken into account in future research, especially if the aim is to build a multi-indicator nowcasting or short-term forecasting model for policy purposes.

Finally, we examined the forecast accuracy of alternative mixed-frequency forecasting models. Our results show that the differences in forecast performance among bridge models, MIDAS models and unrestricted mixed-frequency models are rather small. The exception was the Great Recession, where unrestricted mixed-frequency models and MIDAS models clearly outperform bridge models.

References

Andreou, E., Ghysels, E. and Kourtellos, A. (2010). "Regression models with mixed sampling frequencies." *Journal of Econometrics*, 158, 246–261.

Andreou, E., Ghysels, E. and Kourtellos, A. (2011). "Forecasting with mixed-frequency data." In: M.P. Clements and D.F. Hendry (eds.), *Oxford Handbook on Economic Forecasting*, Oxford University Press: Oxford.

Andreou, E., Ghysels, E. and Kourtellos, A. (2013). "Should macroeconomic forecasters use daily financial data and how?" *Journal of Business & Economic Statistics*, 31(2), 240–251.

Angelini, E., Camba-Méndez, G., Giannone, D., Rünstler, G. and Reichlin, L. (2011). "Short-term forecasts of euro area GDP growth." *Econometrics Journal*, 14(1), C25–C44.

Armesto, M.T., Engemann, K.M. and Owyang, M.T. (2010). "Forecasting with mixed frequencies." *Federal Reserve Bank of St. Louis Review*, 92(6), 521–536.

Baffigi, A., Golinelli, R. and Parigi, G. (2004). "Bridge models to forecast the euro area GDP." *International Journal of Forecasting*, 20(3), 447–460.

Baker, S.R., Bloom, N., Davis S.J. (2015). "Measuring economic policy uncertainty." NBER Working Papers 21633, National Bureau of Economic Research, October 2015.

Banerjee, A. and Marcellino, M. (2006). "Are there any reliable leading indicators for US inflation and GDP growth?" *International Journal of Forecasting*, 2, 137–151.

Banerjee, A., Marcellino, M. and Masten, I. (2005). "Leading indicators for euro-area inflation and GDP growth." *Oxford Bulletin of Economics and Statistics*, 67(s1), 785–813.

Benedictow, A., Fjaertoft, D., Lofsnaes, O. (2013). "Oil dependency of the Russian economy: An econometric analysis." *Economic Modelling*, 32, 400–428.

Bulligan, G., Golinelli, R. and Parigi, G. (2010). "Forecasting monthly industrial production in real-time: From single equations to factor-based models." *Empirical Economics*, 39(2), 303–336.

Bulligan, G., Marcellino, M. and Venditti, F. (2015). "Forecasting economic activity with targeted predictors." *International Journal of Forecasting*, 31(1), 188–206.

Camacho, M., Perez-Quiros, G. and Poncela, P. (2013). "Short-term forecasting for empirical economists. A survey of the recently proposed algorithms." *Foundations and Trends in Econometrics*, 6(2), 101–161.

Clements, M.P. and Galvão, A.B. (2008). "Macroeconomic forecasting with mixed-frequency data." *Journal of Business & Economic Statistics*, 26(4), 546–554.

Clements, M.P. and Galvão, A.B. (2009). "Forecasting US output growth using leading indicators: An appraisal using MIDAS models." *Journal of Applied Econometrics*, 24, 1187–1206.

Diron, M. (2008). "Short-term forecasts of euro area real GDP growth: An assessment of real-time performance based on vintage data." *Journal of Forecasting*, 27, 371–390.

Drechsel, K. and Scheufele, R. (2012). “The performance of short-term forecasts of the German economy before and during the 2008/2009 recession.” *International Journal of Forecasting*, 28(2), 428–445.

Duarte, C. (2014). “Autoregressive augmentation of MIDAS regressions.” Banco de Portugal Working Papers, 2014(1).

Ferrara, L., Marsilli, C. and Ortega, J.-P. (2014). “Forecasting growth during the Great Recession: Is financial volatility the missing ingredient?” *Economic Modelling*, 36, 44–50.

Foroni, C. and Marcellino, M. (2013). “A survey of econometric methods for mixed-frequency data.” Norges Bank Working Paper 2013/06, Norges Bank.

Foroni, C. and Marcellino, M. (2014). “A comparison of mixed frequency approaches for nowcasting euro area macroeconomic aggregates.” *International Journal of Forecasting*, 30(3), 554–568.

Foroni, C., Marcellino, M. and Schumacher, C. (2014). “U-MIDAS: MIDAS regressions with unrestricted lag polynomials.” *Journal of the Royal Statistical Society*, Series A (forthcoming).

Ghysels, E., Sinko, A. and Valkanov, R. (2007). “MIDAS regressions: Further results and new directions.” *Econometric Reviews*, 26(1), 53–90.

Giacomini, R. and White, H. (2006). “Tests on conditional predictive ability.” *Econometrica*, 74(6), 1545–1578.

Giannone, D., Reichlin, L. and Small, D. (2008). “Nowcasting: The real-time informational content of macroeconomic data.” *Journal of Monetary Economics*, 55(4), 665–676.

Golinelli, R. and Parigi, G. (2007). “The use of monthly indicators to forecast quarterly GDP in the short run: An application to the G7 countries.” *Journal of Forecasting*, 26, 77–94.

Hahn, E. and Skudelny, F. (2008). “Early estimates of euro area real GDP growth: A bottom-up approach from the production side.” ECB Working Papers No. 975.

Hendry, D.F. and Clements, M.P. (2004). “Pooling of forecasts.” *Econometrics Journal*, 7(1), 1– 31.

Ingenito, R. and Trehan, B. (1996). “Using monthly data to predict quarterly output.” *Federal Reserve Bank of San Francisco Economic Review*, 3, 3–11.

Kuzin, V., Marcellino, M. and Schumacher, C. (2013). “Pooling versus model selection for nowcasting GDP with many predictors: Empirical evidence for six industrialized countries.” *Journal of Applied Econometrics*, 28, 392–411.

Mikosch, H. and Zhang, Y. (2014). “Forecasting Chinese GDP growth with mixed frequency data: Which indicators to look at?” KOF Working Paper, 359, KOF Swiss Economic Institute.

Porshakov, A.S., Ponomarenko, A.A., Sinyakov, A.A. (2016). “Nowcasting and Short-Term Forecasting of Russian GDP with a Dynamic Factor Model” (in Russian). *Journal of New Economic Association*, 2(30), 60–76.

Rautava, J. (2013). “Oil prices, excess uncertainty and trend growth. A forecasting model for Russia’s economy.” *Focus on European Economic Integration* 4Q/2013, 77–87.

Rüunstler, G., Barhoumi, K., Benk, S., Cristadoro, R., Den Reijer, A., Jakaitiene, A., Jelonek, P., Rua, A., Ruth, K. and Van Nieuwenhuyze, C. (2009). “Short-term forecasting of GDP using large datasets: A pseudo real-time forecast evaluation exercise.” *Journal of Forecasting*, 28(7), 595–611.

Schumacher, C. (2016). “A comparison of MIDAS and bridge equations.” *International Journal of Forecasting*, 32(2), 257–270.

Stock, J.H. and Watson, M.W. (2004). “Combination forecasts of output growth in a seven-country data set.” *Journal of Forecasting*, 23, 405–430.

Stock, J.H. and Watson, M.W. (2006). “Forecasting with many predictors.” Handbook of Economic Forecasting, 1, 515–554.

Stock, J.H. and Watson, M.W. (2012). *Introduction to Econometrics*. Essex: Pearson Education, 3rd Global Edition.

Wallis, K.F. (1986). “Forecasting with an econometric model: The ‘ragged edge’ problem.” *Journal of Forecasting*, 5(1), 1–13.

Appendix 1 Variable description (Monthly variables description, 247variables)

	Variable name	unit	source	lag months
1	Key sectors economic output	SMPY=100	Rosstat	1
2	Consolidated Government Revenue: ytd	RUB bn	RosKazna	2
3	Consolidated Government Revenue: ytd: Company Profit Tax	RUB bn	RosKazna	2
4	Consolidated Government Revenue: ytd: International Trade	RUB bn	RosKazna	2
5	Federal Government Revenue: ytd	RUB bn	RosKazna	1
6	Federal Government Revenue: ytd: Company Profit Tax	RUB bn	RosKazna	1
7	Federal Government Revenue: ytd: International Trade	RUB bn	RosKazna	1
8	Federal Government Expenditure: ytd	RUB bn	RosKazna	1
9	Economically Active Population: Period End	Person th	Rosstat	1
10	Economically Active Population: Period End: Employed	Person th	Rosstat	1
11	Economically Active Population: Period End: Unemployed	Person th	Rosstat	1
12	Nominal Wages: Period Average	RUB	Rosstat	1
13	Real Wages Index: Same Month PY=100	SMPY=100	Rosstat	1
14	Wage Arrears	RUB mn	Rosstat	1
15	Average Monthly Pension: Nominal	RUB	Rosstat	1
16	Real Monthly Pension: Same Month PY=100	SMPY=100	Rosstat	1
17	CPI: SMPY=100	SMPY=100	Rosstat	1
18	CPI: SMPY=100: Food	SMPY=100	Rosstat	1
19	CPI: SMPY=100: Non Food	SMPY=100	Rosstat	1
20	CPI: SMPY=100: Services	SMPY=100	Rosstat	1
21	CPI: SMPY=100: Food excluding Fruit and Vegetables	SMPY=100	Rosstat	1
22	CPI: SMPY=100: Non Food: Gasoline	SMPY=100	Rosstat	1

	Variable name	unit	source	lag months
23	Producer Price Index (PPI): OKVED: SMPY=100	SMPY=100	Rosstat	1
24	Exports	USD mn	Customs	2
25	Exports: CIS Countries	USD mn	Customs	2
26	Imports	USD mn	Customs	2
27	Imports: CIS Countries	USD mn	Customs	2
28	Imports: Non CIS Countries	USD mn	Customs	2
29	Exports: Central Bank: FOB	USD mn	CBR	2
30	Imports: Central Bank: FOB	USD mn	CBR	2
31	Banking Deposits: Corporate	RUB bn	CBR	1
32	Banking Deposits: Personal	RUB bn	CBR	1
33	Banking Deposits: Interbank	RUB bn	CBR	1
34	Banking Deposits: Personal	RUB mn	CBR	1
35	Banking Deposits: Personal: RUB	RUB mn	CBR	1
36	Banking Deposits: Personal: RUB: Demand Deposits	RUB mn	CBR	2
37	Banking Deposits: Personal: RUB: Time Deposits: Up to 30 Days	RUB mn	CBR	2
38	Banking Deposits: Personal: RUB: Time Deposits: 31 to 90 Days	RUB mn	CBR	2
39	Banking Deposits: Personal: RUB: Time Deposits: 1 to 3 Years	RUB mn	CBR	2
40	Banking Deposits: Personal: RUB: Time Deposits: 3 Years and Above	RUB mn	CBR	2
41	Banking Deposits: Personal: Foreign Currency: Time Deposits: Up to 30 Days	RUB mn	CBR	2
42	Banking Deposits: Personal: Foreign Currency: Time Deposits: 31 to 90 Days	RUB mn	CBR	2
43	Banking Deposits: Personal: Foreign Currency: Time Deposits: 91 to 180 Days	RUB mn	CBR	2
44	Banking Deposits: Personal: Foreign Currency: Time Deposits: 181 Days to 1 Year	RUB mn	CBR	2
45	Banking Deposits: Personal: Foreign Currency: Time Deposits: 1 to 3 Years	RUB mn	CBR	2

	Variable name	**unit**	**source**	**lag months**
46	Banking Deposits: Personal: Foreign Currency: Time Deposits: 3 Years and Above	RUB mn	CBR	2
47	Banking Deposits: Corporate: RUB: Demand Deposits	RUB mn	CBR	2
48	Banking Deposits: Corporate: RUB: Time Deposits: Up to 30 Days	RUB mn	CBR	2
49	Banking Deposits: Corporate: RUB: Time Deposits: 31 to 90 Days	RUB mn	CBR	2
50	Banking Deposits: Corporate: RUB: Time Deposits: 91 to 180 Days	RUB mn	CBR	2
51	Banking Deposits: Corporate: RUB: Time Deposits: 181 Days to 1 Year	RUB mn	CBR	2
52	Banking Deposits: Corporate: RUB: Time Deposits: 1 to 3 Years	RUB mn	CBR	2
53	Banking Deposits: Corporate: RUB: Time Deposits: 3 Years and Above	RUB mn	CBR	2
54	Banking Deposits: Corporate: Foreign Currency	RUB mn	CBR	2
55	Banking Deposits: Corporate: Foreign Currency: Demand Deposits	RUB mn	CBR	2
56	Banking Deposits: Corporate: Foreign Currency: Time Deposits: 31 to 90 Days	RUB mn	CBR	2
57	Banking Deposits: Corporate: Foreign Currency: Time Deposits: 91 to 180 Days	RUB mn	CBR	2
58	Banking Deposits: Corporate: Foreign Currency: Time Deposits: 1 to 3 Years	RUB mn	CBR	2
59	Banking Deposits: Corporate: Foreign Currency: Time Deposits: 3 Years and Above	RUB mn	CBR	2
60	Banking Deposits: Interbank: RUB	RUB mn	CBR	1
61	Banking Deposits: Interbank: Foreign Currency	RUB mn	CBR	1
62	Funds Raised from Organizations: Deposits & Other Funds from Legal Entities excl Credit Institutions (DO)	RUB bn	CBR	1
63	Funds Raised from Organizations: DO: RUB	RUB bn	CBR	1
64	Funds Raised from Organizations: DO: Foreign Currency	RUB bn	CBR	1
65	Banking Deposits: Sberbank: Personal	RUB bn	Rosstat	2
66	Banking Deposits: Sberbank: Personal: Foreign Currencies	RUB bn	Rosstat	2
67	Overdue Loans incl Non Residents	RUB mn	CBR	1
68	Overdue Loans incl Non Residents: ow Corporate & Entrepreneurial	RUB mn	CBR	1

	Variable name	unit	source	lag months
69	Overdue Loans incl Non Residents: ow Personal	RUB mn	CBR	1
70	Overdue Loans incl Non Residents: ow Banking	RUB mn	CBR	1
71	Loans Debt incl Non Residents: RUB	RUB mn	CBR	2
72	Loans Debt incl Non Residents: RUB: Corporate	RUB mn	CBR	2
73	Loans Debt incl Non Residents: RUB: Corporate: Up to 30 Days	RUB mn	CBR	2
74	Loans Debt incl Non Residents: RUB: Corporate: 31 to 90 Days	RUB mn	CBR	2
75	Loans Debt incl Non Residents: RUB: Corporate: 1 to 3 Years	RUB mn	CBR	2
76	Loans Debt incl Non Residents: RUB: Corporate: Above 3 Years	RUB mn	CBR	2
77	Loans Debt incl Non Residents: RUB: Banking	RUB mn	CBR	2
78	Loans Debt incl Non Residents: Foreign Currency	RUB mn	CBR	2
79	Loans Debt incl Non Residents: Foreign Currency: Corporate	RUB mn	CBR	2
80	Loans Debt incl Non Residents: Foreign Currency: Corporate: Up to 30 Days	RUB mn	CBR	2
81	Loans Debt incl Non Residents: Foreign Currency: Corporate: 31 to 90 Days	RUB mn	CBR	2
82	Loans Debt incl Non Residents: Foreign Currency: Corporate: 91 to 180 Days	RUB mn	CBR	2
83	Loans Debt incl Non Residents: Foreign Currency: Corporate: 181 Days to 1 Year	RUB mn	CBR	2
84	Loans Debt incl Non Residents: Foreign Currency: Corporate: 1 to 3 Years	RUB mn	CBR	2
85	Credit Institutions: Assets	RUB th	CBR	1
86	Credit Institutions: Loans Debt incl Non Residents & Government	RUB mn	CBR	1
87	Credit Institutions: Loans Debt incl Non Residents & Government: ow Overdue Loans	RUB mn	CBR	1
88	Credit Institutions: Loans Debt incl Non Residents: Corporate	RUB mn	CBR	1
89	Credit Institutions: Loans Debt incl Non Residents: Corporate: ow Overdue Loans	RUB mn	CBR	1
90	Credit Institutions: Loans Debt incl Non Residents: Corporate: ow Non Financial Institutions	RUB mn	CBR	1
91	Credit Institutions: Loans Debt incl Non Residents: Personal	RUB mn	CBR	1

	Variable name	**unit**	**source**	**lag months**
92	Credit Institutions: Loans Debt incl Non Residents: Personal: ow Overdue Loans	RUB mn	CBR	1
93	Credit Institutions: Loans Debt incl Non Residents: Banking	RUB mn	CBR	1
94	Credit Institutions: Loans Debt incl Non Residents: Banking: ow Overdue Loans	RUB mn	CBR	1
95	Credit Institutions: Loans Debt incl Non Residents: Unsecured Consumer Loans (Portfolio of Homogenous Loans)	RUB mn	CBR	1
96	Credit Institutions: Investments in Government Securities & Bank of Russia Bonds	RUB mn	CBR	1
97	Credit Institutions: Investments in Bills	RUB mn	CBR	1
98	Credit Institutions: Budget and Extra-Budgetary Funds in Accounts	RUB mn	CBR	1
99	Credit Institutions: Personal Deposits	RUB mn	CBR	1
100	Credit Institutions: Credit Institutions Bonds, Bills & Acceptances	RUB mn	CBR	1
101	Credit Institutions: Registered Authorised Capital	RUB mn	CBR	1
102	Foreign Currencies Cash Flow: Receipts: Banks' Imports	USD mn	CBR	2
103	Foreign Currencies Cash Flow: Receipts: Purchased from Individuals & Conversion	USD mn	CBR	2
104	Foreign Currencies Cash Flow: Expenses: Bank's Exports	USD mn	CBR	2
105	Foreign Currencies Cash Flow: Expenses: Sales to Individuals & Conversion	USD mn	CBR	2
106	Money Supply: M2	RUB bn	CBR	1
107	Money Supply: M2: M1: M0: Cash	RUB bn	CBR	1
108	Broad Money Supply M2x	RUB mn	CBR	1
109	Official Reserve Assets: Foreign Exchange Reserves	USD mn	CBR	1
110	Monetary Base	RUB bn	CBR	1
111	Banking System Survey: Net Foreign Assets	RUB mn	CBR	1
112	Lending Rate: Credit Institutions: Personal Loans: RUB: 181 Days to 1 Year	% pa	CBR	2
113	Lending Rate: Credit Institutions: Personal Loans: RUB: Up to 30 Days incl Demand	% pa	CBR	2
114	Lending Rate: Credit Institutions: Corporate Loans: RUB: Up to 30 Days incl Demand	% pa	CBR	2

	Variable name	**unit**	**source**	**lag months**
115	Lending Rate: Credit Institutions: Corporate Loans: RUB: 91 to 180 Days	% pa	CBR	2
116	Lending Rate: Credit Institutions: Corporate Loans: RUB: 181 Days to 1 Year	% pa	CBR	2
117	Lending Rate: Credit Institutions: Corporate Loans: RUB: Up to 1 Year incl Demand	% pa	CBR	2
118	Lending Rate: Interbank Loans: RUB: Up to 30 Days incl Demand	% pa	CBR	2
119	Foreign Exchange Rate: Bank of Russia: Avg per Month: US Dollar	RUB/USD	CBR	1
120	Foreign Exchange Rate: Bank of Russia: Avg per Month: Euro	RUB/EUR	CBR	1
121	Short Term Deposit Rate: Credit Institutions Avg: RUB: Households	% pa	CBR	2
122	Deposit Rate: Credit Institutions Avg excl Sberbank: RUB: Individuals: Up to 1 Year	% pa	CBR	2
123	Deposit Rate: Credit Institutions: Personal Deposits: RUB: Up to 30 Days incl Demand	% pa	CBR	2
124	Deposit Rate: Credit Institutions: Personal Deposits: RUB: 91 to 180 Days	% pa	CBR	2
125	Deposit Rate: Credit Institutions: Personal Deposits: RUB: 181 Days to 1 Year	% pa	CBR	2
126	Deposit Rate: Credit Institutions: Personal Deposits: RUB: Up to 1 Year incl Demand	% pa	CBR	2
127	Deposit Rate: Credit Institutions: Personal Deposits: RUB: Over 1 Year	% pa	CBR	2
128	Deposit Rate: Credit Institutions: Personal Deposits: USD: Up to 30 Days incl Demand	% pa	CBR	2
129	Deposit Rate: Credit Institutions: Corporate Deposits: RUB: Up to 30 Days incl Demand	% pa	CBR	2
130	Deposit Rate: Credit Institutions: Corporate Deposits: RUB: 31 to 90 Days	% pa	CBR	2
131	Deposit Rate: Credit Institutions: Corporate Deposits: RUB: 91 to 180 Days	% pa	CBR	2
132	Deposit Rate: Credit Institutions: Corporate Deposits: RUB: 181 Days to 1 Year	% pa	CBR	2
133	Deposit Rate: Credit Institutions: Corporate Deposits: RUB: Over 1 Year	% pa	CBR	2
134	Deposit Rate: Credit Institutions: Corporate Deposits: USD: Up to 30 Days incl Demand	% pa	CBR	2
135	Interbank Rate (MIACR): Moscow Market Avg: Actual: 1 Day	% pa	CBR	1
136	Avg Producer Price: Oil & Gas: Crude Oil	RUB/Ton	Rosstat	3
137	Avg Producer Price: Coal	RUB/Ton	Rosstat	3

	Variable name	unit	source	lag months
138	Avg Producer Price: Petrochemicals: Automobile Gasoline	RUB/Ton	Rosstat	3
139	Avg Producer Price: Construction Materials: Cement	RUB/Ton	Rosstat	3
140	Avg Consumer Price: Fruit & Vegetable: Potato	RUB/kg	Rosstat	1
141	Avg Consumer Price: Fruit & Vegetable: Cabbage	RUB/kg	Rosstat	1
142	Avg Consumer Price: Public Catering: Lunch in Restaurant	RUB/Person	Rosstat	1
143	Average Export Price: Non CIS: Crude Oil	USD/Ton	Rosstat	2
144	Average Export Price: Non CIS: Nitric Mineral Fertilizers: Physical Weight	USD/Ton	Rosstat	2
145	Average Export Price: Non CIS: Refined Copper	USD/Ton	Rosstat	2
146	Average Export Price: CIS: Crude Oil	USD/Ton	Rosstat	2
147	Average Export Price: CIS: Nitric Mineral Fertilizers: Physical Weight	USD/Ton	Rosstat	2
148	Average Export Price: Crude Oil	USD/Ton	Rosstat	2
149	Average World Price: Crude Oil: Urals: per 1 Barrel	USD/Barrel	MinFin	1
150	Average World Price: Nickel	USD/Ton	Rosstat	1
151	Average Consumer Price: Foodstuffs: Hen Eggs	RUB/10 Unit	Rosstat	1
152	US Dollar Denominated Indices: RTS Index	01Sep1995=100	MOEX	1
153	US Dollar Denominated Indices: Market Capitalization: RTS Index	USD mn	MOEX	1
154	RUB Denominated Indices: MICEX Index	22Sep1997=100	MOEX	1
155	Funds Raised by Bills: Rubles	RUB mn	CBR	2
156	Agricultural Production: Value: All Enterprises	RUB bn	Rosstat	1
157	Automobile Imports: Volume: Passenger Car	Unit	Rosstat	2
158	Automobile Imports: Volume: Truck	Unit	Rosstat	2
159	Automobile Production: Passenger Cars	Unit	Rosstat	1
160	Automobile Production: Buses	Unit	Rosstat	1

	Variable name	unit	source	lag months
161	Automobile Production: Trucks	Unit	Rosstat	1
162	Petrochemical Exports: Volume: Petroleum Products	Ton	Rosstat	2
163	Petrochemical Exports: Volume: Diesel Fuel	Ton	Rosstat	2
164	Petrochemical Exports: Volume: Non CIS: Petroleum Products	Ton	Rosstat	2
165	Petrochemical Production: Petroleum Lubricating Oils	Ton th	Rosstat	1
166	Residential Housing Completed: Floor Area	sq m th	Rosstat	1
167	Construction Works Value	RUB bn	Rosstat	1
168	Producer Price Index for Construction	PM =100	Rosstat	1
169	Crude Oil Refining	Ton th	Rosstat	1
170	Industrial Production: Machine Tools: Metal Cutting	Unit	Rosstat	1
171	Industrial Production: Domestic Appliances: Refrigerators and Freezers	Unit	Rosstat	1
172	Industrial Production: Other Vehicles: Railway Locomotives: Diesel	Unit	Rosstat	1
173	Industrial Production: Other Vehicles: Freight Wagons	Unit	Rosstat	1
174	Industrial Production: Cement, Lime and Plaster: Portland Cement, Aluminous Cement, Slag Cement & Similar Hydraulic Cements	Ton th	Rosstat	1
175	Industrial Production Index (IPI): OKVED: SMPY=100	SMPY=100	Rosstat	1
176	IPI: OKVED: SMPY=100: Mining & Quarrying	SMPY=100	Rosstat	1
177	IPI: OKVED: SMPY=100: Mining & Quarrying: Energy Producing Materials (EP)	SMPY=100	Rosstat	1
178	IPI: OKVED: SMPY=100: Manufacturing (Mfg)	SMPY=100	Rosstat	1
179	Industrial Production Index (IPI): SMPY=100: Mfg: Food Products: Meat & Meat Products	SMPY=100	Rosstat	1
180	IPI: SMPY=100: Mfg: Pulp and Paper: Cellulose, Pulp, Paper, Cardboard	SMPY=100	Rosstat	1
181	IPI: SMPY=100: Mfg: Petroleum Coke & Refined Petroleum Products: Refined Petroleum Products	SMPY=100	Rosstat	1
182	IPI: SMPY=100: Mfg: Chemicals: Basic Chemicals Substances	SMPY=100	Rosstat	1
183	IPI: SMPY=100: Mfg: Chemicals: Pharmaceuticals	SMPY=100	Rosstat	1

	Variable name	unit	source	lag months
184	IPI: SMPY=100: Mfg: Basic Metals & Fabricated Metal Products: Fabricated Metal Products	SMPY=100	Rosstat	1
185	IPI: SMPY=100: Mfg: Machinery and Equipment: Mechanical Equipment	SMPY=100	Rosstat	1
186	Passenger Turnover: Estimate	Person-km bn	Rosstat	1
187	Passenger Turnover: Estimate: Railway	Person-km bn	Rosstat	1
188	Passenger Turnover: Estimate: Bus	Person-km bn	Rosstat	1
189	Passenger Turnover: Estimate: Air	Person-km bn	Rosstat	1
190	Passenger Turnover Index: SMPY=100	SMPY=100	Rosstat	1
191	Freight Carried: Railway	Ton mn	Rosstat	1
192	Freight Carried: Automobile	Ton mn	Rosstat	1
193	Freight Carried: Pipeline	Ton mn	Rosstat	1
194	Freight Carried: Air	Ton mn	Rosstat	1
195	Freight Turnover	Ton-km bn	Rosstat	1
196	Freight Turnover: ow Commercial Traffic	Ton-km bn	Rosstat	1
197	Freight Turnover: Estimate: Railway	Ton-km bn	Rosstat	1
198	Freight Turnover: Estimate: Automobile	Ton-km bn	Rosstat	1
199	Freight Transport Price Index: Prev Month=100	PM =100	Rosstat	1
200	Railway Freight Carried	Ton mn	Rosstat	1
201	Railway Freight Carried: Coal	Ton mn	Rosstat	1
202	Railway Freight Carried: Petroleum Coke	Ton mn	Rosstat	1
203	Railway Freight Carried: Crude Oil and Petroleum Products	Ton mn	Rosstat	1
204	Railway Freight Carried: Iron Ore and Manganese Ore	Ton mn	Rosstat	1
205	Railway Freight Carried: Non Ferrous Ore and Sulphur	Ton mn	Rosstat	1
206	Railway Freight Carried: Ferrous Metals	Ton mn	Rosstat	1

	Variable name	unit	source	lag months
207	Railway Freight Carried: Construction Materials	Ton mn	Rosstat	1
208	Railway Freight Carried: Cement	Ton mn	Rosstat	1
209	Railway Freight Carried: Grain and Other Grain Products	Ton mn	Rosstat	1
210	Railway Freight Carried: Imported Freight	Ton mn	Rosstat	1
211	Passenger Turnover: Air	Person-km th	Rosaviation	1
212	Passenger Turnover: Air: International Flights (IF)	Person-km th	Rosaviation	1
213	Retail Trade Turnover	RUB bn	Rosstat	1
214	Retail Trade Turnover: Food Products	RUB bn	Rosstat	1
215	Retail Trade Turnover: Non Food Products	RUB bn	Rosstat	1
216	Wholesale Trade Turnover	RUB bn	Rosstat	1
217	Wholesale Trade Turnover: ow Wholesale Enterprises	RUB bn	Rosstat	1
218	Public Catering Turnover	RUB bn	Rosstat	1
219	Expectation Diffusion Index: Sales Prices: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
220	Expectation Diffusion Index: Purchasing Prices: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
221	Expectation Diffusion Index: Wages: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
222	Expectation Diffusion Index: Employment: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
223	Expectation Diffusion Index: Financial Situation: Enterprises with Improving Situation Next 3 Months	%	IMEMO	2
224	Expectation Diffusion Index: Orders: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
225	Expectation Diffusion Index: Debt to Banks: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
226	Expectation Diffusion Index: Equipment Purchase: Enterprises with Rising Indicator Next 3 Months	%	IMEMO	2
227	Actual Diffusion Index: Sales Prices: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
228	Actual Diffusion Index: Purchasing Prices: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
229	Actual Diffusion Index: Wages: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2

	Variable name	unit	source	lag months
230	Actual Diffusion Index: Employment: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
231	Actual Diffusion Index: Production: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
232	Actual Diffusion Index: Orders: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
233	Actual Diffusion Index: Stocks: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
234	Actual Diffusion Index: Sales/Purchasing Prices Ratio: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
235	Actual Diffusion Index: Equipment Purchase: Enterprises with Rising Indicator over 1 Month	%	IMEMO	2
236	Capacity Utilisation Rate: Actual: Normal Monthly Level=100	%	IMEMO	2
237	Labour Utilisation Rate: Actual: Normal Monthly Level=100	%	IMEMO	2
238	Stocks: Actual: Normal Monthly Level=100	%	IMEMO	2
239	Orders: Actual: Normal Monthly Level=100	%	IMEMO	2
240	Enterprises Debt to Banks: Normal Monthly Level=100	%	IMEMO	2
241	Enterprises in Good or Normal Financial Situation	%	IMEMO	2
242	Enterprises not Buying Equipment for 2 Months and More	%	IMEMO	2
243	Interest Rates on RUB Bank Loans: Attracting by Enterprises Next 3 Months	% pa	IMEMO	2
244	Enterprises without Debt to Banks and not Expected Next 3 Months	%	IMEMO	2
245	Enterprises not Going to Take Banking Loans Next 3 Months	%	IMEMO	2
246	Russia, Economic Policy Uncertainty, News Based Index	Index	http://www.policyuncertainty.com/russia_monthly.html	1
247	OECD, Russia CLI, Amplitude adjusted (CLI)	Index	OECD	2

Notes: SMPY=Same month previous year, PM=Previous month, CBR=Central Bank of Russia, Rosstat=Federal State Statistics Service, IMEMO= Institute of World Economy and International Relations RAS; RosKazna= The Federal Treasury; MOEX=Moscow Exchange; Rosaviation = Federal Agency of Air Transportation; MinFin= Ministry of Finance of the Russian Federation; Customs= Federal Customs Service

Appendix 2 Model overview

	Model class	Sub class	Polynomials	Number of lags	Number of model specifications (resulting from all combinations)
Contender models	**Bridge equations** as described in Schumacher (2016)	with AR component (= lagged GDP growth)		- in high frequency equation: 1 to 12 monthly indicator lags - in bridge equation: 1 to 4 GDP growth lags, 1 to 4 bridged indicator lags	12^4^4
		without AR component		- in high frequency equation: 1 to 12 monthly indicator lags - in bridge equation: 1 to 4 bridged indicator lags	12^4
	Mixed data sampling (MIDAS) as described in Clements and Galvão (2009)	with AR component (= lagged GDP growth) [AR MIDAS]	Almon lag polynomial of order 1 to 4	1 to 12 monthly indicator lags, 1 to 4 GDP growth lags	12^4^4 – 10
		without AR component [Basic MIDAS]		1 to 12 monthly indicator lags	12^4 – 10
	Unrestricted mixed-frequency model as described in Foroni et al. (2014)	with AR component (= lagged GDP growth)		1 to 12 monthly indicator lags, 1 to 4 GDP growth lags	12^4
		without AR component		1 to 12 monthly indicator lags	12
Benchmark models	**AR** (i. e. only lagged GDP, no monthly indicators)	iterative forecast		1 to 4 GDP growth lags	4
		direct forecast			4
	Rolling-window in-sample mean				1

Notes: Each of the around 37 10^6 model specification generates a separate forecast for each of the 247 monthly indicators at each forecast step (2008Q1–2016Q4) and for each forecast horizon (first to sixth monthly horizon). The forecast pooling procedure is described in Section 4. The reason that there are "–10" model specifications for MIDAS models is that the polynomial order must always be bigger than the lag order. Hence, some polynomial-lag combinations need to be excluded.

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ISSN 1456-4564 (print) // ISSN 1456-5889 (online)