Oil Prices, Excess Uncertainty and Trend Growth

A Forecasting Model for Russia's Economy

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The sharp contraction of Russian output in 2008–2009 and the country's recent poor growth performance came as a surprise to policymakers and analysts in Russia and elsewhere. In this paper, we examine the factors behind these developments, using a small structural error-correction (SVEC) macro model built for forecasting purposes. The estimation of the model indicates that Russia's economy is still strongly influenced by international oil prices and that there seems to be no major difference in this respect before and after the 2008–2009 crisis. However, in our linear model setup, oil prices alone cannot, for example, explain the major recession Russia faced in 2008–2009. To improve our forecasts around such particular events, we should explicitly account for increased uncertainty that is likely to have a direct impact on the real economy. Here, we estimate the impact of excess uncertainty by using exchange rate expectations. As to Russia's recent poor growth performance, the computations in this paper suggest that trend growth in Russia has halved from about 4% before 2008 to about 2% in 2013.

JEL classification: C32, E17, O13, P28, Q43
Keywords: Russian GDP, oil prices, trend growth, uncertainty, SVEC, forecasting

After the 1998 ruble crisis, Russia's economy witnessed a sharp turnaround compared with the dismal developments of the 1990s. In the first half of the 2000s, output and incomes increased, on average, by almost 7% on the back of the devaluation of the ruble, increasing oil prices, ambitious economic reforms and disciplined fiscal policy. In 2006–2007, Russia's GDP grew by over 8% per year due to the exceptional boom in the global economy and very high commodity prices. The country managed to repay its foreign debt and built up significant financial buffers in the form of the state oil fund and foreign exchange reserves of the central bank. Consequently, many people – including top Russian decision makers – believed that Russia's economic growth had gained a momentum of its own and could easily withstand any negative shocks, including those that started to threaten the world economy in 2008.

Events in Russia left no doubt, after the deepening of the global financial crisis in the latter part of 2008, however, that the country was still heavily dependent on global developments and in particular on energy prices. Russia's GDP contracted much more steeply in 2009 than in any other major economy, the recovery from the recession was slow, and economic growth has been weaker than expected ever since despite the resurgence of oil prices. These developments have been a source of much puzzlement and discussion among Russian decision makers and analysts in Russia and elsewhere.

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The economic structure of Russia and its oil dependency offer a unique starting point for modeling and forecasting Russia's growth dynamics. Oil prices play a key role in most if not all reported macro models.[2] At the Bank of Finland Institute for Economies in Transition (BOFIT), we have already been running a macro econometric model for Russia as part of our forecasting process for about ten years. The model has been revised and re-estimated to address changes in data and Russia's economy. Despite its small size, we have found that the model is a useful tool for analyzing Russia's growth dynamics and for promoting discussion on Russia's economy and economic policy.[3]

This paper illustrates the structure and performance of the model used at the BOFIT, as we analyze Russia's growth performance during and after the 2008–2009 global financial turmoil. Using our model, we show how the sharp contraction in Russian output in 2009 can be explained by oil prices and excess uncertainty, which is measured by changes in exchange rate expectations. As regards developments since 2009, our estimations indicate that there has been a significant decline in trend growth after the crisis in 2008–2009. There is no evidence that the role of oil prices in the Russian economy radically changed during the years studied here.

The paper is organized as follows: Section 1 offers a short discussion of the modeling strategy and data used in this exercise. In section 2, we estimate the long-run model, which is then integrated into our final short-run forecasting model in section 3. Section 4 presents three scenarios on oil prices and increased uncertainty to produce a baseline forecast and analyze the key properties of the model. Section 5 concludes with a summary of the key findings and comments on the usefulness of our model.

1 Model and Data

In our modeling work, we focus on Russia's GDP and imports as they are the key factors to explain other countries' exports to Russia.[4] To analyze and forecast GDP and import developments, we use vector autoregressive (VAR) modeling and cointegration techniques. The general framework model we use (with two lags) can be written in matrix form as:

$$\Delta y_t = \Pi_0 y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} + \Psi D_t + \varepsilon_t \tag{1}$$

Equation (1) shows how the values of first differences of endogenous variables in the system depend on their own lagged values and lagged values of other endogenous variables, on predetermined variables D_t, and on the error term ε_t.

[2] *See Benedictow et al. (2013) for a recent analysis of Russia's oil dependency based on an econometric macro model.*

[3] *The BOFIT forecast process involves several stages. Given the oil price forecast (often oil futures), we compute with the model a forecast for the current year and the next two years. These forecasts are then evaluated and discussed while taking into account other information. The final published forecasts are seldom exactly the same as the model forecasts.*

[4] *The BOFIT Russia forecast is part of a wider assessment of Finland's export market developments. It is also an integral part of the joint OeNB and BOFIT semiannual forecasts of economic developments in selected CESEE countries. Similar to the Russian forecast model presented in this study, these forecasts are based on a broad range of information, including country-specific time series models. For technical details and country coverage, see Crespo Cuaresma et al. (2009).*

The matrix Π_0 is a product of two matrices, i.e. $\Pi_0 = \alpha\beta'$, and it determines how the levels of our endogenous variables enter the system. The α matrix consists of the speed-of-adjustment coefficients and the β matrix displays the long-run relationships, or cointegration vectors, among the variables.[5]

We start with estimating long-run equilibrium conditions (cointegration vectors) among the levels of our key variables. At the next stage, these equilibrium conditions are included as error-correction terms in the short-run model, where the key variables are expressed in first differences (a vector error-correction (VEC) model). Finally, we impose restrictions on individual equations to exclude variables that are not significant to get a final parsimonious structural vector error-correction model (SVEC model).

In the model, endogenous variables, which are determined within the model, include Russia's GDP *(gdp),* imports *(imp)* and the real exchange rate of the ruble *(reer).* Trends of the key model variables are shown in chart 1. The price for Russia's main crude oil export blend, Urals, is an exogenous variable as its value depends on global energy markets and not on the endogenous variables of our system (see chart 2). In addition to the key variables, a constant term and a time trend as well as a number of time dummies are used as explanatory variables at different stages of the estimation process. Moreover, a step dummy is introduced to capture Russia's poor growth performance in the post-crisis period.

As earlier versions of our model had had difficulty in predicting the extent of Russia's GDP plunge in 2008–2009, we have added in our short-run model a particular variable *(crisis)* to capture excess uncertainty around crisis periods in Russia. This variable is based on the idea that sudden negative market sentiment about coming quarters would immediately impact on real developments in the current quarter. In our exercise, we mimic this kind of uncertainty by using exchange rate expectations. So, our crisis variable is computed by taking the first difference of the value of the nominal ruble basket and raising the remainder to the square. To allow the impact of thus computed excess uncertainty to be distributed more extensively over coming quarters, we employ a distributed lag model to compute the final uncertainty variable, which is used with a one-period lead in our model estimations.[6] Chart 2 shows both the non-smoothed and the final smoothed series, the latter being used in our exercise, to illustrate the behavior of our proxy for excess uncertainty.[7]

[5] *See, for example, Doornik and Hendry (2009), Juselius (2006) or Patterson (2000) for a full description of VAR modeling and cointegration. While using a slightly different variable set, Rautava (2004) offers a more detailed description of the econometric issues related to our modeling strategy. Rautava (2009) presents one later version of the model and discusses its forecast properties during the 2008–2009 crisis.*

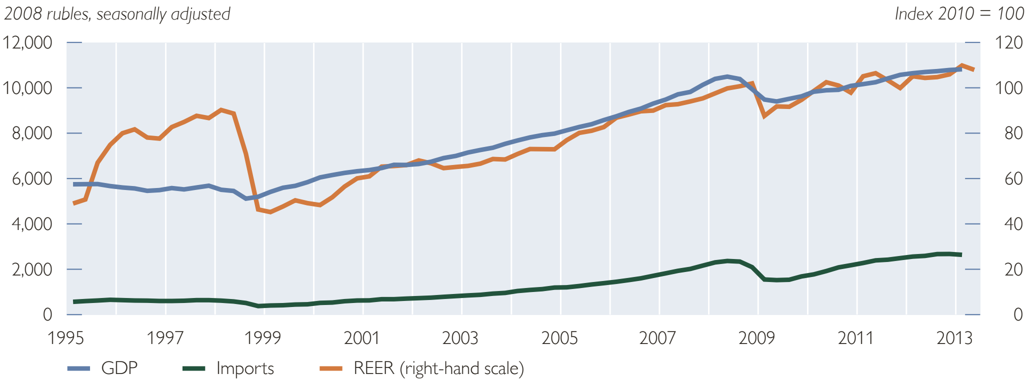
[6] *We use the Almon lag function of PcGive with parameters (lags=3, power=1) to distribute changes in our uncertainty measure over the current and three following quarters as illustrated in chart 2. The choice of these particular parameter values reflects our view on how long a possible uncertainty shock may impact the real sector and is based on a few experiments about how the significance of the crisis variable changes in our model estimations with different smoothing parameters.*

[7] *One should note that our crisis measure does not distinguish between the depreciation and appreciation of the ruble as an indication of increased uncertainty. For estimation purposes, this is, however, not a problem given the absence, during our estimation period, of any exceptional positive shocks to the Russian economy that would have caused a sudden and significant strengthening of the ruble. As regards estimation of the model in the future, we will of course have to reconsider our crisis variable should excess uncertainty related to ruble appreciation become an issue. Actually, we could use a series whose values differ from zero only when the ruble weakens; for our current estimations this would not imply major changes.*

We draw on quarterly data from Q1 1995 to Q1 2013 for our analysis. Data for real GDP *(gdp)* and imports *(imp)* come from Rosstat, while the index of the ruble's real effective exchange rate *(reer)* comes from the BIS. Dollar prices for Russia's Urals oil *(oil)* come from Bloomberg. For GDP and imports, we use seasonally adjusted data. Data for the key variables are in logarithmic form, which allows for the interpretation of estimated parameters as elasticities.[8]

Chart 1

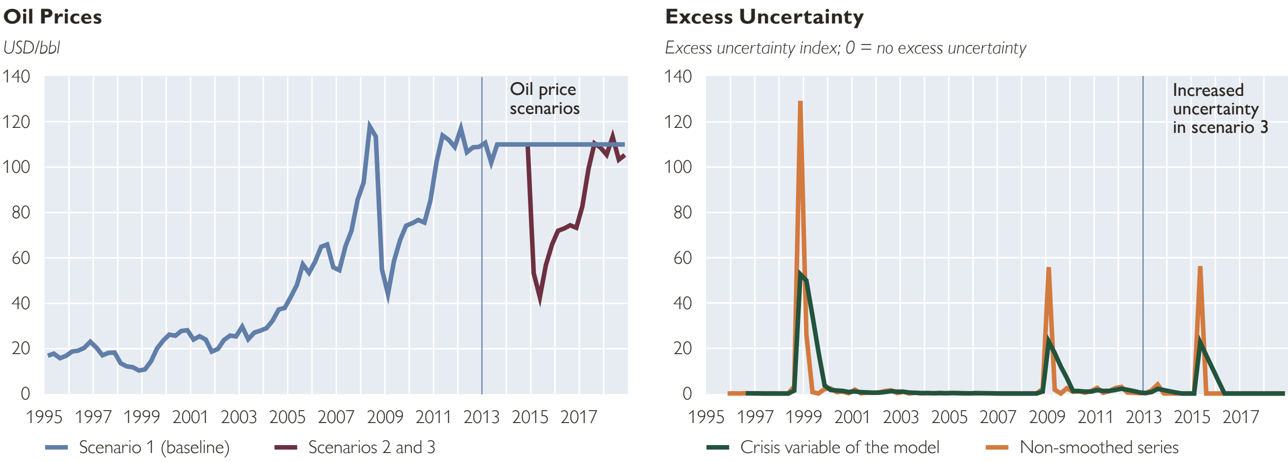
**Key Model (Endogenous) Variables:
Russian GDP, Imports and the Real Exchange Rate of the Ruble**



Source: Rosstat, BIS, author's calculations.

Chart 2

Predetermined (Exogenous) Variables



Source: Bloomberg, author's calculations.

Source: Author's calculations.

2 Long-Run Analysis

Chart 1 suggests that there are strong links among our model variables. This, together with the observation that they seem to be nonstationary in a sense that their statistical means seem to change over time, indicates possible cointegration

[8] *PcGive is used for model estimations. The Tramo/Seats package of EViews is used for seasonal adjustment.*

among the model variables. So, we start with the long-run analysis, which is based on the Johansen method. Given our focus on Russian GDP and imports, as well as our prior understanding about the possible links among the variables, it is in principle relatively easy to identify two long-run cointegration vectors among our three endogenous variables.[9] However, in light of the high volatility of the Russian data and clearly distinct developments, first, before and after the ruble crisis in 1998, and, second, after the global financial crisis in 2008–2009, in practice it is far from straightforward to establish stable long-run relations for our system. In this respect, the current situation seems to be more difficult than that before 2008. Actually, while we try to follow standard modeling practices and use available test diagnostics, the final choice of long-run parameters is based on numerous estimations and previous findings.[10] Nevertheless, it is possible to establish reasonable long-run equilibrium equations for Russia's GDP (equation 2) and imports (equation 3), which are not too different from our earlier estimations and which can be accepted by most test diagnostics. In other words, we may have managed in our model to capture some true long-run features of the Russian economy. As shown later, equations (2) and (3) work well as error-correction terms in our short-run model, which serves as the final test of their significance.

$$gdp = 0.2*oil + 0.005*trend \tag{2}$$

$$imp = 2.0*gdp + 0.7*reer \tag{3}$$

The time trend is the most interesting – and difficult – issue in the long-run model estimations. In equation (2) for Russian GDP, the parameter value of the trend variable (0.005) indicates that the long-run underlying trend growth of the Russian economy is about 2% per annum. This is only half of what we had observed before the onset of the global financial crisis in 2008. While it is not possible to identify the actual reasons for the decline in trend growth in our model setup, one may speculate that it relates to a poor business environment, a slowdown of reforms and a loss of competitiveness of Russian enterprises in post-crisis Russia, which has hit, in particular, investments.[11] The parameter value of the oil variable (0.20) in equation (2) indicates that a permanent 10% increase in international oil prices is associated with a 2.0% increase in the level of Russian GDP, i.e. a gradual

[9] *After having managed to identify cointegration vectors for GDP and imports, i.e. our main interests, we do not consider identifying a long-run equilibrium condition for the real exchange rate as otherwise we should abandon either the GDP or the import equation.*

[10] *After numerous estimations, we test whether our identification of equations and restrictions on parameter values in equations (2) and (3) are in line with data. There are problems with residual heteroskedasticity, but single equation residual tests concerning normality and autocorrelation as well as the likelihood ratio test on restrictions point to no particular problems with our model. The α parameters of GDP and imports are negative, which indicates a proper adjustment of the system to deviations from long-run equilibrium, although a low value of α related to GDP suggests a slow correction. The estimation period for the long-run analysis ranges from Q1 1996 to Q4 2011. Inclusion of data for 2012 would have suggested the elimination of the trend variable in equation (2), a feature we do not, at least not yet, want to introduce in our model.*

[11] *Russia ranks poorly in studies concerning business environment and competitiveness. In the WEF Global Competitiveness Report 2012–2013, Russia's rank is 67 among 144 countries (Switzerland is in first place). The Doing Business 2013 survey by the World Bank and the IFC puts Russia in the 112th position among 185 economies (Singapore tops the list). According to Transparency International, Russia's position was 133 among the 176 least corrupted countries in 2012 (Denmark, Finland and New Zealand shared the first rank).*

increase in output to a new sustainable level. However, estimations indicate that this adjustment process would be relatively slow. Given the on-and-off debate about the role of the ruble in economic policy, it is perhaps interesting to note that the level of the real exchange rate does not seem to play a role in determining long-run growth.[12] In fact, in the longer run, the causality may run from output to the real exchange rate rather than vice versa.

The interpretation of the long-run import equation (3) is straightforward. The long-run output elasticity of imports suggests that a 1% permanent increase in the level of GDP is associated with a 2% increase in real imports. This is in line with our prior knowledge that imports tend to overreact to changes in incomes (GDP).[13] In a similar manner, a 10% appreciation of the ruble's real exchange rate tends to boost the level of real imports by some 7%. Oil prices do not seem to impact imports directly, but rather through GDP, which may explain the relatively high income elasticity of imports in our model.

3 Short-Run Forecasting Model

Next, the above two long-run equilibrium conditions are included in the short-run, first-difference model of our variables as error-correction terms *(ECgdp* and *ECimp)*. In table 1, we report the estimation results of our current model specification. As evidenced in table 1, the parameter values of lagged error correction terms for output *(ECgdp)* and imports *(ECimp)* in their respective short-run equations are significant with negative signs, which indicates that our model adjusts in an equilibrating manner to deviations from the long-run equilibrium. Russia's poor growth performance since 2008 is underlined by our growth dummy *(growth_dummy)* variable that takes the value 0 before the second quarter of 2008 and 1 thereafter. The negative value of the parameter (–0.0060) indicates that the decline in trend growth in our long-run model cannot by itself explain the poor performance of Russia's economy since the 2008 onset of the financial crisis. In addition to their impact via the long-run equilibrium correction mechanism, oil prices also have a direct positive short-run effect on both output and imports. As regards the role of the real exchange rate, while it is not linked to output in the long run, depreciation (appreciation) of the ruble has a positive (negative) impact on output in the short run. In our model setup, the trends in the real exchange rate *(reer)* for their part can be explained by output developments and the lagged values of *reer* as well as our *crisis* variable, which is not a surprise as the latter reflects changes in the nominal exchange rate. Chart 1 illustrates the close relationship between Russian GDP and the real exchange rate of the ruble. Moreover, the output variable also seems to indirectly account for the possible impact of oil prices on the real exchange rate in the model.

Our variable for excess uncertainty *(crisis)* is highly significant in all equations and seems to compensate for some time dummies, which would otherwise have been needed to control for volatility in our data. So, increased uncertainty, measured by nominal exchange rate expectations concerning the next quarter, has a negative

[12] *Kuboniwa (2012) likewise argues that the real exchange rate of the ruble should not enter the long-run equation of Russian GDP.*

[13] *See Senhadji (1998) for income elasticities of imports for a large number of countries and Kuboniwa (2012) for Russia.*

impact on all endogenous variables in our system. Had it been introduced earlier, this variable would have considerably improved our GDP forecast concerning the deepness of recession in Russia around 2008–2009. We will demonstrate this aspect in the next section.

The only puzzle in table 1 seems to be the negative sign of the real exchange rate in the import equation. This implies that appreciation of the ruble would cut imports, which is clearly against our intuition. Whether this negative sign reflects some short-run behavior where households and firms feel confident to postpone their import orders when the ruble appreciates or whether it is only a statistical artifact, remains an open issue. Nevertheless, in our long-run import equation (3) the real exchange rate has an expected sign and the respective error-correction term in the short-run import equation is highly significant. Moreover, our short-run model passes standard test diagnostics without obvious problems, so perhaps we do not have to worry too much about this particular puzzle (see the annex for the test diagnostics).

Table 1

The Final Parsimonious Short-Run Model

	Coefficient	t-value	t-prob
Equation for Dgdp			
Constant	0.4581	2.73	0.010
Dgdp_1	0.2834	3.93	0.000
Dreer_1	–0.0676	–2.47	0.018
Dreer_2	–0.0490	–3.15	0.003
Doil	0.0293	4.22	0.000
ECgdp_1	–0.0554	–2.66	0.012
crisis_–1	–0.0014	–9.23	0.000
growth_dummy	–0.0060	–2.73	0.010
Equation for Dimp			
Constant	–2.8143	–7.05	0.000
Dgdp_1	1.7919	10.8	0.000
Dgdp_2	0.3345	2.33	0.025
Dimp_1	–0.1517	–2.86	0.007
Dreer_1	–0.1935	–4.22	0.000
Doil	0.0647	5.61	0.000
ECimp_1	–0.2027	–7.09	0.000
crisis_–1	–0.0026	–10.6	0.000
Equation for Dreer			
Dgdp_1	1.2749	7.47	0.000
Dreer_2	–0.2292	–4.98	0.000
crisis_–1	–0.0039	–10.1	0.000

Source: Author's estimations.

Note: In the first column, a positive number after the variable indicates lags and a negative number leads. Time dummies are not reported.

Next, we demonstrate the performance of the model by running some scenarios. Here, we will focus only on GDP developments.

4 Three Scenarios on Oil Prices and Uncertainty

While our previous model version without the *crisis* variable was able to forecast the deceleration of growth in Russia in the latter part of 2008, it failed to predict the deepness and duration of the actual recession.[14] We believe that the current model with the *crisis* variable will produce more accurate forecasts if we face a comparable situation in the future. To illustrate the difference between the model which relies only on oil prices and the model where we take increased uncertainty into account, we run three scenarios for the period from Q2 2013 to Q4 2016.

First, we compute a baseline scenario, i.e. scenario 1, using actual prices for oil for Q2 2013; thereafter the oil price is fixed at USD 110 per barrel. In the second scenario, we assume that oil prices plunge to USD 53/bbl at the beginning of 2015 (in analogy to the drop in Q4 2008) and then follow a path similar to

[14] *Based on our model projections, we wrote a policy note on October 17, 2008 (Bank of Finland, Monetary Policy and Research Department, Oil prices and the Russian economy – Sensitivity calculations for 2009), where we warned that Russia's GDP growth might only be 1% in 2009 if oil prices collapsed to USD 50/bbl. The Consensus forecast in October 2008 for 2009 Russian output growth was still 5%. Actually, Russia's GDP declined 8% in 2009, while the average oil price was USD 61/bbl.*

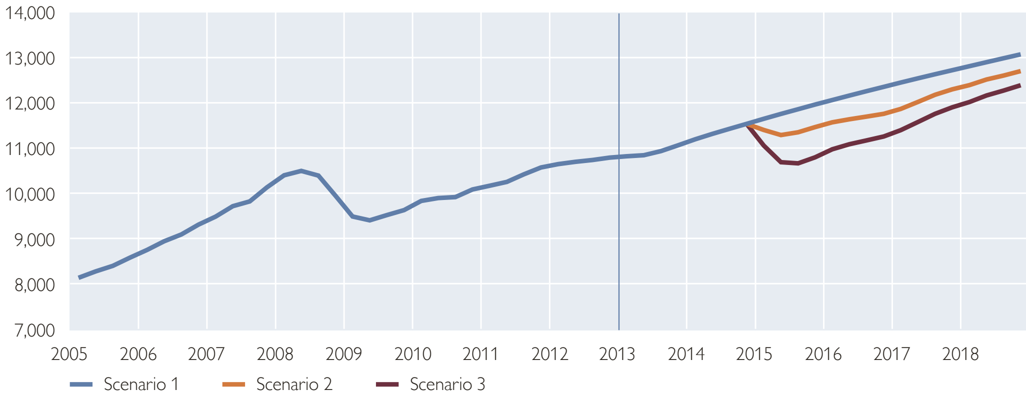
the one seen after the oil price collapse in Q4 2008 (see chart 2)[15]. In these two scenarios, there is no excess uncertainty, which would become evident in our crisis variable. In the third scenario, oil prices are the same as in the second scenario, but now we assume that the sudden collapse of oil prices also causes additional uncertainty. In the terms of our model variables, we may consider a situation where people expect the ruble to depreciate markedly in Q2 2015, which is reflected in our crisis variable. In this respect, the situation resembles conditions in the fall of 2008, when devaluation speculations and massive capital outflow preceded the actual devaluation of the ruble at the beginning of 2009. Moreover, the magnitude of the assumed increase in uncertainty compares well with the situation in 2008–2009 (see the crisis series in chart 2). The three scenarios are presented in chart 3 and table 2.

Forecast simulations show that the halving of oil prices causes a significant deceleration of growth in our model calculations. Yet, it does not trigger a true recession comparable to that in 2008–2009. We see a drop in output at the beginning of 2015 (chart 3), but even if the annual growth rate declines by 4 percentage points, it nevertheless remains in positive territory, albeit marginally (table 2). However, the situation changes dramatically when we take into account the likely increase in overall uncertainty in Russia after the collapse of oil prices. The slump in oil prices combined with increased uncertainty produces a deep recession reminiscent

Chart 3

Russian Output Developments

GDP in RUB billion (in constant 2008 rubles)



Source: Author's computations.

Table 2

Russia's GDP Growth

	Scenario 1	Scenario 2	Scenario 3
Average oil price in 2015, USD/bbl	110	55	55
Increased uncertainty in 2015	No	No	Yes
	GDP growth, %		
2012	3.5	3.5	3.5
e2013	1.8	1.8	1.8
e2014	4.2	4.2	4.2
e2015	3.9	0.1	–5.0
e2016	3.4	2.5	3.0
e2017	3.1	3.7	4.8
e2018	2.8	3.8	4.7

Source: Author's computations.

[15] *Since we use a linear model, assumptions about the oil price (increase/decrease) yield symmetric effects.*

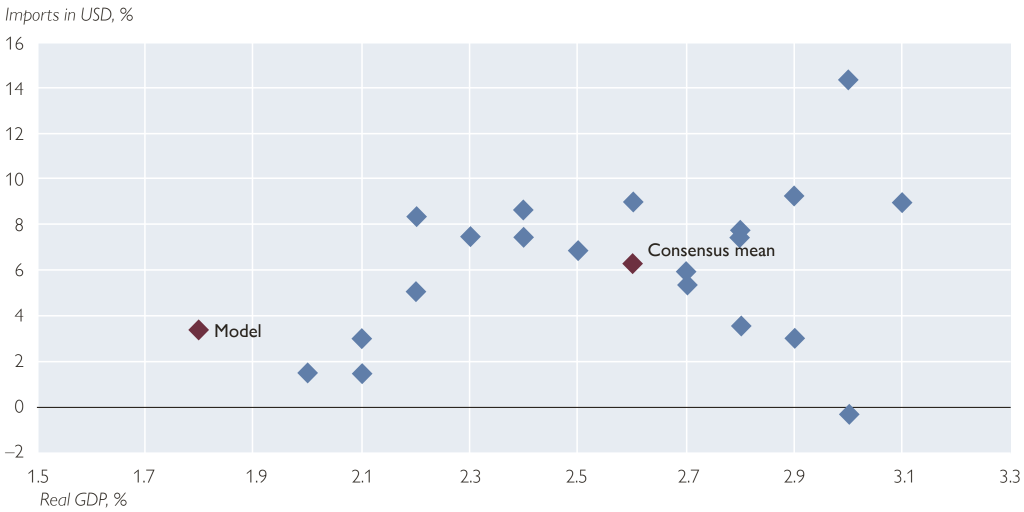
of the situation in Russia in 2008–2009. In scenario 3, it takes GDP two and a half years to recover to the pre-crisis level. In the previous recession, it took slightly more than three years for output to rev back to the Q2 2008 level.

The statistical significance of the crisis variable in the estimated model and the model's ability to produce realistic forecasts during crisis periods attest to the plausibility of our method to model excess uncertainty. First, using excess exchange rate volatility as a proxy for uncertainty allows us to estimate our model parameters in a straightforward way. Second, we may also use market expectations in the forecast process. For example, in the fall of 2008, just before the ruble plummeted, there were plenty of market speculations about the size of the coming devaluation of the ruble. With the benefit of hindsight, using these expectations about the ruble's devaluation would have helped compute more realistic GDP forecasts for 2009 compared with the forecasts published in late 2008. Third, our *crisis* variable offers a flexible way to consider uncertainties of a different kind (e.g. political) concerning the Russian economy if we can formulate them in terms of this variable. Assessing uncertainty in varying circumstances is of course difficult, but as demonstrated by our simulations here, we can use previous crises and the history of our *crisis* series to construct proxies for excess uncertainty that produce interesting and useful results. To accomplish this difficult task of evaluating uncertainties and risks, it naturally helps to have a deep understanding of the Russian economy and society.

Russia's output growth has decelerated from the latter part of 2011 as clearly evidenced by chart 3. Our model calculations in scenario 1, however, indicate a pickup in growth after 2013, after which the model starts adjusting the growth rate toward long-run trend growth of 2% because there are no changes in oil prices or uncertainty. Under this baseline scenario, the oil price is assumed to be

Chart 4

Growth Forecasts for Russia's GDP and Imports in 2013



Source: Consensus Economics July 2013, author's calculations.

Note: The vertical axis reports changes in USD-based imports except in the case of our model for which it shows a change in the volume of imports. Blue diamonds refer to the individual forecasts of economic and financial forecasters that participate in the Consensus Economics exercises, the right red diamond (Consensus mean) denotes the unweighted average of these forecasts, the left red diamond (Model) the forecast of the BOFIT model.

close to actual oil prices as at July 2013. Interestingly, a pure model forecast predicts Russia's GDP to grow by only 2% in 2013 and to rebound to 4% in 2014. Compared with July's Consensus forecasts for Russia, our model projections indicate weaker growth in 2013 (see chart 4), whereas the Consensus mean of 3% for 2014 is lower than our model forecast.[16]

5 Conclusions

In spite of its small size, the macro model of the Russian economy presented in this paper is able to produce useful benchmark forecasts that inspire discussions about Russian developments.[17] It also offers a tool to compute scenarios based on different oil prices, a task that would be very difficult without a model. The above model calculations shed light on three particular issues that have in recent years been widely debated by professional forecasters of the Russian economy.

First, oil prices continue to play a key role in Russia's economy, and the model estimations in this paper show no major changes in this respect during the latter part of the 2000s and the beginning of this decade. However, particularly in very uncertain times, changes in oil prices alone cannot offer a proper explanation for output developments. At least, this is the case in our linear model setup. So, it would be interesting to study whether nonlinear models could reveal some new insights in this respect.

Second, we show that explicitly addressing increased uncertainty in exceptional times helps improve our forecasts. In this exercise, we construct a "crisis" variable based on exchange rate expectations to deal with excess uncertainty. Our model forecasts confirm that such a variable may help understand how sudden increases in uncertainty may negatively affect real sector developments. In addition to standard forecasting, a crisis variable like the one presented here appears to be important for scenario calculations as oil prices alone cannot evidently capture developments in turbulent times in Russia.

Third, our paper contributes to the current discussion about Russia's recent growth performance. We have a case to claim that underlying trend growth in Russia has significantly decelerated in comparison with pre-crisis years. The computations here suggest that annual trend growth halved from around 4% before 2008 to around 2% in recent years, and we cannot exclude an even bigger drop. While it is not possible to analyze the reasons for this decline in our model framework, potential suspects are a worsening – at least in relative terms – of the business environment and a loss of competitiveness of Russian firms as economic reforms stalled in the latter part of the last decade.

[16] *One should note that the low value of Rosstat's Q1 2013 GDP figure inspired a lively discussion about its accuracy. Estimations during the writing of this article give some support to worries that the figure may be too low compared to developments of other factors in our model. Any revisions of the series would of course affect forecasts presented here.*

[17] *The size of the model is perhaps not as critical as one may think as the findings of the earlier versions of our model compare well with the results obtained when using larger structural models, see Benedictow et al. (2013) or Rautava (2010).*

References

Benedictow, A., D. Fjærtoft and O. Løfsnæs. 2013. Oil dependency of the Russian economy: An econometric analysis. In: Economic Modelling 32. 400–428.

Crespo Cuaresma, J., M. Feldkircher, T. Slačík and J. Wörz. 2009. Simple but Effective: The OeNB's Forecasting Model for Selected CESEE Countries. In: Focus on European Economic Integration Q4/09. 84–95.

Doornik, J. A. and D. F. Hendry. 2009. Modelling Dynamic Systems – PcGive 13. Volume II. Timberlake Consultants Ltd., U.K.

Juselius, K. 2006. The cointegrated VAR model: methodology and applications. Advanced texts in econometrics. Oxford: Oxford University Press.

Kuboniwa, M. 2012. Diagnosing the 'Russian Disease': Growth and Structure of the Russian Economy. In: Comparative Economic Studies 54. 121–148.

Patterson, K. 2000. An Introduction to Applied Econometrics: A Time Series Approach. Basingstoke: Palgrave Macmillan.

Rautava, J. 2004. The role of oil prices and the real exchange rate in Russia's economy – a cointegration approach. In: Journal of Comparative Economics 32. 315–327.

Rautava, J. 2009. A forecasting model for Russia's economy. In: BOFIT Online 10/2009. 42–48.

Rautava, J. 2010. Russia's Dependence on Oil – Perspectives from Macroeconomic Models. In: Korhonen, I. and L. Solanko (eds.). From Soviet Plans to Russian Reality. Helsinki: WSOYpro Oy.

Senhadji, A. 1998. Time-Series Estimation of Structural Import Demand Equations: A Cross-Country Analysis. In: IMF Staff Papers 2/45. 236–268.

Annex

The following tables show the test diagnostics of the short-run model.

Table A1

Correlation of Structural Residuals (standard deviations on diagonal)

	Dgdp	Dimp	Dreer
Dgdp	0.0080	0.3573	–0.3655
Dimp	0.3573	0.0132	0.1546
Dreer	–0.3655	0.1546	0.0249

Source: Author's calculations.

Table A2

Single-Equation Diagnostics Using Reduced-Form Residuals

Dgdp:	AR 1-5 test:	F(5,50)=	0.9004	[0.4882]
Dgdp:	ARCH 1-4 test:	F(4,60)=	0.3803	[0.8218]
Dgdp:	Normality test:	Chi^2(2)=	1.4498	[0.4844]
Dgdp:	Heteroskedasticity test:	F(13,52)=	0.4534	[0.9403]
Dimp:	AR 1-5 test:	F(5,43)=	1.6709	[0.1622]
Dimp:	ARCH 1-4 test:	F(4,60)=	0.5797	[0.6785]
Dimp:	Normality test:	Chi^2(2)=	2.8192	[0.2442]
Dimp:	Heteroskedasticity test:	F(14,52)=	0.8357	[0.6286]
Dreer:	AR 1-5 test:	F(5,52)=	0.5041	[0.7718]
Dreer:	ARCH 1-4 test:	F(4,60)=	0.6550	[0.6257]
Dreer:	Normality test:	Chi^2(2)=	2.9323	[0.2308]
Dreer:	Heteroskedasticity test:	F(6,59)=	0.4123	[0.8680]
Vector	SEM-AR 1-5 test:	F(45,110)=	1.0511	[0.4074]
Vector	Normality test:	Chi^2(6)=	12.043	[0.0610]
Vector	Heteroskedasticity test:	F(126,233)=	1.0218	[0.4391]

Source: Author's calculations.