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ESTIMATING OUTPUT GAP AND POTENTIAL OUTPUT FOR RUSSIA AND ITS USEFULNESS BY FORECASTING INFLATION

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Abstract:

This paper deals with an estimation of output gap and potential output for Russian's economy. Three methods of estimation have been used for estimating these two unobservable variables: Hodrick-Prescott filter, production function and SVAR model. All methods of estimation showed very similar course, although obtained values were not identical. Then obtained values of output gap were used to analyse the ability of output gap to forecast inflation. Two simple gap models were used for this purpose. Results showed that output gap could be used as useful indicator of inflation, according to all methods of estimation output gap. Abstrac Abstract Abstract

Keywords:

output gap, HP filter, SVAR model, production function, inflation

JEL Classification: C53, E31, E32

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Introduction

Many central banks and international institutions use output gap, beside other things, for their ability to forecast inflation despite of generally accepted facts, which most economic researches surprisingly agree with, that it is impossible to estimate potential output or output gap with definite precision, and agree more with the term „estimation“. Results of particular estimations are used then in so called gap models, which test ability of output gap to forecast inflation. It should hold true, that when the economy is overheating, when real output is above potential output, there should be inflationary pressures in the economy and inflation should increase. On the contrary, when real output is under its potential level, there should be deflationary pressures in the economy and inflation should go down.

As stated earlier, problems with research of ability of output gap to forecast inflation start already with the estimates of output gap themselves. These variables are not directly observable and they are not easily to be measured with absolute accuracy. It is generally recommended to speak more about „estimation“ than „measurement“.

Output gap in this paper will be defined as deviation of real output from potential output. If real output is above potential output, there will be a positive output gap in the economy, and on the contrary, if real output is under potential output, there will be a negative output gap in the economy. Potential output in this paper will be understood according to de Masi (1997) and will mean the highest possible level of product, which is produced by maximum utilization of resources of production which do not cause inflationary pressures.

For estimating potential output and output gap for Russian’s economy, there will be used some mainstream methods: Hodrick-Prescott filter (1997) (HP), production filter and structural VAR model. Hypothesis, that results of particular estimations confirm ambiguity of measurement of output gap and potential output.

The gained values of previous measurements will be used subsequently for estimating ability of output gap to forecast inflation. For this purpose, a simple gap model according to Coe and McDermott (1997) will be used, where versions with level of output gap and its first differences will be used, too. Both versions of gap model will confirm the hypothesis, that output gap for Russian’s economy is useful for estimation of the inflation.

Because there is very little research of output gap estimation and potential output for Russian’s economy, and its ability to forecast inflation, too, the author of this paper sees in this the biggest value added of this paper.

2. Previous research

If the author of this paper is well- informed, there is very little research dealing with Russian's output gap or potential output. There are also few institutions dealing with estimating these two unobservable variables. IMF does not publish data about output gap or potential output, only OECD[1] does. It is possible to mention a study from Oomes and Dynnikova (2006), which estimated output gap for Russian's economy with production function. Hanson (2009) dealt with forecasting development of Russian's economy generally until 2020. There isn´t any known study or paper dealing with examination of ability of output gap to forecast inflation. Therefore gap model according to Coe and McDermott (1997) will be used for examination of ability of output gap to forecast inflation. The authors applied their model on selected economies of south-eastern Asia and Australia. Other studies dealing with these problems, but for other economies, are for example studies from Claus (2000) (for the economy of New Zealand) or Menyhért (2008) (for the economy of Hungary) or Milučká for economy of Czech Republic (2014) In the lack of this research for Russian's economy, the author of this paper sees the main value added of this paper. The aim of this paper is then to fill up this lack in this research.

3. Data

All data used for estimates of output gap for Russian's economy are from Statistical Office for Russian's Federation. The length of time period was for all estimates the same and was from 1995Q1[2]-2012Q3, in quarterly intervals. The length of this time period has been selected because of accessibility and credibility of data necessary for estimations themselves. By some methods, time series were prolonged by predictions due to more precisely estimations.

4. Estimates of potential output and output gap according the selected methods

Two mainstream methods were selected for estimates of output gap and potential output: Hodrick-Prescott filter and production function. One structural method was added to these two well-known methods for improvement of credibility of estimates: structural VAR model, or SVAR.

4.1 Hodrick-Prescott filter

Hodrick-Prescott filter (1997) (Hodrick a Prescott (1997)) belongs among the most frequently used methods of estimation output gap and potential output, and it is used by many national or international institutions. To the most frequently mentioned advantages of this method of estimation belongs ease of input data, when only time

[1] OECD publish data in annual intervals only, not quarterly.

series of GDP is necessary. Easy mechanical application accessible in most of the econometrical software belongs to the other advantages.

By this method, time series of GDP can be decomposed on its cyclical component c_t and trend component (represents potential growth)g_t. It is possible to write:

$$y_t = g_t + c_t \tag{1}$$

Trend component g_t is obtained by minimising the equation 2, if sum of squares of cyclical component is minimalized, which is also penalised by deviations in second differences of trend component:

$$\min_{\{g_t\}_{t=1}^{T}} \sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \tag{2}$$

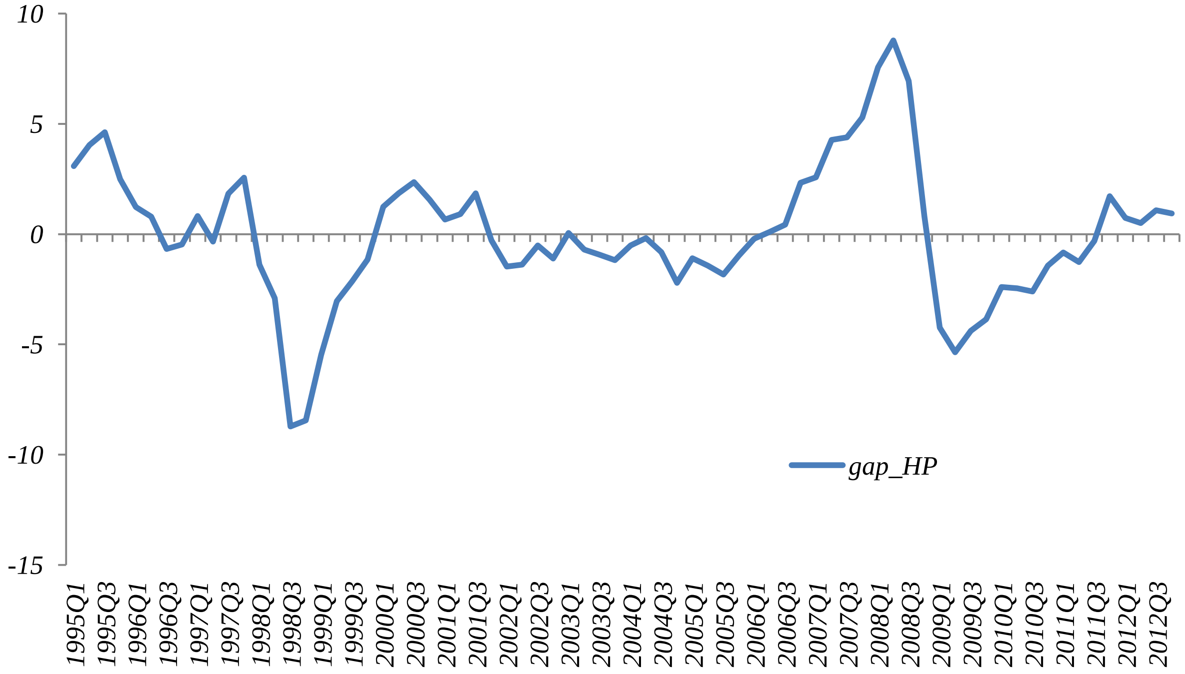
where λ is parameter of smoothness, which penalises variability of trend component. The e higher values of parameter of smoothness mean more smoothed potential component and more volatile cyclical component. For our purpose, we have determined λ = 1600.

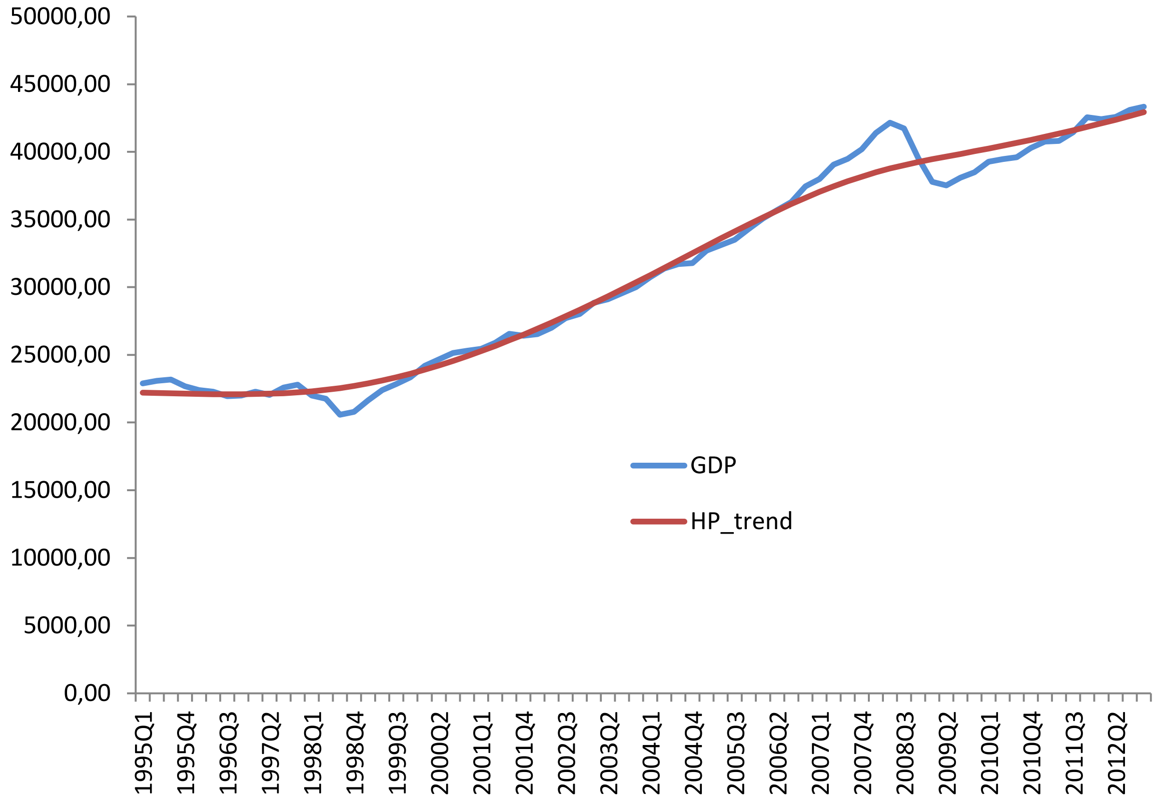
On the other hand, this method of estimating potential output and output gap has some disadvantages, too. Except its strictly statistical character which abstracts from any economic theory, one of the big disadvantages is problem with determining of parameter of smoothness. This parameter is set outside the model and according to many studies; there is endless debate which values are the best ones. Most studies accept values from Hodrick and Prescott (1997), who recommended λ = 100 for annual data, λ = 1600 for quarterly data and λ = 14400 for monthly data. But many economists haven't agreed with this solution, e.g. Coe a McDermott (1997) didn't recommend these values, because they have been set for USA and setting these values for other, different economies could lead to substantial misrepresentation of results of estimates.[3]. Another problem is with value at both ends of time series, known as end point bias. Commonly accepted and by economists used solution is to prolong time series. Time series in this paper has been prolonged too, with the forecast for next two years.

Results of estimates of potential output v billions of euros and of output gap in percent of potential output are shown in figure 1a and 1b.

[3] For further possibilities of solving of this problem, see other studies, e.g.. Cooley &Ohanian (1991) and Correia, Neves &Rebelo (1992), Baxter & King (1999) or Ravn & Uhlig (2002).

Figure 1: Potential output and output gap: HP filter





Source: Statistical office, own estimates

4.2 Production function

Strictly statistical character of previous method of estimation potential output and output gap does not contain any economic theory which could explain more precisely the course of these two variables. This economic theory contains a structural method of estimation: production function. This method belongs beside HP filter among the most frequently used methods of estimation of output gap and potential output, e.g. is used by OECD (see e.g. Beffy, Richardson & Sedilliot (2007)) or EC (see e.g. Hjelm & Jönsson (2010))

In this paper, Cobb-Douglas production function with constant returns of scale and Hicks neutral technological progress was selected for estimation. Likewise HP filter, time series of real output in time *t* (Y_t) is decomposed into components: employment L_t., capital stock K_t and total factor productivity A_t. According to Report of Ministry of Finance of Russian's Federation (2013) is labour share on income for Russian's economy approximately 50% and therefore parameters α and β have following values: α = 0,50 a β = 0,50.

For real output can be written:

$$Y_t = A_t \cdot K_t^{\alpha} \cdot L_t^{1-\alpha} \tag{3}$$

Before the own estimation potential output, values of single potential variables will be estimated. Potential capital stock will be obtained according to well-established standards (see e.g. CBO (2001)) when the capital stock is identified with actual capital stock. The actual capital stock is calculates as sum of current fixed investments of past capital stock adjusted for depreciation. Rate of depreciation was determined according to well-established standards (see e.g. Mourre (2009) to 0, 05.

Another potential component that is necessary for estimation potential output is potential employment. It is divided into three components: working age population, i.e. 15-64 years, trend participation rate, which will be obtained with using HP filter and.[4] We can write for potential employment:

$$L_t^* = pop_t^{15-64} \cdot part_t^* \cdot (1 - NAIRU_t) \tag{4}$$

The last potential component is potential TFP.[5] It will be defined as trend TFP, again with using HP filter.[6]

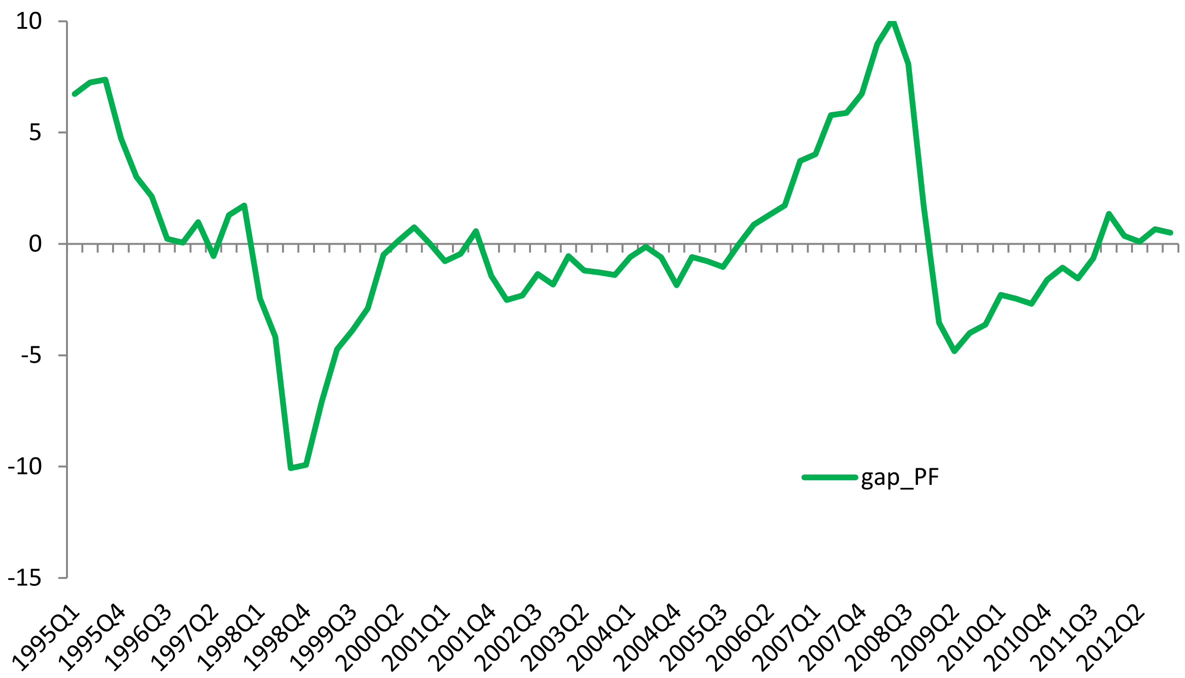
[4] NAIRU – non-accelerating inflation rate of unemployment. For further information about its methodology, see e.g. Hurník (2005).

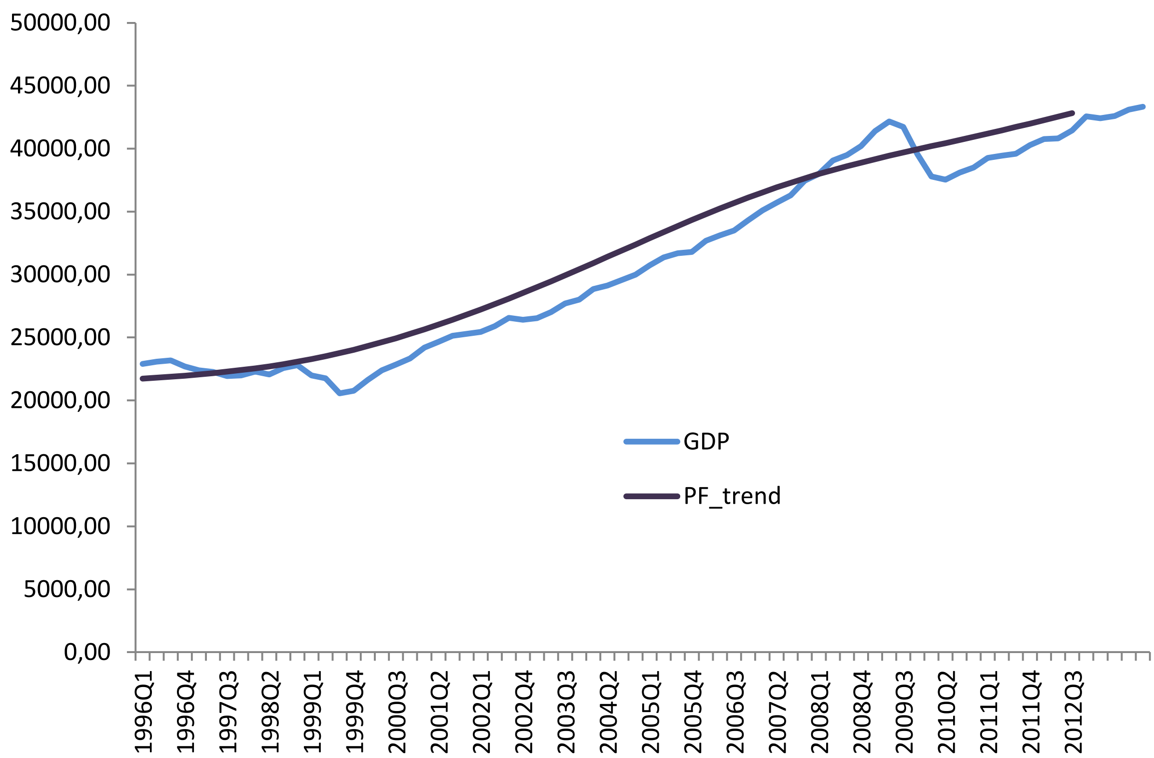
[5] TFP – total factor of productivity

[6] Baxter-King filter is used sometimes.

Results of estimation of potential output and output gap for Russian's economy are shown in figure 2. They will be compared with other methods of estimation later.

Figure 2: Potential output and output gap: production function





Source: Statistical office, own estimates

4.3 SVAR model

A relative sophisticated and quite often used method of estimation potential output and output is gap is structural VAR model or SVAR. These models, first introduced by economists Blanchard & Quah (1989), contain not only robust statistical framework but some economic restrictions that help to explain the course of output gap more precisely. The basic assumption is a division of real output into three components: deterministic trend, shocks which influence supply side of economy and transitory shocks who influence demand side of economy. Deterministic trend and shocks that influence supply side of economy represent potential product while transitory shocks represent cyclical component, output gap. It is important to distinguish between supply and demand shocks, but only supply shocks have influences on output in long run. Demand shocks can influence the economy only in short run.

Procedure of bivariate SVAR model with HDP and inflation is as follows:
Under stationary vector Z will be understood *n x 1* stationary vector with n_1-vector I(0) variables a n_2- vector I(1) variables, that it will hold $Z_t = (\Delta X'_{1t}, X'_{t2})$. Afterwards, stationary vector Z_t can be written with application of Wold decomposition theorem in its reduced form:

$$Z_t = \delta(t) + C(L)\varepsilon_t \tag{5}$$

where $\delta(t)$ is deterministic variable, $C(L) = \sum_{i=0}^{\infty} C_i \, L^i$ is matrix of polynomial lags, $C_0 = I_n$ matrix of identity, vector ε_t will be forecast of errors in Z_t informing about lag values ofZ_t , while it's mean value will be zero and $E(\varepsilon_t, \varepsilon_t^{'})$ = Ω with positively defined Ω. Equation (6) is subsequently decomposed into permanent and transitory components:

$$Z_t = \delta(t) + C(1)\varepsilon_t + C^*(L)\varepsilon_t \tag{6}$$

where $C(1) = \sum_{i=0}^{\infty} C_i$ a $C^*(L) = C(L) - C(1)$. Then is defined $C_1(1)$ as permanent multiplicator of vector X_{1t}. Z_t will have a following structural form:

$$Z_t = \delta(t) + \Gamma(L)\eta_t, \tag{7}$$

where η_t is *n*- vector of structural shocks with nonzeromean value and $E\left(\varepsilon_t, \varepsilon_t^{'}\right) = I_{n.}$ This structural form is possible to obtain from the equation (6) and exploiting of relationship

$$\Gamma_0\Gamma_0^{'} = \Omega, = \Gamma_0\eta_t \; a \; C(L) = \Gamma_L\Gamma_0^{-1}. \tag{8}$$

Subsequently long-term covariance matrix in reduced form is obstained from equations (7) and (8)

$$C(1)\Omega C(1)' = \Gamma(1)\Gamma(1)', \tag{9}$$

Finally is matrix with long-term restrictions of covariance matrix in structual form derived from the procedure mentioned above.

There are relative many modifications of SVAR models.[7] For our purpose, bivariate SVAR model with real output and inflation according to Robertson & Wiskens (1997) was selected. As the restriction was determined that nominal shock has no effect on GPD. Only supply shock can influence GDP in long run.
Two variables were included in reduced bivariate SVAR model:

$$\Delta y_t = \beta_1 + \psi_{11}(L)\Delta y_{t-1} + \psi_{12}(L)\Delta\pi_{t-1} + \mu_{\Delta y,t}$$

(10)

$$\Delta\pi_t = \beta_2 + \psi_{21}(L)\Delta y_{t-1} + \psi_{22}(L)\Delta\pi_{t-1} + \mu_{\Delta\pi,t}$$

(11)

where Δy_t is difference (logarithm) HDP, $\Delta\pi_t$ is difference of inflation and $\mu_{\mathrm{i},t}$ are unexplained shocks in the model. Subsequently, by meeting of assupmtions of realization of structural shocks budou are variables in the model deffined as a sum of current and past schocks[8]:

$$\Delta y_t = S_{11}(L)v_t^s + S_{12}(L)v_t^D$$

(12)

$$\Delta y_t = S_{11}(L)v_t^s + S_{12}(L)v_t^D$$

(13)

Finally the change of product attributed to potential output is defined as follows:

$$\Delta y_t^\tau = S_{11}(L)v_t^s$$

(14)

[7] Blanchard & Quah (1989) analyzed bivariate SVAR model with product and unemployment, where unemployment will have no long-term effect on product, Camba-Mendez & Rodriguez-Palenzuela (2003) extended the model to trivariate model with inflation, which will have no long-term effect on product, too. Fourvariate SVAR model was analyzed by Hjelma & Jönsson (2010), who used product, inflation, unemployment and labour productivity. Fabiani (2001) estimated output gap even with an five variate SVAR modele, where variables were real wage, output, inflation, unemployment and share of labor wages on income.

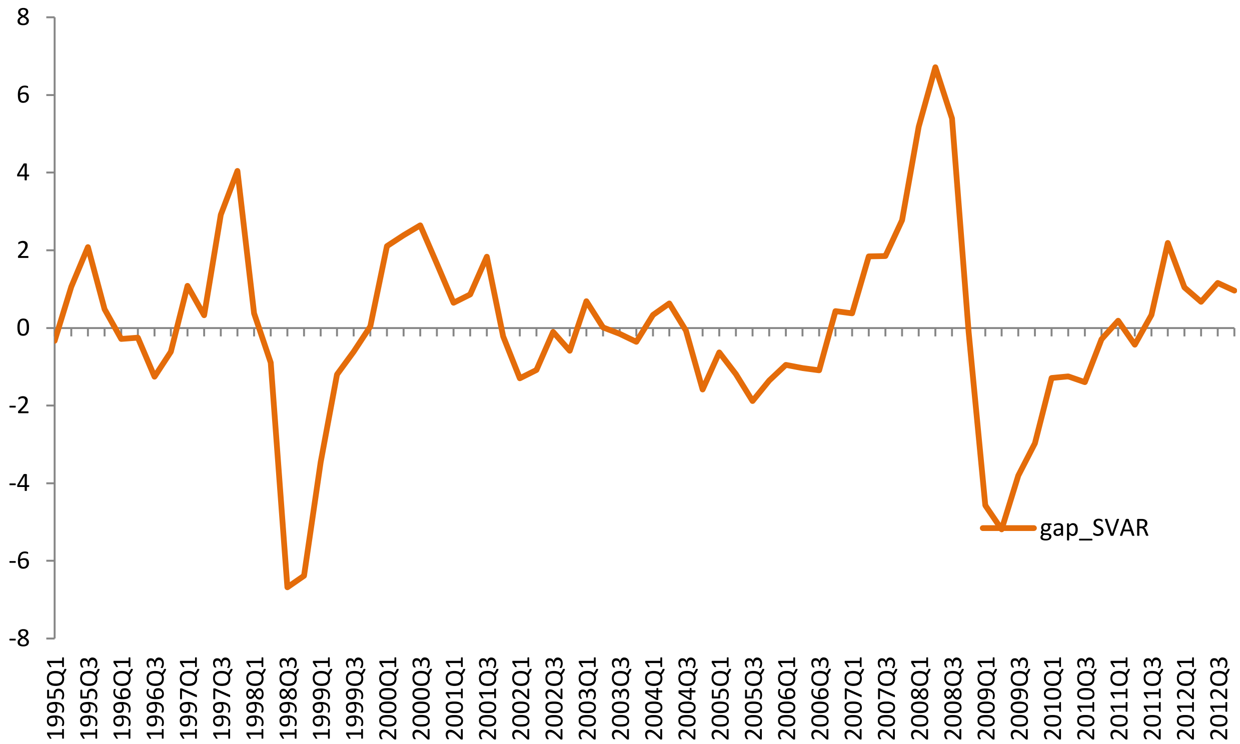
[8] By SVAR2 model is used model in form 2x2 (by SVAR3 model would be form of 3x3used). Both SVAR models meet tests for stationarity of variables, tests for the lag structure, the standard residual tests. Results of all these tests are available only upon requests.

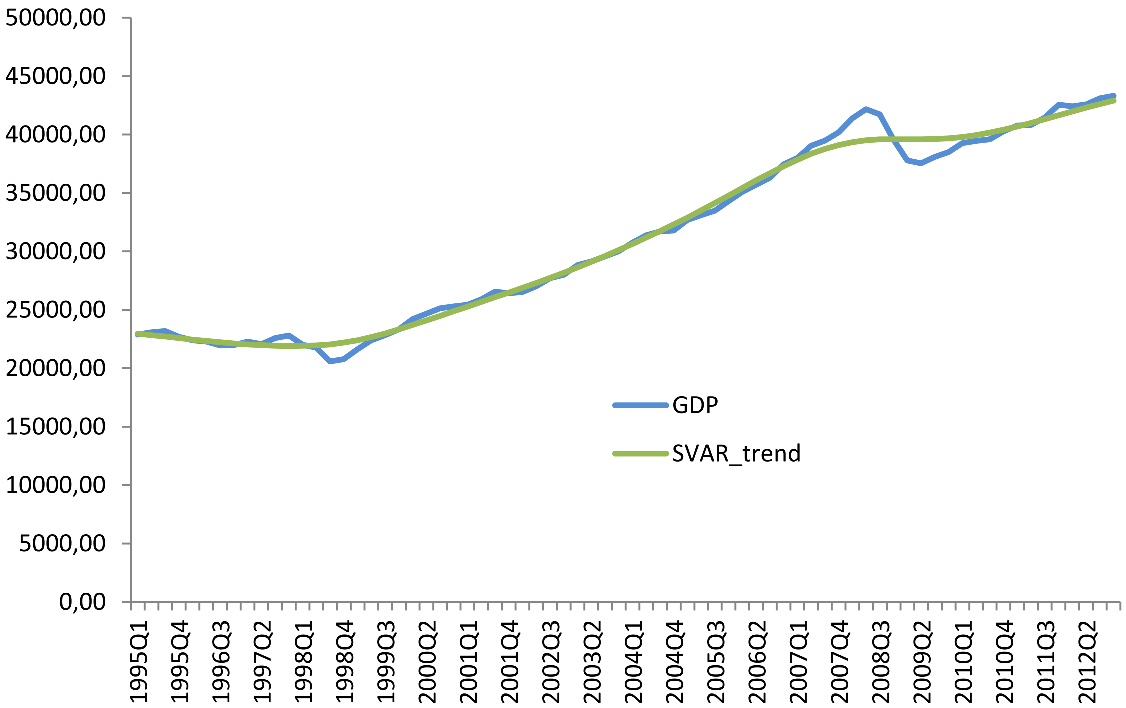
The change of product attributed to its cyclical component (including demand shocks with no long-term effects on product):

$$\Delta y_t^c = S_{12}(L) v_t^D \quad (15)$$

Output gap and potential output for Russian's economy estimated with bivariate SVAR model with GDP and inflation are shown in following picture.

Figure 3: Production function and potential output: SVAR model





Source: Statistical office, own estimates

5. Comparison of estimates

Comparison of estimated values with data from OECD brings table 1. It is possible to see that although data show a similar course, the values are not identical.

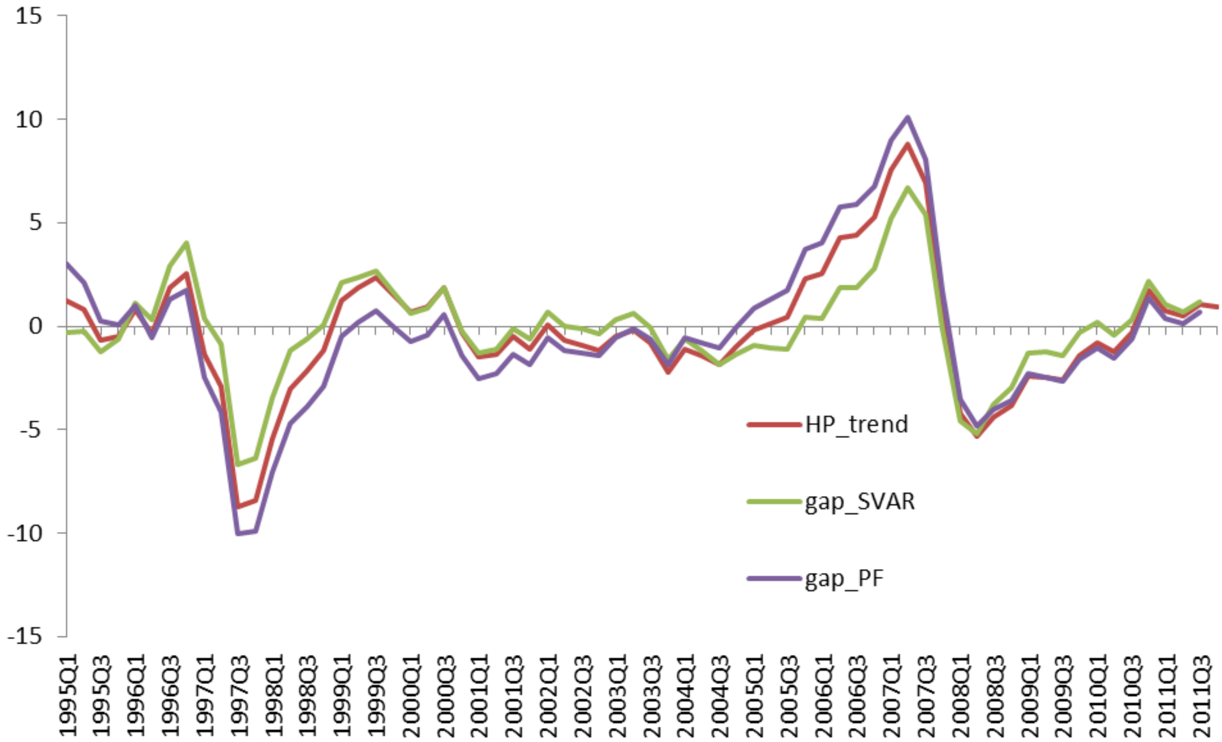
Table 1: Own estimates and OECD: a comparison

Potential output growth	1999	2003	2009	2012
HP filter	-5,5	0,1	-4,2	0,7
SVAR	-3,5	0,7	-4,6	1,0
Production function	-7,1	-0,6	-3,5	0,4
OECD	-4,8	0,2	-3,9	-0,4

Source: Statistical office, own estimates

Single estimates of output gap according to selected methods compares figure 4. It is possible to see, that single methods of estimation have very similar course, but there were not identical values for the same time period. Because selected methods did not measure for output gap the same values, hypothesis about impossibility of measurement of output gap with absolute accuracy was rejected.

Figure 4: Estimates of output gap according to the selected methods



Source: Statistical office, own estimates

6. Output gap and inflation

Although output gap is not possible to measure with absolute reliability, but more only to estimate, it has been shown, that it is possible to use it for forecasting inflation, e.g. according to some studies, e. g Coe a McDermott (1997) or Claus (2000).

Two gap models according to Coe and McDermott (1997) will be used for confirmation or rejection of hypothesis about ability of output gap to forecast inflation. The first model will analyse relationship between level of output gap and change in inflation:

$$\pi_t = \alpha_1 + \sum_{k=0}^{p} \beta_{1k}\, \mathrm{mezera}_{t-k} + \epsilon_{1t}$$

(16)

under π_t will be understood logarithmic difference of CPI, gap_{t-k} logarithmic difference between actual and potential output a ε_{1t} random variable.

Second model will analyse relationship between change in inflation and change in output gap:

$$\Delta\pi_t = \alpha_2 + \sum_{i=0}^{\gamma} \beta_{2k} \Delta \mathrm{mezera}_{t-k} + \epsilon_{2t} \tag{17}$$

where π_t is logarithmic difference of, Δ gap_{t-k} logarithmic difference of actual and potential product and ϵ_{2t} is random variable, Δ means an operator of first difference.

Following hypothesis will be defined in the gap models: if sum of coefficients β_{1k} is positive and statistically significant, positive output gap will lead to increase of inflation. Results of testing of both models brings table 2. By both models, optimal lag length was determined using Schwarz information criterions (SIC) and was set on three. All signs of single coefficients relate to these lags. All F-tests confirmed the ability of output gap to forecast inflation on 5% level of significance. Statistics R^2 indicates that the model with the change in output gap explains changes in inflation better. Sum of coefficients β_{1k} was in all cases positive and statistically significant.

Table 2: The gap models

O. gap	**Lags**	**Sum of koef. beta**	**sign**	**F-test**	**R2**	**t-test**
HP	3	0,072	+-+	3,76**	0,18	0,167**
PF	3	0,0043	--+	5,03**	0,23	0,452**
SVAR	3	0,0021	+++	2,1**	0,32	0,154**
O. gap	**Lags**	**Sum of koef. beta**	**sign**	**F-test**	**R2**	**t-test**
HP	3	0,063	+-+	4,98**	0,22	0,521**
PF	3	0,0038	++-	5,53**	0,32	0,745**
SVAR	3	0,0012	+-+	3,8**	0,33	0,543**

Source: Statistical office, own estimates

7. Evaluation of results and possibility of further research

Single estimates of output gap for Russian's economy showed, that it is impossible to measure output gap for this economy with an absolute accuracy, too. It is better to speak about "an estimation" than "a measurement". Despite of this fact, gap models showed that it is possible to consider output gap as useful indicator of inflation. Unfortunately, a comparison with previous research is impossible, because there is no known study dealing with output gap as indicator of inflation for Russian's economy. On the other hand, improvements of gap models are possible, too. One of the possible improvements of the model could be insertion of additional variables into the gap model, e.g. money demand. All of these arrangements could improve the ability of output gap to explain inflation in the economy.

Conclusion

The aim of this paper was to deal with potential output and output gap for Russian's economy. Three methods for estimating these two unobservable variables were selected: HP filter, production function and SVAR model. Given methods of estimation were estimates for time period 1995Q1-2012Q3. All methods of estimation estimated very similar course of output gap, although particular methods themselves didn't achieve the same values for the same time period. All results were achieved in the case of comparison with data from OECD after re-counting own estimates on values in annual intervals.

Then ability of output gap to forecast inflation was analysed. It should hold that if there is a positive output gap in the economy, inflation should increase and on the contrary, in the case of a negative output gap, inflation should decrease. Two gap models for confirmation or rejection of this relationship was selected. First model analysed relationship between change in inflation and level of output gap, and the second model analysed relationship between change in inflation and change in output gap.

Both models confirmed the hypothesis that output gap is a useful indicator of inflation, where better results were achieved by gap model with the change in output gap. According the models, the best results should be given by SVAR model as the most sophisticated method from the three selected methods of estimation.

Naturally, other results could have been given, if output gap would had been estimated with other, more sophisticated methods of estimation, e.g. with a method from group of multivariate methods of estimation. Suitable modifications of gap models themselves could bring other results, too, e.g. extension by money demand. These problems could stay as one of many other possibilities how to make the gap models better and more relievable. This paper tried to fill up the lack in research on this field for Russian's economy, although naturally other research is not only possible, but suitable, too.

References

BAXTER, M. a KING, R. (1999). „ Measures Business Cycles: Approximate Band – Pass Filters for Economic Time Series". *Review of Economics and Statistics Vol. 84,* 575 – 593.

BEFFY, P. O.; RICHARDSON, P. a SÉDILLOT, F. (2006). „New OECD methods for supply-side and medium-term assessments: Acapital services approach." *OECD, Working Paper No. 482.*

BLANCHARD, O. J.; QUAH, D. (1989)"The Dynamic Effects of Aggregate Demand and Supply Disturbances." *The American Economic Review, Vol. 79, No. 4, pp. 655 – 673.*

CAMBA-MENDEZ, G.aRODRIGUEZ-PALENZUELA, D. (2003): „Assesssment criteria for output gap estimates." *Economic Modelling, Vol. 20, pp. 529 – 562.*

CLAUS, I. 2000. Is the output gap a useful indicator of inflation? *Discussion Paper Series DP 2000/05*. Wellington: Reserve Bank of New Zealand, 2000.

COE, R. J.; McDERMOTT, C. J. 1997. Does the gap work in Asia? *IMF Working Paper No. WP /96/69*. Washington: International Monetary Fund, 1997.

COOLEY, T. J. a OHANIAN, L. E. (1991). „ The Cyclical Behavior of Prices." *Journal of Monetary Economics, Vol. 28, No. 1, pp. 25 – 60.*

CORREIA, I. H.; NEVES, J. L. a REBELO, S. T. (1992). „ Business Cycles from 1850-1950: New Facts about Old Data." *European Economic Review, Vol. 36, No. 3, pp. 459-467.*

DE MASI, P. (1997). „IMF Estimates of Potential Output: Theory and Practise." *IMF Working Paper No.WP/97/177.*

FABIANI, S. a MESTRE, R. (2004). „ A system approach for measuring the euro area NAIRU. " *Empirical Economics, No. 29, pp. 311-341.*

HANSON, P., 2009. "Russia to 2020." Finmeccanica Occasional Paper.

HJELM, G. a JŐNNSON, K. (2010). „ In search of a method for measuring the output gap of the Swedish economy. Economic, econometric and practical considerations." *The National Institute of Economic Research Working Paper No. 115.*

HODRICK, R.J.; PRESCOTT, E.C. 1997. Post-war U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*. 1997,Vol. 29, No. 1, pp. 1-16.

HURNÍK, J. 2005. **„**Labor-Market Performance and Macroeconomic Policy: Time-Varying NAIRU in the Czech Republic." *Czech Journal of Economics and Finance.* 2005, Vol. 55, No. 1_2, pp. 25-40.

MENYHÉRT, B. 2008. Estimating the Hungarian New-Keynesian Phillips Curve. *Acta Oeconomica.* 2008, Vol. 58, No. 3, pp. 295-318.

MILUČKÁ, D. 2014. Inflation dynamics in the Czech Republic: Estimation of the New Keynesian Phillips curve. *International Journal of Economic Sciences,* Vol. 3, No. 2, pp. 53-70.

MOURRE, G. 2009. What explains the differences in income and labour utilisation and drives labour and economic growth in Europe? A GDP accounting perspective. *Economic papers*, 2009, Vol. 354.

Министерство финансов Российской Федерации (Ministry of Finance of the Russian Federation), 2013.

OOMES, N.; DYNNIKOVA, O. The Utilization-Adjusted Output Gap: Is the Russian Economy Overheating? WP/06/68Washington: International Monetary Fund, 2006.

RAVN, M. a UHLIG, H. (2002). „On Adjusting the HP-Filter for the Frequency of Observations." *Review of Economics and Statistics, Vol. 84, pp. 371-380.*

ROBERTSON, D. a WICKENS, M. R. (1997): "Measuring real and nominal macroeconomic shocks and their international transmission under different monetary regimes." *Oxford Bulletin of Economic and Statistics, 59, pp. 5 – 27.*