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Article

Consumption in Russia: real values and impact on GDP

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Abstract: This paper based on systems - theoretic approach to the definition of a country's GDP as not directly observable characteristic of system state. Leontief dynamic model is generalized to take into account the stimulating effect of consumption on GDP growth. In consumption, apart from final consumption, terms are considered: balance of foreign trade, fictitious investments and hidden costs. The Kalman filter uses Rosstat's gross output (for system output) and final consumption (for system control) data from 1995 to 2015. It is concluded that if in the years 2014, 2015 it was possible to increase consumption by 5% by, say, price cuts or some increase in money supply, then GDP would be greater by about 2.5%. GDP real values in recent years are most likely greater than official values. Fictitious investments and hidden costs are found in the amount of up to third the value of final consumption. The accuracy of one-year forecasts of true GDP by the methodology of this article is approximately 1.5%.

Keywords: gross domestic product; Leontief dynamic model; investments in production capital; Kalman filter.

JEL Classification: O11, C51, C32

1. Introduction

At present, various mathematical methods are used in macroeconomic researches. For example, the Bayesian parameters estimation, when the a posteriori distribution is determined through the simulation of the appropriate Markov chain (see, for example, (Kreptsev & Seleznev, 2016). Alternatively, a dynamic factor model, where factor estimation is performed using the Kalman smoother (see, for example, (Porshakov, 2016)). In the last mentioned work, without revealing the mechanism of country's economy functioning, using the published numerous macroeconomic indicators, a forecast is made of the value of GDP, which will soon be announced by Rosstat (based on the same indicators).

To the author's opinion, the most suitable for the study of the dynamics and goals of forecasting is systems - theoretic approach, when the output and the control variables are assigned, comprehensive model of the dynamics of the system in the state space is constructed and its parameters, the evolution of the state and output variables, including forecasts, are being estimated by the Kalman filter (KF). Borodachev (2018a) presented this approach to the definition of a country's GDP as not directly observable characteristic of system state. It was assumed that the gross output y^t breaks up into intermediate consumption and the final product (national income, GDP) x^t

$$y^t = A^t y^t + x^t, \quad (1)$$

the final product x^t is used for investments i^t and final consumption c^t

$$x^t = i^t + c^t. \quad (2)$$

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Investments provide the commissioning of new production funds iw^t, which in turn give an increase in gross output $\Delta y^t = (y^{t+1} - y^t)$ by the next year $iw^t = B^t \Delta y^t$. The estimation of such GDP by the KF according to available data on c^t (controls) and y^t (outputs) turned out to be (especially in recent years) significantly different from the official GDP.

In this paper, it is proposed to improve this approach in two ways. The first improvement: it is known that there are large expenditures claimed as investments, but those that are not (fictitious investments) as well as balance of foreign trade and hidden costs. We denote them in the sum as z^t. They are taken from GDP along with investments that really increase output and final consumption. Therefore, instead of (2), we must write

$$x^t = i^t + z^t + c^t . \quad (3)$$

It is difficult to acquire z^t. A simple way to account for them is to increase (scale) the data on final consumption. That is, in (3) to replace $z^t + c^t = \omega c^t = u^t$ and consider u^t as controls in the system. The factor ω is estimated together with other parameters of the model by the method of minimizing the root-mean-square prediction error (RMSE) by the KF of gross output (see, for example, (Borodachev, 2017a, 2018b)).

Second improvement: it is believed that growing/falling consumption causes growth/fall of GDP. The last example is the crisis of 2008-2009, when the collapsed consumption caused stagnation in production. However, in the simple dynamic Leontief model used in (Borodachev, 2018a), even with the adjustment of ω, an increase in final consumption can only reduce the funds spent on investment and, therefore, cannot increase GDP.

For example, if we estimate the model parameters for all observations except the last two, and then estimate GDP for the last two years with actual consumption data and with an increase of 5%, then in the second case, GDP will be less.

Therefore, it is necessary to include a development term in the model that allows, with increasing consumption, to improve the structure of intermediate consumption, for example, to reduce it by reducing unreleased product stack, which we assume will not go outside production and could not be involved in investment and final consumption. In the formula (1) we replace $A^t y^t \to A1^t y^t - A2^t u^{t-1}$. That is, last year's consumption reduces the intermediate consumption of the current year. The first term in the right hand part can be regarded as purely direct costs. Finally, instead of (1), we have

$$y^t = A1^t y^t - A2^t u^{t-1} + i^t + u^t . \quad (4)$$

2. Calculation results and interpretation

Carrying out the transformations similarly to (Borodachev, 2018a), we obtain the equations of the system for the state vector $X^t = \left(x^t \quad x^{t-1} \quad u^{t-1} \quad u^{t-2}\right)^T$. We will consider the parameters of the model $A1, A2, B, \lambda$ as being independent of time within the window used for their estimation by the RMSE minimum method. The initial data on gross output y^t and final consumption c^t are the same as in (Borodachev, 2018a).

If you evaluate the parameters for all available data from 1995 to 2015, then the best value of RMSE = 4.35 trillion RUB is obtained at $\hat{\omega}$ = 1.5, $\widehat{A1}$ = 0.547, $\widehat{A2}$ = 0.366, $\hat{B}$ = 0.258, $\hat{\lambda}$ = 0.116. Without a development term (at $A2$ = 0), RMSE = 4.46 trillion RUB was the best, and if in addition ω = 1 (Borodachev, 2018a), RMSE = 4.53 trillion RUB was the best.

Thus, in the overall model, the situation is as follows. Coefficient of direct costs 0.547, capital costs 0.258 (real investments are effective); small $\hat{\lambda}$ = 0.116 indicates the rapid incorporation of investment (≈ 1 year). $\widehat{A2}$ = 0.366 means that about a third of consumption is returned by an increase in output after a year. The estimated real GDP is somewhat more than the official one, see Fig. 1,

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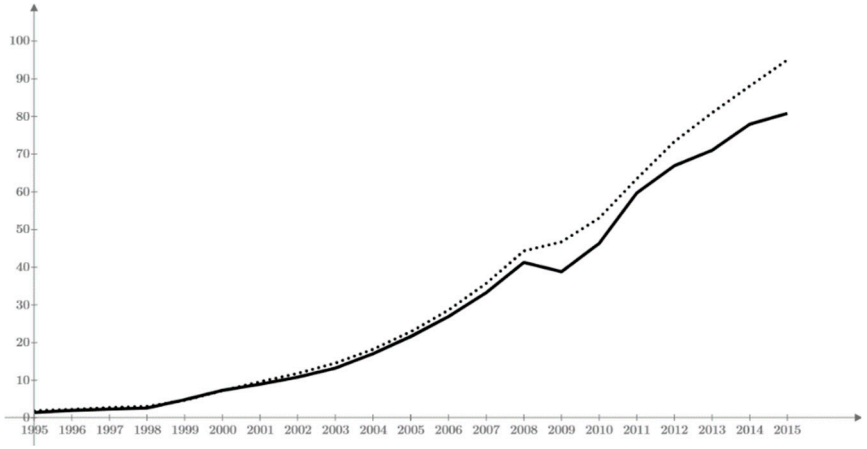

Figure 1. KF estimate of GDP $\hat{x}^{t|t}$ (point curve) and Rosstat data at time t (solid curve), at current prices; trillion RUB.

but it leaks a lot into fictitious investments and hidden costs (together about 34% of the value of final consumption). The structure of real GDP expenditures (except for final consumption): real (worked) investments $x^{t} - u^{t}$, balance of foreign trade + fictitious (unworked) investments + hidden costs $\hat{z}^{t} = (\hat{\omega} - 1)c^{t}$. If you subtract the balance of foreign trade data (http://www.cbr.ru/statistics/credit_statistics/trade/trade.xls) recalculated in rubles from the last values, then you can find fictitious investments + hidden costs. If further to the claimed (official) investments to take the information the same as in (Borodachev, 2018a) and consider that they consist of real and fictitious, then you can find fictitious investments, and then hidden costs. See Fig. 2.

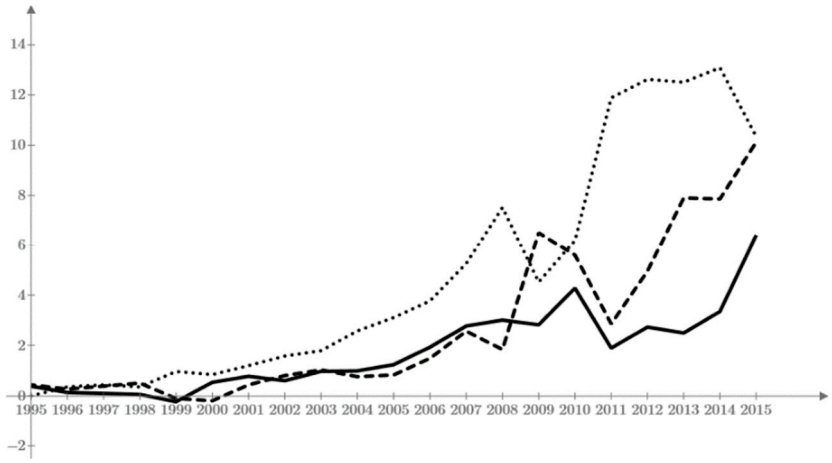

Figure 2. Real investments (solid curve), fictitious investments (point curve) and hidden costs (dashed curve); trillion RUB.

If we now estimate the parameters of the model for all observations except the last two, and then calculate the GDP for the last two years with actual consumption and with an increase of 5%, then GDP in the second case will be greater by approximately 2.5%. This means that if in the year 2014, 2015, it was possible to stimulate consumption by, say, price cuts or some increase in the money supply, it would facilitate the accelerated development of the economy.

If we consider the official GDP data as sufficiently reliable and independent (for example, from the declared investments), then we can choose ω = 1.3 (RMSE = 4.37), when the estimated GDP practically coincides with the official GDP in all years from 1995 to 2015. In doing so, compared to the Fig. 2, the hidden costs will mainly change. They will be approximately equal to zero. Thus, in this case, the main conclusion will be the growth of fictitious investments in the structure of claimed one from 60% before the crisis of 2008-2009 to 80% in 2011-2014, with an improvement to 50% in 2015.

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Forecasts of gross output and GDP for the year ahead are made using information (the gross output and final consumption) up to the current year inclusive. For the purposes of forecasting, it is better to use the adaptive version of the KF (Borodachev, 2017b, 2018b), when the system parameters are estimated in the window immediately preceding the forecasting moment. We fix ω = 1.3, $A2$ = 0.366, B = 0.258. $A1$ and λ are estimated in a moving window 14 years wide. For the forecasts of output (gross output) for the years 2011 to 2015, the average error of forecasts according to information for a year ago (RMSEA) was = 3.43 trillion RUB. $\widehat{A1}$ and $\hat{\lambda}$ in these years slightly changed around 0.6 and 0, respectively. Estimates of GDP for 2011-2015, GDP forecast (according to information for a year ago) $\hat{x}^{2016|2015}$ and Rosstat's data, see in Fig.3.

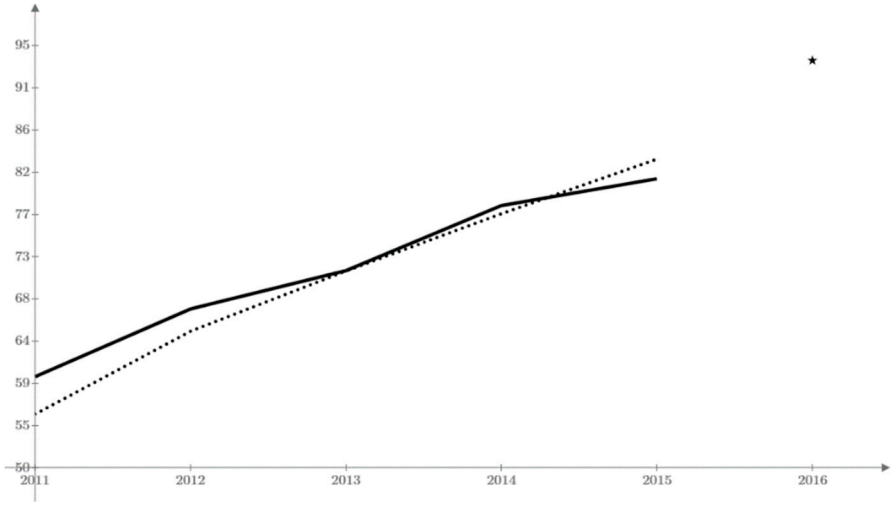

Figure 3. Rosstat data (solid curve), GDP estimates (point curve) for 2011-2015 and GDP forecast for information a year ago $\hat{x}^{2016|2015}$ (asterisk) at current prices; trillion RUB.

In (Borodachev, 2017b) without the two improvements of this article the same RMSEA was 5.32 trillion RUB.

Given the relationship between GDP and gross output (4), one can estimate the forecasting error of true GDP in Fig. 3 equal to ≈ (1-$A1$) * (output forecast error) = 1.37 trillion RUB (1.5%).

3. Conclusions

Compared with previous analysis (Borodachev, 2018a), when additional mechanisms are included in the consideration, the emphasis in explaining the functioning of the Russian economy shifts from the slow incorporation of investments to the presence of large fictitious investments and hidden costs. Speaking about GDP, this means that its real values in recent years are most likely greater than official values. The accuracy of forecasts of true GDP by the methodology of this article is approximately 1.5%..

References

Borodachev, S. M. (2017a). Unobservable characteristics of currency and stock markets system in Russia. In *4th International Multidisciplinary Scientific Conference on Social Sciences and Arts Conference Proceedings Book 1, v. 1* (pp. 831–836). Vienna: SGEM.

Borodachev, S. M. (2017b). Economic applications of adaptive Kalman filter. In *International Congress of Management, Economy and Policy Proceedings Book* (pp. 374–379). Istanbul: ICOMEP. http://www.icomep.com/pdf/icomep1718kasimtammetin.pdf.

Borodachev, S. M. (2018a). GDP and efficiency of Russian economy. *AIP Conference Proceedings, 1926*, 020011.

143 Borodachev, Sergei. (2018b). Monthly Forecasting of the Dollar to the Ruble Exchange Rate with Adaptive
144 Kalman Filter. *International Journal of Systems Science and Applied Mathematics*, 3(2), 24-29.

145 Kreptsev, D. & Seleznev, S. (2016). DSGE-models of the Russian economy with a small number of equations.
146 *SERIES OF REPORTS ON ECONOMIC RESEARCH № 12 / May 2016*. Moscow: Central Bank of the Russian
147 Federation (in Russian).

148 Porshakov, A. S. (2016). Nowcasting and Short-Term Forecasting of Russian GDP with a Dynamic Factor Model.
149 *Journal of the New Economic Association, № 2 (30)*, 60–76 (in Russian).