BOXES

Box 1

ASSESSING US INFLATION DEVELOPMENTS USING THE PHILLIPS CURVE

The recent decline in inflation has been a broadly based phenomenon across major advanced economies, despite differences in the cyclical positions. In the United States, notwithstanding the ongoing robust recovery in economic activity, inflation has been low over the past two years. Headline inflation and inflation excluding food and energy have averaged 1.4% and 1.5% respectively since 2012, implying that prices have not been very responsive to the increasingly robust recovery in the labour market and in economic growth more generally. This box reassesses the empirical relationship between inflation and labour market slack – commonly described as the Phillips curve – and discusses the role of other major drivers of the US inflation outlook.

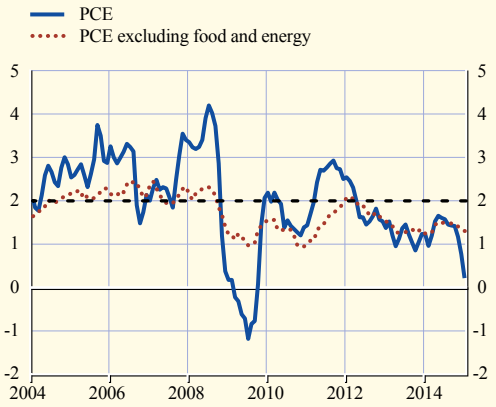
Annual inflation in the United States, measured by the personal consumption expenditure (PCE) deflator, averaged 1.9% over the past decade, broadly in line with the Federal Open Market Committee's (FOMC) longer-run inflation target. However, it exhibited substantial fluctuation around this average value, partly driven by movements in food and energy prices, which led inflation to rise above 4% on an annual basis in mid-2008, followed by a decline into negative territory in early 2009, as oil prices plummeted in response to the global economic crisis (see Chart A). PCE inflation excluding food and energy has generally remained more stable over the past decade, declining only moderately during the latest recession.

The traditional Phillips curve suggests an inverse relationship between inflation and the degree of slack, or spare capacity, in the economy. In order to capture the role of expectations, survey measures of inflation expectations or lagged values of inflation (capturing the so-called adaptive expectations or inflation persistence) are also often included. In augmented Phillips curves, the relationship is expanded with additional variables, such as exchange rates, and commodity or import prices, to capture open-economy aspects and the supply side of the economy.[1]

Since judging the extent of underlying slack in an economy is subject to a significant degree of uncertainty, it is common to employ a variety of indicators.[2]

Chart A US inflation developments

(annual percentage changes)



Sources: Bureau of Labor Statistics and Bureau of Economic Analysis.
Note: The dashed horizontal line is the FOMC's longer-run inflation target.

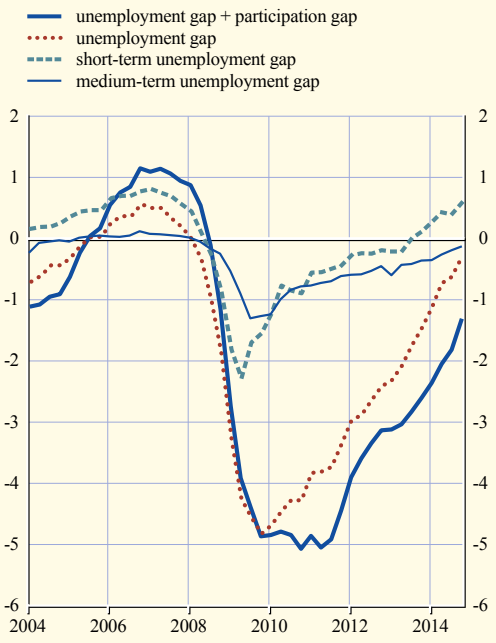
1 Productivity variables are also sometimes included in the Phillips curve. See the triangle model by Gordon, R., "The Phillips Curve is Alive and Well: Inflation and the NAIRU during the Slow Recovery", *NBER Working Paper Series,* No 19390, 2013.

2 At the current juncture, there is a large degree of uncertainty about the extent of slack in the US labour market, in part reflecting a substantial decline in the labour force participation rate, whereby the role of cyclical versus structural factors is strongly debated. See also Box 1 entitled "Is the unemployment rate a sound gauge of labour market developments in the United States?", *Monthly Bulletin*, ECB, April 2014.

Chart B shows four such measures: (i) the unemployment gap, defined as the difference between the non-accelerating inflation rate of unemployment (NAIRU) and the unemployment rate; (ii) the short-term unemployment gap, defined as the difference between the long-term average of the unemployment rate with a duration of up to 26 weeks and the actual data of this series; (iii) the medium-term unemployment gap, i.e. the difference between the long-term average of the unemployment rate with a duration of between 27 and 51 weeks, and the actual data of this series; and (iv) the combined unemployment and participation gap, where the latter is defined as the gap between the structural and actual labour force participation rates.[3] While the short-term unemployment gap suggests that labour market slack had already been eliminated by the third quarter of 2013, the standard and medium-term unemployment gaps point to slack broadly closing by the end of 2014. By contrast, the combined participation rate and unemployment gap indicates the existence of sizeable slack in the US labour market at the end of 2014.

Chart B Measures of labour market slack

(percentages)



Sources: Bureau of Labor Statistics, Congressional Budget Office and ECB calculations.
Note: The NAIRU and potential labour force participation rates are based on annual estimates by the Congressional Budget Office, interpolated by ECB staff.

Phillips curves are commonly used to analyse and explain inflation developments in the United States. While some commentators were surprised that inflation did not decline more during the recent downturn given the severity and length of the latest US recession (commonly referred to as the "missing deflation puzzle"),[4] the estimated Phillips curve models with the four alternative measures of labour market slack, lagged inflation and import prices are able to capture the inflation dynamics since 2008 rather well. Chart C depicts model forecasts for PCE inflation, conditioned on the actual data for labour market slack and import prices. During the US downturn, the forecasts stood above actual inflation rates, mainly owing to rising import and oil prices up to the summer of 2008, which pushed up the inflation forecast. By contrast, from the end of 2009 inflation evolved broadly in line with, although close to the lower end of, the model forecast range.[5] The fact that inflation did not decline more during the downturn is probably related to the persistence of inflation and rising import prices, which both offset the

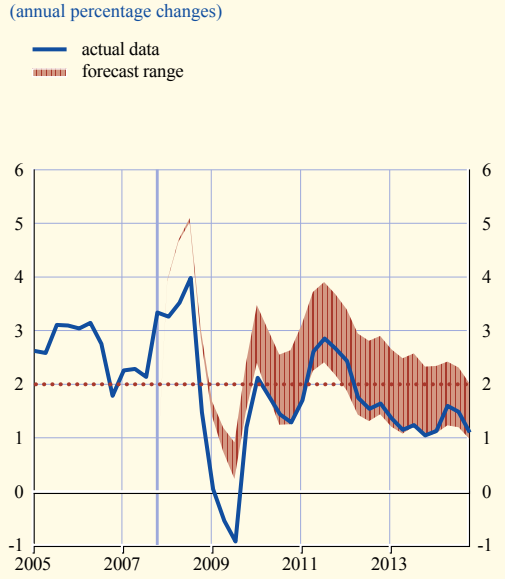
3 Actual developments in labour force participation rates are caused by longer-term (structural) factors, primarily demographic changes, as well as cyclical changes, for example related to discouraged workers that temporarily leave the work force in the face of weak economic prospects. For more details, see "Slack in the labor market in 2014", Congressional Budget Office, 2 September 2014.

4 See, for example, Ball, L. and Mazumder, S., "Inflation Dynamics and the Great Recession", *Brookings Papers on Economic Activity*, Spring 2011.

5 This could be due to the fact that labour market slack may have been larger during the current economic recovery than indicated by some of the various slack measures employed. For example, Janet Yellen, Chair of the Federal Reserve Board, noted that *"the decline in the unemployment rate [...] somewhat overstates the improvement in overall labor market conditions"*, see Yellen, J., "Labor Market Dynamics and Monetary Policy", Speech at the Federal Reserve Bank of Kansas City Economic Symposium, Jackson Hole, Wyoming, 22 August 2014.

Chart C Out-of-sample forecasts for PCE inflation

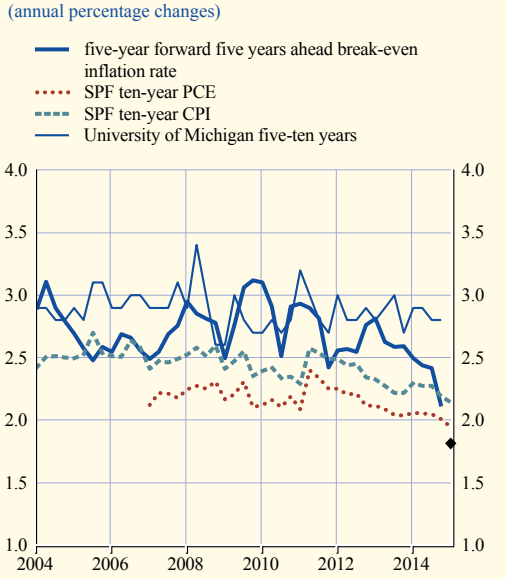
(annual percentage changes)



Sources: Bureau of Economic Analysis and ECB staff calculations.
Note: Dynamic out-of-sample forecasts are for the first quarter of 2008 to the fourth quarter of 2014, with the forecast range derived from four different Phillips curve models augmented with import prices and either the unemployment gap, the short-term gap, the medium-term gap or the combined unemployment and participation gap as slack measures.

Chart D Long-term measures of inflation expectations

(annual percentage changes)



Sources: Federal Reserve Board, University of Michigan, Survey of Professional Forecasters and Bloomberg.
Notes: The break-even inflation rate relates to CPI inflation; the SPF inflation expectations are for PCE or CPI inflation ten years ahead; and the University of Michigan expectations are not related to a specific price index. Market-based inflation expectations data for the first quarter of 2015 are based on an average of daily data up to 25 February 2015.

sharp increase in labour market slack. The increase in central bank credibility, which has resulted in more anchored inflation expectations over time, and the presence of downward nominal wage rigidities have also been put forward in the literature to explain why inflation may have been less responsive to economic slack than in the past.

Looking forward, US inflationary pressures are likely to increase only gradually, as the upward pressure from the ongoing recovery in economic activity is expected to be partially counterbalanced in the near term by oil price and exchange rate developments. Amid the strengthening of economic growth in the United States (see Section 1), the labour market recovery has recently consistently gathered pace. It is anticipated that this will feed gradually into higher price and wage pressures over time. However, other drivers of inflation are expected to act as offsetting forces. First, the sharp decline in oil prices since last summer is expected to lead to a significant decline in headline inflation in the short term, with annual inflation rates turning negative in the first half of 2015. This effect is compounded by the recent appreciation of the US dollar, which is exerting downward pressure on import prices. Both of these effects, however, are expected to fade in the medium term. In the long term inflation expectations should provide an anchor for inflation. While market-based measures of five-year inflation expectations five years ahead have declined substantially since mid-2014 (see Chart D), this could partly be due to a decline in inflation risk premia. Meanwhile, survey measures of long-term inflation expectations have remained more stable and are consistent with a gradual return of inflation to the longer-run goal of the Federal Reserve System.