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Output gap measure based on survey data

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Contents

Abstract

Following Nyman (2010), the paper provides an indicator of resource utilisation (RU) for the Polish economy based on survey and labour market data. The indicator is subsequently used to identify output gap. Using real-time dataset, we find that output gap constructed in this way is revised to a similar or (in recent years) lesser extent than a measure based on the Hodrick and Prescott filter and structural approach. Also, the output gap based on the RU indicator performs comparably to other approaches as a proxy of inflation pressure: real-time data evaluation exercise reveals that RMSE of Phillips curve inflation forecasts with the RU indicator-based output gap is similar to the RMSE of equivalent specifications with alternative gap measures.

JEL Classification: E32, E37

Keywords: Principal component, Output gap, Trend-cycle decomposition, Inflation forecast, Real-time analysis.

I. Introduction

One of the most widely used macroeconomic concepts, crucial both to the monetary and fiscal authorities, is the output gap – a difference between the current level of the economy's output and the potential level of output, both of which are usually expressed in terms of the GDP. Output gap reflects the state of the economy over the business cycle and serves as a measure of the strain on the economy's resources and – in consequences – inflationary pressure. As potential output is unobservable, a wide range of methodologies is applied to estimate it, from univariate statistical filters for real GDP series, like most commonly used Hodrick and Prescott filter (HP), through multivariate filters and structural VARs, to a more theoretically-based production function approach.

In this paper, following Nyman (2010), we estimate an output gap for the Polish economy using an indicator of resource utilisation based on survey and labour market data. This exercise has three purposes. First, the new measure serves as a cross check for other output gap estimates in use at the Narodowy Bank Polski, including the one derived from the NECMOD model built-in production function (see Budnik et al. (2009)). Second, using real-time data, we test whether the estimate of output gap obtained with Nyman (2010) approach is more stable than other measures, in terms of the scale of revisions occurring after publication of subsequent data. Finally, we check whether the resource utilisation-based output gap measure performs better as a proxy of inflationary pressure in the economy – to this end we assess forecasting performance of Philips-curve-like equations with various gap estimates in real-time data environment.

We find that the output gap identified with resource utilisation indicator runs similarly to the measures based on the HP filter and the NECMOD' structural approach. Over 2005-2013 it is revised to a similar extent as the other two estimates. In most recent years, however, the new measure seems to be less volatile. Additionally, output gap measure proposed by Nyman (2010) performs comparably to the other approaches as a proxy of inflation pressure, as indicated by the RMSE of Phillips curve inflation forecasts for different measures of output gap.

The paper is organised as follows. The next section provides details of developing a resource utilisation indicator for the Polish economy based on survey data. Section III uses the indicator to estimate an output gap by means of a simple state space model. Section IV compares, in the real-time environment, the scale of the revisions of the new output gap measure with those of alternative approaches. Finally, Section V provides a real-time assessment of the forecasting properties of the output gap measures in the Philips curve equations, whereas Section VI concludes.

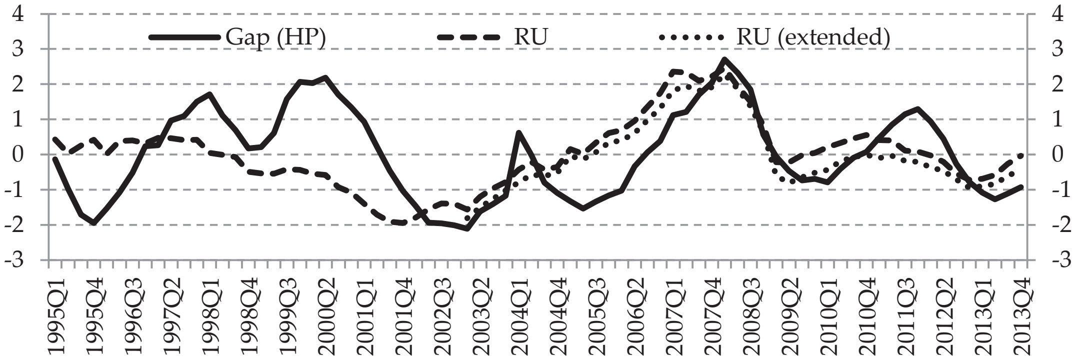
II. The resource utilisation indicator for the Polish economy

In this section, following Nyman (2010), we build a synthetic measure of resource utilisation for the Polish economy, based on survey data. To this end we extract the first principal component from the set of various business climate indicators, extended to include labour market data[1]. The selected series contain information on labour and (to a lesser extent) capital usage in various sectors of the economy. We use quarterly data covering 1995Q1-2013Q4, with some of the series starting in 2003. Since not all variables are available over full sample, we construct resource utilisation indicators in two versions. First indicator (RU), corresponds to the first principal component of the series available over the whole 1995-2013 period, while the other (extended RU) is based on all the variables in the dataset, but has to be restricted to 2003-2013 period only. The series, as well as the resource utilisation indicators themselves, are standardized to have zero mean and standard deviation equal to one. For both RU measures, the first principal component explains approximately 60% of the variation in the corresponding data.

As Figure 1 reveals, the two RU measures run quite close to each other, with the correlation coefficient of 0.99 for the levels and 0.96 for the first differences. Both resource utilisation indicators point to a similar cyclical pattern of the Polish economy to the one indicated by the HP filter trend-cycle decomposition. RU and extended RU, however, seem to react quicker than the HP filter-based output gap to economic developments over the cycle. In the remainder of the paper, due to relatively small sample size in real-time evaluation exercises, we restrict the analysis to the RU indicator.

[1] For details on principal component analysis see e.g. Stock and Watson (2002). In the choice of the set of the indicators we followed Nyman (2010) closely. The list of series used is presented in Table A1 in the Appendix A.

Figure 1. RU indicator and HP gap



Source: Own calculations.

Notes: The RU indicator is calculated based on the series available over the whole 1995q1 – 2013q4 sample. The RU (extended) is calculated for all the variables (the sample cover 2003q1 – 2013q4 period only though).

III. Output gap based on the RU indicator

We apply a synthetic measure of resource utilisation developed in the previous section to construct an output gap estimate for the Polish economy. Specifically, the RU indicator is used to identify the cyclical component of GDP in the following state-space model:

$$Y_t = T_t + C_t \tag{1}$$

$$C_t = \alpha \cdot RU_t + \varepsilon_t \tag{2}$$

$$T_t = T_{t-1} + G_{t-1} \tag{3}$$

$$G_t = G_{t-1} + \eta_t \tag{4}$$

where Y denotes the GDP level (in logs), T – GDP trend, C – cyclical component of GDP, while η and ε the corresponding error terms, with $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$ and $\eta_t \sim N(0, \sigma_\eta^2)$. In order to constrain the number of parameters to be estimated (due to relatively small sample size in real-time evaluation exercises), the noise-to-signal ratio, $\lambda = \frac{\sigma_\varepsilon^2}{\sigma_\eta^2}$ has been calibrated. To match the cycle length implied by the HP filter (with $\lambda^{HP} = 1600$), following Borio et al. (2013) λ was set to satisfy:

$$\frac{var(Y_t - T_t)}{var(\Delta^2 T_t)} = \frac{var(Y_t - T_t^{HP})}{var(\Delta^2 T_t^{HP})} \tag{5}$$

Table 1 presents the results of the maximum likelihood estimation of the model (1)-(4), with $\lambda = 451$ being the outcome of (5)[2].

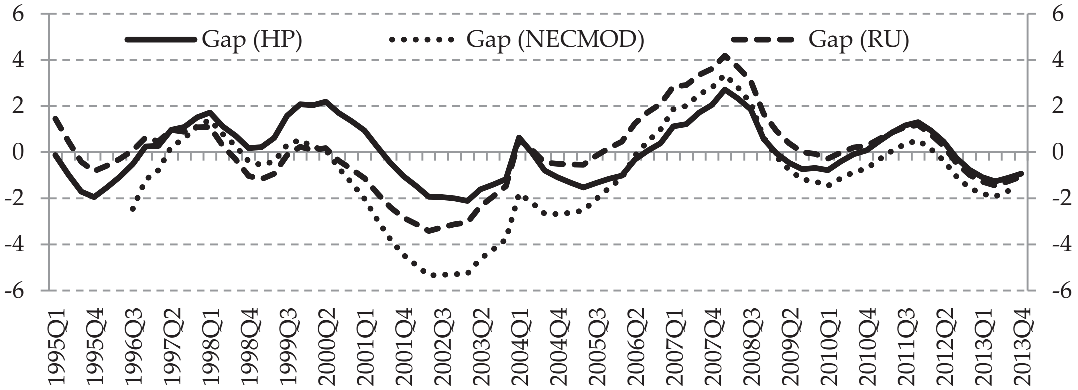
Table 1. Estimation results

	Coefficient (z-stat)
α	1.48
	(5.55)
σ_ε^2	0.96
	(-0.22)
σ_η^2	0.002
	(0.000)
Log likelihood	-133.4
Sample	1995Q1-2013Q4

[2] All the results presented in the paper are robust to changes in λ. Specifically, α varies from 1.34 for $\lambda = 3200$ to 1.49 for $\lambda = 100$.

The estimate of the output gap measure identified with the RU indicator ($C_t = Y_t - T_t$) is presented in Figure 2.

Figure 2. Output gap measures (% GDP trend)



Source: Own calculations.

The RU-based output gap runs similarly to other measures considered here. Its correlation coefficient with the HP filtered gap and the gap derived from the NECMOD model is close to 0.90 and 0.95, respectively (corresponding figures for the correlation of first differences are 0.97 and 0.99). As indicated by Nyman (2010), one of the possible advantages of the output gap measure based on the RU indicator is relatively small scale of revisions, with the new quarters of data being published. We check this hypothesis for the Polish data in the next section.

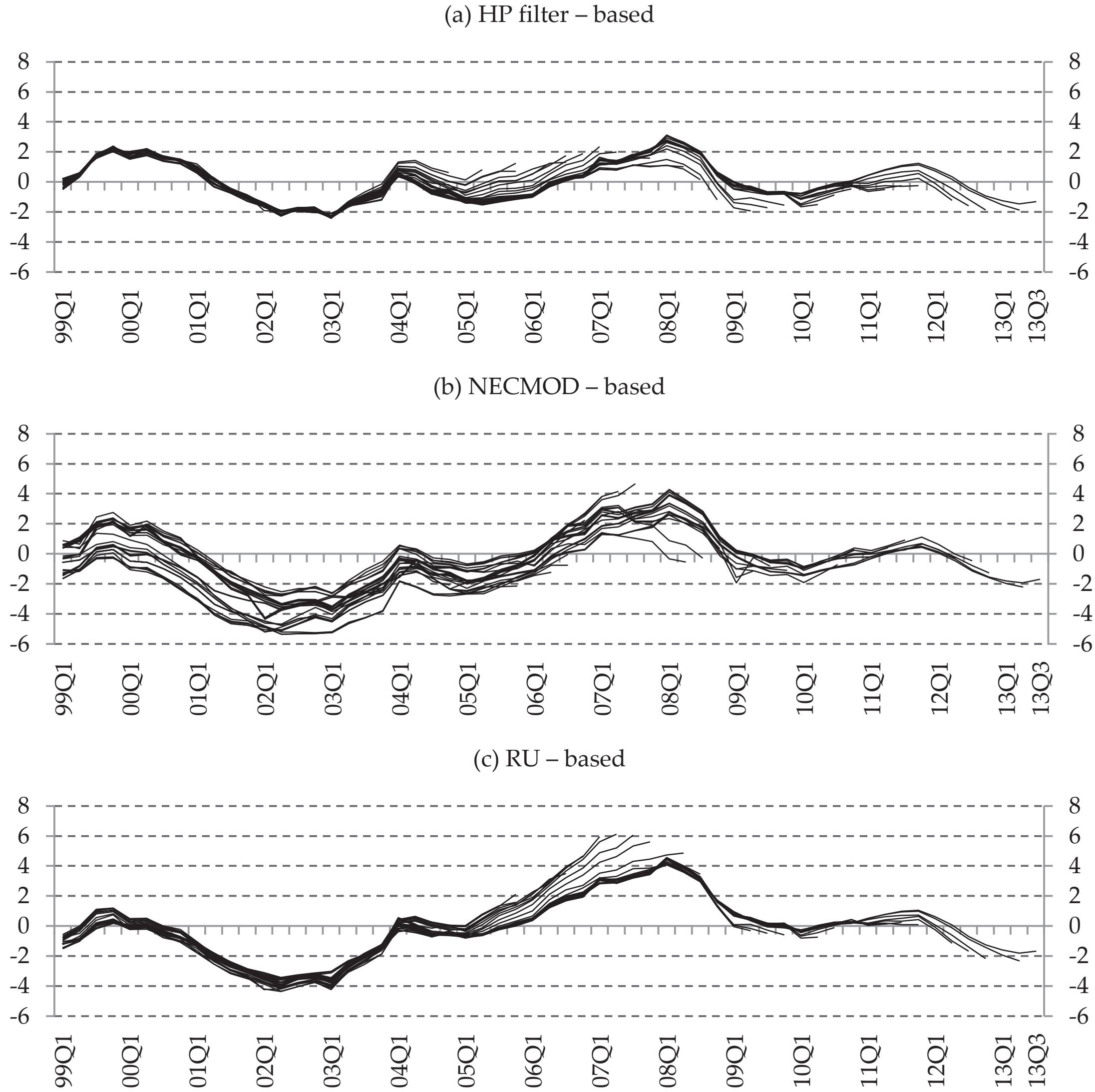
IV. Revisions of the output gap

We compare stability of the output gap measure proposed by Nyman (2010) with stability of the measure published by the Narodowy Bank Polski and the one based on the HP filter. To this end we build a real-time dataset, with the vintages corresponding to the projections published by the NBP in the *Inflation Reports* and check how the gap estimates change between subsequent forecasting rounds. The first vintage analysed corresponds to the first projection from the NECMOD model published in May 2005 (with 2004Q4 being the last quarter of observations in the sample). The last vintage contains data used in the NBP's projection published in March 2014, with the 2013Q3 being the last quarter of observations of some variables used in the model. The NECMOD projections are published three times a year (four times a year over 2005-2007 period) and therefore we gathered 29 vintages of data used in subsequent forecasting rounds. For each data vintage we calculate the gap figures based on the HP filter trend-cycle decomposition and on the RU approach described in the previous section. Subsequent output gap vintages from the HP filter, the NECMOD and the RU approach are presented in Figure 3.

Visual observation suggests that the NECMOD's output gap is revised the most, in particular in more distant horizon, whereas the RU-based gap and the HP filter-based gap revisions' scale is similar. However, gap derived from the RU approach seems to be revised more through 2007/2008, while the one based on the HP filter – at the end of the sample.

Figure 4 presents average absolute (and raw) revisions of output gap estimates for the approaches studied in the paper for each revision horizon. In our case, revision horizon is defined as a number of forecasting rounds (vintages) that elapsed (passed) from the first occurrence of a given quarter of output gap series in the sample, e.g. the mean revision in $t + 1$ is the average revision of the last figure for output gap in a given forecasting round (t) in the subsequent vintage.

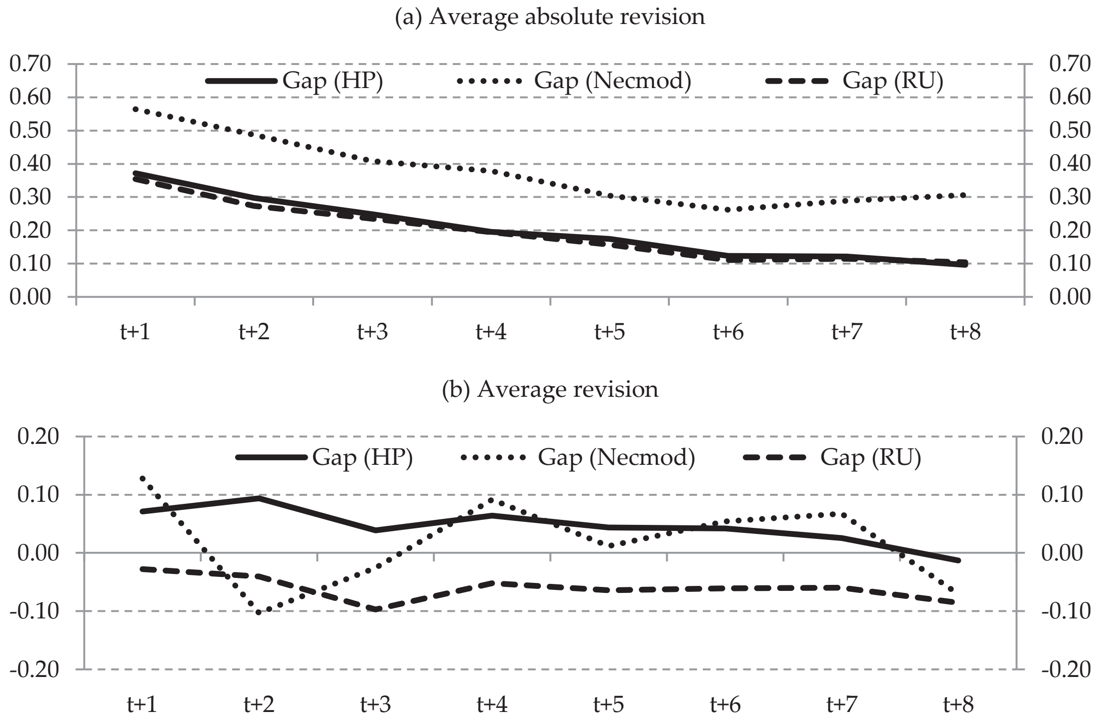
Figure 3. Output gap in subsequent projections



Source: Own calculations.

As panel (a) of Figure 4 indicates, average absolute revision of the output gap based on the RU indicator is comparable to the revisions of the measure based on the HP filter, with the output gap from the NECMOD being somewhat less stable. However, as panel (b) of the same figure reveals, the sign of the NECMOD-based gap corrections changes over the revision horizon (average revision across horizons of 0.01 percentage points), whereas Nyman (2010) measure tends to be systematically revised downward in the evaluation period (in 2005 – 2013 on average by 0.06 percentage points across horizons).

Figure 4. Output gap revisions – real-time representation (2005-2013)

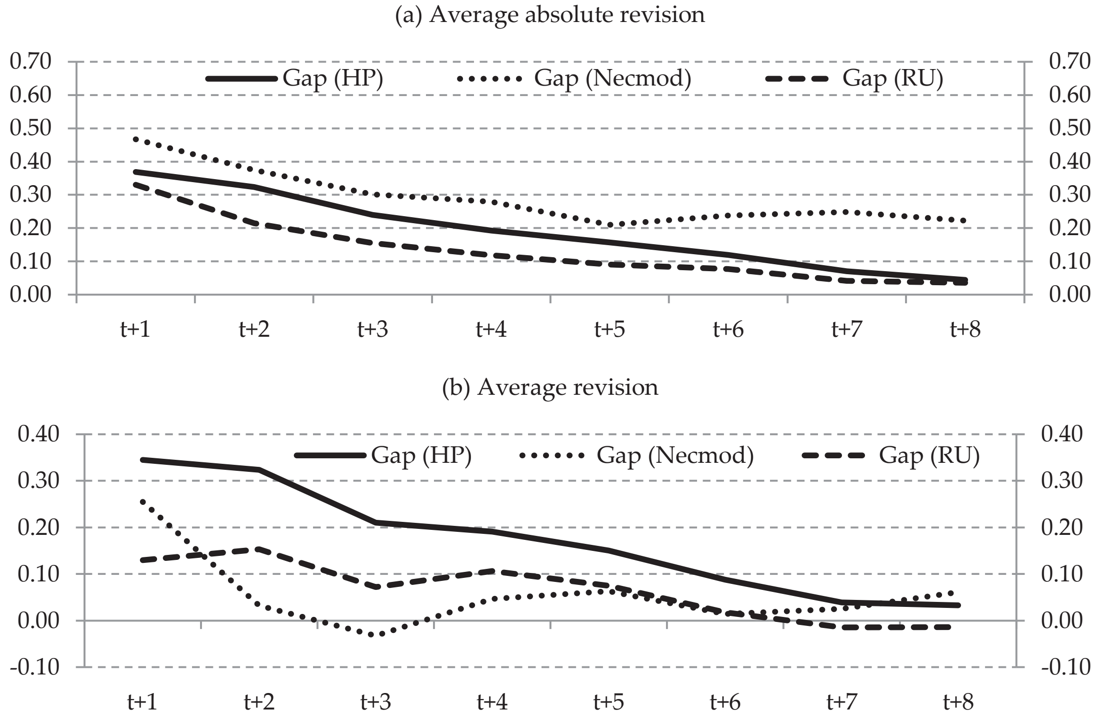


Source: Own calculations.

As Figure 3 suggests, however, mixed performance in terms of stability of output gap estimates based on the RU indicator across vintages can be attributed to 2005-2007 period. Instability of the RU-based output gap in this period has two sources. First is the instability of the RU indicator itself as a result of standardisation procedure and substantial shifts in sample means. These shifts are the consequences of small sample size and the economic boom in those years, with many variables in the dataset taking extreme values. Second, estimates of model (1)-(4) parameters in period 2005–2007 are more unstable than for 2008–2013 period (see Figure B1 in the Appendix B that plots estimates of model (1) – (4) coefficients in subsequent vintages).

Since 2008, the output gap measure constructed on the basis of Nyman (2010) methodology seems to outperform other approaches in terms of stability. This is confirmed in Figure 5 that presents average absolute (and raw) revision of gap measures calculated over 2008-2013 period.

Figure 5. Output gap revisions – real-time representation (2008-2013)



Source: Own calculations.

For evaluation period restricted to 2008-2013, the output gap measure based on Nyman (2010) approach is more stable than other gap estimates. The NECMOD-based output gap revision outperforms the HP filtered-based gap for raw figures (panel (b)), with absolute revisions being somewhat higher than for the HP filter approach (panel (a)).

V. Inflationary pressure

An output gap measure is supposed to provide an assessment of the scale of the inflationary pressure in the economy. In this section we test whether the measure based on the RU indicator performs better in this respect than alternative approaches. To this end, using real-time dataset introduced in the previous sections, we assess forecasting performance of a simple Phillips curve equation for CPI and core inflation, with output gap measures based on Nyman (2010), the NECMOD, and the HP filter methodology. In this respect, the exercise also fits in the broader research on performance of factor models in forecasting inflation in Poland (Baranowski et al. 2010, Kotłowski 2008), which suggests that using factor approach should improve the quality of inflation forecasts.

Specifically, for each output gap measure (and each vintage) we estimate the following Phillips curve specification, following Clark and McCracken (2006):

$$\pi_{t+h}^{(h)} - \pi_t = \alpha + \sum_{l=0}^{L-1} \alpha_l \pi_{t-l} + \sum_{m=0}^{M-1} \beta_m y_{t-m} + u_{t+h} \tag{6}$$

where inflation $\pi_t^{(h)} = \left(\frac{400}{h}\right) \cdot log\left(\frac{P_t}{P_{t-h}}\right), \pi_t^{(1)} = \pi_t$, and y_t denotes the level of the output gap. Both one- and four-quarters ahead forecasts are considered with equation (6) estimated with $h = 1 \; and \; 4$, respectively. Forecasts evaluation period covers 2005-2013. As a benchmark, we use the forecasts from the following AR specification:

$$\pi_{t+h}^{(h)} - \pi_t = \alpha + \sum_{l=0}^{L-1} \alpha_l \pi_{t-l} + v_{t+h} \tag{7}$$

As in Clark and McCracken (2006) lag order (*L* and *M*) in (6) was chosen on the basis of Akaike information criterion. First, *L=4* had been chosen to minimise information loss in (7) and then, taking *L* as given, *M=1* was set to minimise Akaike's criterion in (6).

Results presented in Table 2 indicate that the inclusion of the output gap measures based on HP filter and Nyman (2010) methodology in the Phillips curve specifications do not necessarily improve forecast quality relative to the AR specification for both core and CPI inflation[3]. NECMOD-based estimates seems to provide the best proxy for inflation pressure. McCracken (2007) test for equal forecast accuracy from nested models, indicates that forecasting performance of model that includes NECMOD-based gap measure is significantly better than that of AR specification in CPI regressions. The relative advantage of NECMOD in terms of forecasting performance may be attributed to the economy facing many supply shocks over the analysed sample, including periods of high oil prices and agflation. Such environment might favour structural approach (of NECMOD) and judgment.

The HP filter gap estimates specifications tend to underestimate inflation, especially in the *h=4* horizon, whereas NECMOD-based gap tend to overestimate it (Table 3). Bias of inflation forecast based on the RU gap is mixed, with the size of the bias at the lower end of the errors.

Table 2. Out-of-sample root mean squared forecast errors (2005-2013)

	AR	Gap (HP)	Gap (NECMOD)	Gap (RU)
		Core inflation		
h=1	0.88	1.06	0.98	1.05
h=4	1.07	1.28	1.05	1.34
		CPI inflation		
h=1	1.86	1.74	1.71**	1.81
h=4	1.54	1.62	1.28**	1.66

***,**,* denote the rejection of the null hypothesis of no improvement in terms of forecast accuracy against AR specification at the 1%, 5% and 10% significance level, respectively. Based on MFE-t and MFE-F test proposed in McCracken (2007).

[3] Forecast errors associated with each specification of equation (6) and equation (7) in subsequent vintages are presented in the Appendix C (Figure C1–C4).

Table 3. Out-of-sample mean forecast errors (2005-2013)

	AR	Gap (HP)	Gap (NECMOD)	Gap (RU)
		Core inflation		
h=1	-0.20	-0.27	-0.03	-0.08
h=4	-0.49*	-0.73***	0.03	0.04
		CPI inflation		
h=1	0.27	0.10	0.43	0.15
h=4	0.01	-0.46	0.38	-0.09

***,**,* denote the rejection of the null hypothesis of no bias at the 1%, 5% and 10% significance level, respectively. Test statistics are corrected for autocorrelation of forecast errors.

As in the previous section, as a robustness check, we test how the results change once we constrain the evaluation sample to 2008-2013. Tables 4 and 5 contain the relevant results. For recent years, including the gap measures as one of the explanatory variables reduces RMSE of the inflation forecasts, as compared with the AR specification. This is true especially for NECMOD based gap measure in the 4 quarters horizon.

Table 4. Out-of-sample root mean squared forecast errors (2008-2013)

	AR	Gap (HP)	Gap (NECMOD)	Gap (RU)
		Core inflation		
h=1	0.92	1.10	0.93	0.94
h=4	1.14	1.25	0.91*	0.75**
		CPI inflation		
h=1	1.80	1.58*	1.51**	1.51*
h=4	1.51	1.39	1.06***	1.16

***,**,* denote the rejection of the null hypothesis of no improvement in terms of forecast accuracy against AR specification at the 1%, 5% and 10% significance level, respectively. Based on MFE-t and MFE-F test proposed in McCracken (2007).

Results presented in Table 4 show that, for shorter evaluation period, both output gaps based on Nyman (2010) and the NECMOD improve forecast quality relative to the AR specification for core (in longer horizon) and CPI inflation – the results supported with McCracken (2007) test. Including gap measure based on the HP filter methodology improves CPI inflation forecasts but worsens forecasts of core inflation.

Table 5. Out-of-sample mean forecast errors (2008-2013)

	AR	Gap (HP)	Gap (NECMOD)	Gap (RU)
		Core inflation		
h=1	-0.18	-0.59**	-0.29	-0.41**
h=4	-0.53	-0.91***	-0.30	-0.48***
		CPI inflation		
h=1	0.42	-0.35	0.29	-0.15
h=4	-0.12	-0.69*	0.06	-0.54*

***,**,* denote the rejection of the null hypothesis of no bias at the 1%, 5% and 10% significance level, respectively. Test statistics are corrected for autocorrelation of forecast errors.

For 2008-2013 evaluation period all analysed specifications tend to underestimate core inflation, with the NECMOD gap measure making somewhat smaller errors (Table 5). For CPI inflation, both HP filter-based gap and the RU-based gap lead to underestimation of the inflationary pressure, with NECMOD-derived gap slightly overestimating it.

VI. Conclusions

We find that the output gap estimates identified with the resource utilisation indicator, derived from survey and labour market data, give a similar picture of the historical developments of the resource strain in the Polish economy to the other gap measures used at the Narodowy Bank Polski. One of the advantages of the RU approach is its relative resilience to the new data being published, especially in the recent years. Although, Phillips curve with RU-based output measure do not outperform specifications with other gap measures in terms of the RMSE, the forecasts it provides are less biased than those based on the HP filter gap specifications.

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Appendix A

Table A1. Variables included in RU indicator

Private service industries
Current demand for services*
Current financial situation of the enterprise
Factors limiting activity - shortage of skilled labour*
Current general economic situation of the enterprise*

Retail sector
Current amount of sold goods
Current stocks of goods
Current financial situation of the enterprise
Current general economic situation of the enterprise

Construction industry
Expected domestic order-books
Factors limiting activity - shortage of skilled labour
Current general economic situation of the enterprise
Current financial situation of the enterprise
Capacity utilization of the enterprise (in percentage)

Manufacturing industry
Production capacity*
Capacity utilization of the enterprise (in percentage)*
Current domestic and foreign order-books [stream]
Expected financial situation of the enterprise
Factors limiting activity - shortage of labour*
Factors limiting activity - lack of appropriate equipment*
Current general economic situation of the enterprise
Current stocks of finished products
Factors limiting activity - shortage of skilled labour*

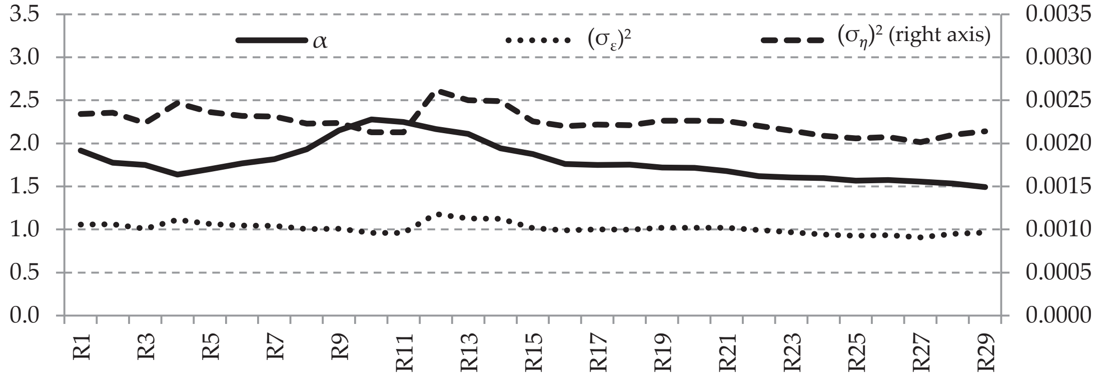
Labour market data
Employment, according to the LFS
Unemployment, according to the LFS
Job offers declared during a month

Other data
Production capacity utilization (NBP)

* Available since 2003.

Appendix B

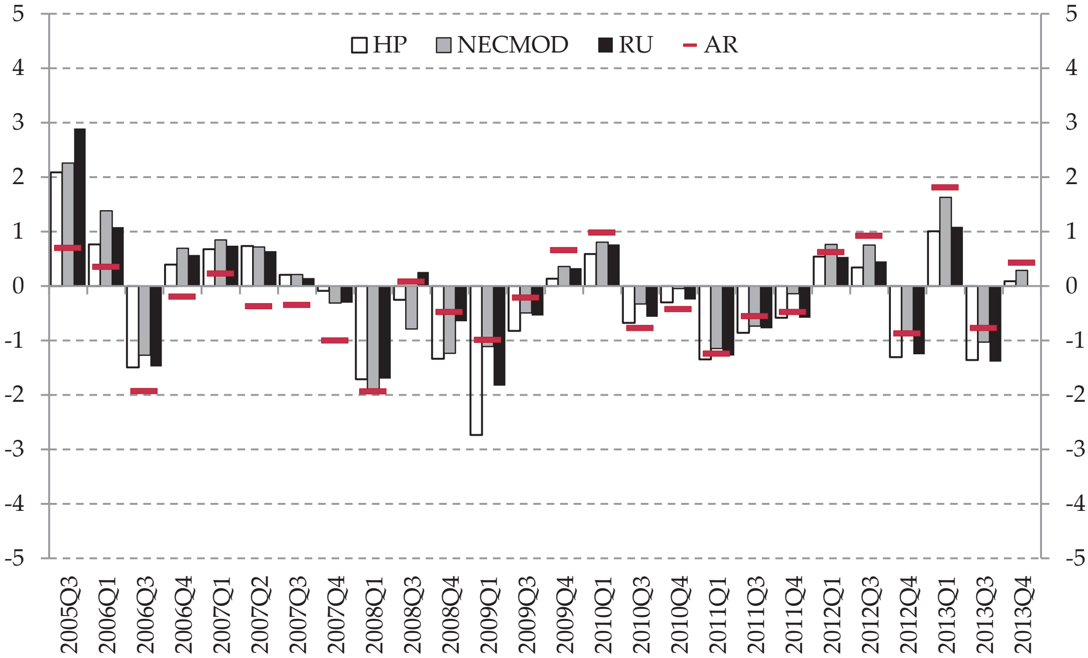
Figure B1. State space model (1)-(4) coefficient estimates in subsequent vintages.



Source: Own calculations.

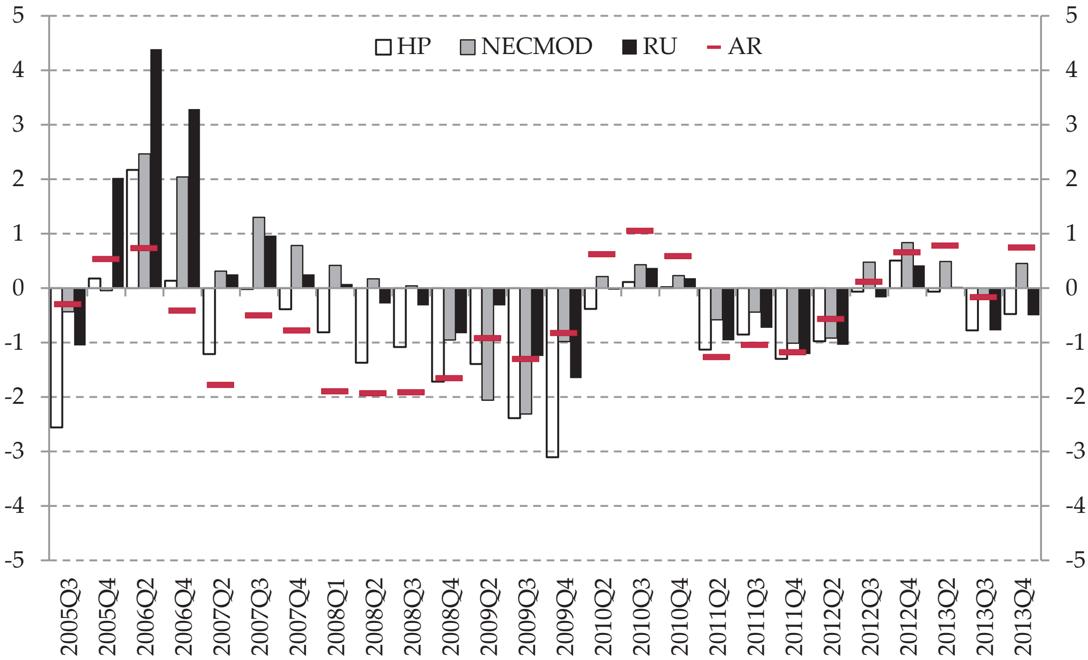
Appendix C

Figure C1. Forecast errors in subsequent vintages (core inflation, h=1).



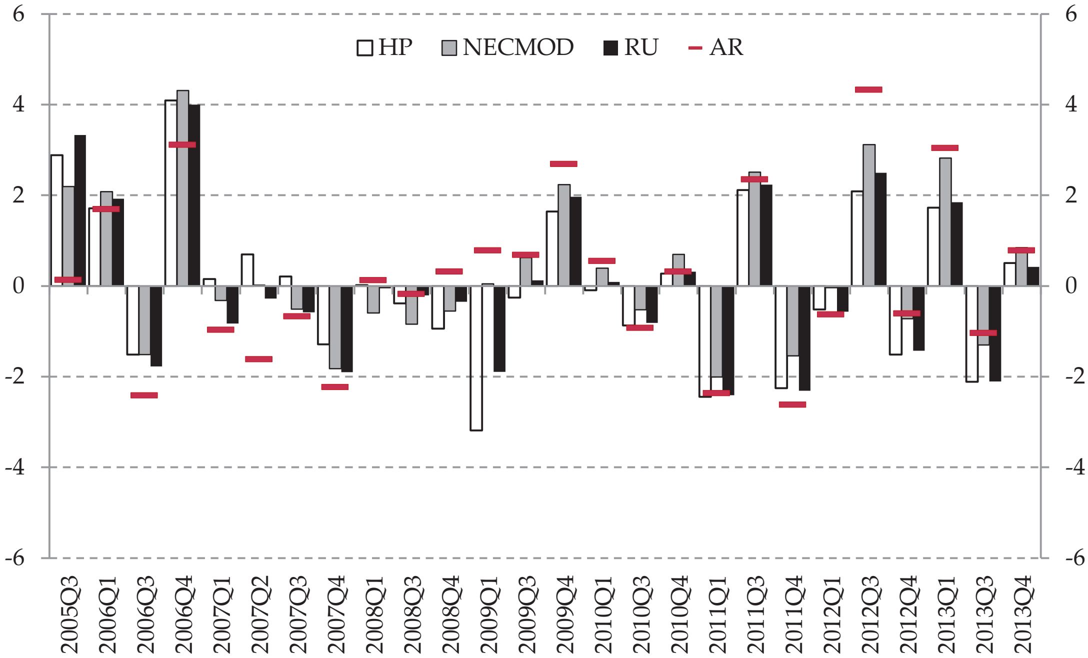
Source: Own calculations.
Note: Inflation forecast errors based on equation (6) and (7).

Figure C2. Forecast errors in subsequent vintages (core inflation, h=4).



Source: Own calculations.
Note: Inflation forecast errors based on equation (6) and (7).

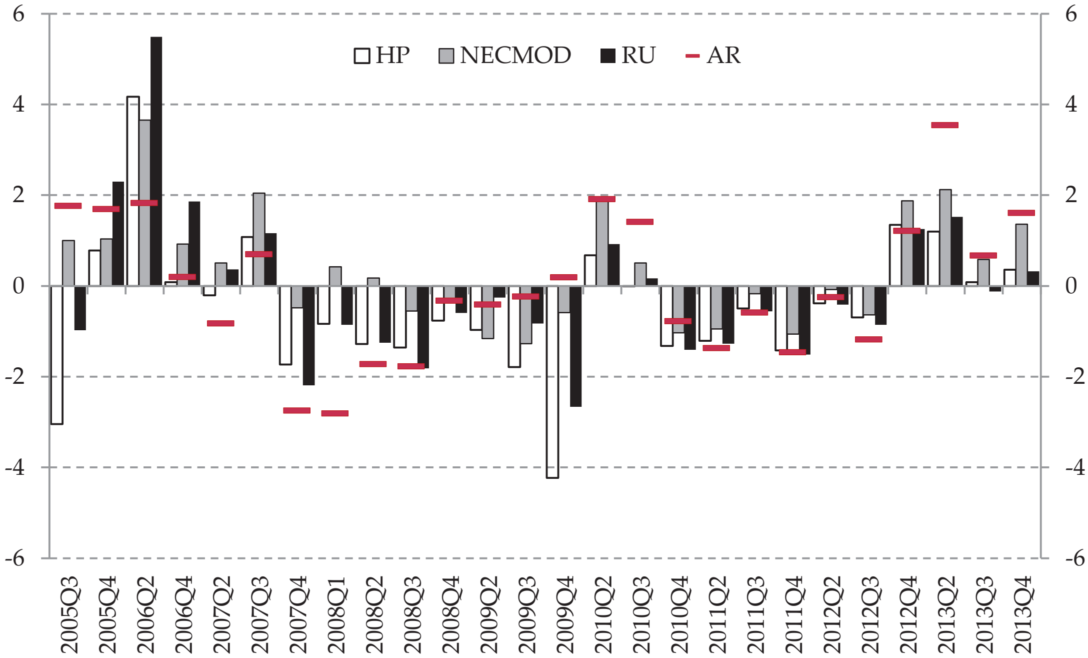
Figure C3. Forecast errors in subsequent vintages (CPI inflation, h=1).



Source: Own calculations.

Note: Inflation forecast errors based on equation (6) and (7).

Figure C4. Forecast errors in subsequent vintages (CPI inflation, h=4).



Source: Own calculations.

Note: Inflation forecast errors based on equation (6) and (7).

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