PRODUCTION FUNCTION: A MULTIVARIATE FILTER TO ESTIMATE POTENTIAL OUTPUT AND OUTPUT GAP IN RUSSIA

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Background and Motivation

The motivation for the research is straightforward and policy-oriented – we need an instrument to better understand current macroeconomic dynamics to make proper decisions on economic policy, including monetary one. For that, we need reliable estimates of both GDP trend and cycle dynamics to understand (dis)inflationary pressure coming from the real sector of the economy at any given time. Production function is a widespread way to do it and it also allows to study the economy from the Supply side, which is usually ignored by other macroeconomic models such as DSGE. The goal of the research is to combine real-time estimation (incl. nowcasting) of the GDP trend and gap dynamics with production function. I do it through building multivariate unobserved components filter which incorporates different measures of labor, capital and utilization in the Russian economy, that is in line with a similar research for the Europe – Toth (2021).

Data and Methodology

In this paper, I construct a **model of unobservable components** (state space model) to decompose the dynamics of the output into trend and cycle, and then to identify the supply side factors contributions into both potential GDP growth and output gap. The model is estimated using the Kalman filter with Bayesian methods in Dynare (Matlab). The model allows to perform nowcast and therefore to obtain estimates of the potential GDP dynamics and output gap in real time.

The model employs available annual and quarterly data for the period from 1992Q1 to 2024Q2. I used data on output (real GDP), labor (combination of total working population, labor participation rate, unemployment rate, average working hours), capital (capital stock, capital utilization rate). I also augment the production function approach with semi-structural Phillips curves both for nominal prices and wages and Okun's law. For that reason, I also used data on CPI deflator and nominal wages.

Since the series of capital dynamics is a great concern and we do not have any reliable official series for that (especially in quarterly frequency), I constructed a satellite **model of unobservable components** (state space model) to identify the dynamics of physical capital in Russia. The model is based on the Law of Capital Motion and estimated using the Kalman filter with Bayesian methods.

The main variable for the satellite filter *("dynamics of change in availability of fixed assets for a full range of organizations (in comparable prices)"*) is calculated by Rosstat with annual frequency. I chose it as the dynamics of gross capital because it recalculates the value of assets in the replacement value for each period and therefore solves the problem of mixed prices, and dynamic comparability of this series is

achieved with a special deflator of fixed assets (provided by Rosstat). Also, the variable has a long span (since 1990).

I also independently calculate the depreciation rate measure using SNA data on consumption of fixed capital to use it to identify net capital dynamics out from the gross capital. The problem of interpolation of annual data into quarters is solved using a series of dynamics of gross investment in fixed capital.

It should be pointed out that the obtained dynamics of net capital is reasonably similar to the estimates of changes in the flow of capital services of Russia KLEMS group (e.g. Voskoboynikov, 2023), and does not contradict economic logic. That is why I used this series in my production function model.

Results

Here you may see the current estimates of output gap and potential output growth rates and also key decompositions of the model, which are the main results (Fig. 1).

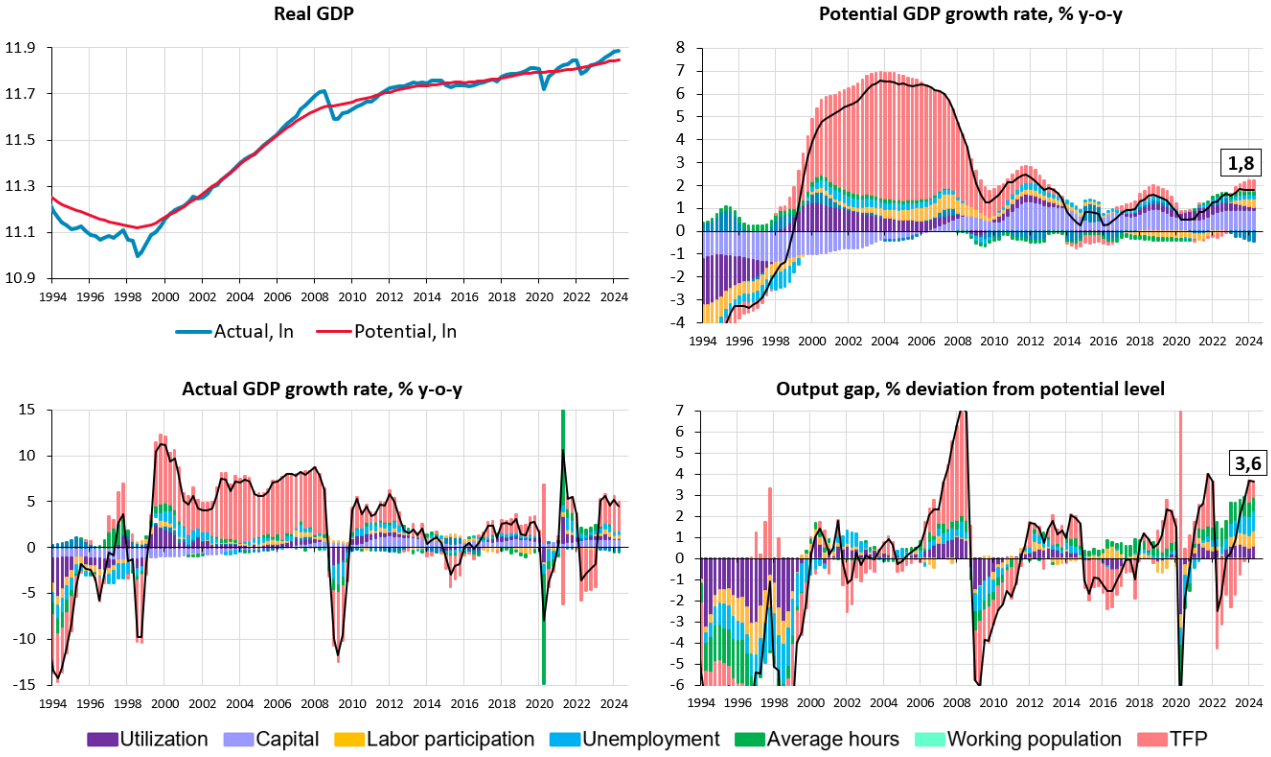

Fig. 1. Results of the model

The results of the model do not contradict the accumulated knowledge about the history of business cycles in modern Russia and complement them with a meaningful identification of the cyclical and trend components. The model can be used to obtain estimates of the output gap and the potential growth rate using only official macroeconomic data.

References

1. I. Voskoboynikov. Chapter 15 (Economic Growth). *«The Contemporary Russian Economy: A Comprehensive Analysis»*, 2023.
2. M. Toth. «A multivariate unobserved components model to estimate potential output in the euro area: a production function based approach». *ECB Working Paper*, 2021.