

**AN EXPLORATION OF REAL-TIME
REVISIONS OF OUTPUT GAP
ESTIMATES ACROSS EUROPEAN
COUNTRIES**

2016

Pablo Hernández de Cos, Aitor Lacuesta
and Enrique Moral-Benito

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BANCO DE ESPAÑA

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Abstract

This document analyses real-time revisions in output gap estimates published by the European Commission for 15 countries over the period 2002-2014. We find that output gap revisions (both in levels and changes) are mainly driven by GDP growth forecast errors. Also, output gap revisions have opposite signs across expansions and recessions: real-time output gaps are downward biased (smaller than the final estimates) during expansions and upward biased (higher than the final estimates) in recessions. Our findings may have relevant implications for the conduct and assessment of fiscal policy in real time. For instance, according to our results, real-time estimates of the structural balance would be upward biased in expansions and downward biased in recessions. This implies that the fiscal stance of an economy estimated in real time would be excessively expansionary in recessions as compared to the final estimate. As a result, we argue that corrections to real-time estimates of the structural balance suggested in the literature should be contingent on the degree of slack in the economy.

Keywords: Output-gaps, real-time data, fiscal policy.

JEL classification: E32, E52, E60.

Resumen

En este documento se analizan las revisiones en tiempo real de las estimaciones de la brecha de producción (output gap) publicadas por la Comisión Europea para 15 países durante el período 2002-2014. De acuerdo con nuestro análisis, las revisiones en tiempo real de las brechas de producción (tanto en niveles como en cambios) se deben principalmente a revisiones en las previsiones de crecimiento del PIB. Por otra parte, las revisiones de la brecha del producto estimadas en tiempo real presentan signo contrario en expansiones y en recesiones: están sesgadas a la baja (la estimación final es mayor que la estimación en tiempo real) en expansiones y al alza (la estimación final es menor que la estimación en tiempo real) en recesiones. Este hallazgo podría tener implicaciones significativas para la estrategia adecuada en el diseño y evaluación de la política fiscal en tiempo real. Por ejemplo, de acuerdo con esta pauta, el saldo estructural estimado en tiempo real estaría sesgado al alza en expansiones y sesgado a la baja en recesiones. Por lo tanto, en caso de considerarse correcciones a las estimaciones en tiempo real del saldo estructural, estas deberían depender del grado de holgura en la economía.

Palabras clave: brecha de producción, datos en tiempo real, política fiscal.

Códigos JEL: E32, E52, E60.

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1 Introduction

The output gap is the extent to which the level of aggregate economic activity exceeds (or falls short of) the economy's productive capacity, i.e. the gap between actual and potential output. The importance of this concept for policy analysis is obvious. Both levels and changes of output gaps can play an important role in the conduct of monetary policy as an indication of inflationary pressures. In addition, the output gap is a crucial ingredient in the calculation of cyclically adjusted budget balances and, therefore, of the measure of the fiscal stance and the underlying fiscal situation of countries. This importance has even increased since fiscal rules, in particular in Europe, assess the fiscal situation of countries based on this indicator.

Nevertheless, the output gap is an unobserved variable that needs to be estimated. Currently, there are several techniques for estimating an economy's potential output growth and, therefore, its output gap. However, it is very often the case that these methods provide different results. Moreover, there is also evidence that, irrespective of the method, the output gap estimates formulated on the basis of current information (so-called real-time estimates) are revised over time, which casts doubt on their usefulness for policy-making.

In this regard, not only the magnitude of the revisions to estimated output gaps but also the causes behind these revisions are relevant. First, the revisions might be due to changes in underlying data, i.e. real GDP growth initial estimates by National Statistical Offices, which are to some extent inevitable. Second, since estimates of the output gap in a given period depend on the expected economic outlook for the future (which conditions both the expected growth outlook and the estimates of potential output growth of the economy), insofar as these expectations (forecast) are not confirmed, they will affect the assessment of the cyclical situation not only of the future but of the past as well.¹ Finally, revisions of output gaps estimated in real time might be due to changes in the modelling techniques employed, which could be based on new theoretical or empirical findings regarding the economy under consideration.

Indeed, a number of papers have already analysed the accuracy of output gap estimates and the origin of the revisions (for instance, see Orphanides and van Norden, 2002; Koske and Pain, 2008; Marcellino and Musso, 2011; Kempkes, 2013; Turner et al, 2016). The main conclusions from this literature are: 1) output gap estimates are subject to significant revisions in terms of magnitude; 2) the real-time output gaps have a negative bias (real-time output gaps are smaller on average than final estimates); 3) the revisions of output gaps are higher at cyclical turning points; 4) data revisions do not play a major role in the revisions of output gaps; 5) revisions seem to be more related to projected actual GDP numbers than to potential GDP, and the former are related to macroeconomic projections.

¹ For example, it might be the case that, if macroeconomic projections are revised downwards over a protracted period, potential output might also be revised downwards even for past data, leading to an upward revision of the output gaps of that past period.

These conclusions are, however, not without some controversy. For example, Koske and Pain (2008) stress that the bias of the revisions of output gap estimates is related to the sign of the initial estimate. Thus, if the sign of the output gap is negative, there is a higher probability of an upward revision in the future. Moreover, Turner et al (2016) find that revisions of output gaps are mostly derived from revisions in potential output estimates as compared to observed output.

These empirical regularities are of course important for policy analysis. In particular, in the case of the implications for fiscal policy, on which this paper focuses, if a negative bias on real-time output gaps is confirmed, this would imply that structural fiscal balances estimated in real time would on average be overestimated (and structural fiscal deficits underestimated), thus providing an optimistic view of the underlying fiscal position of countries. On the contrary, if this bias depends on the sign of the initial estimates as previously mentioned, structural fiscal balances would be overestimated in good times and underestimated in bad times, thus providing an assessment in real time that could lead to a procyclical fiscal policy. Also, the fiscal stance of the economy (measured by the change in the structural balance) might suffer from the same type of shortcomings.

Moreover, if revisions in output gap estimates are mainly due to actual output forecast errors, this would make the concept of potential output less subject to criticism, or at least this criticism would have to be extended to macroeconomic projections in general. This result would also have practical implications for the current discussion on fiscal rules in Europe. In particular, it is often justified that the lack of reliability of output gap estimates should lead to less weight being attributed to the concept of structural balances in respect of the fiscal rules that could be substituted for an expenditure rule in which the ceiling on public expenditure growth would be linked to the evolution of (past and future) GDP growth. Inasmuch as macroeconomic projections are the main drivers of significant revisions, this would not avoid the problem of introducing biases into the analysis of fiscal policy.

In this context, we revisit in this paper the question of how significant real-time output gap revisions are. In particular, we concentrate on the estimates prepared by the European Commission, since these are the relevant ones in terms of the implementation of the Stability and Growth Pact in the European Union.

We examine revisions in real-time output gap estimates in levels and changes for 26 vintages of 15 European countries, to assess explicitly the extent to which real-time revisions might hamper the use of output-gap estimates by policy-makers. To be more specific, we use real-time data from Spring 2002 to Spring 2015 taken from the European Commission. We consider as real-time the estimate for the year t made at Spring of $t-1$ while the final estimate corresponds to Spring 2015.

Our main findings are threefold: (i) real-time revisions are asymmetric² across expansions and recessions. During expansions the estimated output gaps in real time are downward-biased. In contrast, output gaps are upward-biased during economic recessions. This finding casts doubt over the result by Kempkes (2014), who argues that resulting structural balances are always over-estimated in real time because output gaps are downward-biased in real time. According to our findings, the bias in structural balances cannot be systematically corrected as it depends on the state of the economy; (ii) the same happens with the real-time revisions of the changes in the output gaps. Hence the structural component of fiscal adjustments is over-estimated in expansions and under-estimated in recessions; (iii) the real-time revisions in output gaps are mainly driven by revisions in actual GDP growth. The asymmetry in output gap revisions coincides with revisions in GDP growth forecasts and data updates. We also show how revisions in output gaps can be decomposed into revisions in real GDP forecast errors, GDP data revisions and potential GDP, with forecast errors chiefly responsible for the overall real-time revisions in output gaps and their cyclicalities. We discuss the policy implications of these empirical regularities.

² We label as asymmetric those revisions that are positive in expansions and negative in recessions; according to this terminology, symmetric revisions would always be either positive or negative.

2 Data

Our data are taken from the European Commission's real-time output gap database. This database contains real-time output gap estimates for 15 European countries for the period from Spring 2002 onwards. We consider as real-time the estimate for the year t made at Spring of $t-1$. We treat the output gap figures published in Spring 2015 as our final vintage of output gap data (our main findings also hold if we consider Spring 2008 as the final estimate for data up to 2009). Output gap revisions are constructed by subtracting the real-time estimate of the output gap (hereafter, 'real-time vintage') at each point in time from its Spring 2015 estimate ('final vintage').

The European Commission defines the output gap as actual real GDP minus potential real GDP, as a percentage of potential real GDP. Potential real GDP is defined as the level of output that an economy can produce at a constant rate of inflation. However, since potential GDP cannot be directly observed from economic data, the European Commission infers the output gap using a production function approach (see Havik et al., 2014). It is worth mentioning that the different vintages we consider are affected not only by data and forecast revisions but also by methodological revisions in the estimation of potential growth (see Havik et al., 2014).

3 Descriptive evidence of the revision of output gaps in levels and changes

Our main object of interest throughout the paper is the real-time revision of the output gap in year t (REV_t^{OG}), which is defined as:

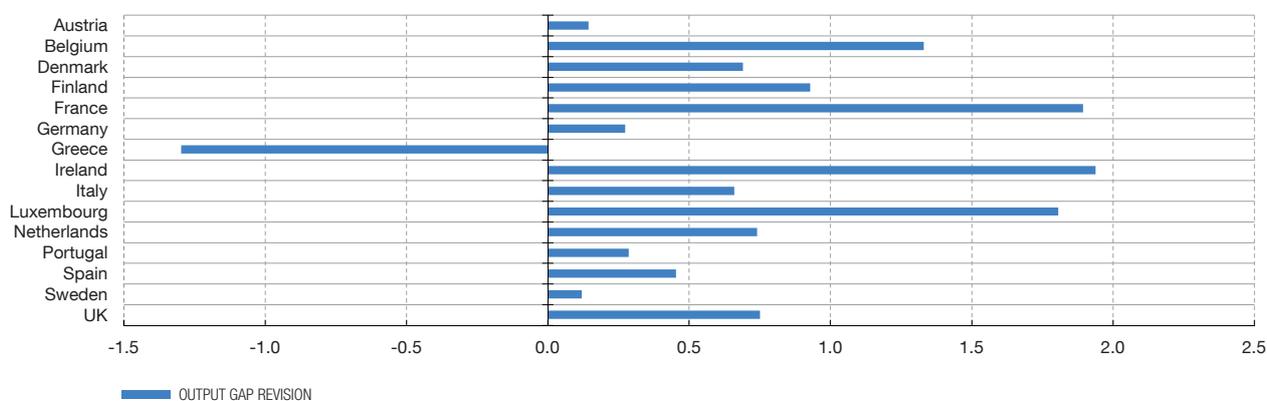
$$REV_t^{OG} = OG_t^F - OG_t^{RT}$$

where OG_t^F refers to the final estimate of the output gap in year t , namely, that of Spring 2015; on the other hand, OG_t^{RT} represents the real-time estimate of the output gap in year t , made in Spring of $t-1$.

We first present some descriptive plots of the real-time revisions of the output gap across countries for the years between 2004 and 2014 (see chart 1). In particular, chart 1 shows that output gap revisions are significant in terms of magnitude with an average change of 0.71 pp. Output gaps in real time were, on average, lower than the corresponding final estimates. Among the 15 countries, only Greece presents a negative output gap revision. In the case of Spain, the average revision is 0.5 pp., which implies an average revision of the structural balance of around 0.25 p.p. under the assumption that the elasticity used to compute the cyclical component is 0.5 and the actual fiscal balance is not revised.

OUTPUT GAP REVISIONS (2004-2014)

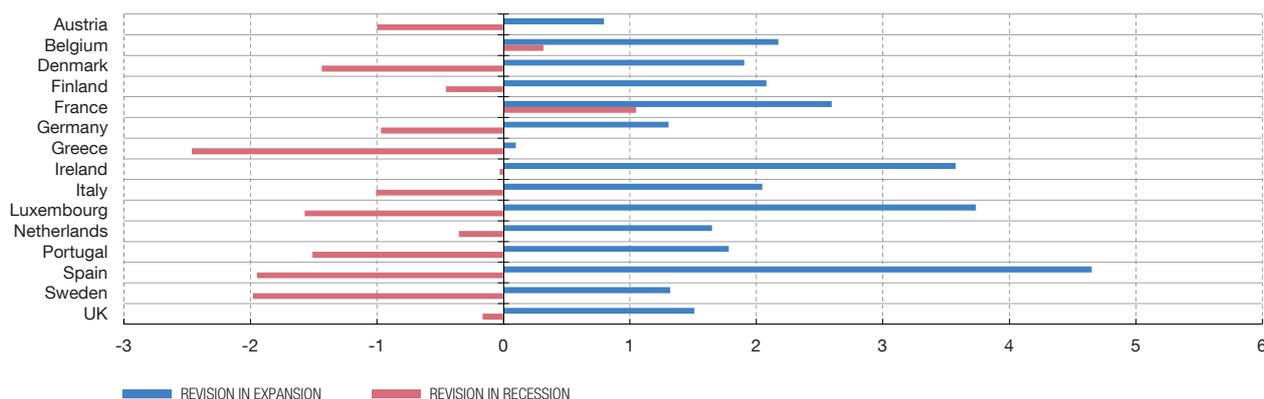
CHART 1



SOURCE: European Commission.

This evidence is in line with that of Kempkes (2014), who claims that, as a result of the downward biases in real-time output gap estimates, structural balances are always over-estimated in real time. As a result, a systematic negative correction of structural balances estimated in real time is proposed to eliminate this bias and its potential negative consequences in terms of fiscal sustainability.

However, real-time revisions in output gaps (and thus of structural balance revisions) might depend on the state of the economy. Along these lines, we observe in chart 2 that the output gap revisions are of an opposite sign if we distinguish between expansion (above the country-specific



SOURCE: European Commission.

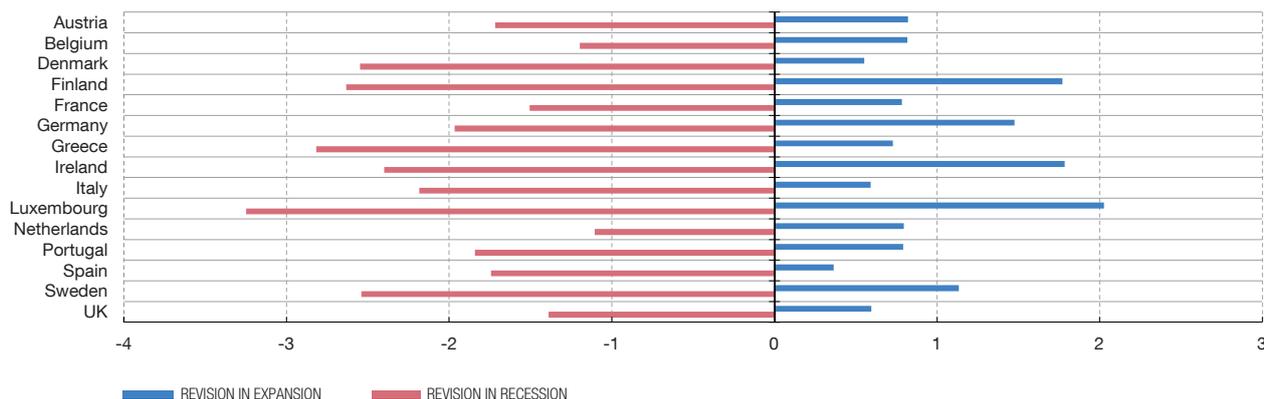
average of GDP growth) and recession (below-average GDP growth). This is true for 13 out of 15 countries in our sample. Only France and Belgium present positive revisions regardless of the state of the economy. The magnitude of the revisions also depends on the state of the economy. For example, in the case of Spain, the revisions during expansions are around 4.4 pp. on average, while the magnitude in recession periods is lower but still large, at -2.0 pp. These average revisions would imply significant revisions in structural balances of -2.2 and 1.0 in expansions and recessions, respectively.

According to these results, while the over-estimation of structural balances advocated by Kempkes (2014) holds during expansions, it becomes an under-estimation during recessions. This means that, during economic expansions, real-time estimates of structural deficits could lead to an overly benign assessment of the underlying fiscal situation of countries, while the opposite is true under recessions. According to this pattern, the systematic correction proposed by Kempkes (2014) would generate overly large structural deficits in recession periods. Indeed, this type of correction, if any, should be contingent on the degree of slack in the economy.

In addition to real-time revisions in output gaps, we also explore revisions in their changes. This is also relevant since the fiscal stance is often defined as a monotonic function of the change in the output gap. In the event that consecutive revisions of the output gap cancel one another, this would lead to a limited revision of the year-by-year change in the final estimates of the output gaps and therefore of the fiscal stance. Chart 3 shows that this is not confirmed by data. Revisions of real-time estimates of changes in output gaps are also sizeable and of an opposite sign if we distinguish between expansions and recessions. This pattern prevails in all the fifteen countries in our sample. In the case of Spain, the revisions during expansions increase to around 4 p.p., while the magnitude in recession periods is -2 p.p. These average revisions would imply significant revisions in the fiscal stance of the Spanish economy. In particular, according to real-time estimates, fiscal policy in Spain was assessed to be making a much heavier structural adjustment in the expansionary period (around a 2 p.p. higher effort estimated in real time on average than the corresponding final estimation), whereas during the crisis fiscal policy was assessed in real time to be making a much lower structural adjustment than the one estimated with final data (around a 1 p.p. lower effort on average).

CHANGE IN OUTPUT GAP REVISIONS (2004-2014)

CHART 3



SOURCE: European Commission.

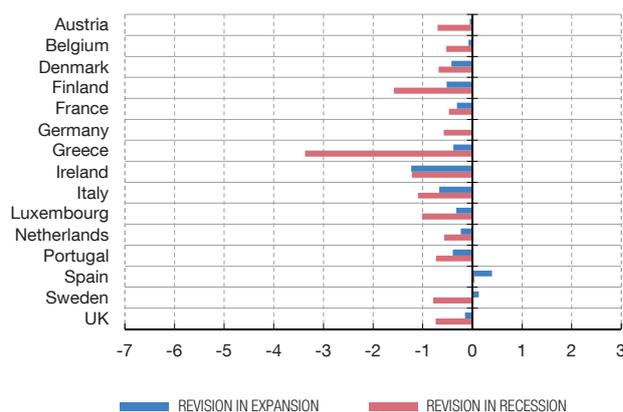
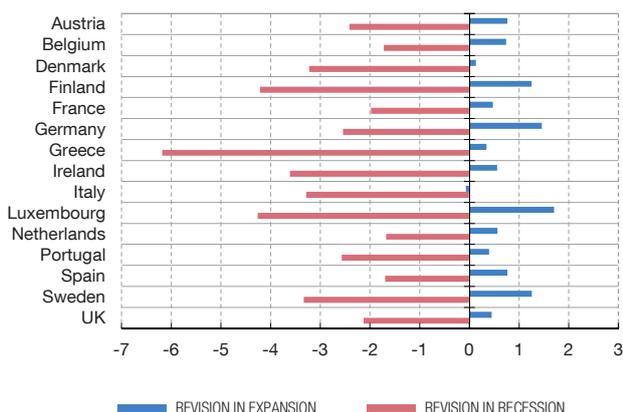
To shed some more light on the factors behind the revisions to real time output gaps in levels, we first explore the role played by revisions in GDP growth and potential growth, which are the main determinants of output gap estimates. Chart 4 plots the average real-time revisions in GDP and potential growth over expansion and recession periods. Positive revisions in GDP growth are observed during expansions while negative ones take place during recessions. In both cases they are sizable (on average, changes are 0.73 p.p. in expansions and -2.97 p.p. in recessions). In contrast, changes in the estimates of potential growth are much smaller (on average -0.28 p.p. in expansions and -0.94 p.p. in recessions) and symmetric, which points to a limited role of potential growth revisions in shaping that corresponding to output gaps. We thus conclude that updates in GDP growth figures might be at the root of the asymmetry in output gap revisions.

REAL AND POTENTIAL GROWTH REVISIONS

CHART 4

REAL GROWTH REVISIONS (2004-2014)

POTENTIAL GROWTH REVISIONS (2004-2014)



SOURCE: European Commission.

We now turn to the analysis of GDP growth revisions in more detail. We decompose the overall revision in GDP growth into two components, namely, forecast errors and data

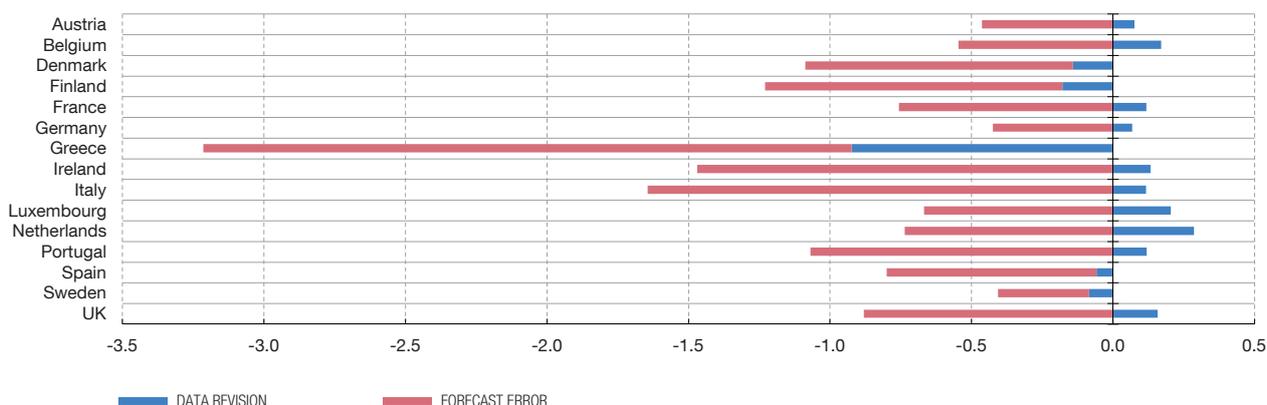
revisions. To be more specific, we consider the following decomposition of the revision in GDP growth (REV_t^{Gobs}):

$$\begin{aligned} REV_t^{Gobs} &= \Delta \ln Y_t^F - \Delta \ln Y_t^{RT} = \Delta \ln Y_t^T - \Delta \ln Y_t^{t-1} \\ &= (\Delta \ln Y_t^T - \Delta \ln Y_t^{t+1}) + (\Delta \ln Y_t^{t+1} - \Delta \ln Y_t^{t-1}) \\ &= (\text{Data revision}) + (\text{Forecast error}) \end{aligned}$$

where superscripts refer to the year in which the GDP growth chart is released. We implicitly assume that the first data release takes place at $t+1$ so that any revision between $t+1$ and T is assumed to be caused by ex-post data revisions. In contrast, any revision between the forecast publication at $t-1$ and the data release at $t+1$ is assumed to be entirely due to forecast errors. If we plot the previous decomposition for the whole period 2004-2014 (Chart 5), we observe that forecast errors are the main drivers of GDP revisions while data revisions play a minor role in most countries. The average overall revision in GDP growth is -0.929 , which can be decomposed into an average forecast error of -0.933 and an average data revision of 0.004 . The minor role played by data revisions in shaping output gap revision was already highlighted by Orphanides and van Norden (2002); however, they ignored the role played by macroeconomic forecasts that were not included in their real-time estimates of output gaps.

REAL GROWTH REVISIONS (2004-2014)

CHART 5



SOURCE: European Commission.

Turning to the asymmetries in forecast errors and data revisions, Chart 6 illustrates that forecast errors are negative and large during recessions while they are positive but smaller during expansions. In both cases, data revisions are much less important and present a similar asymmetric pattern. The average revision in GDP growth during recessions is -2.99 , which is the sum of an average forecast error of -2.88 pp. plus an average data revision of around -0.11 p.p. In the case of expansions, the overall revision is 0.72 resulting from a forecast error of 0.49 and a data revision of 0.23 . According to this finding, we conclude that the principle of prudence prevails in times of expansion when forecasting GDP growth while there is evidence of an optimistic bias in GDP forecasts during recessions. Moreover, our analysis indicates that these two patterns are the main drivers of revisions in real time estimates of output gaps.

REAL GROWTH REVISIONS IN EXPANSION



REAL GROWTH REVISIONS IN RECESSION

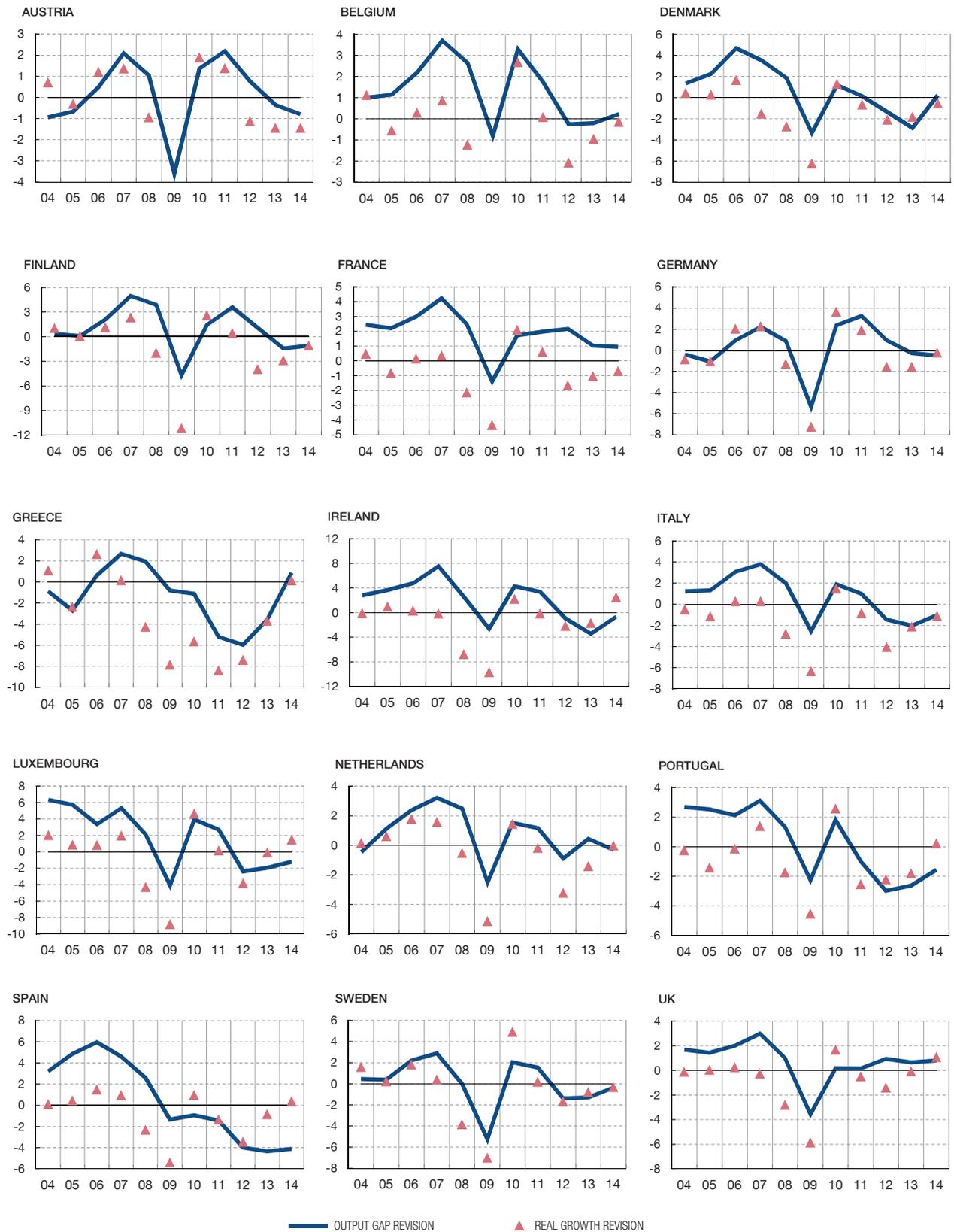


SOURCE: European Commission.

We can also see in Chart 7 and 8 that movements in the output gap revisions are strongly correlated with movements in the updates of GDP growth in all countries. However, this correlation vanishes when we consider revisions in potential growth estimates. Indeed, a regression of the three factors confirms that revisions in GDP growth are able to explain around 40% of the change in output gap revisions and its associated coefficient is significant, while the coefficient on potential growth revisions is not significant and the corresponding R2 falls from 40% to 2%.

COUNTRY-BY-COUNTRY REVISIONS IN OUTPUT GAP AND REAL GROWTH

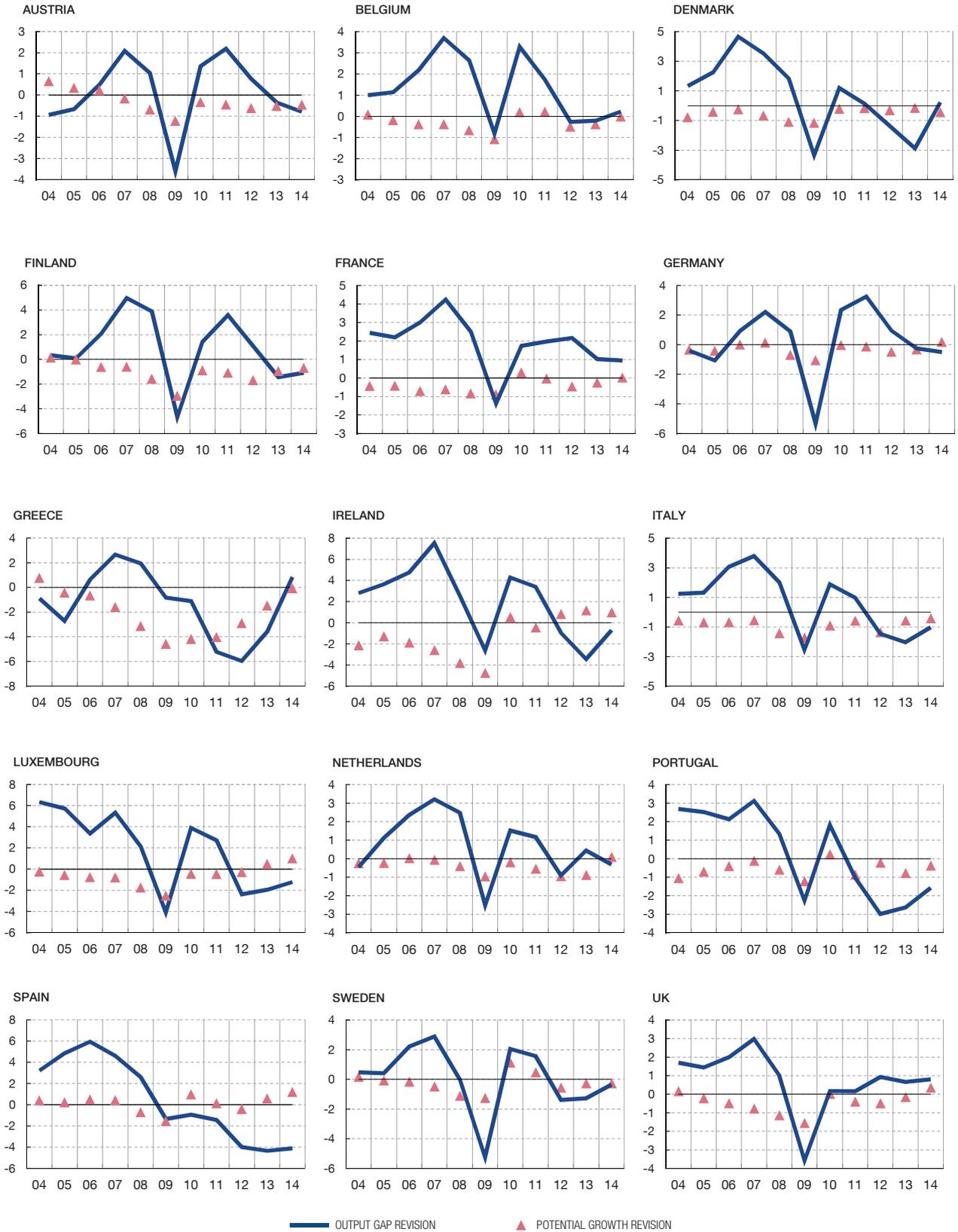
CHART 7



SOURCE: European Commission.

COUNTRY-BY-COUNTRY REVISIONS IN OUTPUT GAP AND POTENTIAL GROWTH

CHART 8



SOURCE: European Commission.

4 The case of Spain

In this section, we aim to quantify the contributions of real and potential growth revisions to the real-time revisions in the output gap for the case of Spain. In particular, the output gap revision in year t can be approximated as follows:

$$\begin{aligned} \text{REV}_t^{\text{OG}} &= \text{OG}_t^{\text{F}} - \text{OG}_t^{\text{RT}} = \left(\frac{Y_t^{\text{F}} - \text{Ypot}_t^{\text{F}}}{\text{Ypot}_t^{\text{F}}} \right) - \left(\frac{Y_t^{\text{RT}} - \text{Ypot}_t^{\text{RT}}}{\text{Ypot}_t^{\text{RT}}} \right) \\ &\approx (\ln Y_t^{\text{F}} - \ln \text{Ypot}_t^{\text{F}}) - (\ln Y_t^{\text{RT}} - \ln \text{Ypot}_t^{\text{RT}}) \end{aligned}$$

where Y_t^{F} and Ypot_t^{F} refer to the final estimates of actual and potential GDP, respectively. Also, Y_t^{RT} and $\text{Ypot}_t^{\text{RT}}$ represent the corresponding real-time estimates. Taking the previous expression and adding and subtracting $\ln Y_{t-1}^{\text{RT}}$, $\ln Y_t^{\text{F}}$, $\ln \text{Ypot}_t^{\text{RT}}$, $\ln \text{Ypot}_t^{\text{F}}$ we can further decompose:

$$\begin{aligned} &(\ln Y_t^{\text{F}} - \ln \text{Ypot}_t^{\text{F}}) - (\ln Y_t^{\text{RT}} - \ln \text{Ypot}_t^{\text{RT}}) = \\ &= (\Delta \ln Y_t^{\text{F}} - \Delta \ln Y_t^{\text{RT}}) - (\ln \text{Ypot}_t^{\text{F}} - \ln \text{Ypot}_t^{\text{RT}}) + (\text{OG}_{t-1}^{\text{F}} - \text{OG}_{t-1}^{\text{RT}}) \\ &= \sum_{j=0}^{t-1} (\Delta \ln Y_{t-j}^{\text{F}} - \Delta \ln Y_{t-j}^{\text{RT}}) - \sum_{j=0}^{t-1} (\Delta \ln \text{Ypot}_{t-j}^{\text{F}} - \Delta \ln \text{Ypot}_{t-j}^{\text{RT}}) \\ &+ (\text{REV}_0^{\text{OG}}) \end{aligned}$$

This decomposition allows us to quantify the contributions of historical real-time revisions in GDP and potential growth together with the initial output gap revisions. In addition, we can also decompose the revisions in actual GDP growth into data revisions and forecast errors as described above. To be more specific, we use this decomposition for the case of Spain in Chart 9 to confirm that forecast errors (brown bar) are the main driver of the magnitude and the symmetric behavior of revisions in output gaps (blue line). Note also that the residual (yellow bar) includes not only the initial revision in the output gap – 2004 in our data – but also the numerical error due to the logarithmic approximation of the decomposition.

SOURCES OF OUTPUT GAP REVISIONS IN SPAIN

CHART 9



SOURCE: European Commission.

The previous decomposition also illustrates the trade-off between a more procyclical potential growth methodology, which implies smaller revisions in the output gap (as the revision in potential would compensate the revisions in real growth), and a less procyclical potential growth estimate, which implies larger revisions in the output gap (as no revisions in potential imply that all revisions in real growth would be translated to output gap revisions).³

3 An illustration of this trade-off is provided in the Appendix on the basis of Hodrick Prescott estimates of potential output under different choices of the smoothing parameter.

5 Concluding Remarks

We have analysed the size and the cyclical behavior of revisions of the output gap in levels and changes. In doing so, we have isolated the role of real-time GDP growth forecasts errors, data updates and changes in the estimation of potential output. We consider as real-time the estimate for the year t made at Spring of $t-1$. This definition of real time is relevant within several fiscal rules such as those used in the Excessive Deficit Procedure of the European Union.

Similarly to Orphanides and van Norden (2002), we find sizable revisions on the levels of the output gap. Those revisions also affect the estimated changes in the output gap. Moreover, we find that revisions in output gap levels are primarily due to macroeconomic forecasting errors, while data updates play a minor role.

We also observe that the output gap revisions (and revisions to the changes in output gaps) are of an opposite sign if we distinguish between expansions and recessions. This asymmetry is mainly due to asymmetric forecasting errors: GDP forecasts tend to be prudent in expansions while they prove to be optimistic during recessions.

According to this pattern, while the over-estimation of structural balances advocated by Kempkes (2014) holds during expansions, it turns to under-estimation during recessions. Moreover, compared to the real-time estimate, the final estimate of the fiscal stance of an economy (measured by the change in the structural balance) would be more expansionary in good times and more contractionary in recessions. Therefore, the type of corrections to real-time estimates of the structural balance suggested by Kempkes (2014) should be contingent on the degree of slack in the economy.

Turning to real time revisions in potential growth figures, we find that they are not only smaller than those of actual GDP, but also symmetric across expansion and recession (i.e. real time potential growth estimates are always larger than the final estimates regardless of the cycle). These two characteristics could make potential growth more suitable than actual GDP growth for the design of fiscal rules based on ceilings on public expenditures.

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Appendix

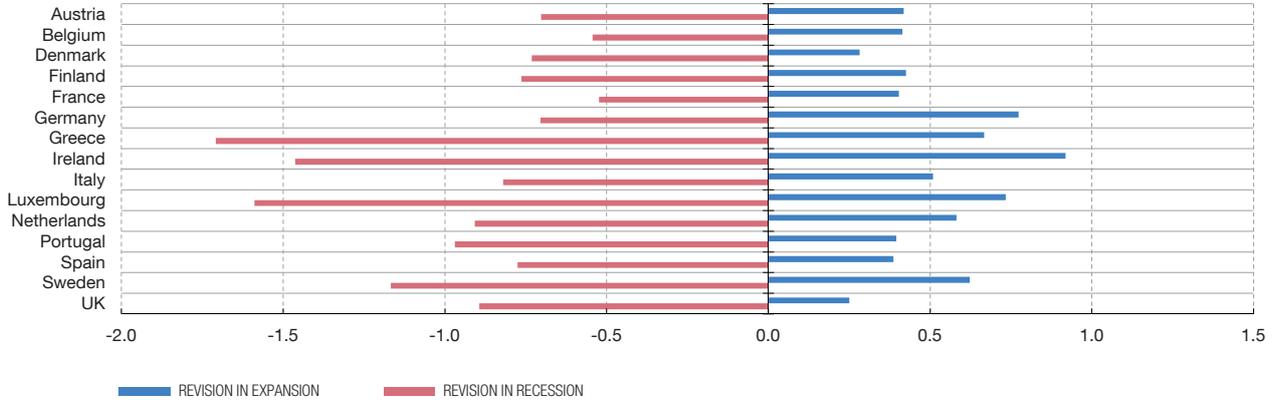
In order to illustrate the trade-off between pro-cyclicality of potential growth and ex-post revisions in output gaps, the next three charts (Chart 10 to 12) plot the revisions in output gaps emerging from three different Hodrick Prescott-based estimates of potential growth (given the EC data on observed GDP growth).

The first is based on the traditional choice $\lambda=6.25$ and produces revisions of a similar magnitude to those of the EC potential growth estimates. The second plots results from the choice $\lambda=0.001$, which basically amounts to a potential growth equal to the real GDP growth (i.e. a fully procyclical estimate of potential). In this case the revisions are much smaller as potential growth revisions fully compensate revisions in real GDP growth – in the extreme case of potential equal to observed growth, the revisions are always zero. Finally, the third chart illustrates the case of constant potential growth, which generates the largest revisions in output gaps because potential growth never compensates revisions in real growth.

Note also that in all three cases, revisions in output gaps are asymmetric across expansions/recessions as they are mainly driven by the observed and asymmetric revisions in GDP growth as illustrated above.

HP OUTPUT GAP REVISIONS (LAMBDA 6.25)

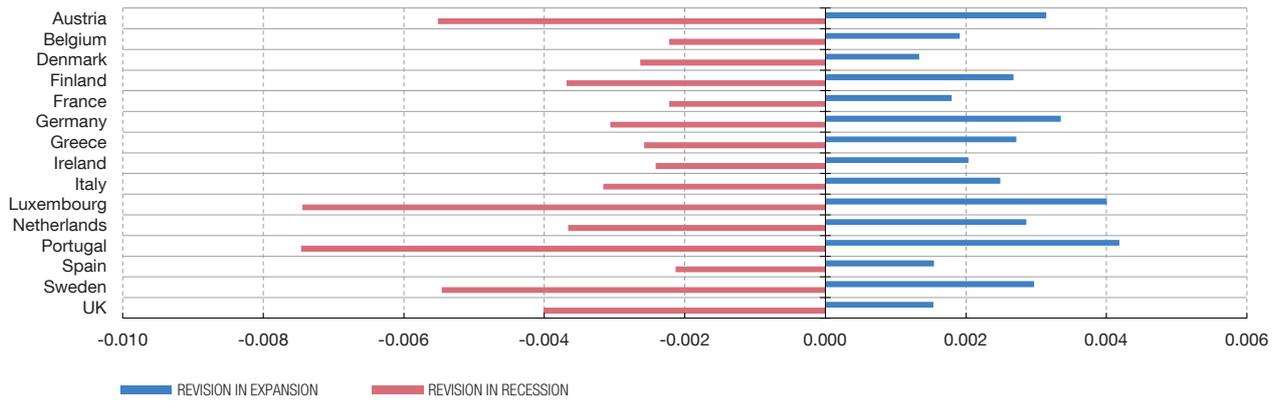
CHART 10



SOURCE: European Commission.

HP OUTPUT GAP REVISIONS (LAMBDA 0.001)

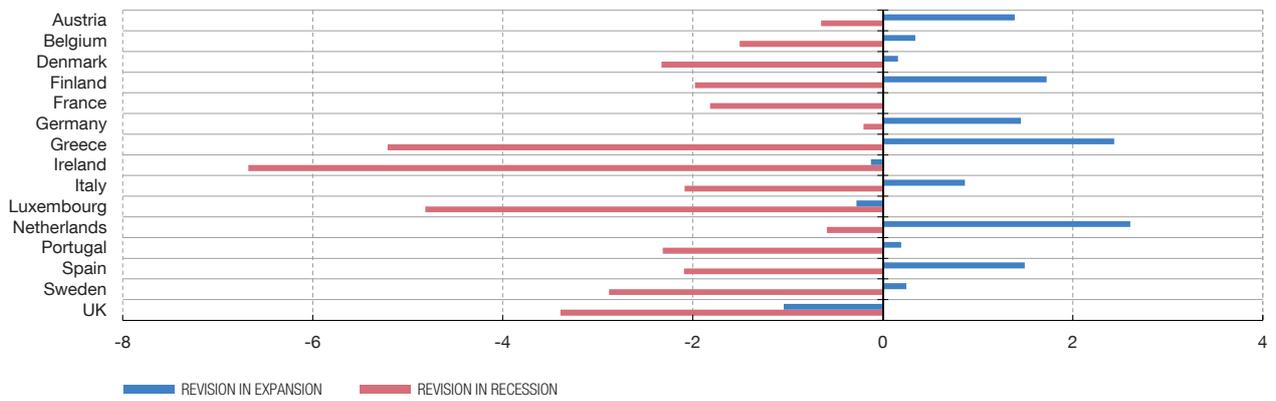
CHART 11



SOURCE: European Commission.

HP OUTPUT GAP REVISIONS (CONSTANT POT. GROWTH)

CHART 12



SOURCE: European Commission.

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