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In 2014 all ECB publications feature a motif taken from the €20 banknote.

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## ABSTRACT

This paper reviews potential output from a euro area perspective by summarising the developments according to international institutions and assessing the impact of the crisis. The paper also considers the methodological basis for potential output estimates, and the high degree of uncertainty that surrounds them. Although it is too early to see the full effects of structural reforms implemented since 2007/08, further structural reforms are needed to support euro area potential growth, especially in view of the negative impact that population ageing is expected to have on potential growth in the future.

**JEL codes:** E23, E25, E32, E37, O49.

**Keywords:** Potential Output, Production Function, Output Gap, Structural Reforms.

## EXECUTIVE SUMMARY

This paper reviews potential output developments from a euro area perspective by summarising the developments according to international institutions and assessing the impact of the crisis, including an analysis based on the New Multi-Country Model (NMCM) developed at the ECB.

Potential output estimates are highly uncertain, but according to estimates from international institutions, potential growth in the euro area has fallen since the onset of the financial crisis in 2007/08, largely due to smaller contributions from capital and labour. The most recent estimates suggest that potential growth may be stabilising in the euro area and that it is already picking up in the United States. In the United States, the greater flexibility of labour markets and the economy more generally is supporting potential growth.

As regards the euro area, although it is too early to see the full effects of structural reforms implemented since 2007/08, further reforms are needed to support potential growth, especially in view of the negative impact that population ageing is expected to have on potential growth in the near future. The outlook for euro area potential growth going forward therefore crucially hinges on further substantial progress being made in terms of structural reforms designed to support higher rates of productivity and potential output growth in the medium and longer term. In order to significantly boost the rate of sustainable growth in the euro area, the positive impact of such reforms also has to considerably outweigh the negative impact of population ageing on future potential growth.

For the period 2008-2013, there is evidence that: first, the recent crisis has reduced potential output growth, although to a lesser extent than actual output growth; second, although TFP has declined as well, the impact of the crisis primarily hit the capital and labour components of potential output; and third, the crisis has also led to heightened uncertainty surrounding potential output and related estimates, including output gaps. The paper also shows that euro area countries with larger pre-crisis imbalances may have suffered a larger fall in their potential output growth.

Looking forward, the paper finds that: first, the effects of the crisis may constrain euro area potential output growth going forward; and second, from the model-based analysis, the exact impact hinges crucially on the structural features of the euro area economy, notably the extent of flexibility in labour and product markets. This suggests that, as regards the euro area, further structural reforms are needed to support potential growth, particularly against the background of population ageing and its expected negative impact on euro area potential growth in the future.

## I INTRODUCTION

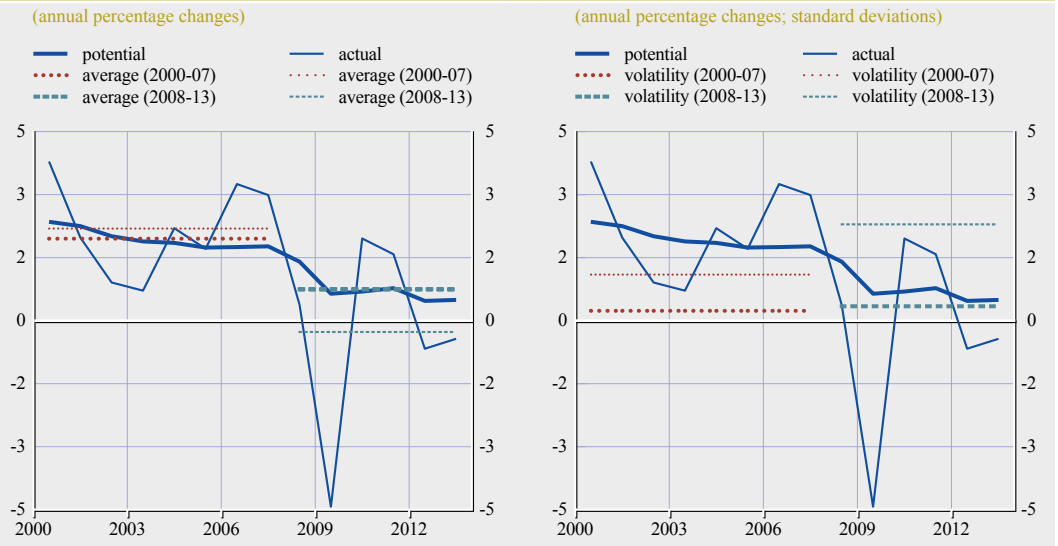
Potential growth and its components are important economic variables for monetary policy making, as they are among the many indicators used to assess the outlook for price and wage developments going forward. However, given that they are not directly observable, they must be estimated, but, as these estimates depend on the concepts used and the methods applied, they are subject to a high degree of uncertainty.

Recent developments in potential output are of particular interest, as the uncertainty surrounding estimates of potential output has been greater since the financial crisis that started in 2007/08 than at other times.[1] This makes it more difficult and challenging to judge both the current degree of slack in the economy and the growth and inflation prospects for the economy going forward and therefore also the appropriate stance for monetary and economic policies.

This uncertainty also applies to the case of the euro area, as can be seen in Chart 1. According to recent estimates by the European Commission, which give a broadly similar picture to estimates from other institutions, euro area potential output growth declined to 0.7% on average over the period 2008-13, compared with 2.0% on average in 2000-07 – a drop of 1.3 percentage points. The differences between the two sets of growth rates are largely explained by the cyclical factors impacting on potential output during the crisis, but they nevertheless illustrate the uncertainty regarding how potential output has been affected by the crisis.

The aim of this Occasional Paper is (i) to review euro area potential output developments since 2000 in more detail, in particular the question of how the recent crisis has affected potential output growth and the contributions from capital, labour and total factor productivity (TFP), (ii) to provide an assessment of potential output developments going forward, including the key

**Chart 1 Potential and actual output in the euro area, pre-crisis and crisis**




Sources: European Commission estimates (CIRCABC) and ECB calculations.

1 See ECB (2013).

factors that might play an important role in underpinning those developments in the medium to longer term, and (iii) to present a model-based analysis of euro area potential output growth, including scenarios for potential growth and estimates of the effects on potential growth of different shocks that hit the euro area economy during the crisis. The paper also refers to the debate on 'secular stagnation'.

The paper is organised as follows. Section 2 considers the concept of potential output and the methodologies for estimating it, and the uncertainty surrounding potential output estimates. Section 3 compares estimates by different international institutions including some for the medium and longer term (up to 2060). Section 4 considers the impact of the crisis on the individual factors of production: labour, capital and TFP, including evidence for the euro area countries. Section 5 provides a comparison of the euro area and the United States. Special attention is paid to the role of macroeconomic imbalances in explaining potential output developments during the crises, and the role of structural reforms in influencing potential output going forward. Section 6 presents a model-based analysis of potential output developments in the euro area. Section 7 presents some conclusions.

## 2 THE CONCEPT OF POTENTIAL OUTPUT

First, it is useful to consider the concept of potential output, and the methodologies that are used to estimate it. It is important to stress that unlike many macroeconomic variables, potential output is not "observed" (i.e. it cannot be measured directly), and so must be estimated. Several concepts and methods exist to do this, and different economists take different approaches. As a consequence, estimates of potential output for a particular country or area for a particular point in time can vary considerably, depending on the methodology and the concept chosen.

The concept of potential output can be viewed from different perspectives. On one hand, it could be seen as having certain statistical properties, i.e. as if it were a smoothed component / trend element of actual output, while, on the other, it could be seen as reflecting an economic rationale, as the sustainable supply capacity of an economy or the growth rate of output sustainable without generating inflationary or financial (in particular from credit and property prices, see Borio et al., 2013) pressures.

Whichever way it is viewed, potential output clearly differs from actual output, and, although it would not be expected to display the same short-term cyclical movements as actual output, it would be expected to fluctuate from year to year. Those fluctuations (in potential output) reflect changes in the trend components of inputs, such as trend TFP, trend labour and capital (in the case of capital, it is often assumed that all capital is trend capital).[2]

### 2.1 METHODOLOGY

Methodologies to derive potential output estimates can be grouped into those that are "statistical" (based on the idea of extracting the unobserved trend from the observed output series, mechanically splitting output into a trend and a cyclical component), and those that are "structural" (such as the production function approach, which is based on a model of the supply side of the economy, and grounded in economic theory).

#### STATISTICAL (FILTERING) TECHNIQUES – UNIVARIATE

Univariate approaches extract the trend from just one variable (output), i.e. fit a trend to the output series, using only that series. The so-called Hodrick-Prescott (or HP) filter is among the most well-known (see Hodrick and Prescott, 1997). This filter extracts (in the time domain) the trend component of output by minimising the squared deviations of the trend from actual output, and the square of the change in the growth rate of the trend.[3] Another example is the Baxter-King (or BK) filter (see Baxter and King, 1999), which (in the frequency domain) separates the fluctuations that are longer-term (low frequency, and associated with the trend) from those that are shorter-term (high frequency, and associated with the cycle).

Univariate filters are simple and easy to use, which makes them appealing, but they also have drawbacks. First, they assume (by default) that a trend / low frequency component exists, and so can mistakenly identify a different cycle from the one that is actually present. Second, if a trend / low frequency component exists, the trend extracted depends on the parameters, the values of which are somewhat arbitrary (although there are "guidelines" for choosing the parameters). Third, if centred, univariate filters tend to suffer from poor reliability at the end of samples.

2 Two key concepts connected to the labour component are the NAIRU (non-accelerating inflation rate of unemployment) and the NAWRU (non-accelerating wage rate of unemployment). As the acronym NAWRU is not used in all cases in which wage inflation and not price inflation is being referred to, the remainder of the paper (except for the boxes) uses the acronym NAIRU for all cases.

3 The key parameter of the HP filter is "lambda", which determines the weights of the trend and cyclical components.

### STATISTICAL (FILTERING) TECHNIQUES – MULTIVARIATE

Multivariate approaches aim to overcome the drawback of using information only from the observed GDP series, thereby better reflecting the data-rich environment in which policy makers also operate. As a result, they have been growing in popularity in recent years. Multivariate approaches derive the trend of the output series by also using information from other (related) series, such as unemployment and inflation, and their empirical relationship to that trend, which is modelled by means of a vector autoregression (a regression of variables on their own and other variables' past values) or the Kalman filter (a two-step algorithm for the projection of an unobserved variable by means of a number of other, observed, variables; for a technical exposition of multivariate (Kalman) filtering approaches, see Box 1).

Whilst being less simple to use than univariate methods, multivariate filtering approaches incorporate some elements of economic theory, and could therefore be considered to be superior to univariate approaches. However, they are also dependent on the specification of a larger number of parameters than the univariate approaches, which may be considered a drawback.[4]

4 An example is the assumption to be made about the underlying trend component of a series (e.g. whether it is a deterministic, smooth or volatile trend), which can become very significant.

Box 1

### MULTIVARIATE KALMAN FILTERING TECHNIQUES FOR ESTIMATING POTENTIAL OUTPUT

This box provides a technical exposition of the multivariate (Kalman) filtering approaches. According to Maybeck (1979), the Kalman filter is an optimal recursive data processing algorithm for extracting unobservable, "state" variables. Variables such as the NAIRU and potential output are examples of such unobservable and/or imperfectly measured state variables, in contrast to actual output and the unemployment rate which are observable.

The Kalman filter combines all measured data with prior information about the paths of the unobservable variables (the so-called "state" or "transition" equations) and produces estimates of the state variables in a way that minimises the statistical error. As the filter moves through the sample, more information becomes available and lower weight is given to observations which have a higher variance (i.e. are more uncertain).

The Kalman filter therefore estimates an a posteriori value of a state variable as being a linear function of the a priori estimate of the state variable and the weighted difference of the actual measurement and the previously predicted value of the state variable. In other words, an adjustment is made to the projected value of the state variable, where the adjustment depends on the size of the measurement error. The Kalman filter attaches a lower weight to cases where the measurement error is large.[1]

1 The parameters can be calibrated or estimated (using either maximum likelihood or Bayesian methods). Bayesian estimation methods are usually used for the calculations, with an a posteriori value of an estimate being calculated conditionally on new information that becomes available.

## A formal exposition

For the formal exposition, we use a small (four-equation) model similar to those in Benes et al. (2010), Konuki (2008) or Toth (2014). The model has four equations, i.e. four observables. The four observables are real GDP (y), inflation (π), wage inflation (w), measured as the change in compensation per employee, and unemployment (u).

We denote the output gap with $\hat{y}_t$, trend output with $\bar{y}_t$, the corresponding stochastic drift term with $g_t$, the cyclical component of inflation with $\hat{\pi}_t$, trend inflation with $\bar{\pi}_t$, cyclical wage inflation with $\hat{w}_t$, trend wage inflation with $\bar{w}_t$, the unemployment gap with $\hat{u}_t$, the structural unemployment rate with $\bar{u}_t$, and the error terms (assumed to be independent identically distributed random variables, or iid) with $\varepsilon_t$.

Equations (1.1) to (1.3) show the transition equations for the output gap and potential output growth, which is assumed to follow a local linear trend.

$$\left.\begin{aligned} \hat{y}_t &= \alpha_1 \hat{y}_{t-1} + \alpha_2 \hat{y}_{t-2} + \varepsilon_t^{\hat{y}} && (1.1)\\ \bar{y}_t &= \bar{y}_{t-1} + g_t + \varepsilon_t^{\bar{y}} && (1.2)\\ g_t &= g_{t-1} + \varepsilon_t^{g} && (1.3) \end{aligned}\right\}$$

Equations (1.4) and (1.5) show Okun's law – the relationship postulated between the unemployment gap and the output gap.

$$\left.\begin{aligned} \hat{u}_t &= \gamma_1 \hat{u}_{t-1} + \gamma_2 \hat{y}_t + \varepsilon_t^{\hat{u}} && (1.4)\\ \bar{u}_t &= \bar{u}_{t-1} + \varepsilon_t^{\bar{u}} && (1.5) \end{aligned}\right\}$$

Equations (1.6) and (1.7) show a price Phillips curve, and the law of motion for price inflation.

$$\left.\begin{aligned} \hat{\pi}_t &= \beta_1 \hat{\pi}_{t-1} + \beta_2 \hat{y}_{t-1} + \varepsilon_t^{\hat{\pi}} && (1.6)\\ \bar{\pi}_t &= \bar{\pi}_{t-1} + \varepsilon_t^{\bar{\pi}} && (1.7) \end{aligned}\right\}$$

Finally, equations (1.8) and (1.9) show a wage Phillips curve, and the law of motion for wage inflation.

$$\left.\begin{aligned} \hat{w}_t &= \beta_3 \hat{w}_{t-1} + \beta_4 \hat{u}_{t-1} + \varepsilon_t^{\hat{w}} && (1.8)\\ \bar{w}_t &= \bar{w}_{t-1} + \varepsilon_t^{\bar{w}} && (1.9) \end{aligned}\right\}$$

Equations (1.10) to (1.13), (1.10) for GDP, (1.11) for HICP inflation, (1.12) for wage inflation, and (1.13) for the unemployment rate, are the measurement equations, and postulate that for each of the four observables, each observation equals trend and gap components for that observable.

$$y_t = \bar{y}_t + \hat{y}_t \quad (1.10)$$

$$\pi_t = \bar{\pi}_t + \hat{\pi}_t \quad (1.11)$$

$$w_t = \bar{w}_t + \hat{w}_t \quad (1.12)$$

$$u_t = \bar{u}_t + \hat{u}_t \quad (1.13)$$

Benes et al. (2010) present a similar model to the one presented above. They use a multivariate filter approach for measuring potential output, whereby, in addition to a Phillips curve and Okun's law type of a relationship, they attempt to obtain information about the cyclical position of the economy using capacity utilisation in the manufacturing sector.

While multivariate filtering approaches are relatively popular, they also need to be used with care, notably in the context of the crisis that started in 2007/08. That crisis, which exposed the large build-up of (ex post) unsustainable imbalances in a stable inflationary environment, has led to suggestions that associating potential output with non-inflationary output may be too restrictive, and that incorporating information about the financial cycle may be necessary to make measures of potential output and the corresponding output gaps more robust (see Borio et al., 2013). In a similar vein, some suggest (e.g. Dobrescu, 2006) that external balance needs to be taken into account alongside internal balance, i.e. the equilibrium potential output is defined as the level of output where inflation is constant and the net export position is sustainable.[5]

### STRUCTURAL TECHNIQUES – THE PRODUCTION FUNCTION APPROACH

One of the most widely used approaches for the calculation of potential output is the production function method. It is also an approach that is used by international agencies, e.g. the European Commission (see also Section 3.2).

The aim of the approach is to take a structural view and build a model of the supply side of the economy using economic theory which can then be used to help explain the key economic forces underlying output and growth developments in the medium term. The production function approach relates output to the level of technology and factor inputs, usually labour and capital. The production function itself can be of various functional types. The most frequent ones are the Cobb-Douglas (CD) type (as used, for example, by D'Auria et al, 2010, and explained in Box 2 and the constant elasticity of substitution (CES) type (as used in the model in Section 6 and explained in detail in Box 8).

As regards the empirical implementation of the production function approach, it should be noted that a key challenge is the measurement of the various inputs. In many instances, that measurement turns out to be difficult, leading applied researchers to proxy the trend components of the various inputs by means of statistical filters. For this reason, the production function approach is sometimes criticised as being a method which shifts the inherent problems of HP filtering (of output) to the level of sub-components of the production function (capital, labour and TFP).

5 Using this line of thought Dobrescu (2006) develops a double conditioned potential output calculation whereby orthogonal regressions are used on a set of equations linking inflation and net export position of an economy to the gap between output and potential.

Box 2

## THE PRODUCTION FUNCTION APPROACH TO ESTIMATING POTENTIAL OUTPUT

For the purpose of this exposition, the production function is assumed to take the form of a constant-returns-to-scale Cobb-Douglas production function. The level of output (Y) is considered to be a combination of two factor inputs namely labour (L) and capital (K), where each factor input is corrected for the degree of excess capacity ($U_L$, $U_K$) and adjusted for the level of efficiency ($E_L$, $E_K$). In addition to the labour and capital inputs, output is expected to be affected by total factor productivity (TFP), which is measured as the Solow residual.

The Cobb-Douglas production function and the implied TFP are given by equations (2.1) and (2.2), respectively.

$$Y = (U_L LE_L)^{\alpha} (U_K KE_K)^{1-\alpha} = L^{\alpha} K^{1-\alpha} TFP \tag{2.1}$$

$$TFP = (E_L^{\alpha} E_K^{1-\alpha})(U_L^{\alpha} U_K^{1-\alpha}) \tag{2.2}$$

Under the assumption of constant returns to scale and perfect competition, equations (2.1) and (2.2) imply that the output elasticities of the two factor inputs equal the factor shares in output, with α representing the output elasticity of labour and 1-α that of capital. The Cobb-Douglas production function also assumes that the elasticity of substitution between labour and capital is 1.

To calculate the potential level of output, it is necessary to calculate the trend components of the various inputs that have been defined.

### The TFP input

The trend TFP series is often obtained as the trend component of filtered GDP growth's Solow residual.

### The capital input

As regards the capital input, the standard assumption is that the trend capital stock equals the actual capital stock. It is computed by means of the capital accumulation rule, which states that the capital stock in a given year equals the capital stock of the previous year adjusted for depreciation (δ) and additions to the capital stock through investment (I).

$$K_t = I_t + (1-\delta_t) K_{t-1} \tag{2.3}$$

The issue of what exactly constitutes capital and investment in equation (2.3) is a matter of definition. In a rather narrow definition, it includes only physical capital (buildings, machines). In a broader definition, it also includes human capital (skills, knowledge) and housing capital.

D'Auria et al. (2010), among others, pointed out that making no distinction for different types of capital stock is commensurate to assuming that all forms of capital have the same output elasticity. It may be reasonable, however, to assume that housing capital may have a lower rate

of return than non-housing capital. D'Auria et al. suggest that, in order to incorporate housing capital, the capital input into the production function needs to make a distinction between housing capital (KH) and non-housing capital (K), and to define a parameter γ as the efficiency of the housing capital stock, yielding a production function as in (2.4).

$$Y_t = L_t^{\alpha}(K_t + \gamma KH_t)^{1-\alpha}\, TFP_t \tag{2.4}$$

The distinction between housing and non-housing capital may prove to be an important factor when attempting to understand the potential output developments of countries which have experienced construction sector booms and busts.

### The labour component of the production function

The labour component is usually broken down into the sub-components of population of working age (POPW), the participation rate (PR), the non-accelerating wage rate of unemployment series (NAWRU[1]) and the hours worked (H), which are linked up by an equation such as (2.5).

$$L_t = POPW_t PR_t (1 - NAWRU_t) H_t \tag{2.5}$$

For the calculation of the potential labour force, the POPW, PR and H series are usually filtered and the trend components are used in equation (2.5).

According to Gianella et al. (2008), three approaches can be used for the calculation of the NAWRU series. The first is the "structural" approach, in which the NAWRU is modelled as a function of labour and product market variables and a system of equations is estimated which explains the wage and price setting behaviour. Gianella et al. argue that, despite the appeal of such an approach of firmly grounding the calculation of the NAWRU on economic theory, the difficulty is to quantify the many structural variables.

The second approach consists of univariate filters of the unemployment series, such as the Hodrick-Prescott and Baxter-King filters discussed in detail in Section 2.1. The third approach is the "semi-structural" approach, which has gained in popularity in recent years. This consists of a combination of the first two approaches, with the NAWRU being estimated on the basis of a Phillips curve type equation which adds economic theory to the determination of the NAWRU, in conjunction with statistical constraints on the path of the NAWRU and/or the unemployment gap.

1 See footnote 2 on the use of the acronym NAWRU in this paper.

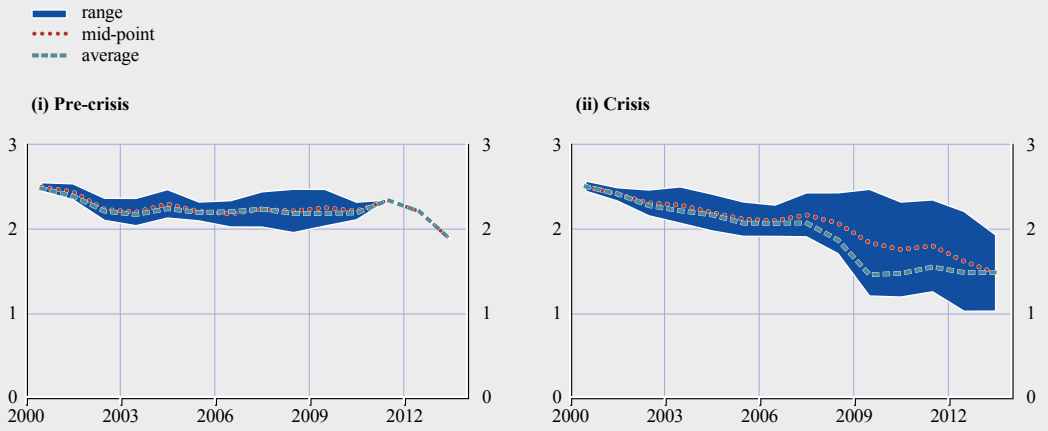
## 2.2 UNCERTAINTY

As potential output is unobserved, and hence has to be estimated, it is also highly uncertain. The uncertainty surrounding potential output stems from several sources. As indicated in Section 2.1, one source of that uncertainty is methodology – there are different ways to derive potential output, and estimates can therefore differ depending on how they are derived, sometimes significantly.

A second source of uncertainty surrounding various potential output estimates stems from the data and assumptions that even affect estimates derived using the same methodology, and this also applies to the production function approach. Under this approach there is, for example, no uniform

**Chart 2 Uncertainty of euro area potential output estimates, pre-crisis and crisis ranges of estimates**

(annual percentage changes)




Sources: Eurostat data, European Commission estimates (CIRCABC) and ECB calculations.
Notes: For panel (i), "pre-crisis", vintages are from 2002 to 2007. For panel (ii), "crisis", vintages are from 2008 to 2013, where available. The number of vintages varies from year to year, which accounts to some extent for the different widths of the range over the sample. The methodology underlying different vintages is subject to small modifications.

approach to the measurement of the capital stock (or whether to extend it to human – as opposed to physical – capital).[6] As a result, estimates of potential output also have a tendency to change and to be revised over time.

However, uncertainty has been heightened since the onset of the crisis in 2007/08. The "real-time" uncertainty about potential output (i.e. the fact that estimates depend on when they are produced) has risen, as estimates made in 2008 or later tend to differ substantially from those made in 2007 or earlier (as illustrated in Chart 2).[7] Until 2007, successive vintages of potential output were relatively closely aligned (i.e. there were only relatively small revisions to estimates), whereas major revisions were made from 2008 onwards, including to some extent for the pre-crisis period.

The greater uncertainty in the crisis period constitutes a challenge for policy making, as decisions may be made on the basis of estimates that are subject to revision as the assessment of the crisis and its impact on potential output is updated.[8] That challenge may apply notably to countries with short data histories (e.g. some central and eastern European countries).

As documented in Box 3, potential growth is likely to have been overestimated and the (positive) output gap underestimated prior to the crisis, in what (ex post) was an episode of unsustainable growth, with the accumulation of, in some cases, large macroeconomic imbalances, rather than growing productive capacity. Accordingly, since 2008, international institutions have revised down their estimates for euro area potential output growth.

6 Data on capital in particular are also going to be impacted by the introduction (in 2014) of the new European System of National and Regional Accounts (ESA 2010), notably because (as one of a number of innovations) research and development expenditure is going to be treated as capital formation (and no longer as intermediate consumption).

7 The real-time uncertainty surrounding statistical (filtering) estimates (especially univariate, and two-sided) of trend output is often referred to as the end-point problem, and is due to the need to forecast actual output, and the impact of revisions on those forecasts, as well as the difficulty in distinguishing between shifts in the level and shifts in the rate of growth of potential output.

8 The challenges associated with estimating potential output in real time, as documented by, for example, Orphanides and van Norden (2002), often lead to large, ex post revisions of potential output estimates when the cyclical position is reassessed. For a recent study of the real-time uncertainty of implied euro area output gaps, see Marcellino and Musso (2011).

Box 3

## UNCERTAINTY AND THE EURO AREA OUTPUT GAP

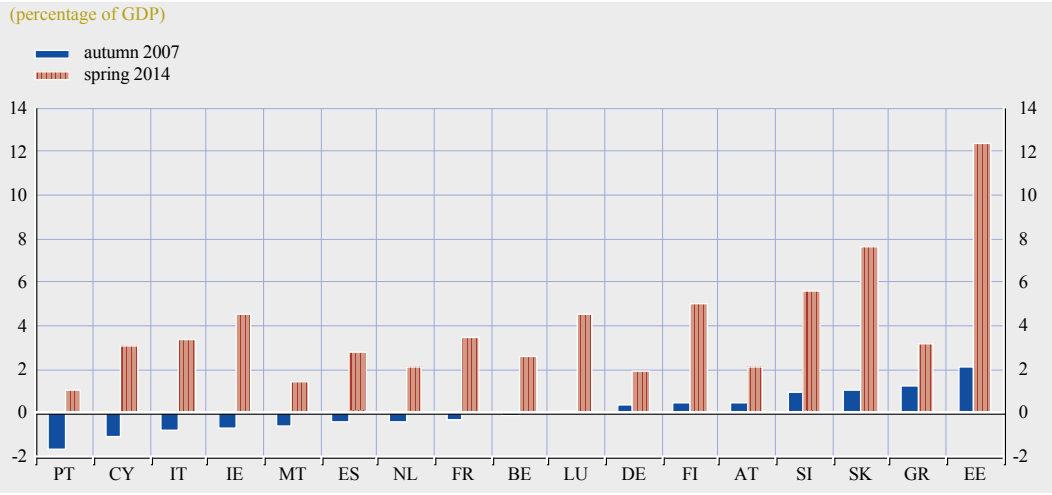
This box assesses the implications of euro area potential output developments for the euro area output gap, and compares the developments during the recent crisis with those observed in previous recessions (see also Box 5 on the debate on 'secular stagnation').

The concept of output gap – the extent of spare capacity in the economy – is crucial in many areas of monetary and economic policy. Misjudging the size of the output gap can lead to significant policy mistakes. The perception of having more spare capacity than is actually available in the economy can lead to a more accommodative monetary or economic policy than needed, fuelling inflation and potential bubbles. In fact, in 2007, prior to the crisis, all euro area countries were perceived to have significantly less favourable output gaps than their ex post assessments have shown (see Chart A). For all countries for which the 2007 output gap was estimated at the time to be negative – Portugal, Cyprus, Italy, Ireland, Malta, Spain, the Netherlands, France and Belgium – it was subsequently (in 2014) estimated to have been positive.

Following the financial crisis and the subsequent recession, actual output has fallen below the level of potential output, which has led to a significant negative euro area output gap. At the beginning of the crisis, the output gap fell more strongly than on average in previous cycles in OECD economies (Chart B). While the contraction in the output gap was also more severe than during systemic crises (which are associated with depressed growth over a prolonged period, see e.g. Reinhart and Rogoff, 2009), it rebounded more quickly three years after the previous peak. However, the output gap contracted again following the sovereign debt crisis and is expected to narrow slowly going forward.

Due to the double-dip recession during the crisis, the development of output and the main aggregates so far is broadly in line with previous financial crises. In general, financial crises tend

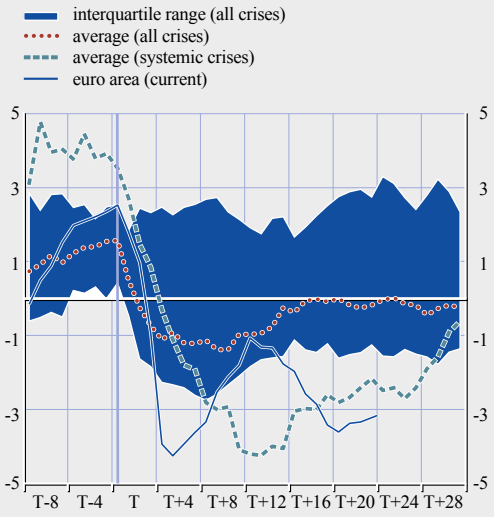
Chart A Estimates of 2007 output gaps made at different points in time




Source: European Commission.

**Chart B Output gap developments following financial crises**

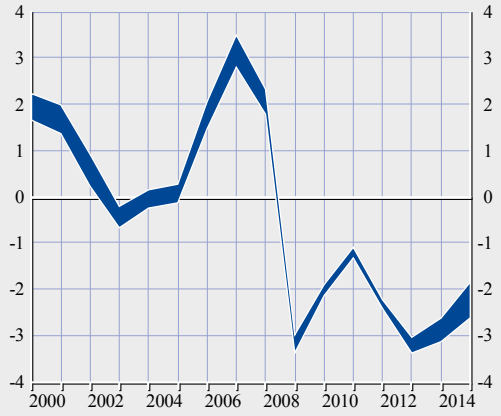
(percentage of GDP; T=peak)




Sources: OECD estimates (Economic Outlook) and ECB calculations.
Notes: T represents the peak GDP level prior to recessions, and the data cover a period stretching from eight quarters prior to a peak (T-8) to 24 quarters after it (T+24). The cycle range for recessions in OECD countries is derived as the upper quartile less the lower quartile of developments during all recessions in OECD countries since 1970. The "Average (all crises excluding systemic crises)" line shows the average development during all recessions in OECD countries not categorised as systemic crises. The "Average (systemic crises)" line is the average development during the previous five severe financial crises since 1970, which occurred in Spain, Finland, Sweden, Norway and Japan.

**Chart C Euro area output gap estimates from different institutions**

(percentage of GDP)




Sources: European Commission, IMF and OECD.
Note: The shaded area represents the range of estimates from the European Commission, IMF and OECD for each year.

to be associated with harsher and more prolonged adjustment processes (i.e. deep recessions, followed by slow, disappointing recoveries). This is partly because these episodes are often preceded by economic booms involving the build-up of large imbalances. Correcting these imbalances often requires sharp adjustments which take time to complete.[1]

Looking at estimates of the output gap from various international organisations (as shown in Chart C), the following picture emerges. In all cases, the euro area economy is projected to remain below potential for several years. A negative output gap is projected throughout (at least) the end of 2015. However, the degree of uncertainty of these estimates is high, as reflected in the considerable width of the range of output gap estimates. The negative output gap estimated by international organisations ranges from 1.8 to 2.6 percentage points of GDP in 2015.

Overall, current euro area economic developments feature some unusual sluggishness compared with previous cycles. The on-going deleveraging in many euro area countries is likely to contain growth below the potential growth rate and, in turn, sustain a negative output gap, suggesting considerable economic slack for some years to come. Thus growth-enhancing structural reforms remain key to putting euro area countries back onto a higher sustainable growth path.

1 See also Reinhart, C.M. and Rogoff, K.S., This Time Is Different: Eight Centuries of Financial Folly, Princeton University Press, Princeton, 2009.
2 See, for example, ECB (2011), Box 5, pp. 71-74.

# 3 DEVELOPMENTS IN POTENTIAL OUTPUT ACCORDING TO ESTIMATES BY INTERNATIONAL INSTITUTIONS

## 3.1 OVERVIEW

This section considers potential output estimates by international institutions, including the European Commission, the International Monetary Fund (IMF) and the Organisation for Economic Co-operation and Development (OECD), either for horizons considered in the context of their forecasts over the short term (2 to 5 years ahead), or for horizons considered for the assessment of longer-term trends and structural issues, in one case up to the year 2060. The specific challenges relating to longer-term estimates of potential output are discussed in Box 4.

The *European Commission* estimates are from the regular projection exercises and from the assessment of stability/convergence programmes of EU Member States. The methodology is based on a Cobb-Douglas production function, in which the trend labour component is derived from population projections, trend participation rate, trend hours worked and NAWRU (estimated using a wage Phillips curve, i.e. an equation relating unemployment to the rate of wage inflation, as used for example in the model described in Box 1). The trend TFP is obtained by means of a bivariate filter, augmented with a capacity utilisation measure.[9] This is supplemented, for the longer term, by a number of considerations, e.g. on cross-country convergence, etc. (see Box 4).

The *IMF* estimates are from the World Economic Outlook.[10] They are not based on any "official" method, and may incorporate judgement by the relevant country desks. However, for the euro area countries, some version of the production function approach is usually involved (see Epstein and Machiarelli, 2010, and Konuki, 2008).[11]

The *OECD* estimates are from the OECD Economic Outlook.[12] They are based on a similar methodology, including a Cobb-Douglas production function with labour, physical and human capital and multi-factor productivity (the equivalent of TFP) as factors as well as an exogenous trend. In the case of the OECD estimates, the NAIRU is derived within a Kalman filter framework (see Cotis et al., 2008).

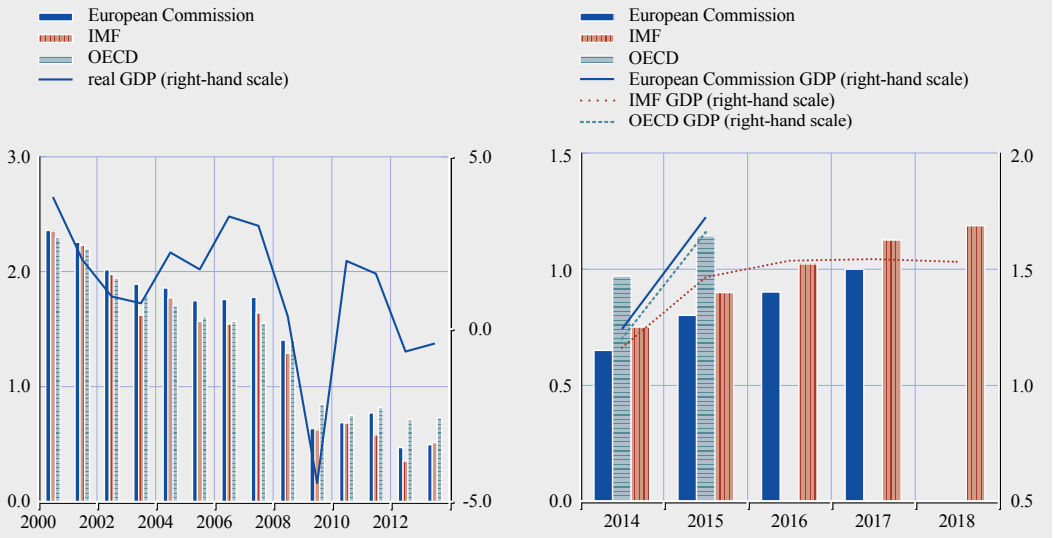
## 3.2 SHORTER-TERM ESTIMATES

Recent estimates of euro area potential output by the three institutions[13] are shown in Chart 3. The chart shows that the fall in euro area potential growth in 2009 and the renewed slowdown in 2012 are features common to the estimates across all institutions. The chart also shows that the range of estimates after 2008 is somewhat broader than up to 2007, with IMF and European Commission estimates displaying a relatively larger decline (to well below 1%), and the OECD estimate remaining closer to 1%.[14] All estimates also suggest there was already a gradual slowing of potential output growth in the run up to the crisis, from around 2000 onwards.[15]

9 See Denis et al., 2006.
10 Since the crisis, intermediate updates have been made.
11 For some economies, models using a multivariate filter approach are also maintained.
12 See OECD (2013).
13 The potential output estimates used cover the euro area 18 for all institutions except the OECD, which reports estimates for the euro area 15 (excluding Slovakia, Estonia and Latvia).
14 The OECD seems to have a more optimistic view of the recovery of the contribution of physical capital and to project a robust positive contribution of human capital in the most recent years. In general, the OECD sees a less pronounced impact of the most recent recession (2011) on potential output, likely attributing a larger part of the decline to cyclical influences.
15 For further explanation of this trend, see Box 4 on the euro area/US comparison of potential output.

**Chart 3 Euro area potential output estimates and real GDP growth**

(annual percentage changes)




Sources: European Commission (2014 spring forecast), IMF (World Economic Outlook, April 2014) and OECD (Economic Outlook, November 2013).
Note: The line showing the OECD estimate is for the euro area excluding Slovakia and Estonia.

Turning to the outlook, all institutions seem to foresee a rather limited and drawn-out recovery of potential output, with potential output growth rates expected to remain clearly below those seen in the period 2000-07 until at least 2017/18. The recovery is most pronounced in the estimates showing the larger crisis-related decline (IMF and European Commission), but the OECD projection stands out as the most upbeat in terms of potential output growth rates in 2013-14.

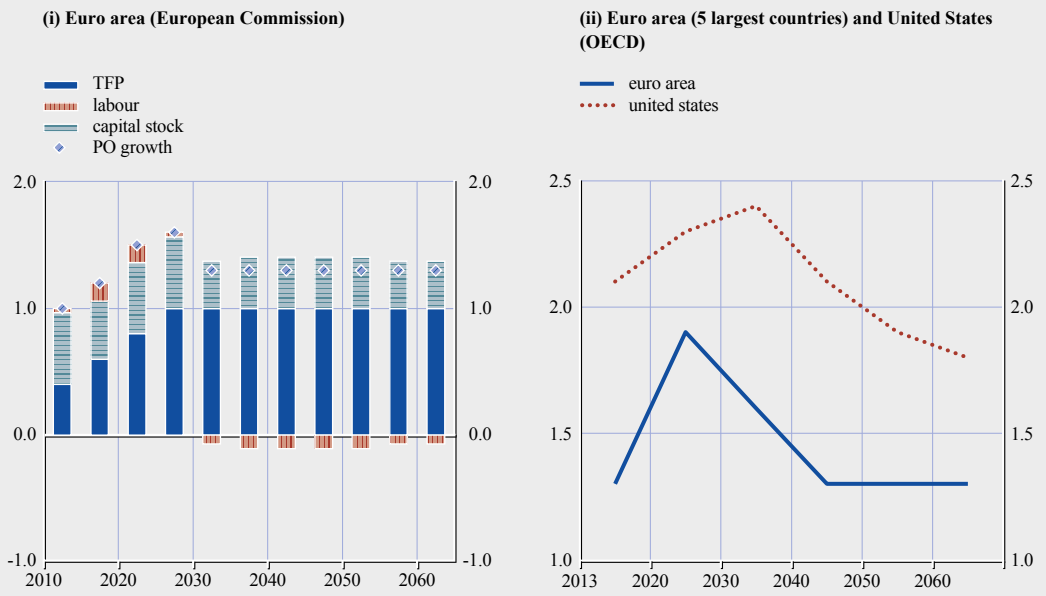
### 3.3 LONGER-TERM ESTIMATES

The available longer term estimates by the European Commission and the OECD are shown in Chart 4, up to 2060. According to those estimates, potential output growth is expected to pick up to around 1.5% by 2025, before slowing slightly to around 1.3% for the rest of the long-term projection horizon. Chart 4 also shows that, in the European Commission projections (from the Ageing Report 2012), the main driver of these dynamics is the labour input, which is expected to contribute positively to potential output growth until 2020, but negatively thereafter, while capital is expected to contribute around 0.5 pp and TFP around 1.0 pp across most of the projection horizon.

The labour contribution is largely driven by the assumed population trends, which imply some increase in the total fertility rate, further gains in life expectancy and continuing, albeit decreasing, immigration flows into the EU and the euro area. As a result, the euro area population is projected to peak around 2040 and then to start decreasing gradually, in parallel with a substantial decline in the share of working-age population. Employment is expected to increase until approximately 2020, as rising employment rates will still offset the decline in working-age population, and to decline afterwards. The unemployment rate is projected to decline slowly to 6.5% for the 15-74 age group in 2040-2060. On average, over the whole projection horizon, labour input contributes negatively to output growth by 0.1 pp (although population growth alone contributes negatively by 0.2 pp), while there is a positive impact of 0.9 pp from TFP and 0.5 pp from capital deepening.

**Chart 4 Longer-term projections of potential output and its components**

(average annual percentage changes; contributions in average percentage points)




Sources: European Commission (2012 Ageing Report), OECD estimates and ECB calculations.
Note: The breakdown of the Ageing Working Group (AWG) estimates into components is available only for the euro area. OECD estimates are available for the five largest euro area countries as well as for the euro area 15.

The OECD long-term model's projection for the euro area (also available up to 2060) is broadly similar to the European Commission forecast and not discussed in detail. In the long term (2020-2060), the OECD projects potential output to continue growing by 0.6 to 0.8 pp faster in the United States than in the euro area (see Chart 4, right panel).

**Box 4**

## DERIVING ESTIMATES OF LONG-TERM POTENTIAL OUTPUT GROWTH IN THE EURO AREA

The estimation of potential output is particularly challenging for longer horizons. This is because there is less information for those horizons in current data, and because at those horizons, potential output is determined to a large extent by structural factors, notably demographics, and the effects of structural reforms, as well as convergence. Despite their particularly challenging nature, such longer-term estimates are necessary (and used) to compute key indicators for fiscal sustainability, notably the structurally adjusted budget balance, and to assess the impact of demographic developments and structural reforms on the long-term productive capacity of the economy.

This box illustrates how the challenge of producing longer-term estimates of potential output may be addressed by means of approaches used at the Economic Policy Committee's Ageing Working Group (AWG) and the OECD.[1] In both cases, potential output estimates are based on Cobb-Douglas production function with constant returns to scale, featuring either labour-augmenting technical progress (AWG) or Harrod-neutral progress with human capital (OECD). A key assumption is that in the long run the economy has converged to the balanced growth path (with a constant ratio of capital to labour in efficiency units).

In addition, the assumption is made that certain variables converge to common trends across countries. This applies to TFP, which is assumed to converge in EU countries, due either to deepening economic integration (AWG) or to global technology trends (OECD). In one case (AWG), it also applies to the growth rate of labour productivity at the end of the horizon.[2] In the other case (OECD), human capital across countries converges to the level of the "frontier countries" (which in turn grow further), and product market regulation (PMR) policies converge to the OECD average (or, in one scenario, to best practice). The treatment of the components of potential output is considered in more detail below.

### TFP

The AWG approach assumes that (common) long-run TFP growth is equal to the long-term historical average TFP growth in the EU (1%). The speed of convergence is country-specific, depending on the relative income position of the Member States. Population ageing is not assumed to have a specific impact on the TFP growth rate. In the OECD approach, country-specific long-run TFP / multi-factor productivity growth rates depend on the projected global long-run rate of technological progress and the country's PMR, with the speed of convergence depending on the trade openness (OECD, 2012b). Cross-country convergence of PMR policies implies that country-specific TFP growth rates tend to converge as well.

### Capital

In the AWG approach, up to 3 years ahead (2015), the capital stock projection is based on the so-called investment rule, i.e. assumptions about future investment/GDP ratios and depreciation rates. Beyond 3 years ahead (2016 and after), the capital rule is used, where capital stock grows at a rate equal to the sum of growth rates of labour and the labour-augmenting technical progress. In the OECD approach, the investment projection is derived from the projected capital stocks. Human capital, which is included as a factor input and measured by the number of years of schooling, is assumed to converge to the level of the frontier countries.

### Labour

Given the central role of the demographics in longer-term potential output projections, the methodology for projecting demographic variables and the labour input is very refined. In the AWG approach, the population projections assume convergence of EU countries in the very long run in mortality rates, fertility rates and net migration rates.

1 For detailed description methodological reference on the AWG estimates, see European Commission (2011). For the OECD long-term estimates, see OECD (2012b).
2 Convergence is assumed for growth rates rather than levels, given limited evidence for convergence in levels in the empirical literature; convergence speed depends on the initial income per country.

The cohort simulation model (CSM) of the European Commission, is used for a detailed projection of participation rates by age group (cohort) and gender (a similar model is used by the OECD). Average historical probabilities of entry and exit in the labour market for each cohort are used to project future participation rates as older generations are gradually replaced by younger ones.

Regarding long-term trends in unemployment, NAIRU is projected to decline slowly towards country-specific historical minima (AWG) or to pre-crisis levels (OECD).

### Structural reforms

A key challenge is how to account for the effects of structural reforms, and often this involves some judgement. For instance, in the AWG approach, legislated pension reforms are incorporated by lowering the exit rates from the labour force of the workers in the 50-74 age group. Available econometric evidence on the impact of reforms on workers' and firms' decisions is also taken into account. In the OECD approach, the concept of "active employment span" or the share of life span spent in the labour force is used. Assuming successful pension reforms, directed towards sustaining labour force participation despite increased longevity, this active span remains constant with time instead of decreasing.

In several instances, alternative reform scenarios are also explored: e.g., in the OECD approach, an optimistic product market reform scenario, in which product market regulations converge towards OECD best practice instead of the OECD average in the baseline, or a "deeper labour market scenario", in which the period of active employment in all countries moves to a certain share of total life expectancy. Finally, a faster OECD-wide fiscal consolidation is considered, which leads to higher potential output growth via lower cost of capital and hence higher investment.

## 4 ASSESSING THE IMPACT OF THE CRISIS ON POTENTIAL OUTPUT

This section discusses how euro area potential output has been affected during the crisis. The first part of the section is organised in the spirit of the production function, i.e. it considers the impact on labour input, the capital stock (notably via investment), and TFP (which is usually taken as a proxy for an economy's long-term technological progress). The second part considers potential output developments across euro area countries, and the third part provides a stylised comparison of the experiences in the euro area and the United States.

In public debate, it is often argued that the crises that started in 2007/08 have led to a permanent reduction in the level of potential output in the euro area, while the impact on the longer-term growth rate of potential output is more uncertain (see e.g. European Commission, 2009; ECB, 2009; and ECB, 2011).

A priori, there may be a number of reasons why the crisis may have caused a permanent loss in the level of potential output. The most obvious reason relates to a fall in the capital stock, due to capital scrapping. There is anecdotal evidence suggesting this may indeed have been part of the story, as the financial and economic crisis has led to a persistent downsizing of some industries, such as the financial and construction sectors.[16]

Another reason may be an increase in structural unemployment. Indeed, the euro area unemployment rate has risen since the crisis. However, the uncertainty surrounding the long-term impact of the crisis is still large. It is very difficult to determine at this stage whether the crisis will also result in a lasting decline in the trend potential growth rate. Indeed it has been argued that while, in general, recessions tend to have only a temporary effect on potential growth, i.e. are limited to a one-time shift in the level of potential output, a prolonged recession may have hysteresis-type effects that are longer-lasting, especially when recessions are associated with financial crises (Reinhart and Rogoff, 2009).

The crisis that started with the collapse of Lehman Brothers in 2007/08 has also been a catalyst for the implementation of some structural reforms. The impact of those reforms is discussed in Box 6, which suggests that those structural reforms should stimulate employment and raise longer term potential output, enhancing the economy's flexibility in the wake of future downturns. The longer-term impact of the crisis on potential output therefore also depends crucially on the progress made in terms of structural reforms.

Section 4 is followed in Section 5 by an analysis based on the New Multi-Country Model (NMCM) developed at the ECB, which aims to provide more evidence on the relative importance of different mechanisms in explaining the development of potential output during the crisis (compared to a hypothetical non-crisis scenario).

16 On the other hand, the persistent downsizing of some industries, notably the (low-productivity) construction sector, but also the financial intermediation sector, may actually raise TFP and its contribution to potential output growth (especially in cases in which that sector had previously been over-expanded due to an unsustainable construction boom).

Box 5

## POTENTIAL OUTPUT AND SECULAR STAGNATION

In the United States, the crisis has triggered a debate, similar to the debate that took place there in the 1930s, in the aftermath of what is now known as the Great Depression, about the possibility of a 'secular stagnation'[1], a scenario in which not only the output effects of the crisis persist, and actual output levels do not return to potential output levels for a protracted period (i.e. negative output gaps and employment gaps do not close until long after the crisis), but also excess savings require real interest rates to be low or negative for an extended time. This box recalls that debate, and its recent resurgence.

### The 'secular stagnation' debate in the United States in the 1930s

Towards the end of what is now known as the 'Great Depression', some economists noted that that episode might be followed by a very long period of low growth and low employment, and a lack of momentum in the return to potential and full employment, caused by a shortfall in demand alongside an oversupply of savings. The oversupply of savings, in turn, was attributed to the population dynamics at the time, which saw the share of the working age population (net savers) increase and that of the young (the net borrowers) decrease. Events that followed reversed the population trend and the shortage of demand, and so brought the debate to an end.

### The 'secular stagnation' debate in the United States following the recent crisis

Given the experience of the recent crisis in the United States and the similarities to the experience there in the 1930s, notably as regards the slow speed of the recovery and absence of a quick closure of output and employment gaps, also against the background of the lost decade in Japan, have led economists in the United States to return to the notion of 'secular stagnation' once more. That notion implies that real interest rates (the difference between nominal interest rates and the rate of inflation) would have to be very low or even negative for some time, in order to support the return of output to potential and the labour market to full employment.

A simple model illustrating the conditions and mechanisms under which employment and output may not recover for a long time, and secular stagnation may arise, and the policy conclusions that may be derived from it, is provided by Eggertson and Mehrota (2014). The authors show that once the net borrowing of the young and net saving of the working age population are properly accounted for (and the often-used modelling assumption of a so-called 'representative agent' is discarded), then (real) interest rates may have to be negative to ensure that demand for and supply of savings are equalised, and a particular policy mix may be required to facilitate a faster return of output to potential and the labour market to full employment.

1 The term 'secular stagnation' was coined following Hansen's (1939) Presidential Address to the American Economic Association.

## 4.1 THE EFFECT OF THE CRISIS ON THE COMPONENTS OF POTENTIAL OUTPUT

### LABOUR

According to estimates from the European Commission, the contribution from labour to euro area potential output growth turned negative in 2009 (see Chart 5). The labour contribution to potential output, measured in hours worked,[17] can be divided into two main factors, trend working hours (per person) and trend employment. In turn, trend employment is determined by the (trend) working age population, the trend participation rate and the trend unemployment rate.

### HOURS

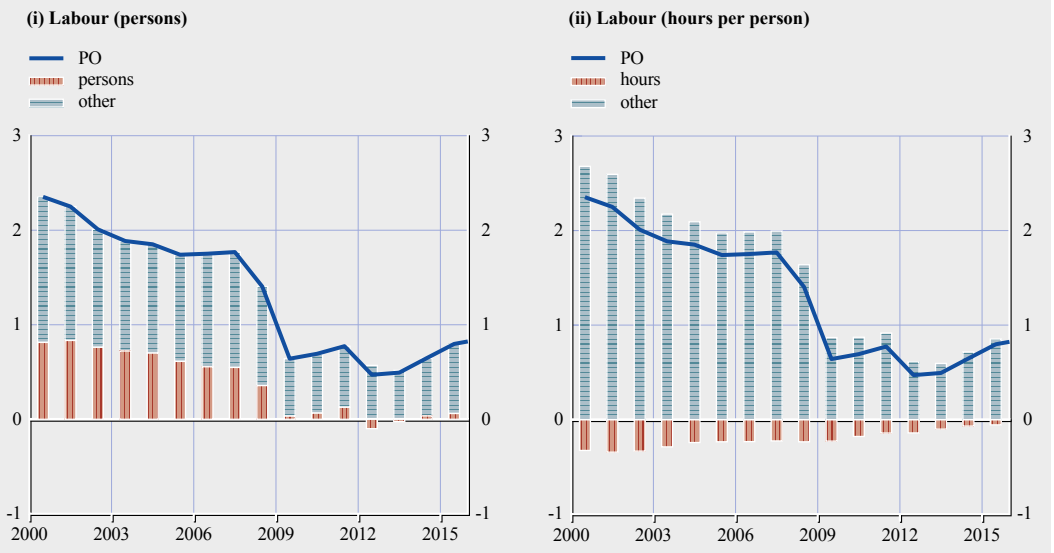
According to the estimates by the European Commission, trend working hours (per person) have been decreasing and their contribution to potential output growth has been negative since 2000. The size of this negative contribution has remained broadly similar over the past few years, which suggests that the fluctuations seen in actual working hours are mainly cyclical.

### PARTICIPATION

It can be argued that actual population growth tends to be pro-cyclical and the recent crisis might have affected fertility rates negatively, as births are postponed due to high unemployment and lower family incomes (see e.g. Sobotka et al., 2011). However, it is less likely that the financial crisis affected long-term population growth. Nevertheless, according to European Commission projections, the slowdown in working age population growth is expected to weigh on potential

**Chart 5 Potential output growth and the labour contribution**

(annual percentage changes; contributions in percentage points)




Sources: European Commission estimates (CIRCABC) and ECB calculations.

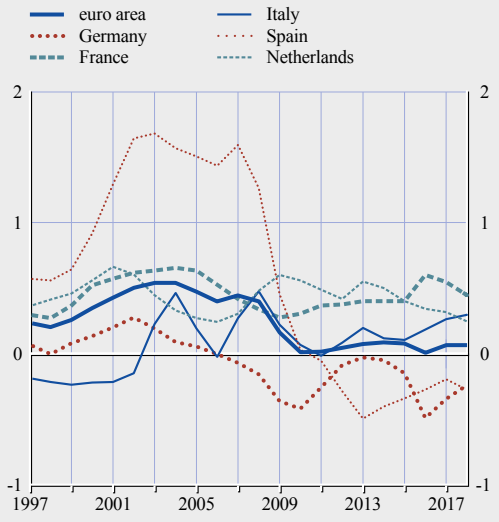
17 There are several alternatives for measuring the labour contribution to potential output, such as employment in persons, hours worked or full-time equivalents. Hours worked is usually the preferred measure of the labour input, as it corrects the labour input for any systematic patterns in hours worked, such as the long-term secular decline in the average hours worked per employee (Denis et al., 2006), which, if not accounted for, would give a downward bias to estimated TFP. At the same time, measuring hours worked may be practically challenging and less reliable than measuring persons employed, owing to the growing importance of self-employment and the emergence of new, flexible working patterns.

growth in the medium term (see Chart 6). Recent migration trends might mitigate this, but it is not clear yet whether the net effect for the euro area as a whole is going to be positive or negative, or whether the effect will also be felt in the longer term. Inward migration from the new EU Member States into some of the euro area countries, in particular Germany, has increased since the crisis, as did intra-euro area migration, but, at the same time, inward migration from outside the EU into some euro area countries has fallen significantly.[18]

Participation rates continued to increase during the financial crisis, although at a significantly slower pace than before. The participation rate in the euro area grew at an average annual rate of less than 0.1 percentage points between 2009 and 2011, compared with 0.5 percentage points in the years before the crisis.

**Chart 6 Population growth**

(annual percentage changes)



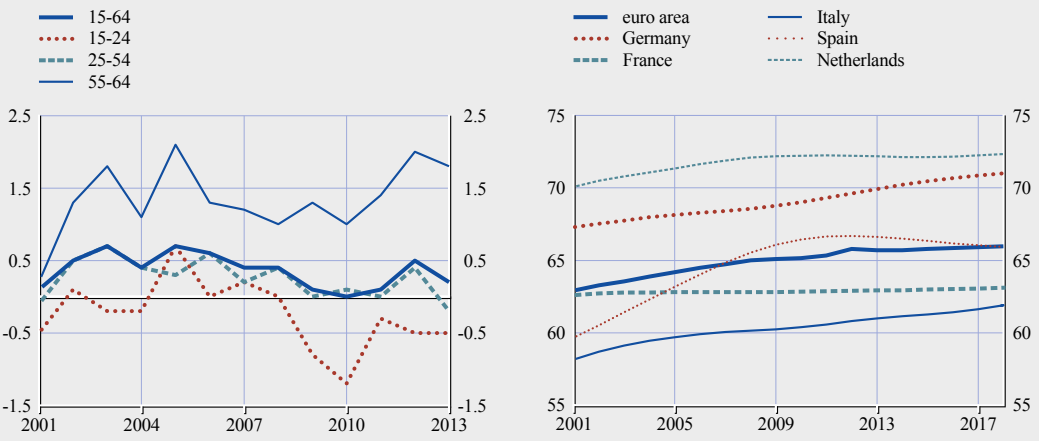

Source: European Commission.

There is, however, considerable variation across different age groups. Labour supply in the older age group continued to grow strongly during the crisis, partly influenced by pension system reforms in several euro area countries. On the other hand, participation rates in the younger age groups have been falling since 2008 (Chart 7).

**Chart 7 Labour market participation**

**(i) Euro area, by age group**
(change in rate; percentage points)

**(ii) Euro area and largest countries**
(rate; percentage)




Source: Eurostat.
Notes: In panel (ii), including projections.

18 See European Central Bank (2012), Box 5, p. 47.

There are several factors which suggest that the crisis is more likely to have had an effect on cyclical variations than on long-term labour force participation trends. In particular, unemployed people might be discouraged from further job seeking and (temporarily) exit the labour market, as indicated by the increasing number of people available for, but not seeking, work.[19] Furthermore, young people might prefer to stay longer in education, which in the short run also decreases participation. In households in which primary earners lost their job or suffered a decline in their real wages, previously inactive second earners might have entered the labour market to restore the household income.

In the long run, labour supply and potential labour force are determined mainly by demographic trends, but also depend on trends in schooling, the setup of (early) retirement schemes or the generosity of public transfers for the inactive (see e.g. Kátay-Nobilis, 2009). In the longer run, those who choose to stay inactive and in school during the crisis, are likely to increase the labour force and less likely to be unemployed later, which in turn might boost potential labour. Nevertheless, the recent financial crisis increased the share of young people not in employment, education or training (NEETs), which counteracts the positive effect.[20]

## UNEMPLOYMENT

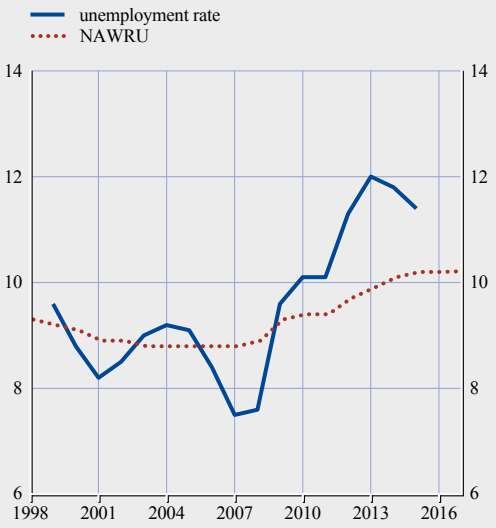
In the long run, structural unemployment is driven by institutional or structural factors, such as the level of unemployment benefits, union density, taxes on labour, or the extent of active labour market policies.[21] Structural reforms focusing on these are therefore essential in order to lower long-term structural unemployment.

On the other hand, prolonged economic downturns can also have an effect on the short to medium-term NAIRU. Since the outbreak of the crisis, several euro area countries have experienced a significant increase in their unemployment rates. The aggregate euro area unemployment rate increased from an annual average of 7.6% in 2007 to 11.4 % in 2012. According to European Commission estimates, about half of this increase is due to an increase in structural unemployment (Chart 8). A similar picture emerges from the estimates of the NAIRU by other institutions.

Several factors may be behind the estimated rise in structural unemployment. First, the share of long-term unemployment has increased in many countries, as well as in the euro area as a whole (left panel of Chart 9). The longer the unemployed are out of work, the more likely it is that skills will diminish and their human capital will depreciate. Individuals experiencing longer periods of unemployment may be viewed less

**Chart 8 Structural and actual unemployment rate, euro area**

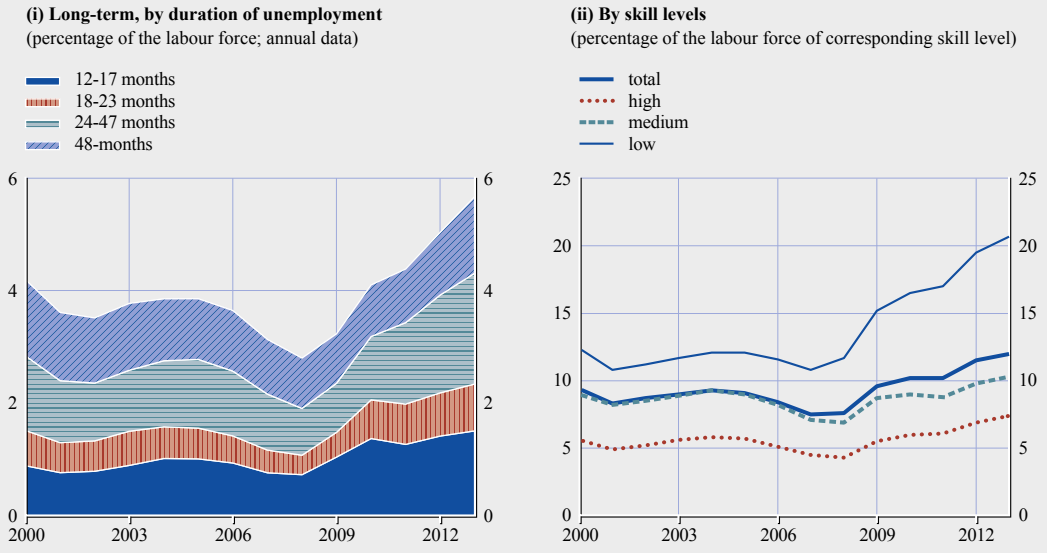
(percentage of the labour force)




Sources: Eurostat and European Commission (CIRCABC).
Notes: The NAWRU of the Commission is the result of a Philips curve in which wage costs are used instead of inflation. See also Box 2.

19 See European Central Bank (2013), Box 7, p. 47.
20 See OECD (2012), Box 1.1, pp. 22-23.
21 See, for example, Orlandi (2012).

Chart 9 Euro area unemployment rate




Source: Eurostat.

favourably by potential employers, making it harder for them to find jobs. Moreover, the longer they remain unemployed, the more discouraged they become in their job searches and they may become increasingly detached from the labour market. The long-term unemployed may therefore become less effective in competing for jobs, resulting in a risk of a further rise in structural unemployment in the future. In some countries, like Spain, the duality of the labour market exacerbated the "insider/outsider problem". In such circumstances, employees inside a firm have strong interests, so the interests of the unemployed outside the firm (such as higher employment, facilitated by the lowering of wages) may be disregarded, which in turn leads to prolonged unemployment.[22] Such mechanisms, which result in the persistence of unemployment, are often referred to as hysteresis (Ball, 2009; and Blanchard and Summers, 1989).

Second, the possible increase in mismatches between labour demand and labour supply may be another factor behind the rise in structural unemployment. In particular, the unemployment rate among low-skilled workers has increased far more than among the higher skilled, indicating a strong fall in demand for the less skilled, which is consistent with a growing skills mismatch (right panel of Chart 9).

The growth in long-term unemployment and mismatches may be partly explained by the fact that it can be difficult for workers laid off from a declining sector to find jobs as their skills may not be appropriate for other sectors. As a consequence, structural unemployment may become higher temporarily until the labour market accommodates the new structure of the economy.

Altogether, a rise in the structural unemployment rate might have a negative effect on the level of potential output, but it is less likely to have a long-term effect on potential growth, as this would require an ever-increasing structural unemployment rate.

22 Concerning the theoretical background, see Lindbeck and Snower (1988). Concerning the recent Spanish experience, see e.g. Bentolila et al. (2011).

Overall, the decline in the labour contribution to euro area potential growth is largely caused by the considerable rise in structural unemployment. Looking forward, recent high unemployment, including structural unemployment, is expected to moderate as demand picks up and as the labour market adapts to the restructured economy. Clearly, economic policy has a role in helping this accommodation by promoting active labour market programmes and by tailoring the education system to the altered needs of the economy, as well as by implementing reforms which make the labour market more flexible.

## CAPITAL

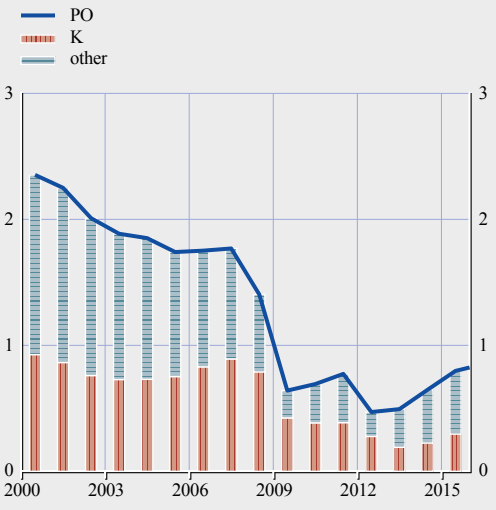
The next component of potential output is the contribution from (changes in) the capital stock. That contribution declined by about half between 2008 and 2009, i.e. in the first year of the crisis, accounting for roughly half of the drop in euro area potential output growth at that time. A further decline in the capital contribution was observed in 2012 - 2013 (Chart 10).

The maximum possible capital contribution to output growth is defined by the full utilisation of all the existing (private and public) capital stock in the economy. For this reason, the capital stock series is usually not smoothed for the purpose of estimating potential output contribution, and there is virtually no distinction between total and trend components.

A problematic feature of estimates of capital stock is the data on which they are based: available official data of the tangible and intangible assets included in the capital stock may not properly capture the relative importance of the assets for the supply potential of the economy (Benito et al., 2010). Different assets may have vastly different impacts on potential output: machinery and equipment are generally more productive assets than housing and non-residential buildings. Insufficient differentiation of assets by type and efficiency may have led to an overestimation of the productivity of the capital stock during the asset-driven cycle prior to the crisis[23].

**Chart 10 Euro area potential output growth and the capital stock contribution**

(annual percentage changes; contributions in percentage points)

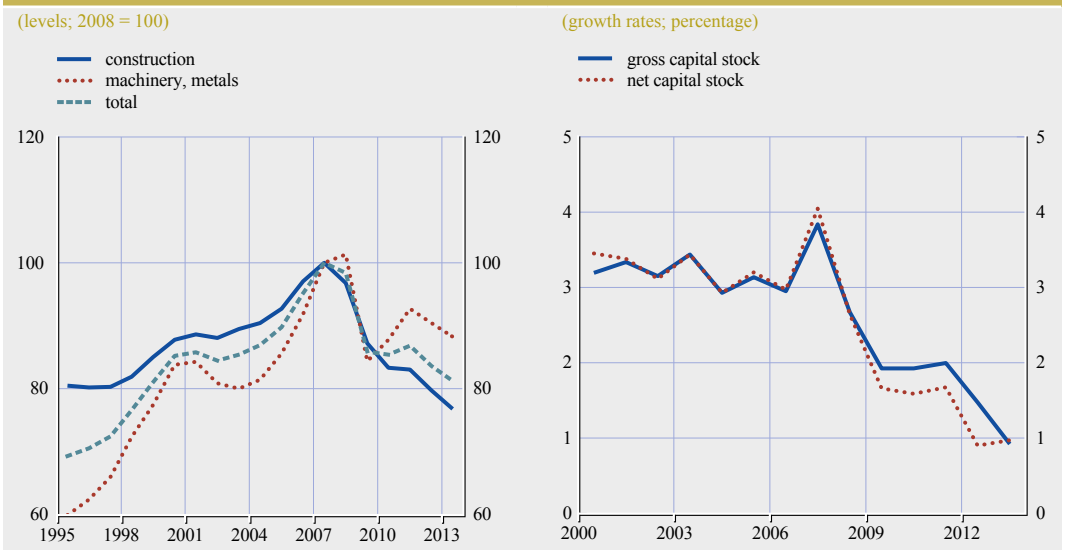



Sources: European Commission estimates (CIRCABC) and ECB calculations.

Capital stock grows in each period by the amount of new investment net of depreciation. Investment, being a very cyclically sensitive expenditure component, is also the one which has contracted most since the beginning of the crisis in the euro area. The cumulative crisis-related drop in euro area investment amounted to about 18% from peak to trough, which is more severe than that observed in any earlier financial crises (ECB, 2013). Moreover, the tentative levelling off was interrupted in 2011, and a renewed decline has taken place. Similarly, the capacity utilisation rate for the

23 This overestimation may also result in a respective underestimation of the TFP contribution. The productivity of housing capital is estimated at only about 30% of non-housing capital. See, for instance, D'Auria et al. (2010).

**Chart 11 Investment and capital stock in the euro area**




Source: Eurostat.

euro area has generally recovered less quickly than in previous recessions and remains well below long-term averages.[24]

While the adverse development in investment has certainly had a cyclical effect, it may also have had a constraining effect on the supply capacity of the economy and hence on potential output growth in the longer run. First, intuitively, lower investment leads to a permanently lower capital stock. To the extent that new capital also embodies technological improvement, lower investment may also be associated with lower TFP growth (see Haltmaier, 2012). Second, several factors distinguish the investment contraction in the recent crisis from previous crises, and the negative impact on the supply capacity is likely to be more pronounced and lasting in comparison.

The above factors have an impact on several parameters of the capital accumulation process – the rate of investment growth, the rate of capital scrapping and the average life of capital assets (Benito et al., 2010). Starting with investment growth, three important factors, all of which are characteristic of the recent crisis, are the changed sectoral composition, the protracted period of heightened uncertainty and the deterioration in the financing conditions. Regarding the structural composition, the excessive pre-crisis expansion of sectors such as construction in some euro area countries has led to the existence of a large stock of unutilised or underutilised capital goods and excess capacity (see ECB, 2011; and ECB, 2013),[25] which would suppress the need for replacement investment in assets of this type. The sharp adjustment and subdued outlook of the construction sector in some countries is bound to remain a drag on investment growth for some time. Indeed, construction investment is the investment component which declined most steeply, by 21% from peak to trough (see Chart 12, left panel), and in some countries (e.g. Spain) its share in total investment declined by nearly 10 pp between 2007 and 2012.

24 The capacity utilisation rate is subject to the caveat that it applies to the manufacturing sector only, which captures a relatively small share of total capital stock, so conclusions cannot be drawn on aggregate capacity utilisation (Musso and Westermann, 2005)
25 Similar considerations may also hold for the United States.

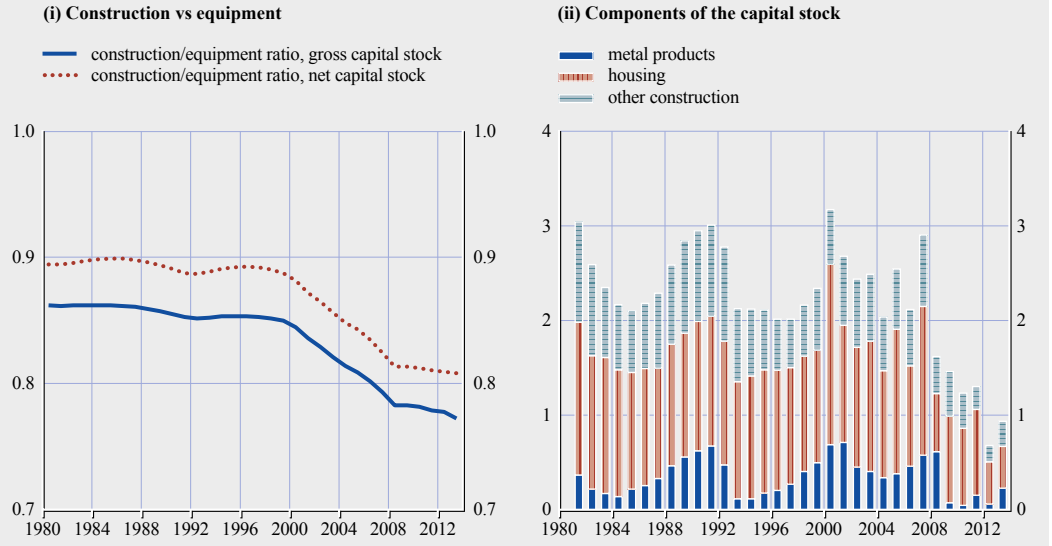
A second factor constraining investment has been the persisting high level of uncertainty. Uncertainty has been shown to have a large effect on business investment, which is characterised by irreversibility and time needed to install and is the result of a forward-looking decision. The IMF (2012) finds that recessions associated with a high level of uncertainty are deeper and longer, with larger cumulative losses than other recessions, and the subsequent recoveries are weaker and slower than the average recovery. The IMF study confirms that investment is the expenditure component most affected by increased uncertainty.

Third, business investment is sensitive to financing conditions and the health of company balance sheets. The credit supply shocks in 2008 and 2009 had a large negative effect on capital investment, as bank credit was a crucial financing channel for corporations in many euro area countries (see e.g. Campello et al., 2010, ECB, 2013). At the same time, corporate sector indebtedness in the euro area increased substantially prior to the financial crisis in some euro area countries. In general, excessive borrowing appears to be associated with overinvestment, as the countries which experienced high debt-to-GDP ratios in the three years prior to the crisis also had the highest investment-to-GDP ratios (ECB 2013). Looking forward, deleveraging needs are likely to continue to restrict investment. The deleveraging needs may be biggest in the countries where investment contracted the strongest during the crisis.

In addition to investment growth, the rate of capital scrapping and the life span of capital assets have also been affected. The average scrapping rate of capital assets may have increased since the onset of the crisis. First, the crisis-related rise in company liquidations might imply a higher rate of capital scrapping if some of the capital is scrapped before the end of its service life. Second, changes in the capital structure, reflected in a drop in the relative share of buildings as compared to machines, imply an increase in the overall scrapping rate, as machines tend to have a much shorter

**Chart 12 Euro area capital stock**

(ratio; EUR billions)



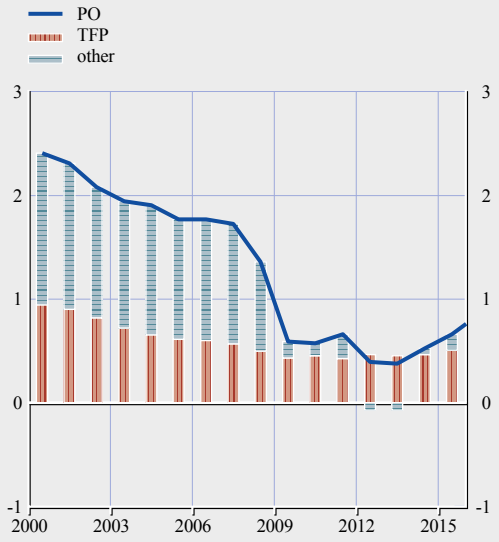

Sources: Eurostat and ECB calculations.

average service life than buildings (see Musso and Westermann, 2005).[26] For the same reason, the average service life of assets may have contracted. However, the total impact on service life is ambiguous, because the active life span of the existing assets may have increased due to lower wear and tear and less intensive utilisation (see Benito et al., 2010).

The right panel of Chart 12 shows the estimated growth rate of gross and net capital stock[27] for the euro area in the period 1980-2012, and the sharp deceleration in 2008-2009 due to the collapse in investment is clearly visible. The growth rate in net capital stock declined after 2008, reaching the lowest point in 2012 (see right panel of Chart 12). Available data on the structure of euro area capital stock, while being only approximate, mirror the evolution in the structure of investment discussed above. Housing and other construction naturally take up a much larger share of capital stock (nearly 90% up to 2000) than its share in investment, owing to the higher average value and much longer service life of structures compared to equipment. The ratio of construction to equipment has been decreasing from around 1998 to 2008 owing to the overall faster (but also more volatile) growth but in equipment but it has levelled off since 2008.

**Chart 13 Euro area potential output growth and the contribution from total factor productivity**

(annual percentage changes; contributions in percentage points)




Sources: European Commission estimates (CIRCABC) and ECB calculations.

## TOTAL FACTOR PRODUCTIVITY (TFP)

The TFP contribution to potential output dropped only marginally during the crisis, having already declined in the pre-crisis period (see Chart 13), which is consistent with experience in previous financial crises.[28] In principle, the effect of the crisis on TFP can be explained by direct effects, independent of the factors of production, or by indirect effects, linked to changes in the composition of the factors of production (e.g. across sectors, from shrinking to expanding sectors; within sectors, from exiting to entering firms; or within firms, from old to new operations).[29]

There is indeed some evidence suggesting that TFP has been affected by the change in economic structure brought about by the crisis, particularly the shift towards sectors with

26 The average service life is less than 10 years for computer equipment (and decreasing), 20 years for other types of equipment, around 50 years for non-residential buildings, and even longer for housing (Musso and Westermann, 2005).

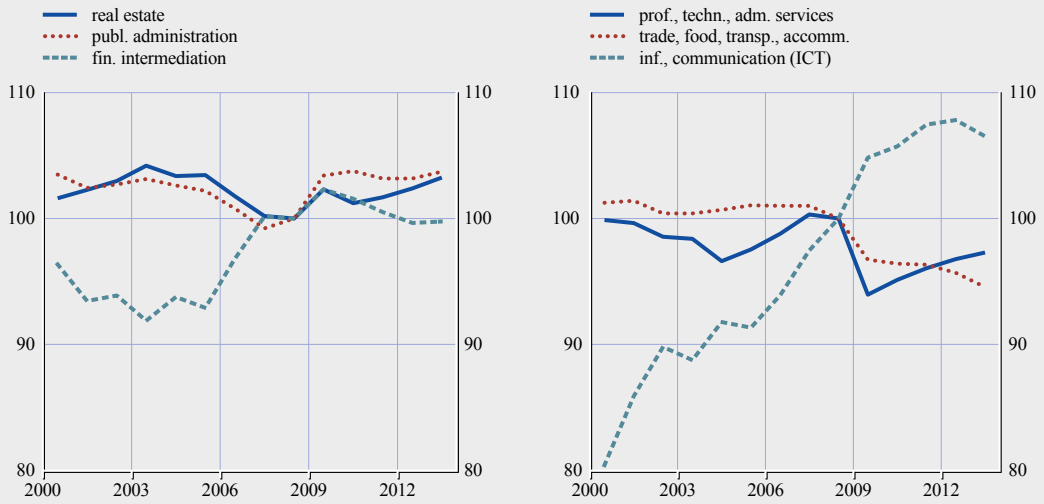
27 *Gross capital stock* is the summed value of all capital assets in use at actual prices, irrespective of the age of the assets; *net capital stock* accounts for depreciation by subtracting from the gross capital stock the consumption of fixed capital. Ideally, it also accounts for the ageing and the quality losses of the capital goods.

28 See IMF (2009).

29 Across sectors, they may arise notably in cases in which major (sectoral) imbalances had built up prior to the crisis. Those imbalances would have affected TFP growth pre-crisis, when building up, and would affect TFP growth post-crisis, when unwinding, if the respective sectors are associated with (sectoral) TFP growth that is different from the overall average (e.g. construction). It may not be easy to judge what the equilibrium sector shares are and what the necessary adjustment is, because this may, for example, depend on the stage of development, and thus for certain sectors be higher in catching-up economies than in other economies. However, there are indications that some (sectoral) imbalances were indeed in place pre-crisis (notably in relation to an over-extended construction sector), and that some post-crisis unwinding of the imbalances has been taking place (notably from construction to services). However, such effects may also occur in the absence of imbalances if the crisis disproportionately impacts on more cyclically-sensitive sectors and those sectors exhibit (sectoral) TFP growth that is different from the overall average (e.g. financial services, with above-average TFP growth).

**Chart 14 Value added in individual service sectors relative to total service sector value added, euro area**

(2008 = 100; annual data)




Sources: Eurostat and ECB calculations.

different productivity.[30] As shown in Chart 14, the share of construction and manufacturing in value added in the euro area has decreased since 2008, while the share of services has increased, to some extent also as a response to a possible pre-crisis misallocation across sectors.

Available research suggests that differences in TFP growth across sectors might be substantial, with the highest TFP growth typically found in manufacturing, particularly of communication and information technology (ICT), lower TFP growth in services, and the lowest TFP growth in construction.

Overall, the decline in the share of construction in value added since 2008 suggests that aggregate TFP growth in the euro area is likely to increase following the crisis. The small decline in the share of manufacturing may have led to a negative impact on TFP growth, but the impact of the higher share of services is difficult to estimate, given the heterogeneity across service sectors with respect to TFP intensity. Looking at the development of these shares (see Chart 14), it can be concluded that, since 2009, a re-allocation within the services sector has taken place towards higher TFP sectors, most notably a higher share of information and communication technologies (ICT) and financial intermediation services.

A more detailed analysis of TFP developments in the euro area, and a comparison with the developments in the United States is provided in Box 7.

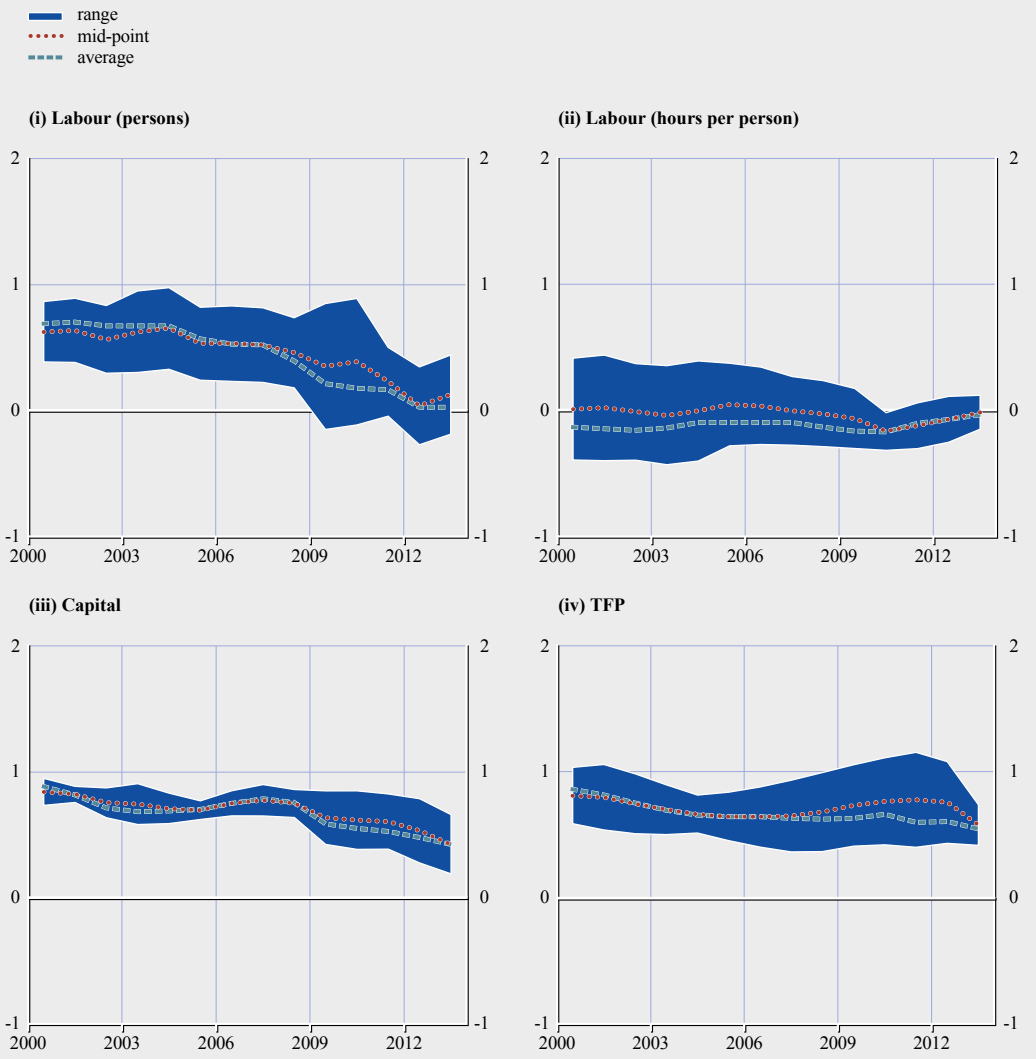
## UNCERTAINTY SURROUNDING THE COMPONENTS OF POTENTIAL OUTPUT

As discussed in Section 2.2, potential output is unobservable, and hence has to be estimated. Chart 15 documents the real-time uncertainty of (the revisions to) the estimated contributions from labour (persons and hours per person), capital and TFP discussed above.

30 Although the focus here is on TFP, sectoral shifts during the crisis may also affect the capital contribution to potential output if different sectors have significantly different investment rates.

**Chart 15 Real-time uncertainty of the components of euro area potential output growth**

(contributions in percentage points; annual data)




Sources: European Commission estimates (CIRCABC) and ECB calculations.
Notes: The panels depict the range of estimates, based on vintages from 2002 to 2013, where available, the mid-point of that range, and the average of the estimates. The number of vintages varies from year to year, which accounts to some extent for the different widths of the range over the sample.

As can be seen from the chart, in general, the real-time uncertainty associated with the contributions from labour (persons and hours per person) seems to have been larger than that associated with capital and TFP. The contribution from labour (persons) in particular, appears to underlie the increased uncertainty in the crisis period, while the contribution from labour (hours per person) was the main source of uncertainty in the pre-crisis period. In addition, uncertainty has also increased markedly for the capital and TFP components during the crisis, particularly TFP.

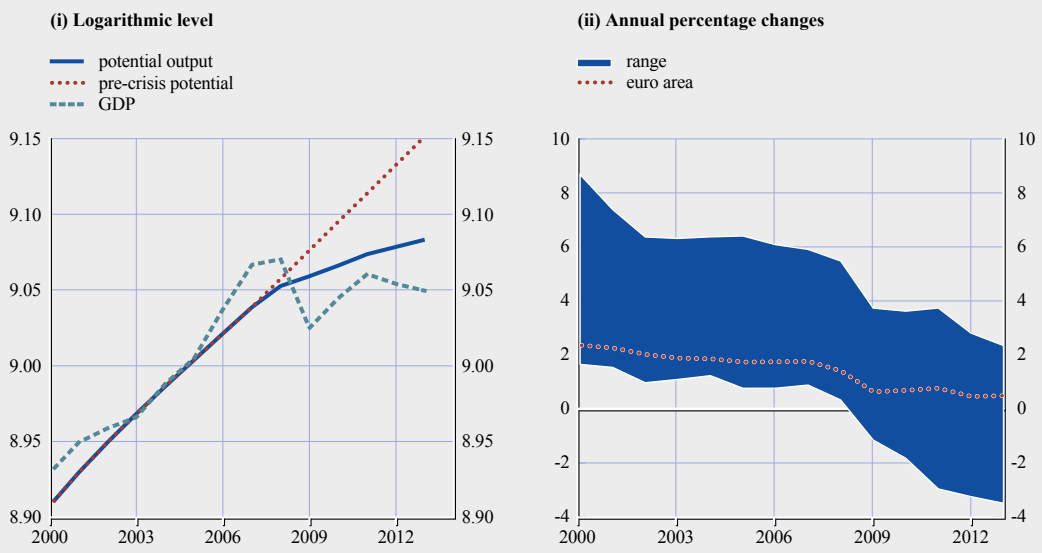
## 4.2 SOME STYLISED FACTS BASED ON CROSS-COUNTRY EVIDENCE

The financial and economic crisis which started in 2007/08 had a sizeable adverse impact on output. Activity was hit quite severely, with a deep contraction in real GDP. By the end of 2013, euro area GDP was still 2.1% below the pre-crisis peak in 2008 (see Chart 16). These developments mask significant cross country heterogeneity: output has decreased in practically all euro area countries, but the recession was deeper in countries which had accumulated large macroeconomic imbalances in the run-up to the crisis. Consistent with previous evidence on systemic financial crises, the fall in output has been large and prolonged, which also implies permanent output losses.[31]

As noted above, it is likely that the financial and economic crisis has had an adverse effect on the level of potential output, owing to the downsizing of some sectors, such as the financial and construction sectors, and the increase in structural unemployment, owing to persistently high and prolonged unemployment rates. According to figures from the European Commission (2014 spring forecast), the potential output level in 2013 is significantly lower than a calculated pre-crisis potential level, assuming the same growth (slope) as in the period 2000-2007 (see Chart 16, panel (i)). However, the crisis may also have had a negative impact on the potential growth rate as a result of a reduction in investments owing to, for example, the increased cost of capital.

Potential growth is estimated to have fallen significantly in the euro area, from 1.9% in the period 2000-07 to 0.7% in the period 2008-13 (see Chart 16, panel (ii)). Interestingly, prior to the crisis, the average euro area potential growth rate was very close to the lowest growth rate across the euro area countries. By contrast, the average euro area potential growth has been closer to the middle of the maximum-minimum range since around 2009. This reflects the degree of disparity of

**Chart 16 Potential output developments in the euro area**

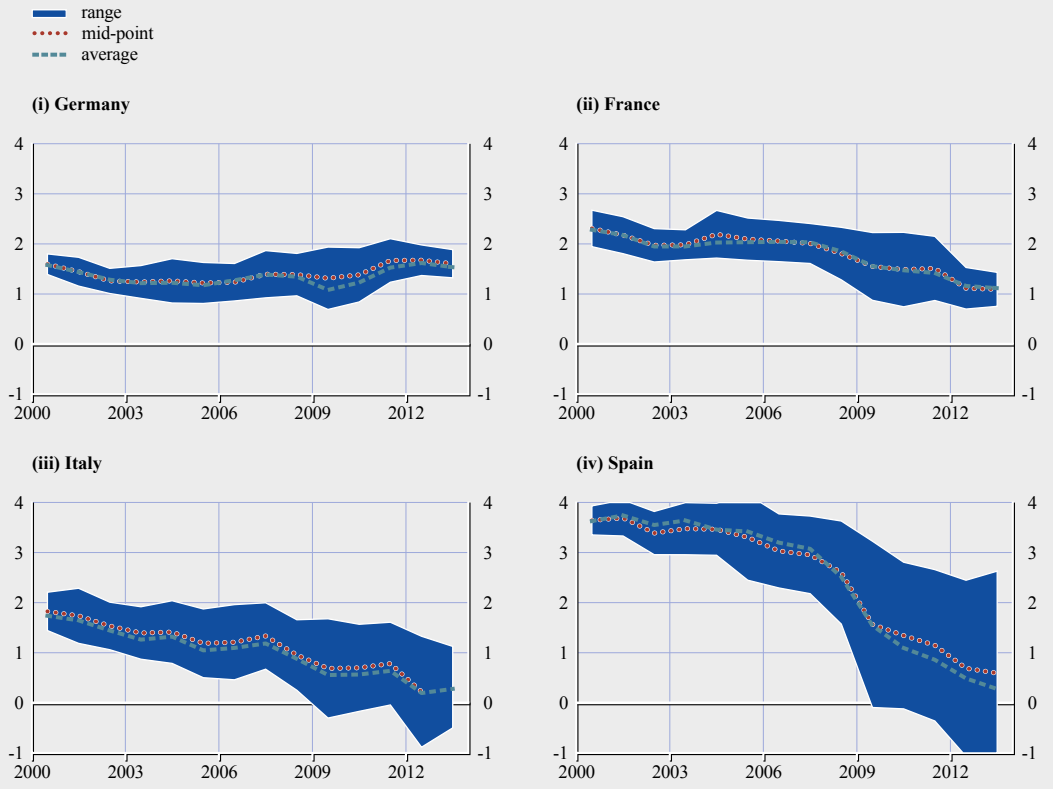



Sources: Eurostat data, European Commission estimates (AMECO) and ECB calculations.
Note: In panel (i), the post-crisis potential level is calculated by assuming the same growth (slope) as in the period 2000-2007. In panel (ii), the range depicts the spread in the growth of potential output between euro area countries.

31 See Reinhart and Rogoff (2009).

**Chart 17 Real-time uncertainty of potential output estimates for the largest euro area countries during the crisis**

(annual percentage changes)




Sources: European Commission estimates (CIRCABC) and ECB calculations.
Notes: The panels depict the range of estimates, based on vintages from 2002 to 2013, where available, the mid-point of that range, and the average of the estimates. The number of vintages varies from year to year, which accounts to some extent for the different widths of the range over the sample.

the potential growth rate across the euro area, where larger countries displayed lower growth rates prior to the crisis. However, since the crisis it is mainly smaller countries that have dragged down euro area potential growth rates.

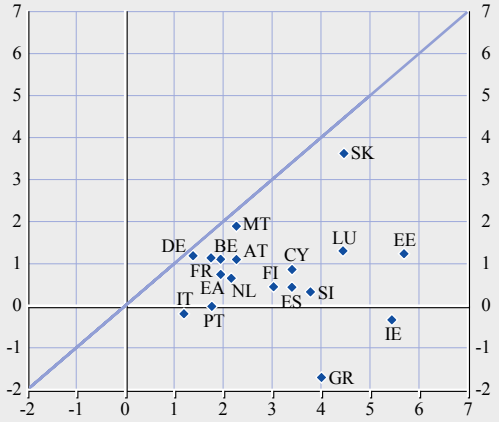
The revisions to potential output growth estimates for the four largest euro area countries are illustrated in Chart 17. The largest revisions have been made to the estimates for Spain (the country that also had by far the highest pre-crisis growth rates of potential output). The revisions have been smaller for France and Italy, and smallest for Germany, which also had one of the lowest pre-crisis growth rates of potential output.

Notwithstanding the uncertainties surrounding estimates of potential output across the euro area countries, a few stylised facts can be observed. First, potential output growth has slowed in all euro area countries, albeit to different extents. This can be seen in Chart 18 (left panel), in which most countries are located below, but at different distance from the 45 degree line (which represents equal growth in 2000-07 and 2008-13). For example, the change in potential output growth has been rather limited in Germany, whereas, for some countries – Greece, Ireland, Italy and Portugal – the average rate of potential growth moved into negative territory in the period 2008-13.

**Chart 18 Change in potential output**

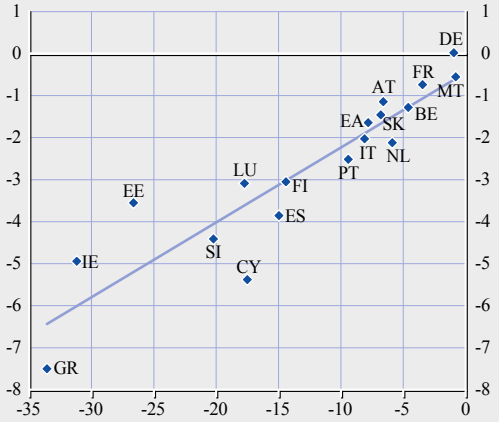
(average annual percentage changes)

x-axis: 2000-07
y-axis: 2008-13




(percentage points)

x-axis: deviation between pre-crisis and current trend, 2013
y-axis: difference between pre-crisis and 2013 potential growth rates




Source: European Commission.

Second, countries with the largest loss in the level of potential output since the crisis tend to be those that experienced the biggest decreases in potential output growth. This is shown in Chart 18 (right panel), where most countries are closely aligned with the implied regression line. However, the loss in potential output owing to the crisis differs widely across countries. Among the countries in the chart for which potential output growth has decreased most are some that had accumulated large macroeconomic imbalances in the run-up to the crisis (i.e. Greece and Ireland).

To shed more light on this, Chart 19 shows the percentage point loss in potential output from 2007 to 2013 against the average rank of the country[32] in terms of the indicators from the scoreboard for the surveillance of macroeconomic imbalances.[33] Some countries ranking low (i.e. subject to a larger number of imbalances) suffered a larger fall in potential growth during the crisis.[34] This applies in particular to Spain, Greece and Cyprus, which are among the "stressed" economies marked in yellow (Cyprus, Greece, Ireland, Portugal, Slovenia and Spain). This distinction between the "stressed" and "non-stressed" group of countries is less visible if we look at the relationship between macroeconomic imbalances and the change in the output gap or in actual GDP (Panels B and C of Chart 20). Larger imbalances prior to the crisis seem

32 The average rank is obtained by first ordering countries according to the pre-crisis outturns for one of the imbalance indicators, e.g. government debt (2007, annual numbers), noting the rank (1 to 17) relative to the perfect scenario (i.e. zero debt), repeating this for all indicators (except the two imbalance indicators for unemployment and exchange rate), then taking the average of the ranks.

33 Concerning the scoreboard, see European Commission (2012b). The real exchange rate criterion has been left out of the analysis because the criterion's symmetry (threshold of plus or minus 5%) makes the ranking of the countries difficult. The unemployment rate criterion was left out because high pre-crisis levels might be a reflection of the overheating of the economy as much as of low structural unemployment.

34 A cross-country analysis of the possible relationship between changes in potential output growth and different country-specific factors reveals what country-specific factors are likely to be associated with recent changes in potential growth. Given that it is based on simple cross-correlations, it is not possible to infer causation, nor its direction. However, endogeneity is addressed to the extent that changes in potential output growth after the outbreak of the crisis are compared with the pre-crisis position of the examined factors. Further, the limited number of observations (17 or less) prevents the strength or significance of the relationships from being reliably judged. The slopes of the trend lines fitted on the observations indicate the sign and the size in the coefficients and whether there might have been a change in these recently.

to have affected the growth potential of most of the "stressed" countries, while their cyclical position was less affected.

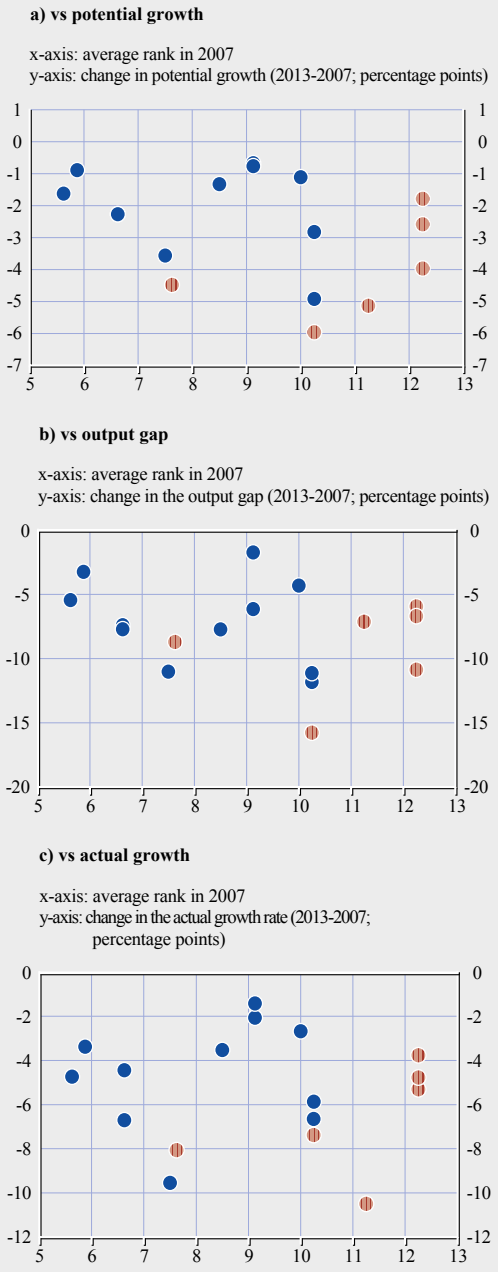
Admittedly, it is not clear from Chart 19 whether there is a systematic relationship. However, it is useful to consider some of the indicators in the scoreboard individually, as some may play a larger role in the changes in potential growth.

One such indicator is the current account of the balance of payments. Prior to the crisis, countries with larger current account deficits tended to have higher potential growth. This has changed since the outbreak of the crisis, and countries with larger pre-crisis current account deficits typically had lower potential (and actual) growth in 2013 (left and right panels of Chart 20). The pre-crisis current account position also seems to be related to the slackness of the euro area economies: countries with more balanced current accounts in 2007 now face small output gaps (middle panel of Chart 20). Similar results can be found for other indicators in the scoreboard (see Appendix 1).

One factor not explicitly included the scoreboard, the size of the construction sector, may be an indicator of misallocation of resources in the pre-crisis period and is often thought to be positively related to overestimates of pre-crisis potential growth. Indeed, countries with larger construction sectors prior the crisis have seen bigger slowdowns in their potential (and actual) growth, indicated by the change in the slope of the fitted trend lines (left and right panels of Chart 21). Countries with larger construction sectors also have larger output gaps, although the relationship appears to be weaker (middle panel of Chart 21).

Overall, there appears to be some, albeit very tentative, evidence that countries with larger deficits in the current account of the balance of payments, and larger construction sectors prior to the crisis, may have experienced larger declines in potential growth than other countries. However, the level of pre-crisis public or private debt may not to be related to recent *changes* in potential growth (Appendix 1). Nonetheless, low potential growth prospects are likely to make it more difficult to reduce elevated debt ratios.

**Chart 19 Macroeconomic imbalances vs growth and slack**

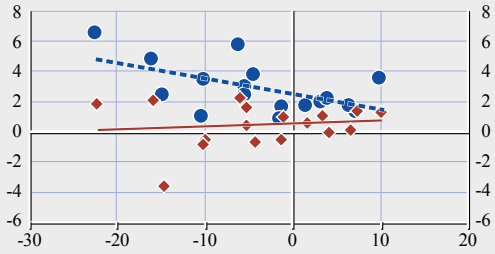



Sources: European Commission estimates (CIRCABC) and ECB calculations.

## Chart 20 Current account balances vs growth and slack

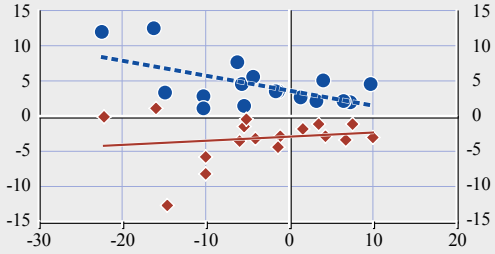
**a) vs potential growth**

x-axis: CA balance 2007 (percentage of GDP)
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



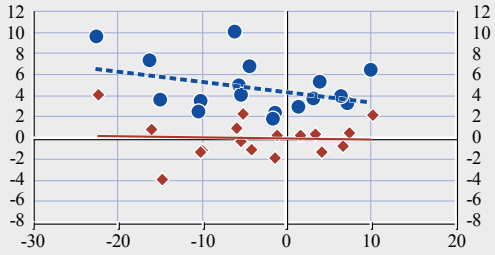

**b) vs output gap**

x-axis: CA balance 2007 (percentage of GDP)
y-axis: output gap 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: CA balance 2007 (percentage of GDP)
y-axis: actual growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)

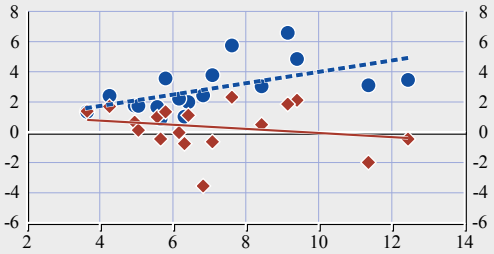



Sources: European Commission and ECB calculations.

## Chart 21 Share of construction vs growth and slack

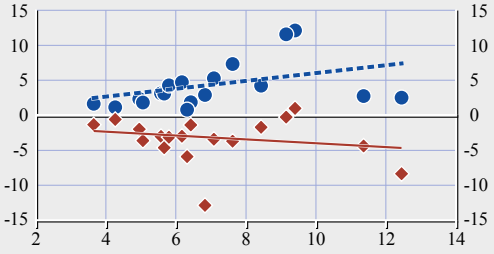
**a) vs potential growth**

x-axis: share of the construction sector in percentage of GDP, 2007
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



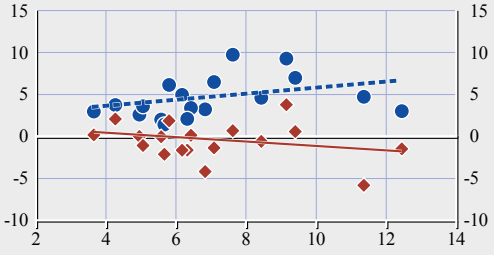

**b) vs output gap**

x-axis: share of the construction sector in percentage of GDP, 2007
y-axis: output gap 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: share of the construction sector in percentage of GDP, 2007
y-axis: actual growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




Sources: European Commission and ECB calculations.

The analysis above and in Appendix 1 suggest that, in a number of cases, the countries that have suffered larger declines in their potential output growth are those with larger pre-crisis imbalances (i.e. larger negative current account balances and significant growth in unit labour costs), extensive construction sectors (employing a mainly low-skilled workforce), and restrictive employment protection regulation. This applies notably to countries subsequently under a programme, i.e. Spain, Greece, Portugal, Ireland, and Cyprus.

It must be noted, however, that the countries most negatively affected by the crisis made considerable adjustments during the crisis, which is likely to positively affect their post-crisis potential growth, so the adjustment signals a move towards a more sustainable growth structure (see ECB, 2013; and ECB, 2014). On the other hand, countries with more balanced current accounts, less stringent employment protection and more moderate unit labour cost developments prior the crisis, notably Germany, Austria and Belgium, have seen a more moderate change in their potential output growth in recent years.

Box 6

## MODEL-BASED SIMULATIONS OF THE IMPACT OF STRUCTURAL REFORMS

Across the euro area countries, the crisis acted as a catalyst for structural reforms, including in areas such as pension and disability schemes which, in the long run, will contribute to higher labour market participation. This box assesses the impact of structural reforms on the labour market in the euro area countries using EAGLE, a calibrated multi-country dynamic general equilibrium model (see Gomes et al (2012)).[1] This stylised framework illustrates how policy measures permanently reducing rigidities and restrictions on the labour market are likely to result in higher output and employment.

Like the New Area-Wide Model (NAWM) developed at the ECB and the Global Economy Model (GEM) developed at the IMF, EAGLE is micro-founded and features nominal price and wage rigidities, capital accumulation, and international trade in goods and bonds. Explicit micro-foundations enable the identification of structural parameters and the proper analysis of the impact of structural changes, while the general equilibrium framework allows the effects of the behaviour of households and firms to be appropriately taken into account.

More specifically, the model features monopolistic competition in product and labour markets. The degree of competition in the two markets is captured by a mark-up between marginal costs and final prices, and between the marginal rate of substitution between consumption and leisure and wages. These mark-ups are inversely related to the degree of substitutability between varieties of goods or labour. By permanently modifying these elasticity parameters, it is possible to simulate the impact of structural reforms that modify the degree of competition in the considered market. In particular, the higher the elasticity of substitution between varieties, the lower the mark-up and the closer the market is to perfect competition (see also Gomes et al (2013)).

The table summarises the long-run effects of labour market reform, simulated via a reduction of 10 pp in the domestic-economy wage mark-up in a euro area country. In the case in which reforms are not coordinated across euro area countries (left-hand panel), enhancing competition on the domestic labour market has a positive effect on potential output, resulting in an increase in hours worked, while real wages decrease. Employment increases since firms now have a stronger incentive to use labour input, which becomes cheaper. Exports are stimulated as well, because the lower real wage translates into a lower marginal cost in the whole economy and hence in lower prices in both tradable and non-tradable sectors. Accordingly, the domestic terms of trade deteriorate.

1 See Gomes et al. (2012) for a more detailed discussion of the EAGLE model; Gomes et al. (2013) assess the domestic and cross-country macroeconomic implications of competition-enhancing reforms implemented in the euro area services and labour market.

At the same time, the domestic real exchange depreciates because the relative price of services, which is a large share of the consumption bundle, decreases. Finally, imports increase as well, mainly due to the increase in consumption, which represents a large share of aggregate demand, though having lower import content than investment. Although limited, spillovers to the rest of the euro area (REA) are positive, as the rest of the euro area now benefits from more favourable terms of trade movements. This effect stimulates consumption and investment in the rest of the euro area. Real output increases, while rest-of-the-euro-area exports to the United States and to the rest of the world (not reported) decline (cheaper domestic tradable goods are more competitive there).

Higher domestic aggregate demand and cheaper domestic goods give rise to an increase in rest of the euro area economic activity, but only to a small extent. Accordingly, when reforms are implemented in one country only, the macroeconomic performance across euro area regions is rather different. Reforms which are not synchronised across euro area countries (i.e., done in isolation) can limit the degree of homogeneity in macroeconomic performance across euro area regions. As a consequence, a country in the euro area may have a stronger incentive to implement reforms when other countries do so and, moreover, coordination can contribute to making the euro area more homogeneous. Against this background, it is possible to assess the impact of implementing reforms simultaneously in the domestic economy and the rest of the euro area. It is assumed that both regions reduce mark-ups by the same amount (10 pp) in the labour markets.

In the case of full coordination across euro-area countries (right-hand panel), relative prices of domestic and foreign goods deteriorate to a lesser extent than in the case of unilateral reforms because the home economy benefits from cheaper imports as aggregate supply in the rest of the euro area increases. Moreover, the increase in economic activity is more evenly spread across the two regions. In each region, output rises by around 3.6% in the case of a simultaneous 10 pp reduction in mark-ups (compared to 3.4% for the home economy in the non-coordinated case). Thus regional welfare increases in both euro area regions, reflecting the lower degree of monopolistic distortions. Finally, cross-country coordination would make the macroeconomic performance of the different regions belonging to the euro area more homogeneous, both in terms of prices and real activity.

Overall, the above results suggest that reforms implemented by only one country in the euro area at a time (i.e., in isolation) produce positive effects, but cross-country coordination of reform implementation produces larger and more evenly distributed (positive) effects.

**The long-run effects of a reduction of 10 pp in the domestic economy wage mark-up**

| Case | Non-coordinated | | Fully-coordinated | |
|---|---|---|---|---|
| Economy | Domestic | Rest of euro area | Domestic | Rest of euro area |
| Real GDP | 3.44 | 0.01 | 3.64 | 3.55 |
| Consumption | 3.05 | 0.03 | 3.49 | 3.43 |
| Investment | 2.85 | 0.02 | 3.43 | 3.30 |
| Hours worked | 3.76 | 0.00 | 3.76 | 3.66 |
| Real wages | -0.68 | 0.03 | -0.26 | -0.21 |
| Exports | 2.57 | 0.14 | 3.30 | 2.48 |
| Imports | 2.56 | 0.14 | 3.30 | 2.50 |
| Real exchange rate | 1.04 | 0.01 | 1.07 | 0.72 |
| Terms of trade | 2.17 | -0.01 | 1.84 | 0.85 |

Source: ECB calculations.
Note: Percentage deviation from baseline.

## 5 A STYLISED COMPARISON OF THE EURO AREA AND THE UNITED STATES

This section compares the developments in potential output growth (and its main components – capital, labour and TFP) in the euro area with those in the United States with a view to outlining the main similarities and differences, and to draw some tentative conclusions on the factors accounting for them, in particular the possible role of structural features in both economies.[35]

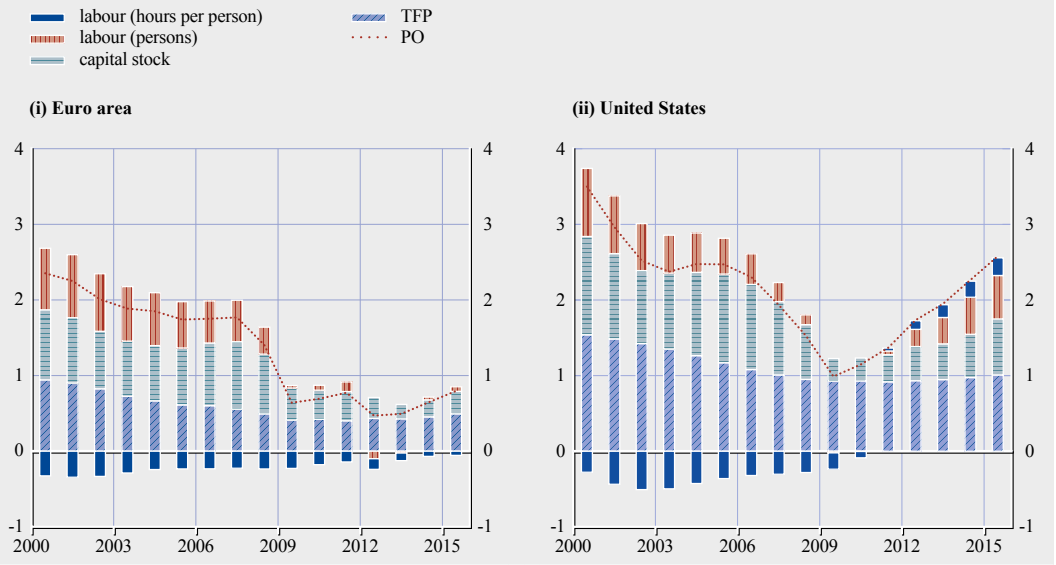
### THE PRE-CRISIS PERIOD (2007 AND BEFORE)

Potential output developments were to some extent similar in the euro area and in the United States in the pre-crisis period, notably as regards the deceleration, although the growth rate remained consistently lower in the euro area (averaging 2.0% in 2000-07) than for the United States (2.5% in the same period). In terms of the contributions, the TFP contribution had been declining pre-crisis faster in the euro area than in the United States, as documented e.g. by van Ark et al. (2008). At the same time, the average labour contribution over the period was higher for the euro area than for the United States. To some extent, this has been linked to a catching-up labour growth following the decline in hours worked per person in the previous period (1973-95), when structural factors in the euro area, e.g. high payroll taxes, the expanding welfare state and growing unionisation, had led to a decrease in employment, as well as an increase in structural unemployment (in particular among young and elderly workers). These developments had caused a decrease in the labour input contribution and intensifying substitution of capital for labour (van Ark et al., 2008).

Compared to the United States, the euro area is characterised by larger labour market rigidities and stronger regulation. During the crisis, these not only caused slower and weaker labour market adjustment to the initial shocks, but also contributed to the less favourable ULC developments in

**Chart 22 Potential output growth and contributions**

(annual percentage changes; contributions in percentage points)




Sources: European Commission estimates (CIRCABC) and ECB calculations.
Note: The labour contribution is the sum of the contributions from labour (persons) and labour (hours per person).

35 In order to minimise the impact of different methodologies, this section makes use of a single source (the European Commission, with series derived using a uniform methodology).

the euro area when compared with the United States (see ECB, 2013). This in turn slowed down adjustment, restructuring and sectoral reallocation, and may have been one of the factors behind the more favourable developments in output (and potential output) in the United States since 2010. Although they will take time to show, the effects of the reforms triggered by the crisis in the euro area will ultimately be reflected in more favourable developments there.

### THE PERIOD SINCE THE ONSET OF THE CRISIS (2008 AND LATER)

As can be seen in Chart 22, developments in the crisis period were broadly similar in the euro area and the United States, in particular regarding the slowdown in potential output growth, attributed mainly to the decline in non-TFP contributions (labour, notably number of persons, and capital) while the TFP contribution decreased only marginally during the crisis, having started to decline already in the pre-crisis period.

However, while potential output growth in the euro area remained weak in 2011-12, in the same period it started to recover in the United States. Regarding the developments in real output, after the initial strong decline in in 2008-09, real output recovered somewhat in both economies in 2010-11, but cycles diverged after mid-2011, as US growth remained relatively resilient, while growth in the euro area slowed down again and returned to negative territory.

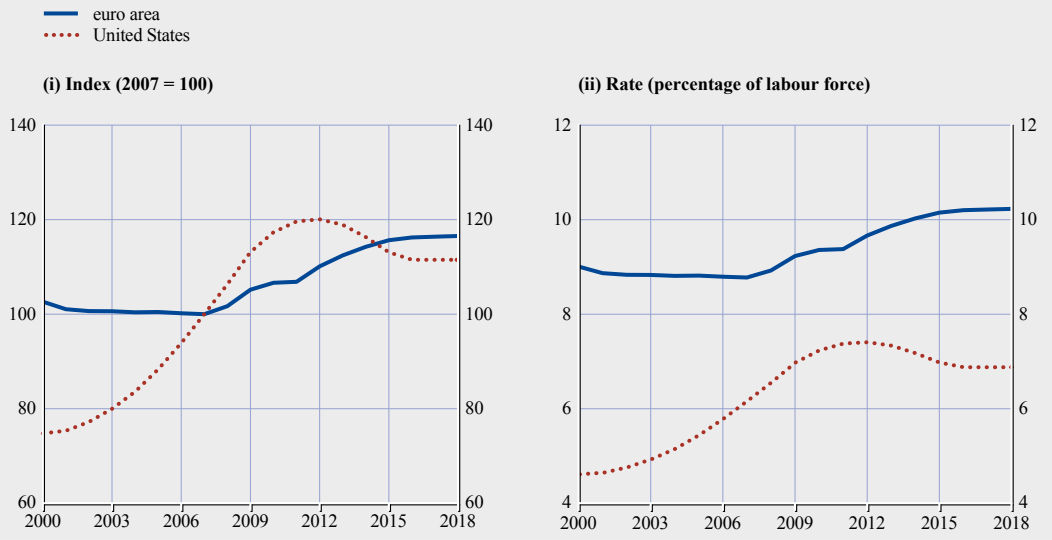
Turning to the outlook, a faster recovery in US potential output is expected: US potential output growth is projected to return to its pre-crisis average growth by 2014-15, while euro area potential output growth is expected to remain below its pre-crisis average at least until 2017.[36] The difference is explained by higher capital and TFP contributions (the latter reaching 0.5 pp for the euro area and 1.0 pp for the United States in the medium run) as well as a substantial difference in the projected labour contribution (which is expected to remain slightly negative in the euro area, while in the United States it is estimated to have already turned positive in 2013 and is projected to grow steadily and reach 1 pp by 2017).

Several factors could explain this recent divergence. First, the US economy is of a more flexible nature, allowing faster labour market adjustment (see "Developments in the NAIRU" below). Second, fiscal policy has played a larger role in supporting activity in the United States. In the euro area, the sovereign debt crisis and the associated surge in uncertainty had a direct negative impact on economic activity, e.g. via cuts in public infrastructure investment. In the United States, there was no such effect, although an indirect effect may also have been at work, as the high public debt and the uncertainty related to the debt ceiling and to events such as the closing of government also had a negative impact on economic activity. Third, while bank credit standards on mortgages and loans to non-financial corporations tightened in both economies during the crisis, developments have diverged since mid-2010, when US standards started to ease. In the euro area, the easing took place much later. One reason for this development might be the additional pressure on the euro area banking sector from the sovereign debt crisis, and the possible need to raise capital buffers.

As noted above, it is not yet clear to what extent potential output growth has been affected by the crisis and this assessment is more uncertain than in previous downturns, owing to the severity of the slowdown in activity and of the imbalances that had accumulated prior to it. The assessment will depend, among other things, on the effects of structural reforms undertaken prior to the crisis and the policy response to the crisis, in particular the effective implementation of structural reforms designed to support productivity in the medium and long term.

36 This particular assessment is based on European Commission data (CIRCABC) but this difference in outlook between the euro area and the United States can also be seen in projections by other institutions, such as the IMF.

Chart 23 NAIRU for the euro area and the United States




Sources: European Commission estimates (CIRCABC) and ECB calculations.

## DEVELOPMENTS IN THE NAIRU

The greater labour market rigidities in the euro area than in the United States are reflected in the respective NAIRUs, which are shown in Chart 23. The euro area NAIRU has remained at a much higher level than in the United States over the entire period 2000-2012 (roughly 3-5 pp higher), and has also been less responsive to cyclical developments.

Starting with the developments in the unemployment rate (not shown in the chart), it initially rose much faster and further in the United States than in the euro area, where labour hoarding practices and the preference of firms for internal flexibility mitigated the employment adjustment, causing the relationship between unemployment and GDP growth to temporarily deviate from long-term trends. Since 2010, unemployment has continued to grow in the euro area, while it has decreased markedly in the United States. There is also a very similar difference in trends between the two economies with regard to long-term unemployment rates.

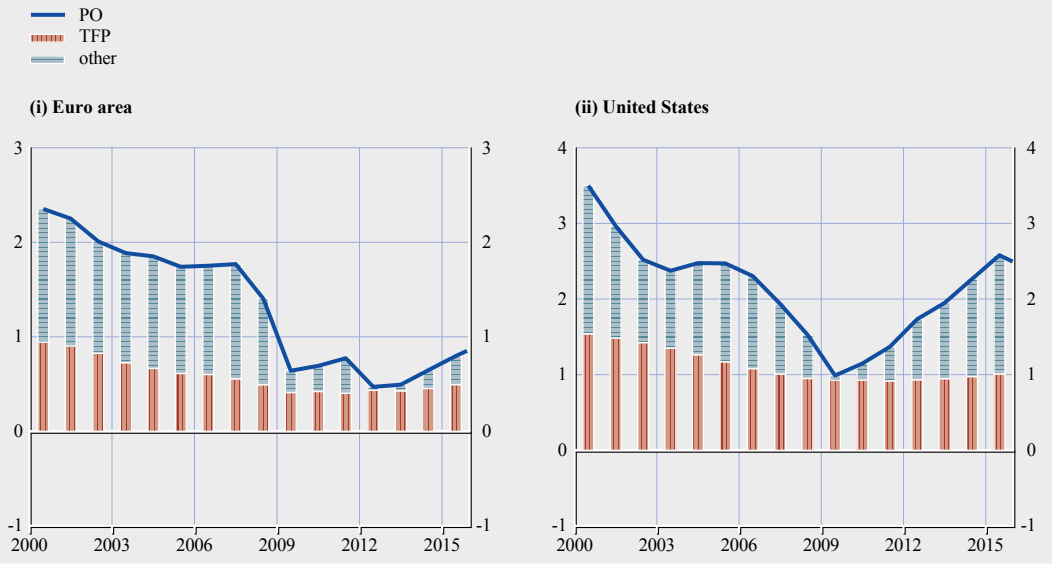
Regarding the NAIRU, from 2008 to 2012 it increased by 1 pp in the United States and by about 2 pp (according to the IMF estimates, close to 3 pp) in the euro area. It was estimated that about 2/3 of the rise in unemployment in the euro area was structural, compared with about 1/3 in the United States (see ECB, 2013). Being characterised by more inertia, the NAIRU in the euro area is also projected to continue increasing over the next few years before levelling off, while it is expected to slowly decrease in the same period in the United States.

## DEVELOPMENTS IN TFP

The remainder of this section compares developments in the TFP contribution in the euro area and the United States, highlighting the crucial role of structural reforms in accounting for the differences between the two economies (more detail on the differences in TFP dynamics between the euro area and the United States is provided in Box 6). During the recent financial crisis, the TFP contribution has followed a similar downward trend in both the euro area and the United States, but has remained consistently lower in the euro area, as shown in Chart 24. The lower TFP contribution

**Chart 24 TFP Developments in the euro area and the United States**

(annual percentage changes; contributions in percentage points)




Sources: European Commission estimates (CIRCABC) and ECB calculations.

and lower potential output growth in the euro area, as compared with the United States, are not recent phenomena, and have been observable since at least the mid-1990s.[37] The TFP contribution for the euro area averaged around 1.0% per year between 1995 and 2007, compared to around 2.0% per year for the United States.

How can this be explained? The slower development of the knowledge economy and the lower TFP in the services sector have been pinpointed as accounting for the weaker relative productivity developments in the euro area since the mid-1990s (see, for example, van Ark, 2008).[38] The slower growth of the knowledge economy is linked inter alia to the lower share of technology-producing industries in Europe. Regarding services, it has been argued that the TFP differences between the United States and Europe are driven by the sectoral TFP of a few sub-sectors (retail trade, renting of machinery and equipment, and other business services) and one manufacturing sector (electrical and optical equipment, which includes computers and telecom) (see McMorrow et al., 2010). Recent work (see ECB, 2011) also suggests that, within the services sector, the distributive (retail) trades sector in particular appears to have much higher productivity growth in the United States than in the euro area. According to that work, more than a third of the widening productivity gap in the period is attributable to the distributive trades, and IT-related factors are not the main driving force.[39]

37 The data for the largest euro area countries suggest that this is to some extent accounted for by developments in Germany (linked to the unification of that country in 1990).

38 See also Sondermann (2012) and Task Force of the Monetary Policy Committee (2006).

39 According to that work, there are the obvious "point-of-sale" innovations (such as bar codes, cash registers providing for electronic funds transfer and smart card technologies) as well as important efficiency gains in respect of "back office" functions (owing to the possibility of more careful supply chain and inventory management and the collation of more precise information about customers' purchasing patterns).

The available research on retailing in the United States suggests that the strong productivity growth seen there since the mid-1990s was led, to a great extent, by new market entrants displacing less efficient incumbent establishments owing to structural factors, such as the less restrictive regulatory environment in the United States, which has helped to boost competition.[40]

The more flexible regulatory environment in the United States includes less severe zoning restrictions (enabling more choices regarding the size and density of larger format stores), less severe restrictions on the number of stores of a certain type in a given location or cross-border expansion. Other structural factors are those in the labour market, which tends to be more flexible, and hence less costly, in the United States. Those examples include more flexible regulations governing hiring practices, working times, overtime and ancillary payments, all of which make it easier for retailers to exploit cyclical demand dynamics.

40 Macroeconomic and "cultural" factors – namely a higher marginal propensity to consume and an earlier switch to higher value goods in the United States, and the preference for smaller "local" stores in the euro area plus language barriers which hinder economies of scale – are also likely to have played a role.

**Box 7**

### EURO AREA PRODUCTIVITY GROWTH - A COMPARISON WITH THE UNITED STATES

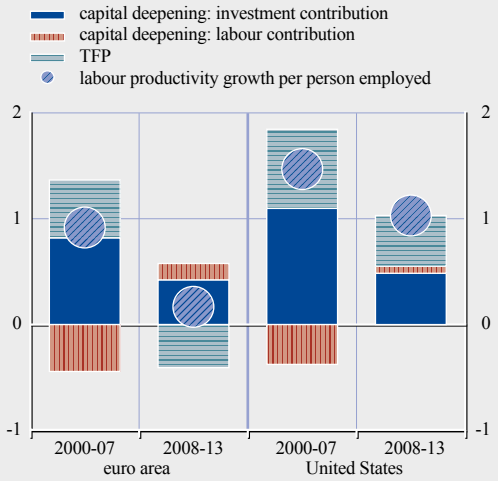
This box compares the euro area's recent productivity performance with that in the United States on the basis of observations from the European Commission's AMECO database. In contrast to the TFP estimates reported elsewhere in this paper (where productivity contributions to potential output are estimated on the basis of assumptions of fully-utilised inputs at optimal capital-labour ratios), the numbers reported in this box are derived from *observed* ("revealed") changes in output and input usage. This focus on *actual* productivity developments thus provides a useful cross-check, in that a strong divergence between actual and potential estimates may be an indication of uncertainty surrounding estimates of trend TFP growth.

Chart A illustrates the aggregate ("headline") labour productivity developments for the euro area and the United States from 2000 to 2013. The chart shows that euro area labour productivity growth (per person employed) was already lacklustre compared with that in the United States before the onset of the crisis and that it has virtually stagnated (averaging 0.1% per year) since 2008. By contrast, while US productivity growth also slowed considerably between the two periods, it has nevertheless averaged around 1.0% per year since 2008.

From a growth-accounting perspective, labour productivity growth can be decomposed into growth attributable to changes in "capital deepening" (i.e. an increase in the capital-labour ratio, combined with changes in capital and labour utilisation) and that attributable to growth in TFP. Capital deepening can be further subdivided to isolate the respective contributions from changes in the rate of investment and changes in employment levels to changes in capital labour ratios. Having accounted for changes in the factor inputs, TFP is then interpreted as representing the underlying growth in economic efficiency not attributable to changes in the factors of labour or capital, i.e. those elements of technological change, resource allocation, managerial "know-how", economies of scale and scope, etc., which affect the long-run trend of aggregate productivity growth.

**Chart A Labour productivity growth breakdown – euro area and United States**

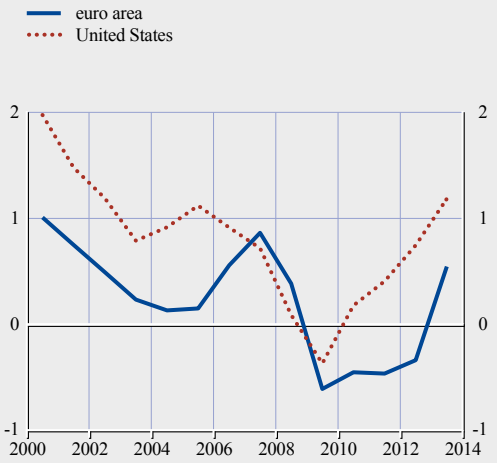
(average annual percentage changes; contributions in percentage points)




Sources: European Commission (AMECO) and ECB calculations.
Notes: The sum of the shaded portions of the bars denotes the contribution to aggregate labour productivity growth from changes in capital deepening, which can be further decomposed into the contributions arising from changes in capital spending (net investment in capital per person employed, multiplied by capital's share of total factor costs) and changes in labour composition (growth in labour, multiplied by labour share in total factor costs). The solid portion of the bars represents the estimated contribution from growth in TFP.

**Chart B Observed TFP growth 2000-13 – euro area and United States**

(percentage changes; annual data; four-year moving average)




Sources: European Commission (AMECO) and ECB calculations.

Chart A shows that, despite virtually halving on both sides of the Atlantic since the onset of the crisis, capital deepening remained positive, as strong declines in rates of net investment were slightly offset by strong job shedding in both economies. However, TFP dynamics have followed very different paths in the two economies. In marked contrast to the mostly positive TFP growth observed in the United States since the onset of the crisis, euro area TFP growth has been negative. As a result, favourable developments from factor inputs were more than offset by revealed TFP developments, leaving headline euro area productivity growth broadly stagnant. The more downbeat picture of TFP developments from this perspective (relative to the contribution of trend TFP examined in the main text) can be largely attributed to differences between trend and observed TFP developments over the course of the crisis, and also underlines the large uncertainty surrounding trend TFP estimates at this juncture.

Focusing on TFP dynamics since the height of the crisis, Chart B suggests signs of a re-emergence of the TFP gap seen in advance of the crisis between the euro area and United States. Although both economies suffered sharp TFP contractions at the height of the global recession, US TFP appears to have rebounded significantly more rapidly and to a stronger extent than euro area TFP.

### Causes and policy implications of the recent slowdown in euro area TFP growth

Several possible factors are likely to explain the continued weakness of euro area TFP performance when compared with the United States. Low levels of capacity utilisation as a result of weak or contracting economic activity have tended to persist rather longer, and to a larger extent, in many euro area economies than in the United States and have undoubtedly affected the efficiency of capital and labour usage, thereby depressing TFP growth. As economic growth returns, measured TFP growth is therefore likely to rebound somewhat in the euro area (and to perhaps slow somewhat in the United States, reflecting outstanding differences in current levels of capacity utilisation).

While both economies are likely to have experienced considerable destruction of firm- and sector-specific human capital in permanently-downsized sectors and enterprises, typically stronger labour and product market regulation in many euro area countries is likely to have slowed both firm-level adjustments and broader sectoral reallocations to a greater extent than in the United States, effectively delaying the rebound in TFP and weakening potential rates of TFP growth. Ongoing financial market frictions, which constrain working capital, affect firms' investment decisions and ultimately limit innovative activity (by curtailing R&D, reducing investment in innovative technologies, and limiting funds available to new, and potentially innovative, firms), are also likely to have been stronger in the euro area than in the United States, leading to a postponement of investments and restructuring.

Since the crisis, actual TFP growth for the euro area has remained weak, which is possibly an indication that there are downside risks to current estimates of trend TFP growth in the medium term. Efforts to support a rebound in euro area TFP growth will require measures to enhance the knowledge-based economy and foster innovation, so as to strengthen competitiveness. These objectives would be supported by further far-reaching structural reforms in product, labour and financial markets in order to encourage investment and innovation, accelerate sectoral and firm-level restructuring and enable adequate incentives for human capital investment.

## 6 NEW MULTI-COUNTRY MODEL BASED ANALYSIS

To complement the previous sections, this section provides an analysis of potential output growth based on the New Multi-Country Model (NMCM)[41] which was developed at the ECB for use, inter alia, in the context of the Eurosystem and ECB macroeconomic projection exercises. As emphasised in the discussion of methodology in Section 2, and in contrast to most of the models behind the estimates in the previous sections, the NMCM potential output is derived from an estimated CES production function, which allows for non-unit elasticity of substitution and non-constant augmenting technical progress (see Box 8).

The production technology of the NMCM production function also defines the marginal products of labour and capital and the normal level of production – the output corresponding to the use of inputs at their normal (optimal) intensities – which is a concept closely related to the concept of potential output. The marginal products and the normal level of output are the central determinants of estimated factor demand equations and the New-Keynesian Phillips curves estimated for price and wage inflation.

The advantage of using this macroeconomic model is that it provides a consistent approach across countries and also takes into account the endogeneity of the macro outlook with respect to potential output and vice-versa. It also means that scenario analysis can be undertaken, and some implications of alternative assumptions are explored later in this section.

### 6.1 POTENTIAL GROWTH ESTIMATES

The NMCM-based potential output growth estimates for the euro area and the five largest euro area economies are shown in Chart 25. For the euro area, they suggest a gradual decline in potential output growth since the start of 2007, and are broadly comparable to the estimates by the international institutions in Section 3.2. According to the NMCM, the slowdown in potential growth was due mostly to weak trend labour (from a smaller labour force) and a lower capital stock contribution as investment decreased. Euro area potential growth stabilised from 2010 onwards at around 0.6%.

As regards the largest euro area economies (Chart 25), the estimates suggest that, despite a broadly similar pattern overall, the financial crisis affected those countries to different extents. At the onset of the crisis, the slowdown was more marked in Spain. In 2012, Germany saw a recovery in potential output growth, notably on account of larger labour contributions[42], and was therefore much closer to the estimated pre-crisis growth rates than others (notably Spain).

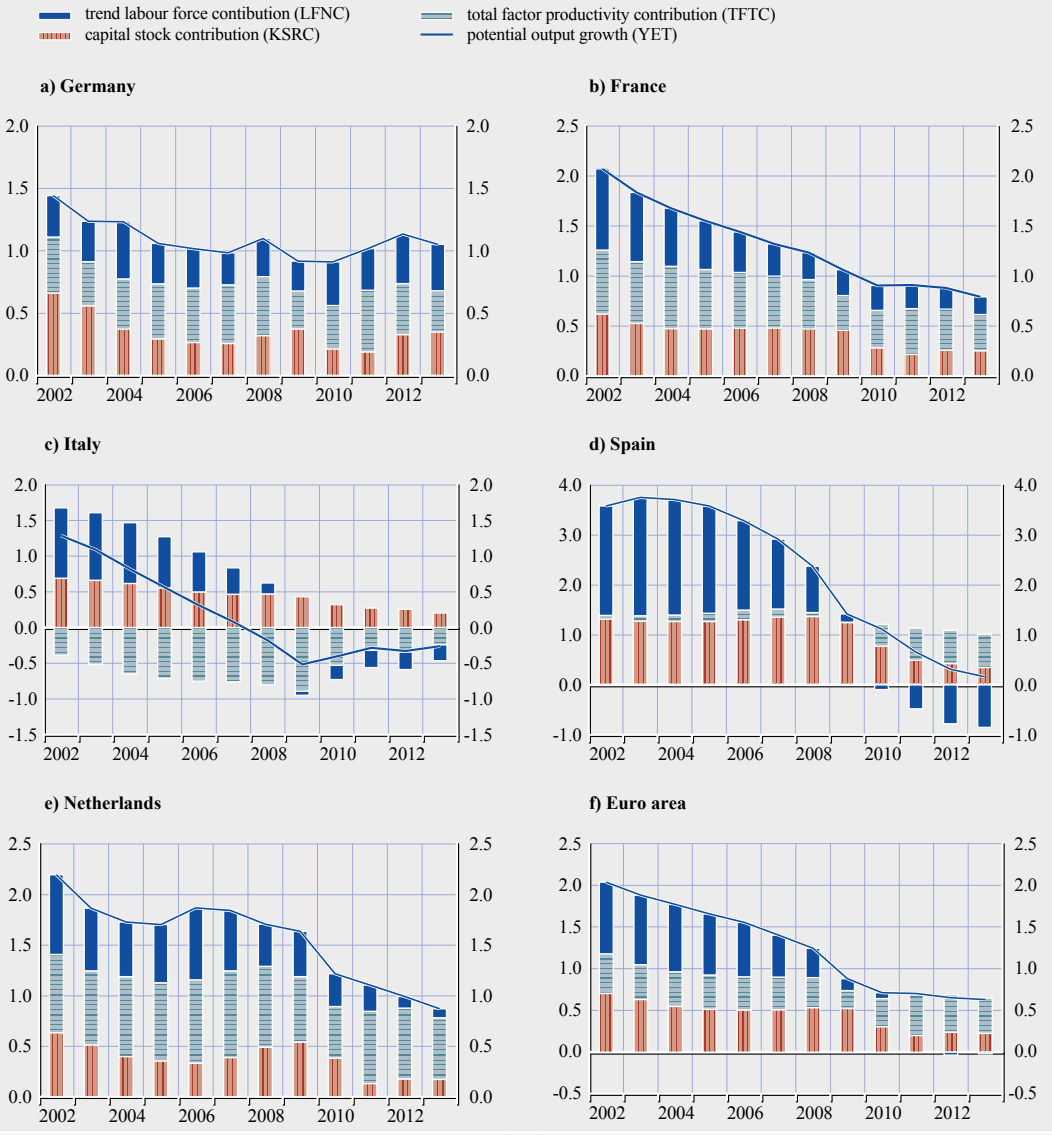
This may be an indication that the structural features of these economies have allowed them to benefit to a different extent from the pick-up in economic activity. In the case of Spain in particular, the recovery in potential output has yet to occur. This is due to a reversal of the high immigration prior to 2007, which persisted through to 2013 and is expected to continue in the coming years, and to higher structural unemployment. Net immigration also has had a negative effect on the smaller countries, leading to a significant slowing of their estimated potential output growth from 2009 onwards.

41 The NMCM is comprised of six country blocks: one for each of the five biggest euro area countries (Germany, France, Italy, Spain and the Netherlands) and an additional block comprising the remaining (smaller) euro area countries. Euro area figures are obtained by aggregating the results obtained from the six blocks. See Dieppe et al. (2012, 2013) for the full specification.

42 Given the CES production function, this reflects reallocation of production factor shares between capital and labour.

**Chart 25 Euro area and euro area countries – model-based estimates of potential output growth and its components**

(annual percentage changes; contributions in percentage points)




Source: ECB calculations.

Looking ahead, as the euro area begins to emerge from the crisis, potential output growth could be higher than the estimates for 2013, owing to stronger investment boosting the capital contribution and stronger TFP developments (e.g. from higher investment in R&D as well as sectoral reallocations away from less productive sectors to more productive sectors, particularly in Spain). However, over the longer-term, demographic factors, notably the ageing of the population, are going to exert a strong negative effect on the labour force and, hence, reduce potential output growth.

Box 8

## THE MCM PRODUCTION FUNCTION

As discussed in Box 2, there are several ways of implementing the production function approach. In the case of the NMCM, the production function is an estimated "normalised" CES production function, allowing for time-varying factor-augmenting technical progress in accordance with the approach of Klump et al. (2007), and forms part of a five-equation supply side system.

The conventional assumption in macro modelling, that the short run fluctuates around the balanced growth path, is contradicted by the data. For instance, the GDP-shares of capital, labour and total factor income as well as the capital-output ratio have exhibited persistent trends over time suggesting that they may be non-stationary.

Furthermore, there are cross-equation restrictions that need to be taken into account. For this reason, the approach taken in the NMCM allows for non-unitary elasticity of substitution, non-constant augmenting technical progress and the consideration of heterogeneous sectors with differentiated price and income elasticities of demand across sectors.

More formally, the normalised production function is as follows

$$Y_t^* = \left\{ \bar{\pi} \left[ \Gamma_K(t,\bar{t}) \mathrm{K}_t \right]^{\frac{\sigma-1}{\sigma}} + (1-\bar{\pi}) \left[ \Gamma_N(t,\bar{t}) N_t^* \right]^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}} \quad (1)$$

and the expression for the output gap is

$$Gap_t = \log\left(\frac{Y_t}{Y_t^*}\right) \quad (2)$$

where $Y^*_t$ is potential output, $Y_t$ is actual output, $Gap_t$ is the output gap, $K_t$ is the capital stock (indexed by the sample average), $N_t^*$ is trend employment, $\sigma$ is the elasticity of substitution between capital and labour, $\bar{t}$ is time (sample average), $\bar{\pi}$ is the capital income share, evaluated at the normalisation point (sample average) and $\Gamma_i$ defines the (indexed) level of technical progress associated to factor $i$. Trend employment $N_t^*$ is determined by the exogeneously given natural unemployment rate (NAIRU) and the labour force, i.e. $N_t^* = (1 - NAIRU_t) * Labour\ Force$.

An agnostic approach is used to model technical progress, drawing on a flexible functional form (Box and Cox, 1964)[1]:

$$\log\left[\Gamma_i(t,\bar{t},\gamma_i,\lambda_i)\right] = \frac{Y_t \bar{t}}{\lambda_i}\left[\left(\frac{t}{\bar{t}}\right)^{\lambda_i} - 1\right]$$

where $i = N, K$. The log level of technical progress, $\Gamma_i(.)$ is, thus, a function of time, $t$ (around its normalization point), a curvature parameter, $\lambda_i$, and has a growth rate of $\gamma_i$ at the representative point of normalisation.[2] When $\lambda_i$=1 (=0)[<0], technical progress displays linear (log-linear) [hyperbolic] dynamics.

1 Box and Cox (1964).
2 Note that the Box-Cox specification has been scaled by t0 to interpret $\gamma_N$ and $\gamma_K$ as the rates of labour-augmenting and capital-augmenting technical change at the fixed (i.e., representative) point.

**NMCM estimates of elasticity of substitution and average labour share**

| | France | Germany | Italy | Spain | Netherlands | Rest of euro area |
|---|---|---|---|---|---|---|
| Elasticity of substitution | 0.532 | 0.614 | 0.609 | 0.55 | 0.575 | 0.516 |
| (standard errors) | -0.0005 | -0.0006 | -0.0004 | -0.0036 | -0.008 | -0.01 |
| Average labour share of total factor income | 0.68 | 0.69 | 0.6 | 0.62 | 0.67 | 0.72 |
| Start of estimation sample | 81q2 | 84q1 | 87q1 | 83q1 | 81q1 | 93q1 |

Source: ECB Calculations.

Technical progress, although estimated in the data utilising a quite flexible functional specification, is primarily determined by exogenous processes. Hence, we see that in (1) the only fully endogenous determinant of potential output is the capital stock, the accumulation of which (net investment) is conditional on the underlying projected macroeconomic developments.

It is noted that in the output gap definition (2) both the numerator (projected potential output) and the denominator (projected actual output) are interrelated via projected investment developments and are conditional on, inter alia, the monetary policy stance.

Estimates of the key technology parameter, the elasticity of substitution between capital and labour, as well as the average labour share of total factor income are presented in the table for the five largest countries and the smaller country aggregate. The average labour share gives a good first order approximation of the time-varying weights used to compute TFP.

## 6.2 POTENTIAL GROWTH SCENARIOS

The potential output estimates are conditional on a number of important underlying assumptions. In the remainder of this section, four scenarios are considered that increase potential output going forward and the effects on employment, and the output gap are analysed.

Two of the scenarios are related directly to productivity. The first scenario is one of higher capital-augmenting productivity ("KAUG" in Chart 26), i.e. an increase in efficiency in the economy, e.g. via increased restructuring of industries and from more investment in R&D and accumulation or diffusion of technology. The second scenario is one of higher labour-augmenting productivity ("LAUG" in Chart 26). This could reflect an increase in human capital via education (or a lower depreciation of human capital), or could reflect the possibility that the crisis resulted in shedding of mostly low-skilled labour, resulting in a higher share of high-skilled employment.

The third scenario consists of a lower capital depreciation rate ("DEP" in Chart 26) as a result of less scrapping or a slowing rate of obsolescence of capital vintages due to better allocation of capital. This scenario implies lower levels of investment and, consequently, higher profits. The fourth scenario is one of higher labour force growth ("LFN" in Chart 26), e.g. as a result of reforms and/or reduced frictions in the labour market which encourage more labour market participation, longer working hours or increased migratory flows.

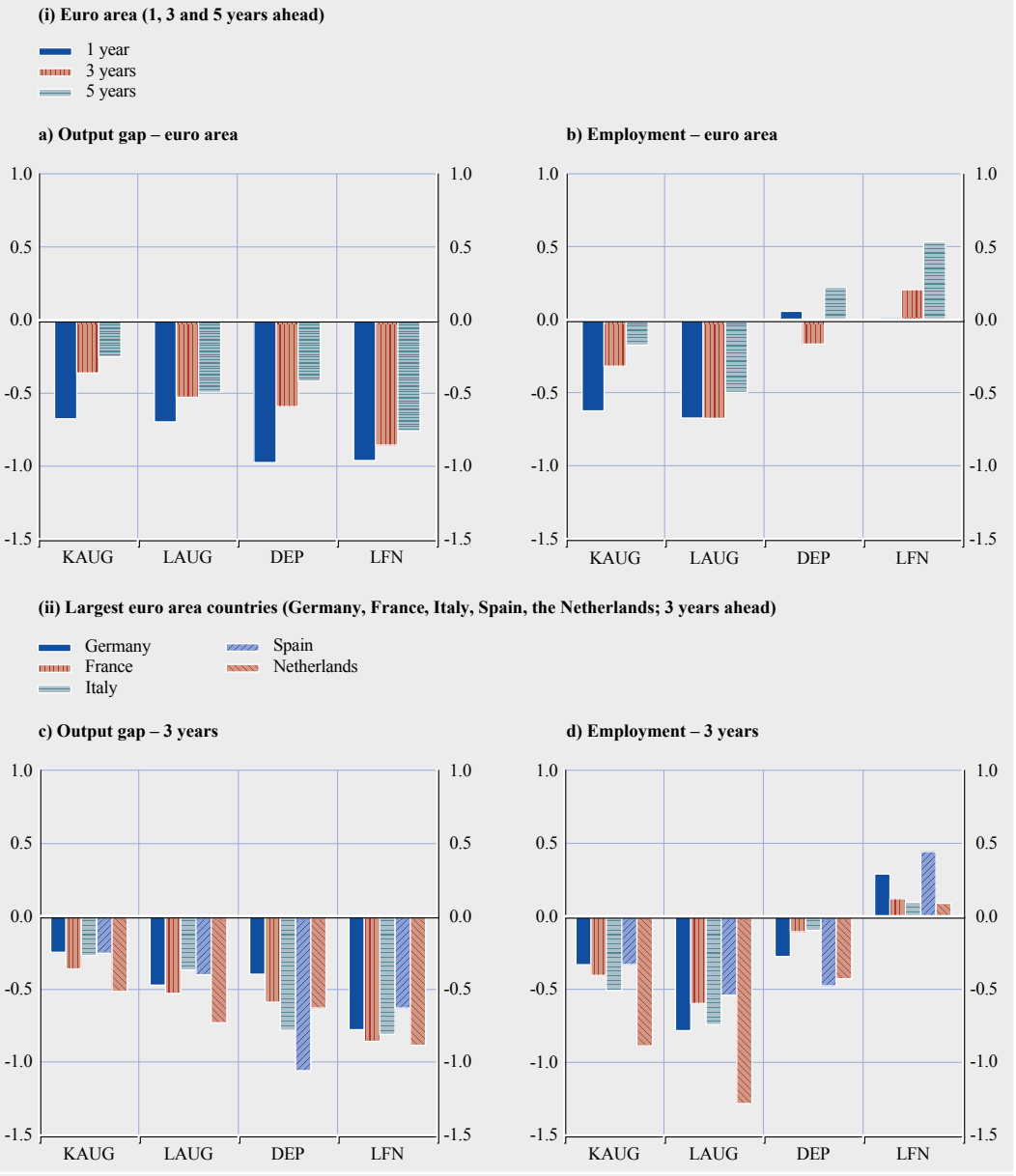
In order to make the shock comparable across the four scenarios, the shock to the four variables is calibrated such that ex post the level of potential output is immediately and permanently 1% higher. The size of the shock necessary to increase potential output depends on the elasticity of substitution

and average labour share and therefore varies from country to country. In the case of the labour force, it amounts to an increase of between 1.2 and 1.5%. For the depreciation rate the first year effects are lower at between 0.2 and 1 pp.

Chart 26 (panel (i)) shows the impact on the output gap and employment in the four illustrative scenarios for the euro area. As can be seen from the chart, there are significant differences across the scenarios regarding the impact on GDP growth, and hence on the output gap.

**Chart 26 Output gap and employment response to a 1% increase in potential output**

(percentage deviation from the baseline)




Source: ECB calculations.

In the case of the technology shocks ("KAUG" and "LAUG") there is a direct pass-through to growth, so in the first year the output gap is less than 1%. However, this effect on growth is less than potential output, reflecting negative short-run labour demand responses to both shocks – i.e. the positive supply effects on GDP are partially crowded out. These effects gradually dissipate, so the output gap slowly closes. The labour-augmenting shock tends to result in larger negative employment and output effects than the capital-augmenting shock and, hence, it takes longer for the output gap to close.

The first year effect on growth is lower for the capital depreciation ("DEP") and labour force ("LFN") shocks. In both of these shocks, employment is initially only marginally affected, and after five years is boosted by stronger demand effects (although, in the case of the labour force scenario, the unemployment rate is up). The low pass-through primarily reflects rigidities in the economy, as in the case of higher labour force, for example, it takes time for higher unemployment to lead to lower wages and hence for it to become advantageous for firms to hire.[43]

The results for the largest euro area economies (see Chart 26, panel (ii)) are broadly similar, with the technology shocks having negative employment effects, and smaller impacts on the output gap. There are some differences across countries though, with the employment and output gap effects after 3 years particularly pronounced in the case of the Netherlands, and less pronounced for the other countries.

43 It should be noted that these simulations have not been conducted under a common endogenous monetary policy rule (which explains the somewhat counterintuitive investment responses to the changes in labour force assumptions).

## 7 CONCLUSIONS

This paper has reviewed potential output developments from a euro area perspective by summarising the developments according to international institutions and assessing the impact of the crisis and by presenting an analysis of potential output based on the ECB's New Multi-Country Model (NMCM).

It indicates that, while TFP has been affected as well, the negative impact on potential output has been concentrated on the capital and labour components, which is accounted for by lower investment rates, demographics and higher structural unemployment. While these factors are likely to be temporary, they may become more permanent unless further structural reforms are implemented to prevent them from becoming entrenched and affecting potential output growth also in the medium to long term.

The outlook for euro area potential growth therefore crucially hinges on further substantial progress being made in terms of structural reforms designed to achieve higher rates of potential output growth in the medium and longer term. In order to boost significantly the rate of sustainable growth in the euro area, the positive impact of such reforms also has to considerably outweigh the negative impact of population ageing on future potential growth.

Some of the recent developments and the challenges ahead are illustrated by the New Multi-Country Model (NMCM) developed at the ECB. The results suggest that shocks raising the efficiency of the economy (either via increased restructuring of industries, more investment in R&D and accumulation or diffusion of technology, or via human capital) may lead to negative short-run labour demand responses, which partially reflect crowding out of supply effects, and so may not feed through fully to actual output.

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## APPENDIX I – IMBALANCES AND POTENTIAL OUTPUT

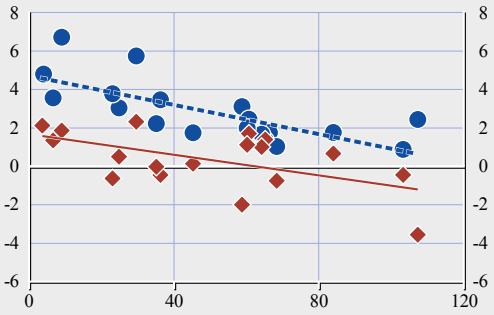
The deleveraging of previously accumulated high debt levels of households, corporations and the public sector is thought to have weighed on economic growth in the past years. Data show that potential growth is indeed slower in countries with higher general government debt and this is true for both the pre-crisis and the crisis period. The slope of the trend-line does not change between the two periods, which suggest that the slowdown in potential growth during the crisis might not be the consequence of pre-crisis public indebtedness (left hand panel of Chart A2). At the same time, the middle panel of Chart A2 suggests that pre-crisis public indebtedness affected the cyclical position of the euro area economies: countries with higher public debt in 2007 faced a deeper recession. The level of pre-crisis private indebtedness seems to have less effect on potential growth, and private indebtedness also seems to have no influence on the cyclical position of the euro area economies (Chart A2). There seems to be a weak positive relationship between the pre-crisis (i.e. between 1999 and 2007) change in nominal unit labour cost (ULC) and potential growth prior the crisis. However, this appears to have changed, and countries that experienced strong ULC growth prior the crisis do not now appear to have higher potential growth (left panel of Chart A3). According to the right panel of Chart A3, ULC is also weakly positively related to actual growth. This relationship seems to have weakened further, and the recent change in potential growth seems to be independent of the pre-crisis ULC growth.

Countries with larger financial sectors prior the crisis experienced slightly slower potential growth at that time, while post-crisis it is not clear for potential and actual growth, and the reverse for the slack (Chart A4).

**Chart A1 General government debt vs growth and slack**

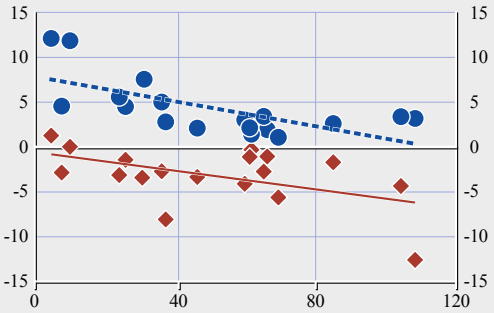
**a) vs potential growth**

x-axis: general government debt (percentage of GDP; 2007)
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



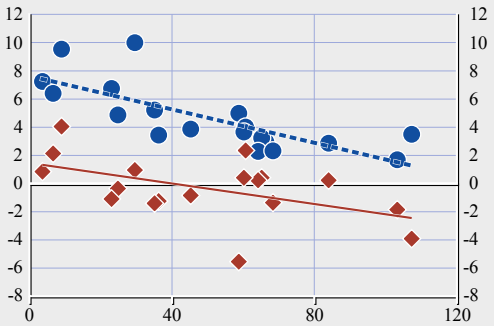

**b) vs output gap**

x-axis: general government debt (percentage of GDP; 2007)
y-axis: output gap, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: general government debt (percentage of GDP; 2007)
y-axis: actual growth, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)

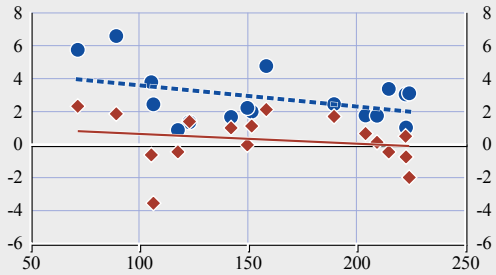



Sources: European Commission and ECB calculations.

**Chart A2 Private sector indebtedness vs growth and slack**

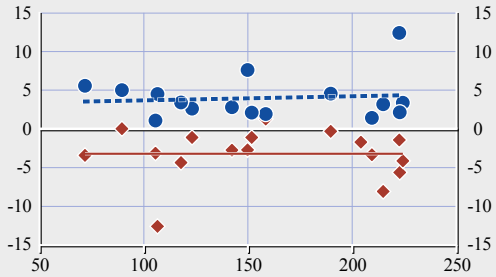
**a) vs potential growth**

x-axis: private sector debt (percentage of GDP; 2007)
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



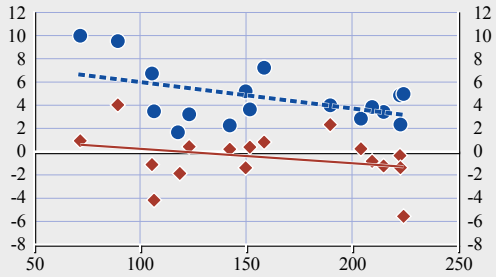

**b) vs output gap**

x-axis: private sector debt (percentage of GDP; 2007)
y-axis: output gap, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: private sector debt (percentage of GDP; 2007)
y-axis: actual growth, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)

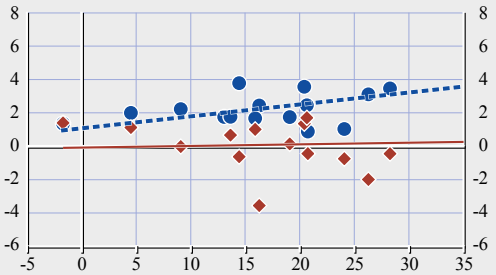



Sources: European Commission (AMECO) and ECB calculations.

**Chart A3 ULC developments vs growth and slack**

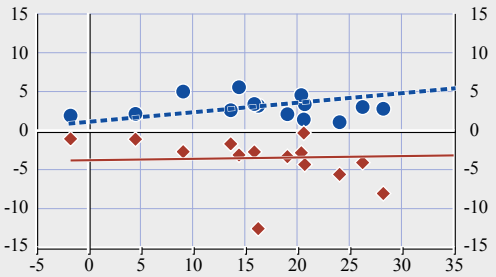
**a) vs potential growth**

x-axis: change in ULC (percentage, 1999-2007)
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



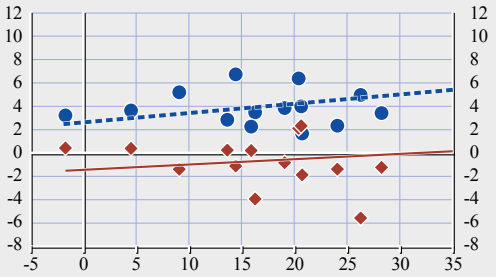

**b) vs output gap**

x-axis: change in ULC (percentage, 1999-2007)
y-axis: output gap, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: change in ULC (percentage, 1999-2007)
y-axis: actual growth, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



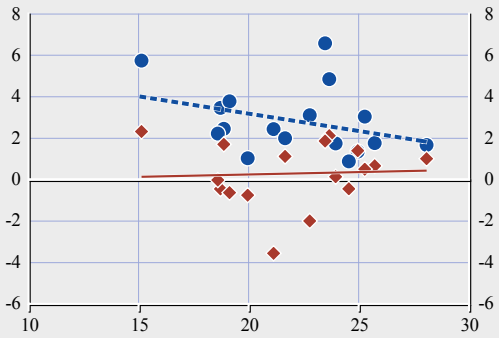

Sources: European Commission (AMECO) and ECB calculations.
Notes: Excludes outliers (EE and SK).

Data on employment protection legislation show that countries with less stringent regulations already had higher potential growth than countries with restrictive regulation. This relationship appears to be even stronger since the crisis; i.e. countries with more rigid labour markets suffered a larger loss in potential growth. Countries with more flexible labour markets have also experienced less slack in recent years (Chart A5).

## Chart A4 Share of financial sector vs growth and slack

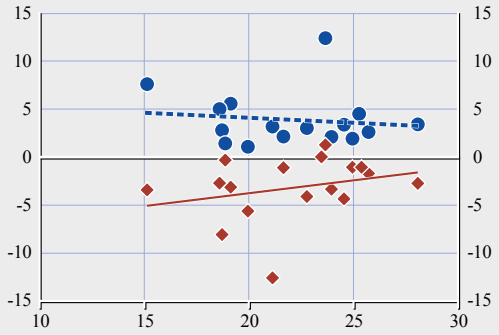
**a) vs potential growth**

x-axis: share of the financial sector (percentage of GDP)
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



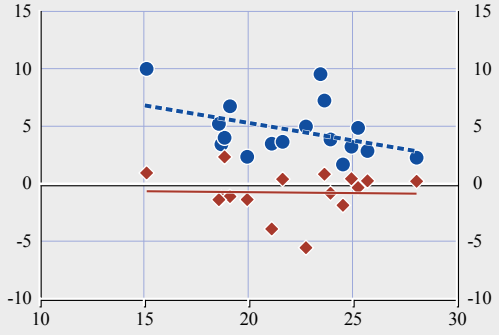

**b) vs output gap**

x-axis: share of the financial sector (percentage of GDP)
y-axis: output gap, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: share of the financial sector (percentage of GDP)
y-axis: actual growth, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)

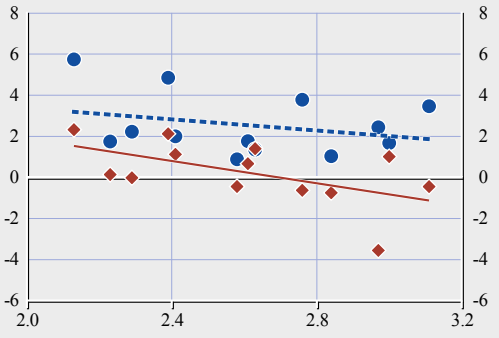



Sources: European Commission (AMECO) and ECB calculations.
Note: Excludes outliers (LU).

## Chart A5 Employment protection legislation (EPL) vs growth and slack

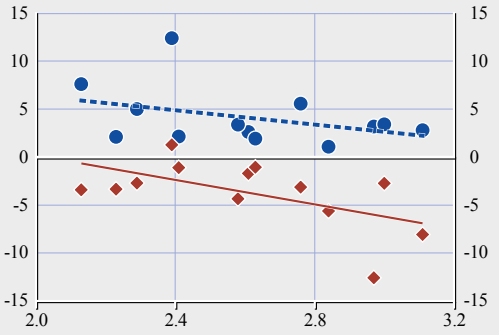
**a) vs potential growth**

x-axis: OECD EPL index, 2008
y-axis: potential growth 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)



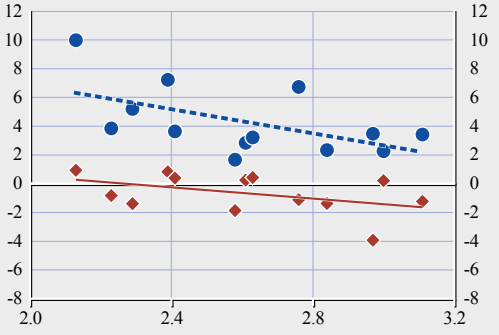

**b) vs output gap**

x-axis: OECD EPL index, 2008
y-axis: output gap, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




**c) vs actual growth**

x-axis: OECD EPL index, 2008
y-axis: actual growth, 2007 (percentage; dots and broken line) and 2013 (percentage; diamonds and solid line)




Sources: OECD and ECB calculations.