THE PHILLIPS CURVE RELATIONSHIP IN THE EURO AREA

The Phillips curve, which is broadly understood as the relationship between inflation and economic slack, is a standard framework for explaining and forecasting developments in inflation. At the same time, the framework is surrounded by considerable uncertainty, both conceptually and empirically. In particular, there is no single concept of the Phillips curve. Instead, there are various – similarly plausible – specifications, for example using different measures of economic slack and inflation, different assumptions on the role and form of expectations, different variables accounting for supply-side factors, or different econometric designs. This article reviews the Phillips curve relationship between inflation and economic slack in the period since 1999 for the euro area as a whole and for the individual euro area countries. The cross-country aspect is relevant, as the countries display substantial heterogeneity in economic structure and institutional landscape. The article highlights the uncertainty surrounding the Phillips curve relationship, notably regarding the choice of relevant measure of economic slack, instabilities in the relationship over time and its limitations in forecasting inflation. Taking into account different versions of the Phillips curve can to some extent serve as a hedge against such uncertainties. The Phillips curve can be considered a useful tool for cross-checking inflation developments with those in output and demand. However, given the complexity of the inflation process, it is an insufficient basis for forecasting inflation and for policy guidance. The Phillips curve should hence only be considered as one element in a broader-based analysis.

1 INTRODUCTION

In the period since 2008 the fallout from the financial and sovereign debt crises has left its mark in the form of a protracted period of depressed economic activity and high unemployment. Available estimates of potential output and structural unemployment imply persistently negative output gaps and positive unemployment gaps. Economic theory and historical regularities suggest that such protracted underutilisation of capacity should lead to lower inflation.

The Phillips curve – broadly understood – links price or wage growth to a measure of economic slack, such as the output or unemployment gap, and provides a conceptual framework for analysing and forecasting inflation developments. Many macroeconomic models used for policy advice explicitly or implicitly embed this relationship. However, the use of Phillips curve relationships in actual practice needs to be guided by various considerations. For instance, one such consideration concerns the uncertainties surrounding empirical estimates of economic slack. Another is that the rate at which prices change can reflect many more influences than the supply and demand imbalances in labour and goods markets approximated by measures of economic slack. For example, the fact that consumer price inflation in the euro area did not decline more strongly with the wide output gaps in recent years partly reflected the increases in indirect taxes and administered prices implemented in several euro area countries as part of fiscal consolidation efforts. Similarly, import price developments – most notably for energy products – have had alternating upward and downward impacts on euro area inflation in recent years. Such factors influence inflation beyond the degree of domestic economic slack prevailing at the time.

In addition, the strength in the relationship between inflation and economic slack can depend on the state of the economy and may change over time. For instance, structural economic reforms in labour and product markets aimed at relaxing price and wage rigidities may change the response of inflation to economic slack. Furthermore, if prices are downwardly rigid, the relationship becomes non-linear: especially in protracted periods of economic slack, inflation would not decline or would decline only slightly, while it would increase significantly as soon as production capacities were fully employed. Accordingly, inflation developments cannot be linked one-to-one to estimates of economic slack.

This article reviews the relationship between inflation and economic slack (henceforth referred to as the Phillips curve) for the euro area since 1999. As a Phillips curve at the euro area aggregate level may conceal substantial differences across euro area countries, the analysis also assesses the Phillips curve relationship at the country level.

The article is structured as follows: Section 2 reviews the concept of the Phillips curve in order to elicit the different sources of uncertainty that can arise in its empirical application. Section 3 looks at Phillips curve relationships in the euro area as a whole and individual euro area countries in the period 1999-2013, examining differences in the link with alternative measures of economic slack and cross-country differences. Section 4 discusses possible changes in the relationship following the financial and sovereign debt crises. Section 5 reviews additional factors that can affect the Phillips curve relationship, and Section 6 concludes with some general considerations on the use of this relationship for policy analysis.

2 THE PHILLIPS CURVE CONCEPT

The Phillips curve was introduced in the seminal work by A. W. Phillips in 1958, which observed a negative relationship between unemployment and the rate of change in nominal wage rates in the United Kingdom.[1] This observation led some to believe that there was an exploitable trade-off between inflation and employment in an economy, and that monetary policy could permanently lower unemployment at the cost of higher inflation. However, subsequent contributions pointed out that inflation expectations play an important role and that monetary policy cannot permanently affect unemployment, which instead converges in the long run to its natural level, determined by the structural features of the economy.[2] Nevertheless, on account of rigidities in consumer prices or wages, deviations in unemployment from its natural level or, more generally, economic slack could have an impact on inflation in the short term.

Empirical applications of the Phillips curve often link inflation to a measure of economic slack, proxied by estimates of the unemployment or output gaps, but also to past inflation developments as a broad proxy for inflation inertia. In addition, supply-side factors, such as the developments in oil prices (or, more generally, import prices) or in trend productivity, have been incorporated.[3] This "triangular" framework has enjoyed considerable popularity as a way of explaining past inflation dynamics and for forecasting.

Various versions of the Phillips curve have been proposed that incorporate different measures of economic slack, allowing a more explicit role for inflation expectations (for example, by including inflation expectations from survey data as explanatory variables) or, more recently, positing a role for global developments beyond those embodied in commodity prices. Economists continue to disagree on the precise representation of the Phillips curve or its empirical validity. In particular, it has been argued that the contribution of economic slack to explaining inflation developments has

1 Phillips, A.W., "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957", *Economica*, Vol. 25(100), pp. 283-299.

2 Friedman, M., "The role of monetary policy", *The American Economic Review*, Vol. LVIII, 1968; Phelps, E.S., "Phillips Curves, Expectations of Inflation and Optimal Unemployment Over Time", *Economica*, Vol. 34(135), 1967, pp. 254-281; Lucas R.E. Jr., "Expectations and the neutrality of money", *Journal of Economic Theory*", Vol. 4(2), 1972, pp. 103-124. For an extensive review of how the concept has evolved over time, see, for example, Gordon, R., "The History of the Phillips Curve: Consensus and Bifurcation", *Economica*, Vol. 78, 2011, pp. 10-50 or the first chapter in Fuhrer, J., Sneddon Little, J., Kodrzycki, Y. and Olivei, P. (ed.) "*Understanding Inflation and the Implications for Monetary Policy: A Phillips Curve Retrospective*", The MIT Press, 2009.

3 See the "triangle" model proposed in Gordon, R., "Inflation, flexible exchange rates, and the natural rate of unemployment," in Baily, M.N. (ed.), "*Workers, Jobs, and Inflation*", Washington, Brookings, 1982.

been low. Furthermore, it has been observed that the relationship has not been stable over time, and non-linear or time-varying features have been introduced. For example, it has been suggested that the responsiveness of inflation to changes in economic slack in advanced economies has been gradually declining in recent decades and that credible monetary policy leading to strongly anchored inflation expectations could be one of the driving factors behind this development.[4] Finally, many studies have found the Phillips curve to have rather weak forecasting accuracy.

The following sections discuss some of these aspects, with particular focus on the uncertainty related to the measurement of economic slack, the stability of the Phillips curve relationship and its forecasting performance.

3 INFLATION AND ECONOMIC SLACK IN THE EURO AREA IN THE PERIOD 1999-2013

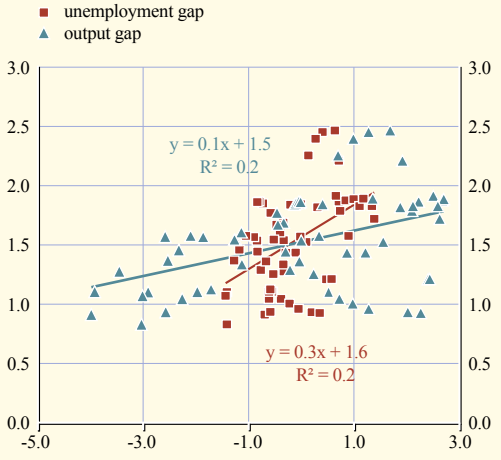
This section looks at the coefficients and fit of simple Phillips curves for the euro area as a whole and for individual euro area countries over the period 1999-2013.[5] The focus is on a linear relationship between inflation and various measures of economic slack, and the analysis abstracts from the role of inflation expectations and supply-side shocks. As a measure of inflation, the analysis uses HICP inflation excluding energy and food, as it is less affected by commodity prices and better reflects price pressures originating within the euro area.

Starting with the analysis for the aggregate euro area, Chart 1 shows a scatter plot of annual HICP inflation excluding energy and food for the period 1999-2013 against two measures of economic slack: the (reversed) unemployment gap and the output gap (both lagged by one quarter).[6] Thus, negative gaps are associated with a high degree of unutilised capacity or economic slack. The coefficients of a linear fit and the associated R^2 measure of the closeness of this fit are also displayed. The coefficients associated with the gaps, or the "slopes" of the Phillips curve, are significant and their signs are as expected – wider negative gaps are typically accompanied by lower inflation rates. According to the R^2 coefficient, the output and unemployment gap can explain around 20% variation in inflation in this simple framework. On the basis of this measure of fit, there seems to be no preference for one measure of economic slack over the other.

Chart 1 HICP inflation excluding energy and food and measures of economic slack

(annual percentage changes and percentage points)

x-axis: economic slack (lagged by one quarter)
y-axis: HICP inflation excluding energy and food



Sources: Eurostat and European Commission.
Notes: Based on quarterly data for the period 1999-2013. The unemployment gap has been used in reversed form (multiplied by -1). Gap measures have been interpolated to obtain quarterly values.

4 See, for example, "The dog that didn't bark: has inflation been muzzled or was it just sleeping?", *World Economic Outlook*, IMF, April 2013.
5 The period before 1999 was characterised by a different monetary policy regime and inflation convergence in the run-up to monetary union in many countries. Therefore, a reduced form relationship such as the Phillips curve might not be meaningful for this period.
6 The unemployment and output gap estimates used throughout the article are taken from the Winter 2014 European Economic Forecast of the European Commission. The annual data are interpolated to quarterly frequency.

These simple regressions, while illustrative, do not account for inflation persistence, which matters, for example, for the overall dynamic impact of economic slack on inflation. To take this into account, the following analysis is based on regressions that relate the annualised quarterly inflation rate to its value in the preceding quarter and to a measure of economic slack.[7]

It should be emphasised that the economic slack is an unobserved variable, and its measurement is subject to considerable uncertainty – especially in real time.[8] Typically used measures – the unemployment and output gaps – are based, respectively, on the estimates of the natural level of unemployment and potential output, which, in turn, are imputed using specific statistical or model-based tools. Therefore, the gaps are surrounded by a high degree of uncertainty and are subject to considerable revision. They also tend to differ depending on the particular methodology used.[9] For this reason, the analysis also relies on alternative proxies of economic slack, including the unemployment rate, the short-term unemployment rate, GDP growth, real unit labour cost, as well as survey measures for the manufacturing sector indicating the degree of capacity utilisation and factors limiting production related to demand and shortage of labour.[10]

Chart 2 shows the estimated cumulative one-year impact of one unit change in economic slack measures on HICP inflation excluding energy and food for different measures of economic slack.[11] For each measure, the chart shows the range of point estimates of one-year impacts obtained across the euro area countries, with the upper and lower end of the boxes indicating the upper and lower quartile of the ranges and the red mark indicating the impact coefficient for the aggregate euro area.[12] To make the results easier to read, the signs of the coefficients for the slack measures related to unemployment have been reversed and those for the survey-based measures have been rescaled to match the variability of these measures to that of the unemployment gap. Chart 3 presents the ranges of in-sample fits of the corresponding Phillips curves as measured by the R^2 coefficient.

7 That is, the regressions: $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$, where π_t denotes annualised quarterly rates of change in seasonally adjusted HICP excluding energy and food, gap_{t-1} refers to a measure of economic slack and εt is a random error. It has also been popular in empirical work to include a measure of inflation expectations as an explanatory variable. Nevertheless, inflation expectations are not available for all the euro area countries or for HICP inflation excluding energy and food. Nevertheless, long-term inflation expectations for the euro area have been stable over the period considered and are thus already captured by the constant terms in these regressions.

8 See, for example, the article entitled "Potential output, economic slack and the link to nominal developments since the start of the crisis", *Monthly Bulletin*, ECB, Frankfurt am Main, November 2013 or the box entitled "Slack in the euro area economy", *Monthly Bulletin*, ECB, April 2014.

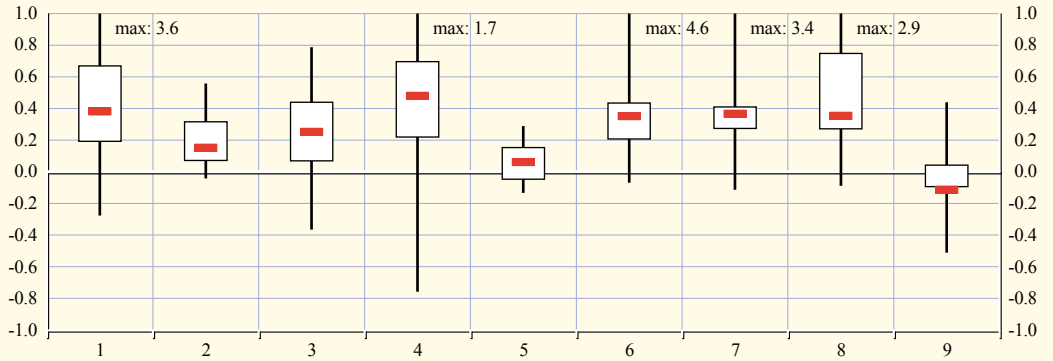
9 See, for example, Orphanides, A. and van Norden, S., "The Reliability of Inflation Forecasts Based on Output Gap Estimates in Real Time", *Journal of Money, Credit and Banking*, Blackwell Publishing, Vol. 37(3), 2005, pp. 583-601; or the box entitled "Recent evidence on the uncertainty surrounding real-time estimates of the euro area output gap", *Monthly Bulletin*, ECB, November 2011; or the article entitled "Zur Verlässlichkeit der Schätzungen internationaler Organisationen zur Produktionslücke", *Monatsbericht*, Deutsche Bundesbank, April 2014.

10 Short-term unemployment as the relevant measure of slack in the labour market has been advocated, for example, by Gordon, R., "The Phillips Curve is Alive and Well: Inflation and the NAIRU During the Slow Recovery", *NBER Working Paper*, No 19390, August 2013 or by Llaudes, R., "The Phillips curve and long-term unemployment," *Working Paper Series*, No 441, ECB, 2005. The short-term unemployment rate is defined as the difference between the total unemployment rate and the percentage of active population that is unemployed for 12 months or more. In Gali, J., Gertler, M. and Lopez-Salido, J.D., "European inflation dynamics", *European Economic Review*, Vol. 45(7), 2001, pp.1237-1270, it is advocated to use the log deviation of real unit labour costs from its mean as a measure of real marginal cost in a New Keynesian Phillips curve for the euro area. Real unit labour cost is defined as the ratio of compensation of employees to nominal GDP. For a discussion on the use of survey measures to assess economic slack, see, for example, the box entitled "A cross-check of output gap estimates for the euro area with other cyclical indicators", *Monthly Bulletin*, ECB, June 2011. While these survey measures have the advantage that revisions are very limited, they only reflect information for the manufacturing sector of the economy.

11 For a regression $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$ with quarterly data, the cumulative one-year impact is defined as $\gamma(1+\beta+\beta^2+\beta^3)$, see, for example, Borio, C.E.V. and Filardo, A., "Globalisation and Inflation: New Cross-Country Evidence on the Global Determinants of Domestic Inflation", *Working Paper Series*, BIS, No 227, 2007.

12 The lower and upper quartile refer to the upper bound of the interval containing the 25% and 75% lowest values respectively. The ranges are for the point estimates across countries and thus the statistical parameter uncertainty is not reflected in the charts.

Chart 2 Range of one-year impact coefficients for different euro area countries in a Phillips curve for HICP inflation excluding energy and food



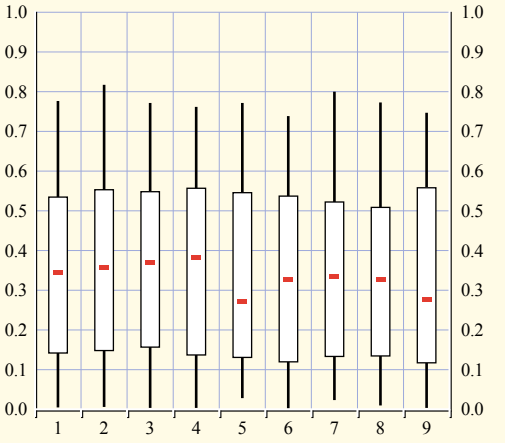
1 Unemployment gap
2 Output gap
3 Unemployment rate
4 Short-term unemployment rate
5 GDP growth
6 Capacity utilisation
7 Insufficient demand
8 Shortage of labour
9 Real unit labour cost

Sources: Eurostat, European Commission and ECB calculations.
Notes: Based on quarterly data in the period 1999-2013. Range of one-year impact coefficients, $\gamma(1+\beta+\beta^2+\beta^3)$, across countries of the euro area from a regression $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$, where π_t denotes annualised quarterly rates of change in seasonally adjusted HICP excluding energy and food. The bottom and upper end of the boxes indicate the lower and upper quartile of the ranges. Red '-' marks the coefficient for euro area. The signs of the coefficients for the slack measures related to unemployment have been reversed and those for the survey-based measures have been rescaled to match the variability of these measures to that of the unemployment gap. The short-term unemployment rate is defined as the difference between the total unemployment rate and the percentage of active population that is unemployed for 12 months or more. "GDP growth" refers to annualised quarterly rates of change. "Capacity utilisation", "Insufficient demand" and "Shortage of labour" are from the European Commission business survey for the manufacturing sector. Real unit labour cost is defined as the ratio of compensation of employees to nominal GDP and its log deviation from the mean is included in the regressions. For some countries and slack measures the estimates are based on a shorter sample due to unavailability of data.

A marked heterogeneity across countries can be observed with regard to the magnitude of the impact coefficients and to the fit of the Phillips curve. For most of the countries and most of the slack measures, with the notable exception of the real unit labour cost, the signs of the coefficients are as expected. For some countries, they are nevertheless very close to zero or even negative. For other countries, the magnitude of the coefficients is rather high. The ranges of in-sample fits (R^2) are also relatively wide and they do not favour any particular measure of slack.

From the country results underlying Charts 2 and 3, two observations stand out. First, there are differences between the countries in terms of the measure of economic slack that best fits inflation data. Second, the extent to which Phillips curves fit actual inflation developments across countries is diverse and, for some countries, a Phillips curve relationship seems to explain only a very small portion of inflation developments. These results are broadly in line with earlier analyses of the wage Phillips curve

Chart 3 Range of R^2 coefficients for different euro area countries in a Phillips curve for HICP inflation excluding energy and food



1 Unemployment gap
2 Output gap
3 Unemployment rate
4 Short-term unemployment rate
5 GDP growth
6 Capacity utilisation
7 Insufficient demand
8 Shortage of labour
9 Real unit labour cost

Sources: Eurostat, European Commission and ECB calculations.
Notes: Based on quarterly data for the period 1999-2013. Range of R^2 across countries of the euro area from a regression $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$. The bottom and upper end of the boxes indicate the lower and upper quartile of the ranges. Red '-' marks the R^2 for euro area. For definitions of the variables see the notes to Chart 2.

in the euro area and the largest five euro area countries, which found marked heterogeneities across countries in the wage responsiveness to the unemployment gap and some limited advantages to analysing wage developments at the national rather than the euro area-wide level.[13]

The observed cross-country heterogeneity in the slope and fit of the Phillips curve can be explained by a number of factors. The difference across countries in the degree of labour and product market flexibility is one potential factor. There is ample evidence on the heterogeneity of price and wage rigidities in the euro area.[14] Nominal rigidities vary substantially across countries and depend strongly on such features as the intensity of competition, the exposure to foreign markets or the institutional framework.[15]

Another source of heterogeneity could be differences in cyclical developments during the period considered. Some research shows that the slope coefficients could be time-varying and depend on the cyclical position or on the amount of economic slack.[16] Furthermore, for the countries that joined the euro area after 1999, the relationship between inflation and economic slack could be distorted by a declining inflation trend, which reflects inflation convergence in the run-up to joining the monetary union and changes in longer-term inflation expectations. The role of inflation expectations is discussed in more detail in Section 5.

The above analysis is based on a simplified specification of the Phillips curve, which is subject to important caveats. For example, the regressions are not optimised in terms of lead/lag relationships. The relationship could also be blurred by the impact of supply shocks, such as changes in commodity prices or exchange rates. While changes in commodity prices, most notably in oil prices, affect HICP inflation excluding energy and food to a much lesser extent than they affect headline inflation, some indirect effects could be present. Therefore, the correlation between inflation and economic slack observed in such a simplified Phillips curve can be lower than expected a priori, or can even change sign, when, for example, cost components such as commodity prices increase during episodes of economic slack. Finally, high in-sample fit does not necessarily translate into good forecast performance, in particular in the presence of instabilities in the relationship. Some of these issues are studied in the subsequent sections.

Although subject to several caveats, the analysis in this section illustrates that, while there is evidence of a Phillips curve-type relationship in the euro area for the period 1999-2013, the specification and its goodness of fit are subject to considerable uncertainty and cross-country variation. The next section analyses the stability of the relationship, focusing on changes associated with the financial and sovereign debt crises.

13 See Fabiani, S. and Morgan, J., "Aggregation and euro area Phillips curves", *Working Papers Series*, No 213, ECB, February 2003. This article also discusses in more detail the pros and cons of analysing the Phillips curve at the aggregate and at the country level (noise reduction versus aggregation bias, respectively).

14 For more details, see "Final Report on the Wage Dynamics Network (WDN)", ECB, 7 January 2010, http://www.ecb.int/home/html/researcher_wdn.en.html.

15 For example, Morsy, H. and Jaumotte, F., "*Determinants of Inflation in the Euro Area: The Role of Labor and Product Market Institutions*", International Monetary Fund, No 12/37, 2012, using a Phillips curve framework for ten countries of the euro area, shows that "high employment protection, intermediate coordination of collective bargaining, and high union density increase the persistence of inflation".

16 See, for example, Barnes, M.L. and Olivei, G.P., "Inside and outside bounds: threshold estimates of the Phillips curve," *New England Economic Review*, Federal Reserve Bank of Boston, 2003 or Dotsey, M., Fujita, S. and Stark, T., "Do Phillips Curves Conditionally Help to Forecast Inflation?", *Working Paper Series*, No 11-40, Federal Reserve Bank of Philadelphia, September 2011. The evidence for the euro area and selected countries can be found in Benkovskis, K., Caivano, M., D'Agostino, A., Dieppe, A., Hurtado, T., Karlsson, E., Ortega, E. and Várnai, T., "Assessing the sensitivity of inflation to economic activity," *Working Paper Series*, No 1357, European Central Bank, Frankfurt am Main, 2011.

4 THE PHILLIPS CURVE AND THE FINANCIAL AND SOVEREIGN DEBT CRISES

The financial and sovereign debt crises have had a considerable impact on economic activity in the euro area, leading to a protracted period of wide output and unemployment gaps, and have given impetus to structural reforms and other economic adjustments, such as sectoral re-allocations. This section analyses how the crises affected the Phillips curve relationships and provides an assessment of how useful the concept has been in explaining the developments in inflation during these crises. It also illustrates to what extent inflation developments in the recent period of protracted economic slack are in line with historical experience during such episodes.

4.1 STABILITY OF THE PHILLIPS CURVE

Some estimates of Phillips curve relationships have suggested that, for the euro area as a whole, the impact of slack on inflation has weakened in the period since the onset of the financial crisis.[17] On the other hand, a strengthening of the relationship has been observed for some countries over the same period.[18] This section analyses the changes in the relationship by looking at the impact of economic slack on inflation estimated on a pre-crisis sample (1999-2007) and on an entire sample (1999-2013), and provides possible explanations for these changes.[19]

Chart 4 presents the change in the one-year impact on the euro area HICP inflation excluding energy and food for the slack measures considered above. The one-year impact accounts for potential changes both in the estimated slope coefficient and in inflation persistence. For most of the slack measures considered, the changes are minor, with the notable exception of the unemployment rate and the short-term unemployment rate, for which the estimated one-year impacts have declined markedly.[20] To provide a cross-country perspective, Chart 5 reports the number of countries for which the estimated one-year impact has increased, remained the same or declined respectively. Once again, there are marked differences across countries. For some countries, the result is opposite to that for the euro area aggregate – the responsiveness of inflation appears to have actually increased once the data following the financial crisis have been included. This is the case for some stressed countries and could reflect the fact that structural reforms in labour and product markets undertaken in those countries in recent years may have increased competition or reduced nominal rigidities, allowing for stronger adjustment of prices to economic conditions.

It should be noted that, for some of the countries, the change in the magnitude of the impact could be affected by the impact of increases in indirect taxes, which had a non-negligible positive contribution to inflation in a number of countries in recent years. As the increases were at least partly passed through to consumer prices, inflation was higher than what could have been expected

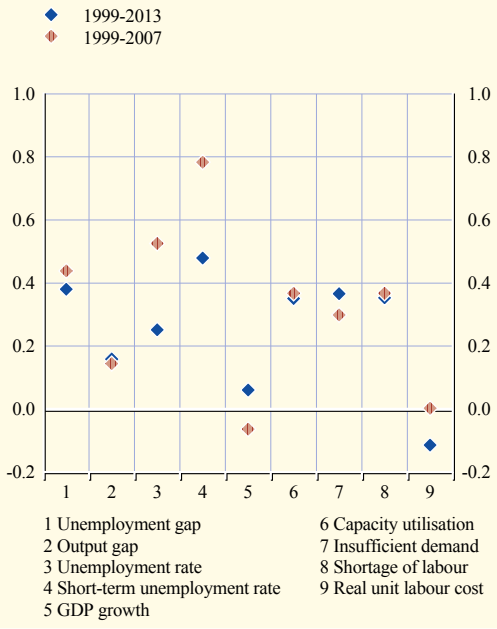
17 See, for example, the article entitled "The development of prices and costs during the 2008-09 recession", *Monthly Bulletin*, ECB, Frankfurt am Main, April 2012 and the article entitled "Potential output, economic slack and the link to nominal developments since the start of the crisis", *Monthly Bulletin*, ECB, Frankfurt am Main, November 2013.

18 See, for example, the article entitled "Variation in the cyclical sensitivity of Spanish inflation: an initial approximation", *Economic Bulletin*, Banco de España, July-August 2013; or *Economic Bulletin*, Banca d'Italia, January 2014. For an analysis on the evolution of the Phillips curve over a longer period, see, for example, IMF, op. cit., or the article entitled "What Inflation Developments Reveal About the Phillips Curve: Implications for Monetary Policy", *Economic Review*, National Bank of Belgium, December 2013.

19 The sample since 2008 is relatively short and features mostly negative output gaps. Therefore, the changes are investigated more indirectly by extending rather than splitting the samples, acknowledging that relatively strong changes over the period 2008-13 might be needed to signal changes in the extended sample.

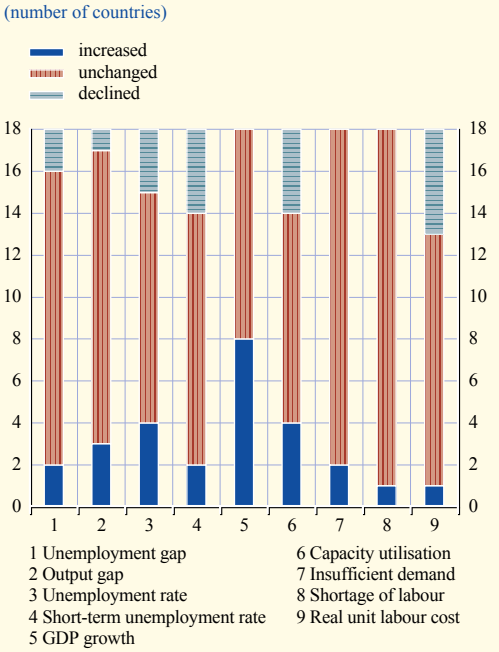
20 The change in the estimated impact is more than twice the standard error estimated over the entire sample. The 2014 article by the Deutsche Bundesbank (op. cit.) compares the slopes of the Phillips curves with the output gap estimated over the periods 1996-2009 and 1996-2013 and, similarly, does not find any evidence of substantial changes for the euro area.

Chart 4 The sensitivity of euro area HICP inflation excluding energy and food to economic slack



Sources: Eurostat, European Commission and ECB calculations.
Notes: Reports $\gamma(1+\beta+\beta^2+\beta^3)$ from a regression $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$, estimated over the period 1999-2007 and over entire sample. For definitions of the variables, see the notes to Chart 2.

Chart 5 Changes in the sensitivity of HICP inflation excluding energy and food to economic slack in euro area countries



Sources: Eurostat, European Commission and ECB calculations.
Notes: Based on quarterly data for the period 1999-2013. Reports the number of countries for which $\gamma(1+\beta+\beta^2+\beta^3)$ from a regression $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$ has increased, remained the same or declined. The impact is considered to have remained the same if it does not differ by more than twice its standard error estimated over the entire sample. For definitions of the variables, see the notes to Chart 2.

given the Phillips curve relationship and the amount of economic slack prevalent at the time, leading to an apparent "flattening" of the Phillips curve.[21]

An important point is that the results could at times be sensitive to the choice of Phillips curve specification.[22] For example, for some countries, the direction of change of the one-year impact depends on the particular measure of slack used. Therefore, it is advisable to look at a wide range of specifications when drawing conclusions about the evolution of the Phillips curve and its implications for future inflation.

4.2 CONDITIONAL FORECASTS BASED ON THE PHILLIPS CURVE FOLLOWING THE FINANCIAL CRISIS

Several studies have documented that the forecasting performance of the Phillips curve has been at best mixed. It has been shown that it only occasionally outperforms simpler univariate models and that the best performing Phillips curve specification may change over time. Nevertheless, it has also

21 See, for example, the box entitled "The impact of recent changes in indirect taxes on the HICP", *Monthly Bulletin*, ECB, March 2012. Changes in indirect taxes belong to the broadly defined supply-side shocks, which for simplicity are omitted in the analysis provided in this article.

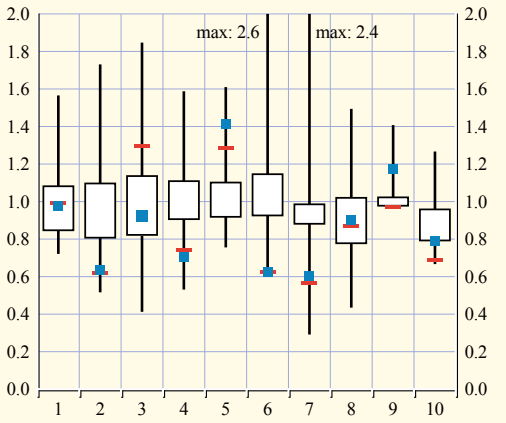
22 For example, Oinonen, S., Paloviita, M. and Vilmi, L., "How have inflation dynamics changed over time? Evidence from the euro area and USA", *Research Discussion Papers*, No 6, Bank of Finland, 2013 show that the impact of the output gap on inflation has increased in recent years. However the analysis is mainly based on the output gap estimates based on the Hodrick Prescot filter, which look rather implausible over the recent period, as the gap turns positive.

been argued that, during an economic downturn, the correlation between inflation and economic slack, and the relative forecast performance of a Phillips curve model may actually increase.[23] In order to see how meaningful the Phillips curve relationship has been in explaining inflation developments during the recent crises, a set of conditional forecasts is performed, which relies on the latest available data on measures of economic slack for the period in question.

Chart 6 summarises the forecast performance over the period 2008-13 of one-year ahead forecasts for HICP inflation excluding energy and food based on the different measures of economic slack considered in the previous sections. The coefficients are estimated recursively. Forecast accuracy is measured by the root mean squared error (RMSE) for annual inflation rates. To better assess the performance of the model, the relative RMSE is reported. Specifically, Chart 6 shows the ratio of the RMSE of the Phillips curve relative to the RMSE of a univariate autoregressive model of order one (AR(1))[24]. A ratio of less than one indicates that the forecast of the Phillips curve has been, on average, more accurate than the one from the univariate AR(1) model. For the euro area, two forecasts are generated: the first forecast uses the euro area aggregated data (marked by a red minus sign), while the second aggregates forecasts based on country data (marked by a blue square). Box plots represent the range of relative RMSEs for the countries. The last column reports the performance of the forecast that is derived as an average over the slack measures.

Chart 6 Range of relative performance of one-year-ahead conditional forecasts from a Phillips curve for HICP inflation excluding energy and food for the period 2008-13

(relative RMSE)



1 Unemployment gap
2 Output gap
3 Unemployment rate
4 Short-term unemployment rate
5 GDP growth
6 Capacity utilisation
7 Insufficient demand
8 Shortage of labour
9 Real unit labour cost
10 Average forecast

Sources: Eurostat, European Commission and ECB calculations.
Notes: Range of relative Root Mean Squared Errors (RMSEs) for HICP inflation excluding energy and food from the model $\pi_t=\alpha+\beta\pi_{t-1}+\gamma gap_{t-1}+\varepsilon_t$ across countries. The model is estimated recursively, starting in 1999 and the RMSE is evaluated for the period 2008-13 for annual HICP inflation excluding energy and food. The RMSE is relative to the RMSE of an autoregressive process of order 1 (corresponding to the above regression with $\gamma=0$). For the euro area, the forecasts are derived either directly, using the model for the aggregated data (red minus sign) or indirectly by aggregating the country forecasts (blue square). For definitions of the variables, see the notes to Chart 2.

Over the period in question the Phillips curve conditional forecasts for the euro area are more accurate than those from the simpler univariate model for most of the slack measures considered. However, the performance is not robust across countries. For each slack measure, there are countries for which the performance of the corresponding Phillips curve is worse than that of the univariate model. In line with typical findings in the forecasting literature, averaging forecasts across slack measures appears to offer gains in the robustness of the forecasting performance of the Phillips curve. For example, the maximum and the upper quartile of the relative RMSE of the average across the measures of slack are lower than for any of the individual slack measures. For the euro area, the

23 See, for example, Atkeson, A. and Ohanian. L.E., "Are Phillips Curves Useful for Forecasting Inflation?", *Quarterly Review*, Federal Reserve Bank of Minneapolis, 2001 or Stock, J.H. and Watson, M.W., "Phillips Curve Inflation Forecasts", in Fuhrer, J., Kodrzycki, Y., Little, J. and Olivei, G., "*Understanding Inflation and the Implications for Monetary Policy*", Cambridge: MIT Press, 2009, pp. 361-382; Stock, J.H. and Watson, M.W. "Modeling Inflation After the Crisis", Federal Reserve Board of Kansas City Symposium, Jackson Hole, Wyoming, 2010, http://www.kc.frb.org/publicat/sympos/2010/stock-watson.pdf; Faust, J. and Wright, J., "Inflation Forecasting" in Elliott, G. and Timmermann, A. (eds.), *Handbook of Economic Forecasting*, Vol. 2, Amsterdam: North Holland, 2013.

24 This corresponds to the Phillips curve regression described in footnote 7 with the coefficient on the slack measure constrained to 0. Thus the relative RMSE can be considered as indicating the "value added" of including a slack measure in the equation.

accuracy of the indirect forecasts (obtained by aggregating country forecasts) is comparable to the accuracy of the forecasts obtained from aggregate data, with more substantial improvement for the former only in the case of the unemployment rate as the measure of slack.

One important caveat to this analysis is that it is based on the latest estimates of the output and unemployment gaps and these estimates are subject to considerable uncertainty, in particular for more recent quarters, and could be subject to sizeable revisions. In particular, the explanatory power of the gap variables compared with the alternative measures of slack could be overstated as gap measures are often derived conditional on a Phillips curve relationship.[25]

4.3 INFLATION DYNAMICS DURING EPISODES OF PERSISTENT AND SIZEABLE SLACK

Following the financial crisis and the subsequent recession, actual output has fallen below the level of potential output, implying a significant negative output gap in the euro area. Given that most countries in the euro area are expected to recover only slowly, a large amount of slack is expected to persist for an extended period. Nevertheless, inflation is projected to rise slowly over the projection horizon. Several factors can explain rising inflation, despite the amount of slack in the economy remaining large, such as well anchored inflation expectations, downward nominal rigidities, regional or sectoral bottlenecks and the speed of change in the economy or "speed limit" effects (see the box).

25 Like previous results, the assessed forecast performance could also be sensitive to the choice of specification. However, alternative specifications including the exchange rate as another explanatory variable or lag selection by the AIC criterion did not result in systematically more accurate forecasts.

Box

EVIDENCE OF "SPEED LIMIT" EFFECTS ON INFLATION IN THE EURO AREA

The relationship between inflation and slack in the economy is typically considered in a simple linear Phillips curve model (as described in Section 2), where inflationary pressure is related to the level of the output or unemployment gaps. However, the speed of change in the economy and in the gaps may also play a role. This box assesses whether there is evidence of such "speed limit" effects in the euro area, whereby a strong change in the output or unemployment gap can lead to inflationary pressures, even if the level of economic slack is still high.

There are several channels through which speed limit effects could arise. For example, frictions affecting the reallocation of the production factors, capital and labour, could cause the economy to run into bottlenecks and lead to upward pressure on inflation even in the presence of slack in the economy. Firms generally need time to adjust their capacity (i.e. plan and install) to meet changing demand. Moreover, laid-off workers cannot be reemployed and do not become productive instantly, but often need training and education. Hence, firms face output adjustment costs in addition to production costs, which can give rise to temporary supply bottlenecks if demand increases more rapidly than capacity can be put in place. Changes in the composition of demand may also put upward pressure on prices in some sectors, while considerable slack remains in others.[1] In the euro area, frictions owing to large cross-country heterogeneity and

1 For more details, see Dwyer, A., Lam, K. and Gurney, A., "Inflation and the Output Gap in the UK", *Economic Working Paper*, No 6, Treasury, 2010.

Philips curve estimates for the euro area using the level of and changes in slack

	Slack = output gap		Slack = unemployment gap	
	(1)	(2)	(3)	(3)
$Inflation_{t-1}$	0.88***	0.90***	0.90***	0.92***
$Slack_{t-1}$ (level)	0.06***	0.06***	0.09**	0.06**
$Slack_{t-1}$ (change)		0.11**		0.37***
Adjusted R-sq.	0.884	0.887	0.876	0.883
Countries = 18				
Observations = 1075				

Sources: Eurostat, European Commission and ECB calculations.
Notes: ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. The table shows panel estimates for 18 euro area countries using a fixed effect model. The sample period is from the fourth quarter of 1999 to the fourth quarter of 2013. A general Phillips curve relationship is estimated using the annual growth rate of HICP excluding food and energy as a dependant variable, and the regressors include a lagged value of the dependent variable, and a lagged slack term, as well as a lagged one-quarter change in the slack to capture both the level and speed limit effect on inflation. Columns (1) and (2) report the estimated coefficients using the output gap as slack measure, while the unemployment gap is utilised in columns (3) and (4). European Commission estimates (interpolated to obtain quarterly values) of the output and unemployment gaps are used in the estimations.

limited factor mobility could give rise to bottlenecks in some countries and exert a pull on inflation, although there continues to be a high degree of slack for the euro area as a whole. Empirical evidence of speed limit effects is mixed.[2]

At the current juncture, the existence of speed limit effects could be one factor that might explain inflation increases in the euro area in the future, although slack in the economy is expected to remain considerable.[3] As shown in the table, estimates from a general Phillips curve relationship, including both a lagged slack term and a lagged one-quarter change in slack, finds support for the existence of speed limit effects in the euro area (regardless of which measure of slack is assessed). In fact, the results suggest positive and statistically significant effects from both the level of and change in euro area slack on inflation.

2 For example, Turner, D., "Speed Limit and Asymmetric Inflation Effects from the Output Gap in the Major Seven Economies", *Economic Studies*, No 24, OECD, 1995 presents evidence for speed limit effects in three (Germany, Italy and Japan) of the major seven OECD economies over the period 1960-93.

3 Other factors, such as the role of inflation expectations and global slack, may also exert a pull on inflation, although euro area slack remains large. For a discussion on the importance of inflation expectations in the inflationary process, see, for example, Forsells, M. and Kenny, G., "Further evidence on the properties of consumers' inflation expectations in the euro area" and Paloviita, M. and Vrén, M., "The role of expectations in the inflation process in the euro area", both in Sinclair, P. (ed.), "*Inflation Expectations*", Routledge, 2010. For more details on the role of global slack, see, for example, Borio, C. and Filardo, A., "Globalisation and inflation: New cross-country evidence on the global determinants of domestic inflation", *Working Paper Series*, No 227, BIS, 2007.

Against this background, this section illustrates the inflation dynamics in the euro area during episodes with a persistent and high degree of slack in the economy and examines how the most recent episodes of this kind compare to historical experiences. In accordance with previous research, a period of persistent large output gaps is defined as an episode of negative output gaps exceeding -1.5% for at least eight consecutive quarters.[26] Considering a maximum sample period from the first quarter of 1970 to the fourth quarter of 2011, 27 such historical episodes are identified in the euro area (see the table).

All euro area countries, except Austria, Cyprus, Italy and Malta, feature at least one episode of persistent large output gaps and some countries, such as Spain, Greece, Ireland, Luxembourg and Finland, feature up to three such episodes. In this sample, an episode of large and persistent negative output gap lasts on average around three years (11.9 quarters), with an average output gap of -3.7%

26 See Meier, A., "Still Minding the Gap – Inflation Dynamics during Episodes of Persistent Large Output Gaps", *Working Paper*, No 189, IMF, 2010, pp. 10-189.

Historical episodes of persistent and large output gaps

Country	Period	Length (quarters)	Average gap	Trough
Belgium	Q1 1977 - Q3 1979	11	-1.9	-2.4
	Q2 1985 - Q3 1987	10	-1.7	-2
Germany	Q2 2003 - Q4 2005	11	-1.9	-2.4
Estonia	Q1 2009 - Q4 2010	8	-8	-11
Spain	Q3 1980 - Q3 1986	25	-2.5	-3.1
	Q1 1993 - Q1 1997	17	-2.9	-3.8
	Q1 2009 - Q4 2011 (at least)	≥12	-4.4	-5
France	Q1 2009 - Q4 2010	8	-2.5	-3.3
Greece	Q1 1974 - Q4 1975	8	-4.1	-6.4
	Q3 1982 - Q2 1984	8	-2.2	-2.8
	Q3 2009 - Q4 2011 (at least)	≥10	-5.9	-10.2
Ireland	Q4 1982 - Q4 1988	25	-3.6	-5.7
	Q1 1993 - Q4 1994	8	-2.7	-3.1
	Q1 2009 - Q2 2011	10	-4.4	-5.8
Luxemburg	Q1 1982 - Q4 1983	8	-2.7	-3.1
	Q3 1995 - Q3 1997	9	-2.8	-3.7
	Q1 2009 - Q1 2011	9	-3.5	-5.5
Latvia	Q1 2009 - Q4 2011 (at least)	≥12	-9.7	-14.3
Netherlands	Q1 1982 - Q4 1983	8	-2.2	-2.6
	Q4 2002 - Q3 2005	12	-2.1	-2.7
Portugal	Q1 1975 - Q4 1978	16	-6.3	-8.8
	Q1 1984 - Q4 1986	12	-3.7	-4.3
Slovenia	Q1 2009 - Q4 2010	8	-3.2	-5
Slovakia	Q4 1999 - Q2 2003	15	-2.2	-2.7
Finland	Q2 1976 - Q2 1979	13	-4.2	-5.8
	Q3 1991 - Q3 1996	21	-4.1	-6.4
	Q1 2009 - Q4 2010	8	-4.1	-6.3
Average		**11.9**	**-3.7**	**-5.1**

Sources: European commission and ECB calculations.
Notes: The list contains all periods where the output gap was lower than -1.5% for at least eight consecutive quarters. The data under consideration covers the European Commission's estimates of the output gap of 18 euro area countries, with a maximum sample period from the first quarter of 1970 to the fourth quarter of 2011. In the available sample for Austria, Cyprus, Italy and Malta there are no episodes of interest. The output gap estimates have been interpolated to obtain quarterly values.

during the episode. The period since the 2008 global financial crisis accounts for one-third (nine) of all observed episodes. The majority of euro area countries (ten countries) have experienced a renewed episode of persistent and large output gaps since the fourth quarter of 2011.

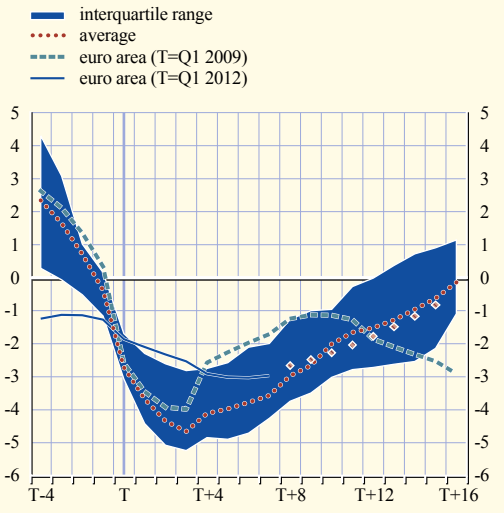
Chart 7 displays the distribution of output gap paths in the identified sample of episodes with persistent and large amounts of slack. Following the onset of the financial crisis in 2008, the euro area output gap reached a trough after three quarters in line with past regularities, but it narrowed more quickly compared with the average of previous episodes. This is partly attributed to the slowdown in euro area potential growth after 2008.[27] The estimated negative gap would have been larger if, in addition to actual output growth, potential output growth had not decelerated substantially as well. The sovereign debt crisis that followed the financial crisis led to a new contraction in economic activity, and the output gap widened, starting from a negative level. In this episode, the trough in the output gap was reached later, and it narrowed more gradually compared with previous episodes. Going forward, projections (based on the European Commission's Winter 2014 projections) suggest that the output gap will gradually close, but will still be slightly negative at the end of the projection horizon. This implies a development in line with historical regularities for episodes of protracted slack.

27 For more details, see the article entitled "Potential output, economic slack and the link to nominal developments since the start of the crisis", *Monthly Bulletin*, ECB, November 2013.

Episodes of sizeable and persistent output gaps have been associated with a strong decline in inflation rates (see Chart 8).[28] In fact, HICP inflation excluding energy and food tends to decline somewhat ahead of the episode, and the decline lasts for ten quarters on average before bottoming out at lower levels. The declining inflation ahead of the episode reflects the negative output gap prior to the start of the episode. The development in euro area HICP inflation excluding energy and food since 2012 features some unusual sluggishness of decline vis-à-vis previous episodes (see Chart 8), even when compared with the financial crisis, when its decline was also small and short-lived by past standards (see Chart 9). The more limited adjustment of HICP inflation excluding energy and food since the financial crisis largely reflects increases in indirect taxes and administered prices owing to the ongoing fiscal consolidation taking place in several euro area countries, as well as the resilience of profit margins in sheltered sectors.[29] It may also reflect nominal downward rigidities, which may become more binding at lower levels of inflation.

Chart 7 Output gap during episodes of persistent and large amounts of slack

(percentages of GDP)



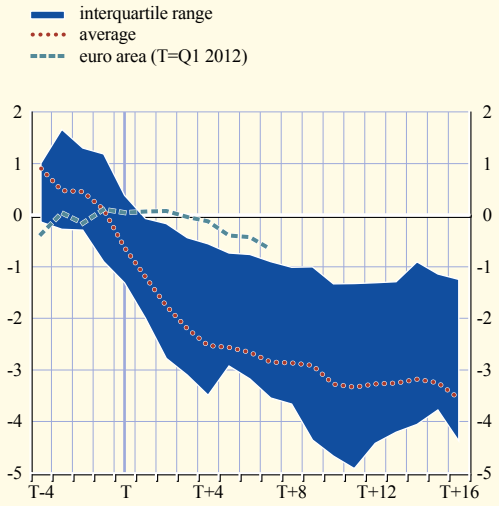
Sources: European Commission and ECB calculations.
Notes: T represents the first quarter of each episode where the output gap has been lower than -1.5% for at least eight consecutive quarters. The data cover a period from four quarters prior to the episode (T-4) to 16 quarters after it (T+16). The cycle range for episodes of large and persistent output gaps is derived as the upper quartile less the lower quartile of developments during all identified episodes. The data under consideration covers the European Commission's estimates of the output gap of 18 euro area countries, with a maximum sample period from the first quarter of 1970 to the fourth quarter of 2011. The output gap estimates have been interpolated to obtain quarterly values. Red diamonds represent the European Commission's projections of the euro area output gap for 2014 and 2015.

Clearly, the responsiveness of euro area HICP inflation excluding energy and food to slack in the economy seems to have diminished compared with previous decades, indicating that a relatively large movement in slack is required to affect inflation in a significant way. These findings are consistent with the findings of a flatter Phillips curve relationship in the euro area in recent decades, as reported in other studies (see, for example, the reference in footnote 4).

28 See also, Meier, A., op. cit., for similar results based on an assessment made on 15 OECD countries.
29 For more details, see the article entitled "Country adjustment in the euro area: where do we stand?", *Monthly Bulletin*, ECB, Frankfurt am Main, May 2013.

Chart 8 Normalised HICP inflation excluding energy and food during episodes of large and persistent output gaps

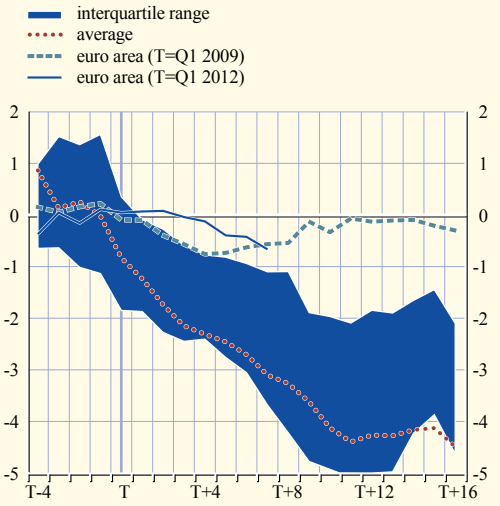
(annual growth, normalised relative to average year-on-year inflation in the five years before the first quarter of each episode)



Sources: Eurostat, OECD and ECB calculations.
Notes: Normalised quarterly HICP inflation rates excluding energy and food during 24 episodes of large and persistent output gaps (output gaps below -1.5% for at least eight consecutive quarters) between the first quarter of 1970 and the fourth quarter of 2011. Normalisation of inflation rates is to the mean inflation during the five years before the first quarter of each episode (denoted by T). The data for Greece (1974-75; 1982-84) and Portugal (1975-78) have been excluded owing to lack of data.

Chart 9 Normalised HICP inflation excluding energy and food during episodes of large and persistent output gaps excluding the financial crisis period

(annual growth, normalised relative to average year-on-year inflation in the five years before the first quarter of each episode)



Sources: Eurostat, OECD and ECB calculations.
Notes: See the notes to Chart 8. The sample covers 15 episodes of large and persistent output gaps, with a maximum sample period from the first quarter of 1970 to the fourth quarter of 2007, thus excluding the global financial crisis. The data for Greece (1974-75; and 1982-84) and Portugal (1975-78) are omitted owing to lack of data.

5 ADDITIONAL FACTORS AFFECTING THE RELATIONSHIP BETWEEN INFLATION AND ECONOMIC SLACK

The analysis presented above abstracts from several factors that may affect the relationship between inflation and economic slack. These include, among other things, inflation expectations, globalisation or structural reforms that are aimed at making labour and product markets more flexible.[30]

It has long been recognised that expectations which are related more directly to inflation or, more indirectly, to the objectives and conduct of monetary policy can change the coefficients of the Phillips curve. In particular, commitments from monetary authorities to achieve price stability by aiming at an inflation target have been successful in lowering inflation rates and anchoring expectations of future inflation in many countries. Some versions of the Phillips curve posit an explicit role for inflation expectations by including them as an explanatory variable.[31] However, it is not straightforward to establish the empirical relevance of such a forward-looking component as opposed to the backward-looking formulation with lags of inflation only, and there is a lack of consensus among economists as to which version provides a better representation of the data.[32]

30 For more details, see Galati, G. and Melick, W., "The Evolving Inflation Process: An Overview", *Working Paper Series*, No 196, BIS, 2006.

31 The most prominent example is the (hybrid) New Keynesian Phillips curve in which current inflation is determined by the real marginal cost, by expectations of future inflation (and by past inflation). See, for example, Galí, J. and Gertler, M., "Inflation Dynamics: A Structural Econometric Approach", *Journal of Monetary Economics*, No 44(2), 1999.

32 See, for example, discussions in Gordon, R., op. cit.; Mavroeidis, S., Plagborg-Møller, M. and Stock, J.H. "Empirical Evidence on Inflation Expectations in the New Keynesian Phillips Curve", *Journal of Economic Literature*, Vol. 52(1), 2014.

Nevertheless, there is evidence that it is important to account for a changing inflation trend when estimating Phillips curve-type relationships or when applying them for forecasting purposes, and long-term inflation expectations can serve as a proxy for this trend.[33] Finally, it has been suggested that often-used professional forecasts might not be the most relevant proxies of inflation expectations in the Phillips curve context.[34] Thus, while inflation expectations are believed to be an important determinant of inflation, there is no consensus as to how and whether they should be incorporated in the empirical short-term Phillips curve framework.

Global economic factors, including stronger international competition owing to increased openness, have become important drivers of domestic inflation and can thus influence the Phillips curve relationship.[35] There are various channels through which globalisation can influence inflation dynamics. For example, increased international competition may change the price-setting behaviour of individual firms, which becomes more countercyclical in order to defend market shares (i.e. price increases remain contained during booms). At the same time, a larger amount of traded goods and services in the economy makes the exchange rate a stronger element of international inflation transmission through import prices. Moreover, in the labour market, increased supply of foreign labour or the threat of outsourcing production to cheaper labour may contain wage growth and make it less responsive to domestic conditions. Accordingly, globalisation can make prices less sensitive to domestic demand pressures, i.e. induce a flattening of the Phillips curve, but could also lead to a steepening of the Phillips curve relationship if increased competition contributes to greater price and wage flexibility.[36] However, so far there is no conclusive empirical evidence to support the notion that globalisation has made domestic inflation less responsive to domestic slack and more dependent on worldwide capacity utilisation. While some have argued that traditional models of inflation are mis-specified, as they do not incorporate the influence of global slack on domestic inflation, others find that global variables have only limited or no systematic impact on domestic prices.[37]

The degree of price flexibility (as represented by the frequency of adjustment or the degree of indexation) and institutional settings (union power and wage bargaining institutions, employment protection legislations, etc.) play an important role in determining the responsiveness of inflation to slack in the economy. With flexible and competitive markets, the economy could achieve higher levels of output in the long run. At the same time, inflationary pressures would remain contained. In addition, reduced rigidities would make prices and wages more responsive in the short run to changing costs or measures of economic slack (i.e. change the slope of the Phillips curve). Therefore, an economy with flexible product and labour markets can respond more rapidly to shocks and avoid the higher costs of lost output and higher unemployment associated with the slower and more protracted adjustment of rigid economies. In particular, it has been shown that

33 See, for example, Faust, J. and Wright, J.H., op. cit. and Carlstrom, C.T. and Fuerst, T.S. "Explaining Apparent Changes in the Phillips Curve: Trend Inflation isn't Constant", *Economic Commentary*, Federal Reserve Bank of Cleveland, 2008.

34 See, for example, Coibion, O. and Gorodnichenko, Y., "Is The Phillips Curve Alive and Well After All? Inflation Expectations and the Missing Disinflation," *NBER Working Paper*, No 19598, 2013.

35 For example, in Borio, C. and Filardo, A., op. cit., a link is drawn between the flattening of the Phillips curve and the spread of globalisation.

36 For more details, see Rogoff, K.S., "Impact of Globalization on Monetary Policy", *Proceedings of the Federal Reserve Bank of Kansas City Jackson Hole Conference,* 2006, pp. 265-305.

37 Evidence of the importance of global slack as a determinant of domestic inflation has been provided by, for example, Borio, C. and Filardo, A., op. cit.. However, their results have been challenged by, for example, Ihrig, J., Kamin, S.B., Lindner, D. and Marquez, J.,"Some Simple Tests of the Globalization and Inflation Hypothesis", *International Finance*", Vol. 13(3), 2010, pp. 343-375. Similarly, Calza, A., "Globalisation, domestic inflation and global output gaps – evidence from the euro area", *Working Paper Series*, No 890, ECB, 2008 finds limited evidence in support of the "global output gap hypothesis" for the euro area.

the necessary economic adjustment after a financial crisis comes with a smaller loss of output and larger reductions in prices in an economy in which real and nominal rigidities are low.[38]

The recent price adjustments in the euro area may be influenced by structural shifts in many countries. Indeed, the relative decline in inflation in the most stressed countries coincides with substantial structural reform efforts aimed at removing nominal rigidities in prices and wages and enhancing labour and product market flexibility. While such structural reforms entail higher potential output and thereby have implications for the estimates of the degree of slack in the economy, they might also amplify the responsiveness of inflation to slack in the future. Thus, the Phillips curve relationship becomes even more uncertain in many euro area countries depending on the impact of the structural reforms undertaken.

6 CONCLUSIONS

The Phillips curve provides an intuitive framework for gauging the relationship between the level of slack and the rate of inflation in the economy and has been a popular tool for explaining and forecasting inflation developments.

At the same time, a range of limitations, as highlighted in this article, suggest that a simple Phillips curve perspective constitutes an insufficient analytical basis to forecast inflation and guide monetary policy. In particular, to date no single best concept of the Phillips curve has been clearly established for such purposes. Instead, there are various – similarly plausible – specifications of the Phillips curve, for example using different measures of economic slack. Furthermore, the suitability of each of these specifications might vary across countries. This is particularly relevant in the euro area, whose constituent countries display substantial heterogeneity in economic structure and institutional landscape, for example relating to labour and product markets.

Considering a wide range of Phillips curve specifications can to some extent serve as a hedge against such uncertainties and, in particular, can result in a more robust forecasting performance. Nevertheless, overall, the framework cannot sufficiently account for the complexity of the inflation process and the relationships with its determinants.

Against this background, the ECB's two-pillar analytical framework is built on a broad and granular set of tools and indicators to assess real economic and price developments, with the Phillips curve relationship between slack and inflation being just one element among others. In particular, the framework includes a comprehensive forecasting framework for short and medium-term inflation developments, relying on a wide set of models and on an economic and monetary analysis.[39]

38 For more details, see Cuerpo C., Drumond, I., Lendvai, J., Pontuch, P. and Raciborski, R., "Indebtedness, Deleveraging Dynamics and Macroeconomic Adjustment", *Economic Papers*, European Economy, p. 477 (Brussels: European Commission).
39 See "*A guide to Eurosystem staff macroeconomic projection exercises*", ECB, June 2001, which is available on the ECB's website.