**Forecasting Russian GDP, inflation and interest rates**

**using DSGE-VAR model [[1]](#footnote-1)**

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DSGE models assume theoretically justified restrictions on the parameters of the relationship of variables, which can reduce the fit of the model to the data. VAR models, on the other hand, have fewer constraints and therefore better fit to the data. On the other hand, a high degree of in-sample fit does not guarantee good out-of-sample predictive properties. The use of the DSGE-VAR method, in which the DSGE model is used as a prior for estimating the BVAR model, allows you to simultaneously prevent overfitting of the model on the sample and ensure that the identification matches the theoretical model.

The DSGE-VAR method can also be represented as a relaxation of the cross restrictions on the coefficients generated on the basis of the VAR representation of the DSGE model. The procedure for reducing the constraints of the DSGE model to the constraints of the VAR model is given in Del Negro and Schorfheid 2004 [1]. For simplicity, this process can be represented as three steps: it is necessary to reduce the DSGE model to a state-space model, followed by reduction to an infinite vector autoregression and reduction of the latter to a finite-order vector autoregression. This procedure also makes it possible to match the innovations of the reduced VAR model with the structural shocks of the DSGE model, which significantly increases the possibilities of economic analysis using the DSGE-VAR model compared to the unconstrained VAR model.

DSGE-VAR combines the compliance of DSGE models with Lucas' critique and the accuracy of the BVAR forecast [2]. The first allows you to use the DSGE-VAR model as a reference when comparing DSGE models and assessing the degree of misspecification. And the second is confirmed by comparisons of the forecast properties of the DSGE-VAR model with the forecast properties of the DSGE model, BVAR with a Minnesota prior and TVP-VAR, which were made on the basis of macroeconomic data from a number of countries: USA, Australia, New Zealand, South Africa and Romania, and DSGE-VAR models turned out to be competitive. Despite this, such a forecasting approach is being used for the first time for the Russian economy.

The paper proposes a structural BVAR with a prior based on a DSGE model for forecasting key macroeconomic indicators of the Russian economy: real GDP, nominal key interest rate and inflation. As a source of a prior I chose the DSGE model of the Russian economy with a small number of equations presented in the work of Kreptsev and Seleznev [3], which is further called the basic model. An augmented DSGE model was also used, which was obtained by adding a variable inflation target level to the basic DSGE model.

The study uses the following data for the period from the Q2 2003 to Q4 2021: average overnight MIACR, real GDP growth rate, real export growth rate, oil price growth rate, US dollar exchange rate growth rate, CPI inflation.

Based on the calculations, it can be concluded that with the help of a prior formed on the basis of the basic DSGE model, it is possible to increase the marginal likelihood of the estimated DSGE-VAR model compared to the unrestricted VAR model. This means that the DSGE-VAR describes the dynamics of the observed variables of the Russian economy better than the unrestricted VAR model. The analysis also showed that since the beginning of 2021, the Russian economy is better described by the DSGE model with a fixed inflation target of 4% than by the DSGE model with a variable inflation target, which better describes the data up to the beginning of 2018. Therefore, for retrospective analysis, it is better to use a DSGE model with a variable target level, and for forecasting, it is better to use a basic DSGE model.

Based on a comparison of the predictive properties in terms of the root mean square forecast error (RMSFE) of the basic DSGE model and the DSGE-VAR model based on it, presented in Tables 1-3 with respect to the corresponding RMSFE of the naive forecast, we can conclude that on a horizon of up to 5 quarters inclusive, it is better to use the DSGE-VAR model to predict output growth, inflation and interest rates, since the average gain of the last model on a horizon of up to 2 years inclusive was 12.5%, 12.7% and 11.4%, respectively, which is a serious advantage .

The addition of a variable inflation target level to the DSGE model and its use as a prior for the DSGE-VAR model made it possible to improve the quality of the forecast of the latter relative to the predictive properties of the DSGE-VAR model based on the basic DSGE model as follows. Over the horizon of up to two years inclusive, the improvement in the output forecast, inflation and rates averaged 1.4%, 3.1% and 3.6%, respectively.

The best quality of the interest rate forecast over all forecast horizons of the 4 models presented in Table 3 is demonstrated by the DSGE-VAR model based on the augmented DSGE model, however, the forecast obtained using the best model in terms of predictive strength loses to the naive forecast in the form the last available level on the horizon up to 6 quarters inclusive.

From the point of view of the inflation forecast, all the models under consideration manage to demonstrate higher accuracy compared to the naive forecast. On the horizon of the 1st quarter, the DSGE-VAR model based on the basic DSGE model turned out to be the best, on the horizon of 2 to 5 quarters inclusive, the best forecast quality was shown by the DSGE-VAR model based on the augmented DSGE model, in other cases, the augmented DSGE-model turned out to be the best. model. A similar picture emerged for the forecast of real output growth.

Table 1 – Gain of the corresponding model in forecasting GDP, quarter-on-quarter of the previous year, in terms of RMSFE relative to the RMSFE of the naive forecast as the latest available value

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Horizon, quarter | Basic DSGE | Basic DSGE-VAR | Augmented DSGE | Augmented DSGE-VAR |
| 1 | 0,96 | **0,77** | 0,96 | **0,77** |
| 2 | 1,07 | **0,79** | 1,06 | **0,79** |
| 3 | 1,14 | 0,83 | 1,12 | **0,81** |
| 4 | 1,11 | 0,80 | 1,07 | **0,77** |
| 5 | 0,92 | 0,86 | 0,90 | **0,83** |
| 6 | 0,87 | 0,88 | **0,85** | **0,85** |
| 7 | 1,03 | 1,07 | **1,03** | 1,06 |
| 8 | 0,98 | 1,01 | **0,97** | 1,01 |

Table 2 – Gain of the corresponding model in inflation forecasting, quarter-on-quarter of the previous year, in terms of RMSFE relative to the naive RMSFE as the latest available value

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Horizon, quarter | Basic DSGE | Basic DSGE-VAR | Augmented DSGE | Augmented DSGE-VAR |
| 1 | 0,77 | **0,67** | 0,69 | 0,68 |
| 2 | 0,77 | 0,65 | 0,67 | **0,63** |
| 3 | 0,75 | 0,63 | 0,64 | **0,61** |
| 4 | 0,77 | 0,63 | 0,62 | **0,60** |
| 5 | 0,62 | 0,53 | **0,50** | **0,50** |
| 6 | 0,55 | 0,47 | **0,45** | 0,46 |
| 7 | 0,40 | 0,36 | **0,32** | 0,35 |
| 8 | 0,29 | 0,30 | **0,26** | 0,29 |

Table 3 – Gain of the corresponding model in predicting the interest rate in terms of RMSFE relative to the RMSFE of the naive forecast as the last available level

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Horizon, quarter | Basic DSGE | Basic DSGE-VAR | Augmented DSGE | Augmented DSGE-VAR |
| 1 | 1,41 | 1,30 | 1,29 | **1,29** |
| 2 | 1,50 | 1,34 | 1,35 | **1,26** |
| 3 | 1,47 | 1,35 | 1,32 | **1,24** |
| 4 | 1,43 | 1,30 | 1,29 | **1,22** |
| 5 | 1,37 | 1,22 | 1,25 | **1,17** |
| 6 | 1,28 | 1,10 | 1,19 | **1,08** |
| 7 | 1,10 | 0,95 | 1,04 | **0,93** |
| 8 | 0,97 | **0,81** | 0,92 | **0,81** |

# **Bibliography**

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| 1. | Del Negro M., Schorfheide F. Priors from general equilibrium models for VARs // International Economic Review. 2004. Vol. 45. No. 2. pp. 643-673. |
| 2. | Del Negro M., Schorfheide F., "Take your model bowling: forecasting with general equilibrium models," *Economic Review-Federal Reserve Bank of Atlanta.*, Vol. 88, No. 4, 2003. pp. 35-50. |
| 3. | Kreptsev D., Seleznev S., "Forecasting for the Russian Economy Using Small-Scale DSGE Models.," *Journal of Money and Finance*, Vol. 77, No. 2, June 2018. pp. 51–67. |

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2. The Bank of Russia and the Russian Presidential Academy of National Economy and Public Administration [↑](#footnote-ref-2)