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Separating the trend from the cycle : the debate on euro area potential output and implications for monetary policy = Tendance ou cycle?

Separating the trend from the cycle : The debate on euro area potential output and implications for monetary policy

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Introduction

A decade since the onset of the financial and economic crisis, estimates by international organisations suggest that economic activity in the euro area is now at or close to its potential level. Rather than being a cause for celebration, the closing of the output gap has sparked debate.

This is not surprising. Given that potential output is unobservable, any estimates of it are always surrounded by uncertainty. Consequently, whether the economy is operating above, at, or below its potential is often subject to discussion. What has been noteworthy this time though, is that despite the output gap closing, inflationary pressures have remained weak. And when digging a little deeper, it turns out that the closing of the output gap is in large part due to potential output being revised downwards rather than the economy fully recovering from the damage caused by the crisis. It is these large downward revisions in potential output in particular that have been questioned. Are they mainly statistical artefacts resulting from modelling approaches that have problems with correctly separating the trend from the cycle ? That may suggest that slack in the economy may be larger than what published output gap estimates suggest. Or do these downward revisions of potential output reflect reality ? And if they do, are they permanent or transitory ? Or, in the words of Coeuré (2017), has the crisis and the related persistent shortfall in demand scarred or merely scratched the euro area economy's potential ?

This article addresses these questions. It discusses recent research in this area and backs it up with NBB analyses focusing on the euro area. More specifically, it provides evidence that many methods of estimating potential output face challenges in distinguishing between cyclical and structural forces that are driving the economy. This makes these estimates procyclical, meaning that potential output tends to weaken when the economy is weak and pick up when the economy is strong. Clearly, procyclicality induced by statistical methods is undesirable and should be corrected for.

However, from an economic perspective, it is not clear-cut whether procyclicality should be ruled out altogether. According to the standard view, potential output is a supply-side concept and should thus be purely driven by structural, slow-moving forces that are unrelated to the business cycle. In other words, demand-side developments (shocks or policies) cannot influence it. But since the crisis, the idea has resurfaced

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that demand-side developments, if persistent, may also influence the economy's supply side and, in turn, potential output too (i.e. hysteresis view).

The discussion about the procyclicality of potential output is not only important from an econometric and theoretic point of view, but is also relevant for policy. Over- or underestimations of potential output may guide policy-makers to run the economy respectively too hot or too cold. Furthermore, the standard versus hysteresis view on potential output differ on how policy should boost potential output: the former advocates structural policies, whereas the latter also sees scope for demand-side policies (e.g. monetary policy stimulus).

While this article stresses the many uncertainties that surround estimates of potential output and, thus, the output gap, it does not dismiss these concepts altogether, like some have done [1]. On the contrary, it explores how the estimation of potential output can be improved. For monetary policy-makers, the large uncertainty implies that they should not give too much weight to one specific output gap measure and should keep an open mind about various estimates that might tell a different story and raise important questions.

The remainder of the article is structured as follows. Section 1 sketches the different paths that potential output in the euro area may have followed since the crisis. Section 2 gives a concise overview of different methods for estimating the economy's potential. Section 3 addresses the issue of procyclicality in the estimates of potential output and how to deal with it. Finally, section 4 presents some take-aways for monetary policy-makers. [2]

1. Potential output after the crisis

Ten years after the start of the financial crisis, economic activity remains more than 10 percentage points below its pre-crisis trend path in the euro area, the US and the UK (Barnichon *et al.,* 2018). From a historical perspective, such a persistent gap is not unusual. In fact, a cross-country analysis shows that about two-thirds of recessions are followed by lower output relative to the pre-recession trend even as the economy has recovered (Blanchard *et al.*, 2015). This is also more common for recessions caused by a financial crisis (83 %) than in the absence of a financial crisis (66 %).

From a conceptual point of view, an important determinant of this gap is the level of potential GDP – defined as the highest level of economic activity that can be sustained without generating inflationary pressure (ECB, 2018).

So, where does potential GDP in the euro area currently stand? Let's consider some stylised examples. A first possibility is that potential GDP has stayed high (i.e. in line with the pre-crisis trend, see blue line in chart 1). In this case, the "output gap" – the percentage difference between real GDP and its potential level – would remain considerably negative [3]. A second option entails a slowdown in potential GDP growth, in which case the output gap may already have closed or even be positive. In this respect, three sub-options can be distinguished:

- Potential output growth was already slowing well before the onset of the crisis (see green line in chart 1 and Fernald, 2014). In this case, there is nothing peculiar about the low post-2008 potential growth rate. It is simply the continuation of a long-term downward trend in productivity which can only be offset by structural (i.e. supply-side) changes or policies.
- Potential growth may only have started slowing during or after the crisis (see red line).
- The level of potential GDP declined due to a series of negative shocks around the financial crisis, but potential growth then caught up with its pre-crisis trend (see orange line).

1 See, for instance, Brooks and Basile (2019) and Efstathiou (2019).

2 Fiscal policy implications, while important, are beyond the scope of this paper.

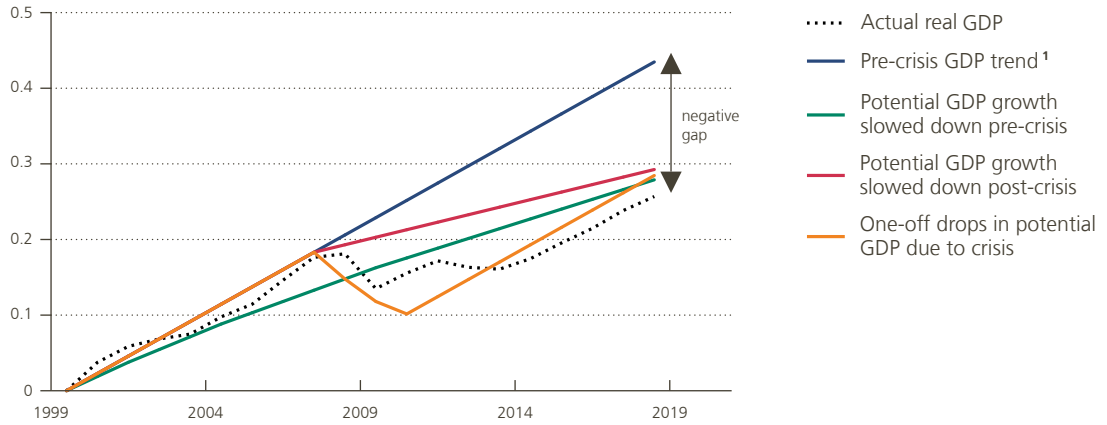
3 The output gap is defined as (Real GDP – Potential GDP)/Potential GDP. Figure 1 visualises this expression in (natural) logarithmic terms as output gap = log(Real GDP) – log(Potential GDP). A similar concept is the unemployment gap – defined as the difference between the unemployment rate and its "natural rate".

Why would potential output undergo persistent level shifts or grow slower post crisis (as depicted by the orange and red lines)? On the one hand, an explanation could be given by the supply side of the economy. Just as slow-moving supply-side developments may be gradually lowering potential output, a recession that starts with a negative supply shock, e.g. permanently higher oil prices due to turmoil in the Middle East, may cause a sudden fall in potential output. On the other hand, the demand side of the economy may also be involved, as a recession that starts because of negative demand shocks can also have permanent or long-lasting effects on the economy's supply side or potential output. This is called hysteresis and could happen when, for instance, people become unemployed for a long time and lose their skills or leave the labour market; firms invest less during the recession and the capital stock becomes permanently lower than in the absence of the recession; the recession and restricted credit hampers the creation of new and innovative start-up firms. It is worth noting, though, that hysteresis can work both ways, with positive demand shocks, for example in the context of a tight labour market, lifting potential output. This also implies that the loss of potential output since the crisis could be recovered by demand-side policies.

Chart 1

Potential trajectories of potential GDP in the euro area

(in natural log index 1999 = 0)



Sources: EC, NBB.
Note: Depicted trajectories of potential GDP are only illustrative.
1 The pre-crisis (1999-2007) average annual growth rate was 2.3 %.

The level of potential output relative to actual output determines the output gap – an important concept for monetary policy-makers because it is often linked to inflation dynamics. According to the Phillips curve framework, a positive (negative) output gap indicates an economy that is running hot (cold), and this will induce upward (downward) pressure on inflation (see e.g. Cordemans and Wauters, 2018). Knowing the sign and size of the output gap is thus expected to help in forecasting the future path of inflation and setting the course of monetary policy. Specifically, a negative output gap generally calls for demand stimulus, while a positive output gap prompts monetary tightening.

However, the level of potential output – and thus also the output gap – is unobservable and must be estimated using observed data. In practice, a plethora of different types of models (and specifications) are used to gauge the degree of slack in the economy, and the results can differ substantially. As a result, there is an ongoing debate on the degree of slack in the euro area economy and what it implies for inflation dynamics.

2. How to measure potential output?

There are three basic approaches to estimating potential output: (1) statistical approaches: (2) production function, or growth-accounting, approaches: and (3) the newest addition, dynamic stochastic general equilibrium (DSGE) approaches. The DSGE approach is more micro-founded whereas the other two are mainly based on empirical relations between macroeconomic variables with fewer theoretical restrictions. This section takes a closer look at each of the three approaches, briefly mentioning their advantages and drawbacks. The aim is not to determine which approach is best – there is no consensus about this – but rather to show which shocks to potential output the different methods consider and how this influences potential output and thus the output gap. So, the focus is not on quantitative results.

2.1 Statistical approaches: trend-cycle decompositions

Statistical methods are often used to obtain estimates of potential output. In their simplest form, a univariate time series, being actual GDP, is split (e.g. by the Hodrick-Prescott (HP) filter) into a trend component – which is identified as potential output – and a cyclical component. More sophisticated multivariate approaches also use information from other economic indicators to disentangle the trend from the cycle. For instance, output, unemployment and inflation can be combined and potential output obtained by using a Phillips curve relationship. Statistical approaches define potential output as the long-run stochastic trend of output.

The advantage of statistical methods is that they are relatively simple. One disadvantage is that potential output estimates at the beginning and end of the sample may be inaccurate. In addition, univariate methods disregard the economic relationships underpinning potential output. Statistical approaches may also struggle with correctly separating the cycle from the trend. Especially during a slow recovery following a deep recession, this approach may find it difficult to distinguish persistent from permanent shocks. In other words, the potential output estimate comoves with the economic cycle (we return to this issue of procyclicality in section 3).

2.2 Production function approach: the semi-structural practical choice

Most central banks (including the NBB) and international organisations (including the EC and OECD) use the production function approach to estimate potential output. This method models potential output in terms of its underlying building blocks: labour, capital and total factor productivity[1]. The method requires choosing an appropriate specification of the production function, which (in the NBB and EC's case for instance) is typically a Cobb-Douglas aggregate of labour and physical capital with constant returns to scale. Next, the potential level of the input factors must be determined. This corresponds to the maximum or normal amount of each variable that could be used for production without leading to an acceleration of inflation. For labour, this is generally structural employment, for capital, it is the actual capital stock, while (trend) total factor productivity is typically a residual category.

The production function approach defines potential output as the level of output consistent with current technologies and normal utilisation of capital and labour input.

The production function approach has several advantages, the main one being that it is grounded in bottom-up or growth-accounting principles as it enables GDP growth to be broken down into the contributions of labour, capital and total factor productivity. However, some assumptions on the structure of the economy need to be made and they may not fully correspond to reality (e.g. the assumption of constant returns to scale). Another drawback is that the production function approach focuses solely on the supply side. Nor is the potential level of

1 Havik *et al.* (2014) describe the production function methodology of the EC, and Turner *et al.* (2016) that of the OECD. See Basselier *et al.* (2017) for an example for Belgium.

the input factors straightforward to obtain. Production function measures of potential output are also inherently cyclical because each of its components may exhibit some degree of cyclicality. This is especially true for capital: this input factor usually enters the production function unfiltered so that cyclicality in the capital stock induces cyclicality in potential output. Like with the statistical approach, the filtering techniques used to obtain the sub-components of the production function can also introduce cyclicality. For instance, an HP filter is often used to estimate the trend in labour force participation. Depending on the smoothing parameter used, this may produce estimates of the trend component that are affected by the business cycle.

Note that there is no clear-cut separation between production function methods and statistical approaches. The methods can be combined, for instance with a production function being used in a trend-cycle decomposition.

2.3 DSGE models: in line with economic theory, but relatively complex

DSGE models represent a micro-based approach to macroeconomic modelling. They have a New-Keynesian (NK) structure and are thus consistent with current monetary policy thinking. This means that, because of distortions related to the delay in wage and price adjustment and associated time-varying profit mark-up fluctuations, the consequences of real (demand) disturbances can be inefficient and their degree of inefficiency can be mitigated by the monetary policy response. Regarding the estimation process, in a first step, the parameters of the model are calibrated or estimated on the relevant economy so that the different shocks hitting the economy can be identified. In a second step, potential output is obtained from the solution of the model when certain shocks and frictions are turned off.

Within a NK-DSGE framework, the concept of potential output is more complex than in traditional approaches. Typically, it is defined as the level of output that could be attained if prices and wages are fully flexible and price and wage mark-ups are constant (so-called flex-price potential output; see Appendix 1 for an overview of the various potential output concepts in DSGE models). The resultant (flex-price) output gap is a relevant guide for central banks focusing on price stability over the medium term, as long as wage and price mark-up shocks are not too persistent.[1] However, note that there is no direct positive Phillips curve-type relationship between inflation and the output gap in DSGE models with both price and wage stickiness. Instead, price inflation depends positively on the current and future expected inverse profit margin of firms, while wage inflation depends on the ratio between the marginal disutility of working (expressed in consumption goods) and the real wage. A simple Phillips curve-type relationship between inflation and output exists only in stylized models with flexible wages (e.g. Woodford, 2003).

The advantage of a DSGE model is that it enables a structural interpretation: potential output and structural shocks are jointly estimated within a general equilibrium framework which thus makes it possible to conduct a quantitative and internally consistent assessment of inflationary pressures and a normative evaluation of alternative policy measures. But potential output estimates obtained from DSGE models also have their disadvantages. They are quite hard to communicate, as they are rather abstract (see above). They are highly dependent upon the underlying model and the frictions assumed therein. They may not capture structural changes appropriately: many DSGE models assume that all shocks are transitory and, thus, that the economy ultimately returns to a fixed steady state. Consequently, these models should be handled with care when analysing long-term shifts (like in demographics and productivity). For instance, a trend slowdown in the rate of productivity growth would, through the lens of these models, appear as a long sequence of negative shocks to productivity. Once these shocks disappear, everything will return to normal, with the new normal being the same as the old normal. DSGE models designed to estimate potential output should ideally thus include longer-term shocks, trends and dynamics.

1 This condition is met for the DSGE based output gap estimates discussed in Chart 5.

Summing up, all the available methods have their pros and cons, and none is unequivocally declared better than the alternatives. In practice, given their relative simplicity and transparent methodology, policy institutions tend to use production function and statistical approaches rather than DSGE models. On the other hand, every economic cycle is different. Hence, keeping analyses simple and purely data-driven may be problematic in a complex world. In this respect, the microfoundations of DSGE models could be a useful economic cross-check to understand what is driving potential output and how to better estimate it.

3. The issue of procyclicality in potential output estimates

One of the most controversial features of potential output estimates is that they tend to be procyclical : potential growth tends to be weak when the economy is weak and strong when the economy is strong. This feature is also apparent during the financial crisis. At first sight, procyclicality seems to contradict the standard view of potential output, namely, that it is driven by structural, slow-moving forces that are unrelated to the business cycle. It is a supply-side concept that demand-side developments (shocks or policies) cannot influence (exemplified by the statement that "monetary policy is neutral in the long run"). Nevertheless, some procyclicality in potential output estimates can be explained or justified.

On the one hand, there are statistical reasons for cyclicality. Some potential output concepts are based on the actual capital stock (e.g. production function approach). Cyclicality in actual capital thus automatically causes cyclicality in potential output. Cyclicality in estimates of potential output can also stem from incorrect trend-cycle decompositions. This may be due to end-of-sample problems or methods that do not provide for long enough cycles after deep recessions and identify slow recoveries as lower trend output. For instance, estimates of structural employment may also be procyclical. Gechert *et al.* (2016) find that EC's methodology implies that the estimated structural unemployment rate is largely determined by actual unemployement as opposed to other data used in the estimation.

On the other hand, there may also be economic reasons for cyclicality. These are related to hysteresis. *Inter alia*, Ball (2014), Blanchard (2018a) and Reifschneider *et al.* (2015) have suggested that an extended weakness in cyclical demand can damage the supply potential of the economy through hysteresis effects. So, if one finds the hysteresis view relevant, one also expects to see some cyclicality in estimates of potential output.

Note that the three estimation methods described above can deliver procyclical potential output estimates. If so desired, their degree of procyclicality can be attenuated, though. The following sections take a closer look at recent research in this respect. More specifically, section 3.1 shows that potential output estimates made by international institutions tend to be too sensitive to demand shocks but not sensitive enough to supply shocks. Subsequently, section 3.2 looks at how estimation methods could be amended so that they can better identify the shocks that ought to drive potential output. Yet there remains a caveat, which is discussed in section 3.3, namely, that economic theory is inconclusive about the appropriate degree of cyclicality in estimates of potential output or, put differently, whether only supply shocks drive the economy's potential.

3.1 Traditional approaches to estimating potential output may overreact to demand shocks and underreact to supply shocks

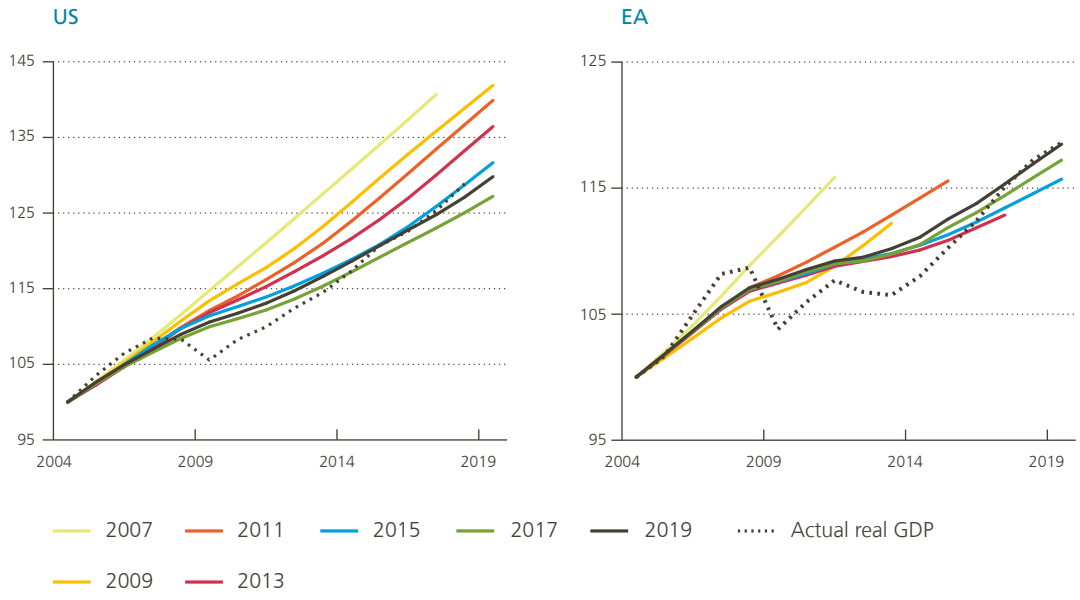
It is natural that revisions to actual GDP data cause revisions to potential output estimates. But, merely looking at different vintages of potential output estimates suggests that these estimates may be too procyclical. For instance, chart 2 shows that since the onset of the financial crisis in 2008, initial estimates of the EC's potential output have been subject to downward revisions over subsequent vintages, thus following the decline in actual GDP. By contrast, once the recovery started in 2013, potential output estimates for the euro area were revised upwards, thus following the increase in actual GDP. The procyclical nature of these revisions suggests

that the methods used by international institutions to estimate potential output have difficulty in identifying the shocks that ought to drive potential output.

Chart 2

Potential output vintages (full line) and actual output (dotted line)

(index 2004 = 100)



Sources: CBO, EC, FRED.

Coibion *et al*. (2018) make this point in a more elaborate way. They empirically find that institutional estimates of potential output obtained from production function and statistical approaches are too cyclical. More specifically, across countries, they find an over-response of real-time estimates of potential output to demand shocks and an under-response to supply shocks.

This finding has two implications. First, estimation methods used by international institutions may not seem to differ that much from simple statistical filters. To the extent that these methods fail to identify the different shocks behind the changes in economic activity, they will naturally lead to slow-moving dynamic responses of potential output to all shocks that move actual output. Second, the downwardly revised path of potential output since the crisis (see chart 2) may thus not be a good reference for the future path of actual GDP. In fact, the strong performance of the US economy has recently led to upward revisions in US potential output.

3.2 Solutions for dampening statistical procyclicality

In order to obtain less cyclical potential output estimates – and consequently get estimates that are more in line with the standard theory according to which longer-term developments in potential output should respond to supply shocks but be largely independent from demand shocks – Coibion *et al.* suggest combining statistical approaches with economic restrictions.

Methods proposed by Coibion et al.

One proposed method entails applying a Blanchard-Quah (BQ, 1989) structural decomposition to a 2-variable vector autoregression (VAR) model consisting of output and unemployment. This approach relies on long-run restrictions to distinguish shocks that have permanent effects on output (labelled supply shocks) from those with only temporary effects on output (labelled demand shocks) and, by construction, rules out hysteresis. Potential output is in fact recovered from the contribution of shocks that have a permanent impact on output. Coibion *et al*. find this estimate of potential output to be less cyclical and less subject to revision. In addition, the BQ potential output estimate has also fallen by less than that of the Congressional Budget Office (CBO) and thus implies a more negative US output gap.

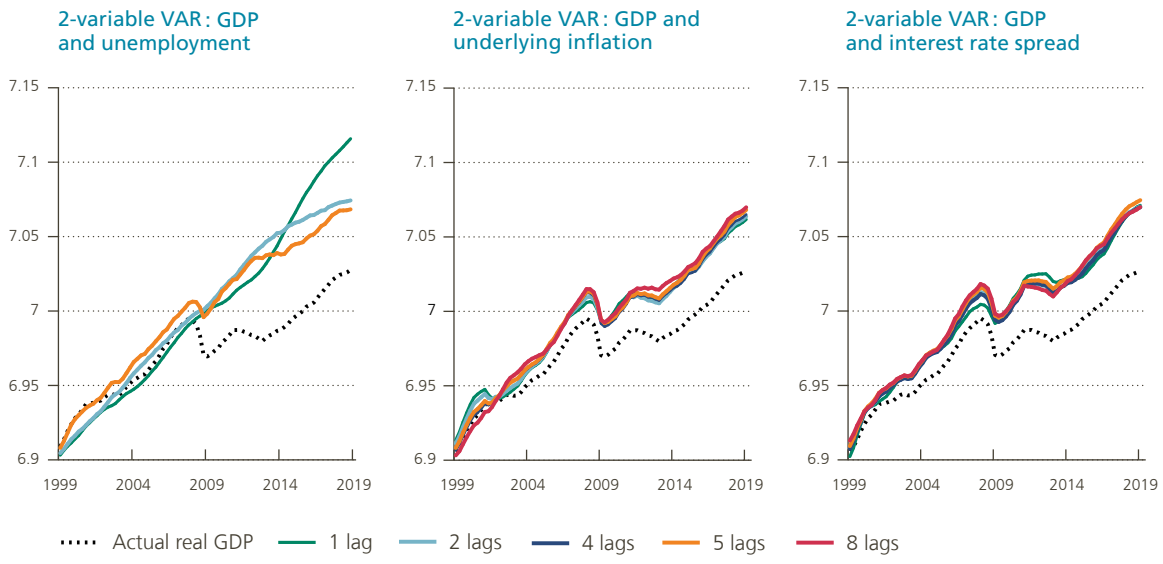
While attractive given its simplicity, the method comes with some caveats. Blanchard (2018b), the co-founder of the BQ method, has, in a reaction to Coibion *et al.*'s research, mentioned the method's limits, one being that it does not necessarily identify supply and demand shocks but rather separates permanent from temporary shocks. A supply shock that has a temporary and thus non-permanent effect on potential output will be incorrectly labelled as a demand shock and will thus not show up in the reconstructed series for potential output. Similarly, a demand shock that affects potential output (hysteresis) will not show up in the reconstructed potential output series.

In addition, applying the simple BQ decomposition to a similar 2-variable VAR but with euro area data looks less promising to obtain better potential output estimates. A first problem is related to the fact that euro area unemployment has a unit root while the BQ approach requires the series to be stationary. The unemployment rate can be replaced by another stationary variable that captures the state of the business cycle, but results are in general quite dependent on the lag length and on the variables included in the system (see results in chart 3). So, instead of a 2-variable VAR, a bigger model on which to apply a modified BQ approach would be needed to obtain a more reliable estimate of potential output for the euro area.

Chart 3

Estimates for euro area potential output following the BQ approach

(potential output in log levels)



Source : NBB.

Note : To extract the level of potential output from the BQ VAR, the output gap is assumed zero in 1997Q1 and the long-run growth rate of output is assumed to be stable at 2 %.

Moreover, the dynamics of potential output do not only depend upon the choice of variables and lags, but also on the assumptions about the long-run growth rate of the economy. Depending upon whether one includes a high or a low long-run growth rate of GDP, the output gap will be bigger or smaller today. Coibion *et al.* (2018) recognise this problem of sensitivity of the assumed long-run growth rate and thus consider several values for the pre-crisis long-run growth rate. Their benchmark is 3.1 % (being the average GDP growth rate over the period 1977-2007) but considering other sources of long-term growth projections, they find that the output gap can work out at anywhere between –15 % (Macro Advisers) and –2 % (CBO) since the great recession.

Another approach to estimating potential output follows Gali (1999), who defines potential output as being solely driven by technology shocks. Given this narrower interpretation of what can drive potential output, it is probably not surprising that Coibion *et al.* (2018) find that US potential output estimated according to this approach has declined by even less than when using the BQ approach.

The different estimates of potential output depending on the alternative approaches used by Coibion et al. (2018) again highlight that it is extremely important to know what concept of potential output is being estimated : different concepts imply different reactions of potential output to shocks and they have different (monetary) policy implications. In addition, the precise implementation needs to be fine-tuned.

An alternative way of trying to better identify trend and cycle effects (and avoid excess cyclicality as well) entails adding extra sources of information to the statistical model through variables related to inflation or financial factors (just as DSGE models do). The following section discusses some of these more sophisticated multivariate approaches.

Phillips curve models

A broad range of models include the Phillips curve relationship as a source of information for measuring the economy's output gap more accurately. According to this relationship, demand shocks can be identified through the fact that they lead output and inflation to co-move in the same direction. Therefore, these models contain an inflation equation which links the "inflation gap" – the difference between inflation and its trend – to the output (or unemployment) gap, so that positive (negative) output gaps translate into upward (downward) pressure on future inflation. This feature is particularly relevant for the recent "lowflation" years in the euro area where upbeat economic growth coincided with weak inflation. Not taking account of the latter fact could bias the estimates of potential output downwards, in that univariate methods would risk interpreting a long period of relatively strong growth as fast convergence to (and even above) potential while the inflation trajectory would suggest another view (still room to grow towards potential).

We highlight two recent studies in this domain. First, Jarociński and Lenza (2018) build a dynamic factor model of the euro area, where deviations of output from its trend – the output gap – are consistent with the behaviour of inflation. The authors compare different model specifications based on how well they forecast core inflation in real time. According to the best models, the output gap is very wide after the crisis. In the best model, it even reaches –6 % of euro area GDP in 2014, a figure twice as negative as the official estimates by international institutions.

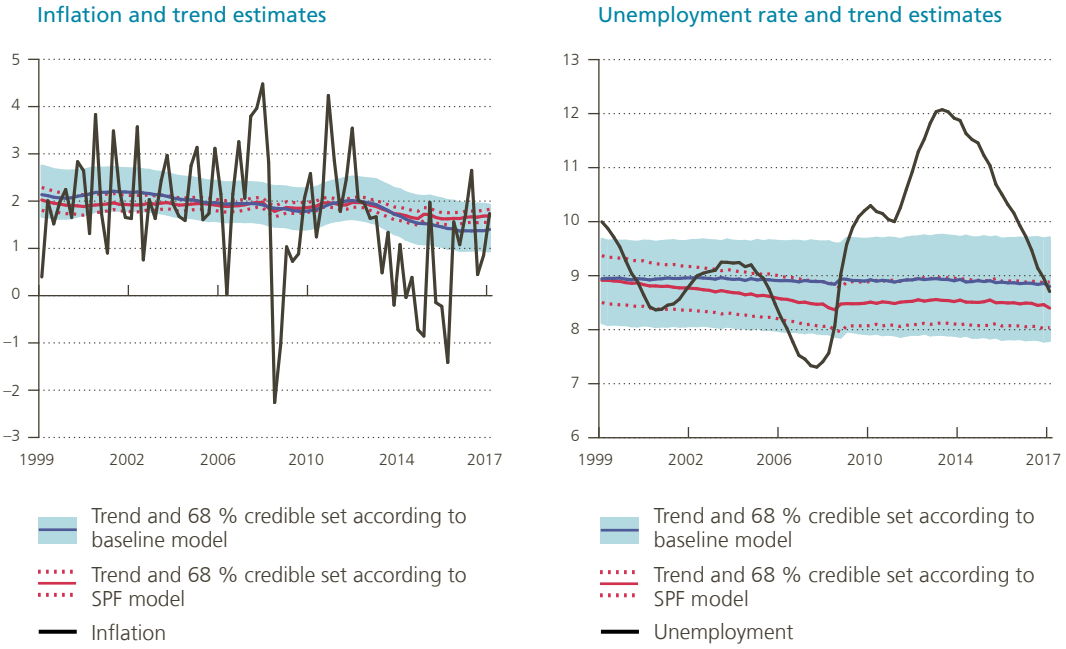
A second example is the work by Stevens and Wauters (2018), who estimate a Phillips curve model where the trends and parameters can vary over time. In addition, they estimate specifications where the model's forecasts are made consistent with the average inflation expectations from the ECB's Survey of Professional Forecasters (SPF) at short- and long-term horizons. Several papers in this field of literature also use long-term inflation expectations to inform the estimates of trend inflation : not doing so can lead to low inflation being interpreted as a lower trend while a long and slow recovery could explain the below-target inflation. Their approach differs from the literature in that it uses a term structure of expectations and not only long-term inflation expectations. In fact, the inclusion of short-term expectations should also make it possible to measure how quickly the economy reverts (or is expected to revert) towards its trend rates, thereby helping to distinguish between changes in trends and persistent deviations from those trends. That could be particularly relevant in the wake of the double-dip recession in the euro area.

The results[1] show that euro area lowflation up to 2017 was mainly driven by cyclical (and thus temporary) forces, i.e. by an economy operating persistently below potential. Chart 4 shows euro area inflation and trend inflation – the expected rate of inflation in the long term – for the "baseline" Phillips curve model which neglects expectations data, and the expanded "SPF model" which makes the model forecasts consistent with SPF data. The inclusion of survey data (whose long-term inflation expectations remain fairly stable) leads to a more muted decline in trend inflation at the end of the sample. Trend inflation is about 1.7 % at the end of 2017 in the SPF model, and 1.4 % in the baseline model. To explain persistent low inflation, the SPF model attributes a larger role to economic slack. Chart 4 shows the euro area unemployment rate and the estimated natural (or trend) rates from both models. At the end of the sample, the natural rate is close to the unemployment rate for the baseline model, indicating an economy operating at its potential. By contrast, the natural rate is lower in the SPF model, and the unemployment gap remains positive at the end of 2017.

Chart 4

Adding extra data can help models to better distinguish the trend from the cycle

(in %)



Source: Stevens and Wauters (2018). The figure on the left shows quarter-on-quarter annualised headline HICP inflation for the euro area, and two types of trend estimates. The figure on the right shows the euro area unemployment rate, and two types of estimates of the natural rate. The baseline results correspond to a model estimation which does not take SPF expectations into account, whereas the SPF model has model-based forecasts which are in line with the SPF expectations.

The key take-away from these examples is that weak inflation developments in the last few years in the euro area could be the symptom of more slack than had been generally presumed.

Models with financial variables

Another view is that financial factors, and the financial cycle more generally, help to identify potential output. Barnichon *et al.* (2018) estimate a non-linear vector moving-average (VMA) model which allows for asymmetric

1 The sample ends in 2017Q4, updated estimates are in production.

effects from adverse and favourable financial shocks. They find that temporary adverse financial shocks have persistent effects on output and prices. Using a counterfactual simulation which shuts down the financial shocks of 2007-2008, they show that these shocks had very large effects, and persistently lowered GDP by roughly 7 percentage points in the US, and by 8 percentage points in the UK. In a next step, the authors investigate how the financial shocks affect the components of GDP. Interestingly, adverse financial market disruptions deliver strong and persistent negative effects on R&D spending, thereby providing a potential channel for how these shocks influence the economy's long-term economic performance.

Borio e*t al.* (2017) propose an unobserved components model that includes information from the financial cycle in measures of potential output. They report that this approach of creating "finance-neutral" output gaps makes the output gap estimates more precise, less procyclical and more robust in real time[1]. By contrast, they argue that inflation (see the above section on the Phillips curve) carries very little information to infer potential output. In similar vein, Basselier *et al.* (2017) report finance-neutral output gap estimates for Belgium. The inclusion of financial measures in the estimation leads to a more positive output gap that exceeds traditional estimates by around 1 percentage point between 2001 and 2011, whereas the opposite is true in the most recent period (2014-2016). However, the larger output gap prior to the great financial crisis is not due to financial variables, because the financial gaps are found to be negative in that period. And there is no proof of the output gaps being more stable in real time.

3.3 However, economic theory is not clear about how cyclical potential output should be

While advances in modelling may help to better identify the economic shocks that influence potential output in a given economic framework, theory is not at all clear as to which shocks potential output should ultimately react or not.

It is straightforward that permanent supply shocks should be a driver of potential output as they determine the productive capacity of the economy. But what about demand shocks? At first sight, and in line with standard thinking, potential output should not react to demand shocks. However, if these demand shocks have persistent effects and, consequently, also impact the supply side of the economy, potential output may also react to these demand shocks (i.e., the hysteresis view introduces an economic rationale for cyclicality in estimates of potential output).

The degree of cyclicality in estimates of potential output also has significant monetary policy implications. First, it may substantially affect monetary policy's stabilisation decisions. Following a (persistent) decline in aggregate demand, a highly cyclical potential output estimate, by implying a less negative output gap, would signal less need for monetary easing than a more stable potential output estimate. Second, it determines the extent to which monetary policy may influence potential output. To understand this, it should be recalled that the standard view implies no impact from monetary policy on potential output (i.e. it is neutral in the long run), whereas, according to the hysteresis view, monetary policy can have permanent or at least persistent effects on potential output.

We illustrate the first issue by showing how the cyclicality in a sub-component of potential output, namely the capital stock, impacts potential output and consequently the output gap and monetary policy's reaction to it. More specifically, building on the DSGE model of de Walque *et al.* (2017), we compare the impact on flex-price potential GDP of a cyclical measure of the capital stock, namely actual capital, to a less cyclical measure of the capital stock, referred to here as hypothetical capital (i.e. which would prevail in the absence of any nominal

1 This works as follows: by removing the unsustainable part of GDP that is driven by financial imbalances, the sustainable output measure evolves more steadily during financial crisis periods compared to traditional potential output measures. Therefore, the corresponding sustainable output gaps tend to suggest more severe overheating (i.e., a larger positive output gap) before the crisis and more excess capacity afterwards (i.e. a more negative gap) compared to traditional output gap measures (Basselier *et al.*, 2017).

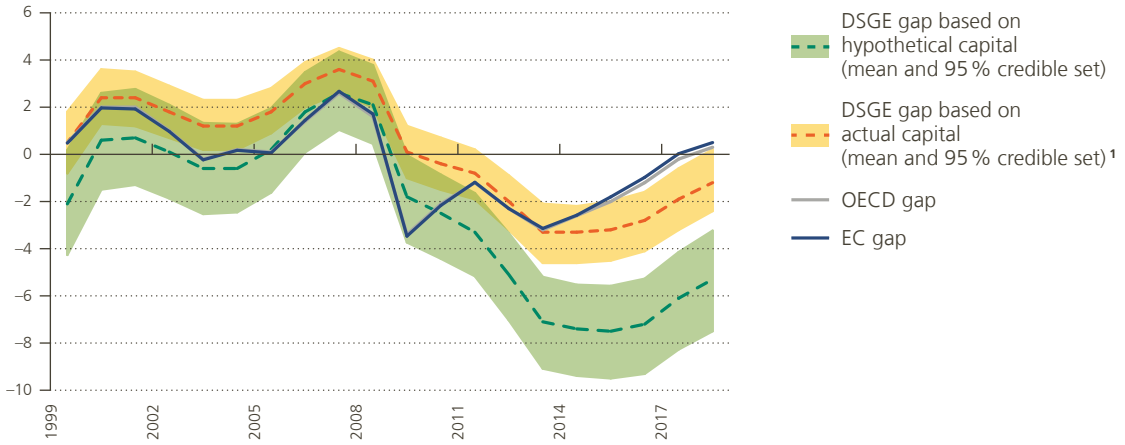
rigidities)[1]. In 2018, the output gap for the euro area that takes the hypothetical capital stock into account was more negative than that based on the actual capital stock (see chart 5). This reflects the large wedge between the hypothetical and the actual capital stock, with the latter suffering from low investment during the financial crisis. In addition, the output gap for the euro area based on actual capital tracks the EC's and OECD's output gap estimates closely, which would be expected as international institutions' potential output estimates are typically also based on the actual capital stock (see above).

At first sight, the different sizes of the output gap based on actual versus the hypothetical flexible price capital stock have different policy implications, with the former suggesting less need for monetary stimulus than the latter. However, potential output has fallen more strongly in the concept based on actual capital compared to that based on hypothetical capital, reflecting spillovers of reduced aggregate demand (a risk premium shock in this model) onto the physical capital stock and thus potential output (hysteresis view). As the economy recovers, capital accumulation may again lift potential output in the concept based on actual capital. Economic slack may thus be bigger than suggested by the output gap based on actual capital. So, even if the output gap based on actual capital were closed, additional demand stimulus need not threaten price stability (if the supply side of the economy were to expand to a similar degree). We do find that the euro area economy has scope to grow at rates above its long-run trend for several years until the hypothetical output gap is closed, without price stability being threatened. This would justify basing monetary policy decisions on the outlook for price stability, rather than on the (uncertain) magnitude of the output gap.

Chart 5

Euro area output gap measures based on different capital stock concepts

(in % of potential GDP)



Source: NBB.

1 The series has been demeaned – implying that, on average over the sample, the output gap is zero – to better align it with EC and OECD output gap estimates.

This brings us to the second issue, being the extent to which monetary policy may influence potential output. The analysis above suggests that the standard view's assumption of monetary policy having no impact on potential output may be a bit too strong. In fact, Blanchard (2018a) highlights that in any standard DSGE model,

1 Note that potential output based on hypothetical capital would correspond to unconditional flex-price potential output and that based on actual capital broadly to conditional flex-price potential output (see again Appendix 1).

monetary policy is likely to affect actual output for some time because of nominal rigidities.[1] If there is monetary tightening that triggers a recession, output will decline. This decline in output is likely to come with a decline in investment (or in other factors of production). As output declines, the capital stock is lower for some time and, by implication, so is (conditional) flex-price potential output.

Using a workhorse DSGE model (derived from Christiano, Eichenbaum and Trabandt, 2016), which allows for capital accumulation and matching frictions in the labour market, Blanchard (2018a) illustrates that (conditional) flex-price potential output follows a path similar in shape to that of actual output (without such deep a drop) after an adverse monetary policy shock. When actual output reaches its trough, potential output also reaches its trough. After 15 quarters, potential output is still lower than before the shock[2].

Based upon this finding, Blanchard (2018a) concludes that the issue is not about models (standard versus hysteresis – as in a standard DSGE model potential output is also procyclical) and consequently not about the existence nor permanence of monetary policy effects on potential output, but rather about their size and persistence. Blanchard urges macroeconomic research to assess the degree of persistence of monetary policy effects on potential output and microeconomic research to identify and examine specific channels of persistence. He himself sees macro- and microeconomic evidence as suggestive, but not conclusive, evidence against the "long-run neutrality of money" hypothesis. Therefore, he suggests that monetary policy-makers retain the standard view (no permanent effects of monetary policy on potential output) as their baseline, but also keep an open mind and put some weight on alternatives.

Overall, the existence of different concepts of potential output (standard versus hysteresis view) suggests that a deeper understanding of potential output is required. Is it purely a supply-side concept or can demand shocks also have an impact? This has important implications for monetary policy as it implies that continued stimulus may either overheat the economy above potential or lift its potential.

4. Take-aways for monetary policy-makers

The concept of the output (or unemployment) gap is important for monetary policy-makers: it is used for understanding and forecasting future inflation developments, and minimising the output gap is welfare-improving (both inflation and the output gap typically enter a monetary policy-maker's loss function). However, the considerable uncertainty surrounding estimates of potential output and the output gap question the prominent place that they have in policy-making in general. This uncertainty stems from multiple sources and is unlikely to disappear in the foreseeable future because:

- potential output is unobservable;
- economic data used to estimate potential output are often subject to revision (although unemployment and inflation are revised less frequently);
- data revisions can in turn alter the perspective on the underlying supply-side factors shaping potential output;
- there are multiple statistical approaches to estimate potential output and there is no consensus as to which one performs best;
- there is no consensus about the shocks influencing potential: do only slow-moving supply-side factors drive it or do demand shocks also play a role (standard versus hysteresis view) and, if so, what is their persistence?

1 More precisely, this is the case when potential output is defined as the level of output that can be attained when prices are flexible in the present and the future (i.e. conditional flex-price output). In contrast, in our above analysis, potential output that is based on the hypothetical capital stock corresponds to the level of output that can be attained when prices are flexible in the past, present and future (i.e. unconditional flex-price output). See Appendix 1 for nuances on conditional and unconditional potential output concepts

2 Similar cyclicality can be detected in the natural unemployment rate.

Monetary policy-makers should take this uncertainty into account in their work. Uncertainty about where the economy stands relative to its potential increases the risk of policy missteps, which at the current juncture entail either being too tight and not tapping the economy's full potential or being too lenient and thus overheating the economy with higher inflation. Yet, given that inflation currently stands below 2 %, such overheating of the economy need not imply that inflation will rise above the ECB's inflation aim.

To minimise policy mistakes, it is best to look at a wide range of potential output estimates and have a good understanding about how different assumptions and methodologies shape these estimates. In that way, information about the economy stemming from a preferred output gap – which is consistent with the general view on what drives potential – can be cross-checked against information stemming from alternative output gaps, thus leaving room to quantify alternative views and mechanisms.

Nevertheless, given the uncertainty about the magnitude of output gaps and the role they play in driving inflation, monetary policy-makers should (and indeed do) look at a broad number of variables when assessing the temperature of the economy and inflationary pressures. An important variable to watch in this respect is (wage) inflation and its projections.

Appendix: Four different concepts of potential output in a DSGE model

Within a NK DSGE framework, there are four distinctive notions of potential output. Three, namely efficient, natural and potential output, are flex-price and more short-run concepts, whereas the other, namely steady-state output, focuses on the long run (see also Vetlov *et al.,* 2011):

- Efficient output is the flex-price level of output that would prevail under perfect competition (implying that both steadystate mark-ups and mark-up shocks are zero). The related output gap measures the relevance of imperfect competition and nominal rigidities. From a welfare point of view, theory suggests that this is the relevant output gap to focus on;
- Natural output is the flex-price level of output that would prevail under imperfect competition (implying that steady-state mark-ups and mark-up shocks can be different from zero). The related output gap measures the relevance of nominal rigidities (the inefficient allocation due to infrequent adjustments of prices and wages to their optimal level). From an inflation point of view, this is the relevant output gap to focus on. Monetary policy-makers thus aim for the natural level of output. Note that, due to imperfect competition, the natural level of output is in general below the socially-efficient level. In most cases, i.e. in the presence of cost-push shocks or other real frictions (e.g. real wage rigidities), central banks face a trade-off between stabilising the natural output gap, and thus inflation, and stabilising the welfare-relevant output gap. Only in the absence of these frictions (i.e. under "divine coincidence") is the central bank able to stabilise both, or more correctly, it stabilises the natural output gap at the zero level and the efficient output gap to a constant (as in this scenario the difference between natural and efficient output is constant, invariant to shocks and proportional to the level of the steady-state mark-up). However, as natural output tends to be very volatile, potential output is a more practical benchmark for optimal monetary policy;
- Potential output is the flex-price level of output that would prevail under imperfect competition and constant mark-ups. These potential output estimates often correspond more closely to more traditional potential output estimates;
- Steady-state output is the level of output resulting from the sequence of permanent (unit root) technology shocks.

Steady-state output takes a longer-term view on potential, just like more traditional approaches do: in both cases, shocks affecting the economy at business cycle frequencies have no major effects on potential output, but they are captured in the corresponding output gap. In contrast, efficient, natural and potential output estimates from DSGE models are affected by structural shocks that push the economy temporarily away from the steady state. They thus tend to be more volatile – but not necessarily all to the same extent – and to imply smaller and less persistent output gaps than those using steady-state output or more traditional approaches.

With respect to the above flex-price potential output concepts, one can make yet another distinction based on the treatment of "state" variables – these variables are typically pre-determined at the beginning of the considered time period, like e.g. physical capital.

- Conditional flex-price potential output is obtained if prices and wages are flexible in the present and in the future but taking the actual capital stock as given. Note that under this definition, bygones are bygones. For example: a monetary policy mistake in the last period (t–1) that reduces or increases the capital stock – and thus potential output – today (t) does not open the conditional output gap (the capital stock at time t is the same for both actual and conditional potential output). Consequently, there is no need for monetary policy today to correct its past mistake when it uses this potential output concept.
- Unconditional flex-price potential output is obtained if prices and wages are flexible in the past, present and future. Under this computation of potential output, the considered capital stock would be the one that would exist if prices had always been flexible, implying that potential output is defined as what it could be today in a hypothetical world. In particular, if monetary policy fails to stabilise the economy in

response to, say, an adverse demand shock and thus the actual capital stock is lower than its flexible price counterpart, monetary policy should take into account the potential for the actual capital stock to recover towards its flexible price counterpart if sufficient stimulus is provided.

Under the unconditional concept, potential output is always independent of monetary policy whereas this is not the case under the conditional concept.

Bibliography

Ball L.M. (2014), *Long-term damage from the Great Recession in OECD countries*, NBER, Working Paper Series 20185.

Barnichon R., C. Matthes and A. Ziegenbein (2018), *Are the Effects of Financial Market Disruptions Big or Small?*, Working Paper.

Basselier R., G. Langenus and P. Reusens (2017), "The potential growth of the Belgian economy", NBB, *Economic Review*, September, 37-53.

Blanchard O. (2018a), "Should we reject the natural rate hypothesis?", *Journal of Economic Perspectives*, 32(1), 97-120.

Blanchard O. (2018b), *Brief reaction to real-time estimates of potential GDP, by Coibion, Gorodnichenko, and Ulate*, Policy Futures, Center on Budget and Policy Priorities, 31 January.

Blanchard O., E. Cerutti and L. H. Summers (2015), *Inflation and activity: two explorations and their monetary policy implications*, Peterson Institute for International Economics, Working Paper Series 15-19.

Blanchard O. and D. Quah (1989), "The dynamic effects of aggregate demand and supply disturbances," *American Economic Review*, 79(4), 655-673.

Borio C., P. Disyatat and M. Juselius (2017), *Rethinking potential output: embedding information about the financial cycle*, Oxford Economic Papers, 69(3), July, 655-677.

Brooks R. and G. Basile (2019), *Campaign against nonsense output gaps (CANOO)*, Global Macro Views, Institute of International Finance, 23 May.

Christiano L.J., M.S. Eichenbaum and M. Trabandt (2016), "Unemployment and business cycles", *Econometrica*, 84(4), July, 1523-1569.

Coeuré B. (2017), *Scars or scratches? Hysteresis in the euro area,* Speech given at the International Center for Monetary and Banking Studies, Geneva, 19 May.

Coibion O., Y. Gorodnichenko and M. Ulate (2018), *The cyclical sensitivity in estimates of potential output*, *NBER,* Working Paper Series 23580.

Cordemans N. and J. Wauters (2018), "Are inflation and economic activity out of sync in the euro area?", NBB, *Economic Review*, June, 79-96.

de Walque G., P. Jeanfils, T. Lejeune, Y. Rychalovska and R. Wouters (2017), *An estimated two-country EA-US model with limited exchange rate pass-through*, NBB, Working Paper Reseach 317.

ECB (2018), "Potential output in the post-crisis period", *Economic Bulletin*, issue 7, August, 49-70.

Efstathiou K. (2019), *The campaign against 'nonsense' output gaps*, Blog Post, Bruegel, 17 June.

Fernald J. (2014), *Productivity and potential output before, during and after the Great Recession*, NBER, Working Paper Series 20248.

Gali J. (1999), "Technology, employment, and the business cycle: do technology shocks explain aggregate fluctuations", *American Economic Review*, 89(1), 249-271.

Gechert S., K. Rietzler and S.Tober (2016), "The European Commission's new NAIRU: Does it deliver?", *Applied Economics Letters*, 23(1), 6-10.

Havik K., K. Mc Morrow, F. Orlandi, C. Planas, R. Raciborski, W. Roeger, A. Rossi, A. Thum-Thysen and V. Vandermeulen (2014), *The production function methodology for calculating potential growth rates & output gaps*, European Commission, European Economy, Economic Papers 535.

Jarociński M. and M. Lenza (2018), "An inflation-predicting measure of the output gap in the euro area", *Journal of Money*, *Credit and Banking*, 50(6), 1189-1224.

Reifschneider D., L.W. Wascher and D.W. Wilcox (2015), "Aggregate supply in the United States: Recent developments and implications for the conduct of monetary policy", IMF, *Economic Review*, 63(1), 71-109.

Stevens A. and J. Wauters (2018), *Is euro area lowflation here to stay? Insights from a time-varying parameter model with survey data*, NBB, Working Paper Research 355.

Turner D., M. Cavalleri, Y. Guillemette, A. Kopoin, P. Ollivaud and E. Rusticelli (2016), *An investigation into improving the real-time reliability of OECD output gap estimates*, OECD Economics Department, Working Papers 1294.

Vetlov E., T. Hlédik, M. Jonsson, H. Kucsera and M. Pisani (2011), *Potential output in DSGE models*, ECB, Working Paper Series 1351.

Woodford M. (2003), *Interest and prices: Foundations of a theory of monetary policy*, Princeton University Press.