

# Understanding Inflation Dynamics and Monetary Policy

---

*Vitor Constâncio*

## **I. Introduction**

This paper addresses the main challenges in understanding inflation dynamics. It discusses recent developments in euro area inflation and their related implications for monetary policy.

Inflation dynamics since the Great Recession have shown signs of instability that have led to a sequence of systematic forecast errors. Following a short introduction, Section II of this paper dwells into the two puzzles of “missing disinflation” in 2009-11 followed by “excessive disinflation” after 2012 for the euro area case. In particular, it examines the drivers of low inflation, assessing domestic and external factors. Section III reviews a number of unsettled issues pertaining to the Phillips curve that prove essential for its use as a vehicle to discuss inflation dynamics: 1) the measurement of the economic slack, the curve’s slope and its stability; 2) the merits of the hybrid New Keynesian Phillips curves in understanding inflation dynamics and 3) the stability of the coefficients of inflation inertia, economic activity, inflation expectations and external prices. The Phillips curve seems to be working well in the euro area but it faces some limitations that justify the need to use several different approaches to understand inflation dynamics. Finally, Section IV concludes, drawing the lessons for monetary policy, notably

the use of models and judgment to understand, forecast and design policies to influence medium-term inflation. As the link between inflation and real activity appears to have strengthened recently in the euro area, it concludes that, as long as policies are able to significantly reduce the output gap, they should be contributing to bring the inflation rate closer to target in the euro area.

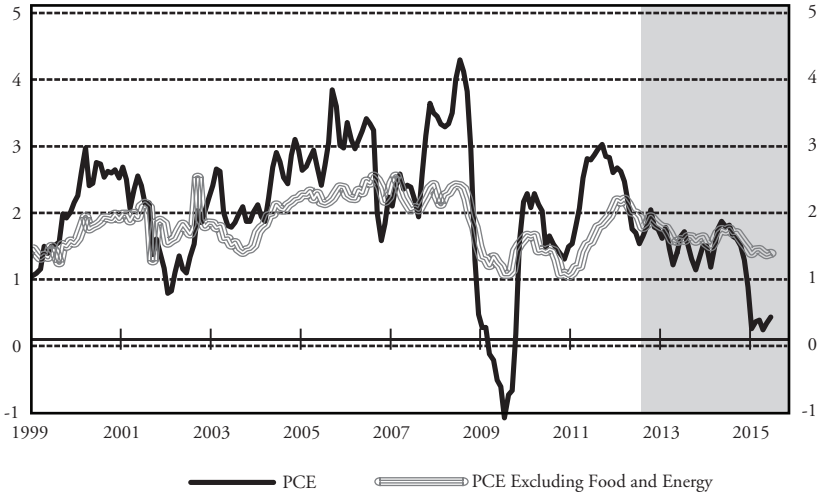
Understanding inflation dynamics has become particularly important in view of the low inflation regime now prevailing (Panels A and B of Chart 1) and because the traditional relationship between slack in the economy and inflation seems to have weakened significantly in some countries.

If confirmed, the flattening of the Phillips curve would be relevant for monetary policy because that relationship was the traditional linchpin of the transmission mechanism that gave central banks control of inflation. The subsequent focus on the role of expectations and their management in the toolkit of monetary policy reduced but did not eliminate the relevance of that traditional mechanism. In 2006, both the International Monetary Fund (IMF) and the Federal Reserve started to highlight a decade-long decline in the slope of the Phillips curve, i.e. the coefficient of economic slack (IMF 2006, Iakova 2007 and Roberts 2006). This decline has been challenged by Gordon (2007 and 2013) as being too dependent on the Phillips curve specification, being particularly associated with variants of the New Keynesian Phillips curve (NKPC), but not verified by Gordon's own "triangle model." Coibion and Gorodnichenko (2015) show that evidence of slope decline is mixed for the United States. Stock and Watson (2010) say that "there are some hints that the slope parameter might be smaller at low levels of inflation but these hints are not robustly confirmed by statistical tests." Stella and Stock (2012) even find signs of a steepening of the Phillips curve for the United States.

## **II. Prolonged Low Inflation: Puzzles and Forecasting Errors**

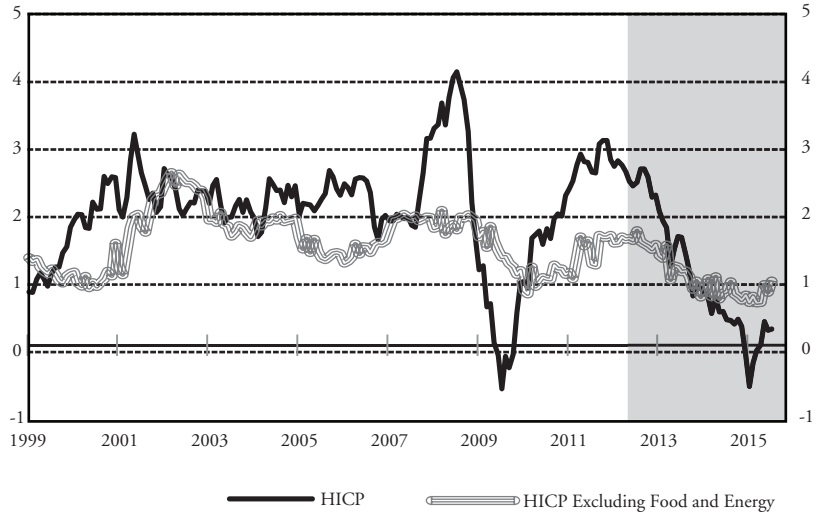
More important, however, was the emergence, after the Great Recession, of a twin puzzle: first, missing disinflation in 2009-11, and second, excessive disinflation after 2012, particularly in Europe. During the Great Recession (the recession that followed the financial

**Chart 1**  
**A. Inflation in the United States**  
(annual percentage changes)



Sources: Eurostat and Haver Analytics.

**B. Inflation in the Euro Area**  
(annual percentage changes)



Sources: Eurostat and Haver Analytics.

crisis), inflation in advanced countries did not fall as much as a traditional Phillips curve and past experiences would have predicted, given the severity and length of the recession (Williams 2010; Ball and Mazumder 2011). Just as puzzling, more recent global developments point in the opposite direction, since, in spite of the ongoing recovery, headline inflation rates in advanced (and a few emerging market) economies remain below target. Clearly, one reason for the low inflation rates is the recent large decline in oil prices. But core or underlying rates of inflation have also been below average almost everywhere. The seemingly weakened relationship between inflation and economic slack in the cases of the two puzzles seemed to have disposed of the Phillips curve. We will see why that is not true after all.

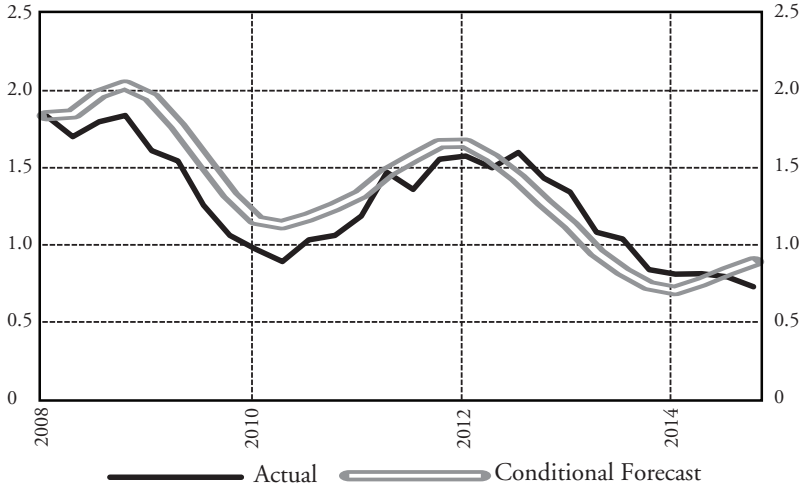
Ex post, we are not in the dark: If we exploit all available information we can recover the dynamics of inflation after the fact fairly well (Chart 2), and rationalize inflation developments after the financial crisis. For the euro area we can identify two distinct periods of disinflation in the case of HICP excluding energy and food: the first from 2008 to 2010 and the second starting in 2012. The analysis is based on a Bayesian VAR, which includes HICP excluding energy and food, real activity indicators (real GDP, the unemployment rate and real investment), external variables (NEER, non-energy commodity prices, oil price in dollars and foreign demand) and financial variables (short-term interest rates lending rates and real loans to nonfinancial corporations).<sup>1</sup>

Each inflation dip had different origins: the first was mainly due to external factors (falling energy and food prices), while the second was driven more by domestic sources in an environment of weak demand (Chart 2, Panel D).

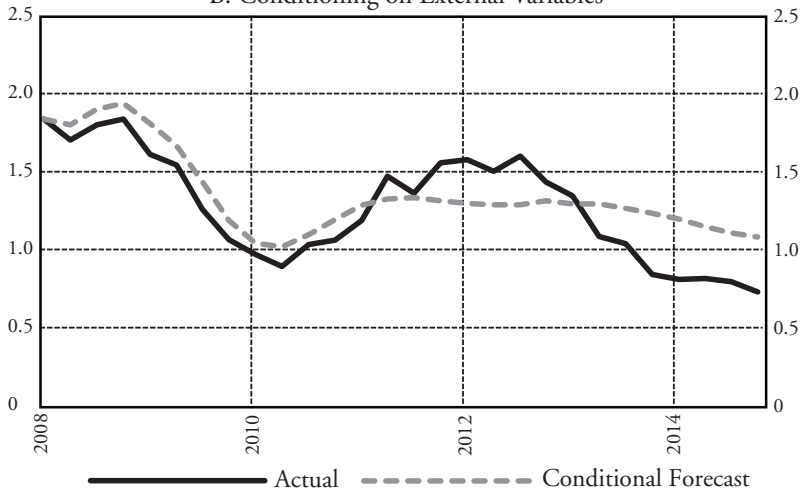
There is a vast body of literature on the first puzzle of the “missing disinflation,” which offers a variety of explanations: the increased anchoring of expectations by a credible monetary policy (Bernanke 2010 and IMF 2013); the continued decline of the responsiveness to economic slack (IMF 2013); the increased downward wage rigidities in a recession that bend the wage Phillips curve (Daly and Hobijn 2014); the higher forward-looking expectations of marginal costs in a dynamic stochastic general equilibrium (DSGE) model

### Chart 2 Ex-post Analysis of HICP Excluding Energy and Food (annual percentage changes)

A. Conditioning on Real Activity Variables

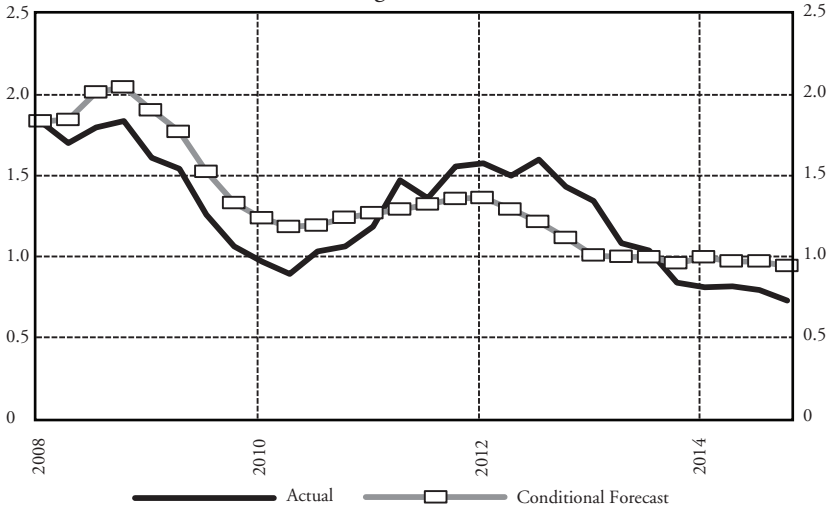


B. Conditioning on External Variables

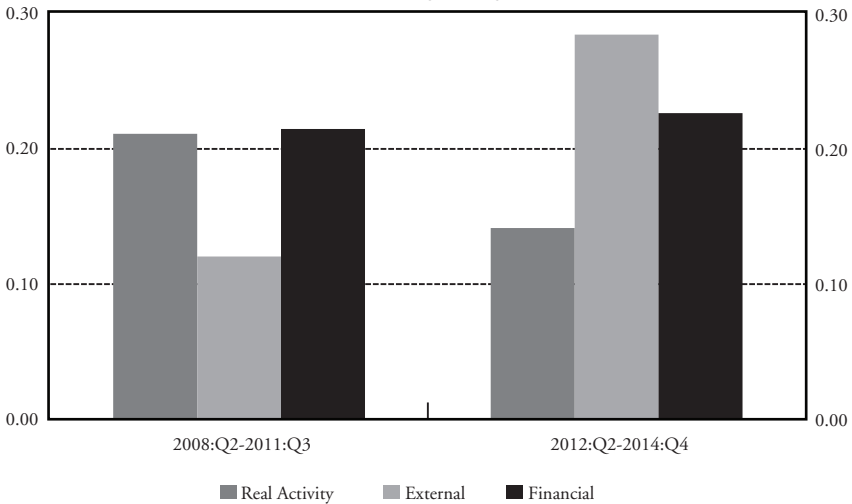


**Chart 2 continued**

C. Conditioning on Financial Variables



D: RMSE of Conditional Forecasts of HICP Inflation Excluding Energy and Food



Notes: evidence from the ESCB Task Force on Low Inflation. Results based on Bayesian VAR including: HICP excluding energy and food, real activity indicators (real GDP, the unemployment rate, real investment), external variables (NEER, non-energy commodity prices, oil price in U.S. dollars, foreign demand), financial variables (short term interest rate, lending rate to NFCs, real loans to NFCs). Estimation sample: 1995-2014, conditional forecasts start in 2008:Q2. The RMSE is computed vis-à-vis actual inflation.

(Del Negro, Giannoni and Schorfheide 2015); a fall in total factor productivity and increased costs of working capital (Christiano, Eichenbaum and Trabandt 2014); a regime switch in the slope explained by sticky prices and sticky information (Murphy 2014); or, finally, the role of higher mark-ups of liquidity-constrained firms (Gilchrist, Schoenle, Sim and Zakrajsek 2015). Others pointed to important measurement issues and suggested e.g. using short-term unemployment to measure slack (Gordon 2013; Krueger et al. 2014; and Ball and Mazumder 2014) or household expectations from surveys to relevantly measure inflation expectations (Coibion and Gorodnichenko 2015).

Most of these approaches, besides solving the puzzle a posteriori, also provide new methods that promise to improve future inflation forecasting, even in the context of reduced-form Phillips curves. The use of short-term unemployment or household inflation expectations that are closer to those of economic agents, are two examples of promising developments.<sup>2</sup> It is also helpful to introduce time-varying coefficients or regime-switching estimates, to account for many possible sources of nonlinearity in the Phillips curve.

For headline inflation, external supply shocks, for example in commodity prices, have played a significant role but the two highlighted puzzles also apply to core inflation. Very importantly, the trend for a weaker relationship with economic slack applies also to core inflation. Most of the papers I have cited use the consumer price index (CPI) without energy and food or the GDP deflator as inflation variables. Only a few also use headline inflation. Core inflation reflects mostly domestic factors, as indirect effects from external developments are muted and take time to operate. That is why I consider it more useful to focus on core inflation dynamics for the purpose of discussing their consequences for monetary policy. Despite a few dissenters, the majority view in these papers is favorable to the idea that the slope of economic slack in the Phillips curve has declined. There are several possible explanations:

1. The increased anchoring of inflation expectations makes inflation less sensitive to economic activity.

2. Higher import volumes as a result of increased globalization have also increased the importance of international prices relative to domestic prices, forcing domestic mark-ups to be less sensitive to the state of the domestic economy.
3. Also as a result of globalization, inflation across countries displays an important common factor that explains a substantial part of the national inflation variation. Ciccarelli and Mojon (2010) and Ferroni and Mojon (2014) show that the commonality of inflation goes beyond what can be captured by commodity prices. They also report that the global inflation factor would improve forecasts of domestic inflation in different specifications, from augmenting an AR (1) model to using it in Phillips curves or BVARs. Further, they demonstrate that the importance of the common factor does not depend on spillovers among countries but is more the result of common shocks and convergence of monetary policy frameworks around the world. Confirming these results, Medel, Pedersen and Pincheira (2014), using a sample of 31 OECD countries, report that the global inflation factor improves the inflation forecast for 50 percent of the countries in the case of headline inflation and for 40 percent in that of core inflation. Nevertheless, the improvements in the forecasts mentioned in these papers are contained, producing a 5 percent to 6 percent reduction in the root mean squared errors.
4. The fourth type of explanation relates to possible nonlinearities in the relationship between inflation and real activity. More precisely, the coefficient of the real activity measure in a Phillips curve may depend on the size and duration of economic slack, on the level and volatility of inflation, and on the degree of anchoring of inflation expectations. Specifically:
  - a. Clark, Laxton and Rose (1996) and Macklem (1997) point to the role of capacity constraints: during recessions, when firms operate below their full capacity, if demand is successfully stimulated, firms will be able to produce more without incentives to raise prices. During



boom times, when firms operate closer to full capacity, additional demand translates into stronger price increases. Thus, the slope of the Phillips curve is an increasing function of excess demand.

- b. Ball, Mankiw and Romer (1988) and Ball and Mankiw (1994) discuss convexity of the Phillips curve in the context of adjustment/menu costs. Ball, Mankiw and Romer (1988) show that in a new-Keynesian framework the frequency of price changes increases when the average rate of inflation increases, because firms must adjust their prices more frequently to keep up with the general rise in prices. As a consequence, the slope of the Phillips curve increases with the level of inflation.
- c. Stiglitz (1986), Fisher (1989) and Akerlof, Dickens and Perry (1996) developed models with downward wage and price rigidities. These models embed the fact that workers are more reluctant to accept a decrease in their wages than an increase. At times of excess supply, the slope of the Phillips curve becomes an increasing function of the level of inflation.

The theories that imply convexity rationalize relatively stronger expansionary monetary policy action during times of recession (as price pressures induced by expansionary policy are expected to be smaller during recessions).

The consequences for monetary policy of the weakening of the link between the level of economic activity and inflation, if this weakening indeed happened, would be significant. First, it has consequences on the sacrifice ratio: if inflation increases as a result of shocks not related to domestic slack, then the cost of bringing inflation down in terms of output loss would increase sharply. Second, if instead inflation becomes very low, monetary policy would have to stimulate economic activity more strongly and could lack effective instruments to do so. In sum, a flatter slope of the Phillips curve makes controlling inflation either more costly or more difficult. Naturally, when that

flattening is associated with more strongly anchored expectations, the difficulties are mitigated.

What this underlines is the need to carefully monitor the relative importance of different drivers of domestic inflation: inertia, expectations, economic slack, supply shocks and external variables. Several methods and models are necessary for the task, as policymakers cannot rely on the perspective provided by a single tool.

Nevertheless, the fact remains that forecasters were not able to anticipate the disinflation for the euro area as a whole from 2012, or for the larger member countries. This is particularly surprising because forecasters did take into account the decline in economic activity in most euro area countries after 2011, which generated significant gaps between actual and potential output. The ECB has not been alone in overpredicting euro-area inflation. The IMF, ECB Survey of Professional Forecasters (SPF), Consensus Economics, Eurozone Barometer, OECD and European Commission also have systematically overpredicted both headline and core inflation at all horizons, especially since the second quarter of 2012 (Chart 3).

### **III. The Phillips Curve as a Vehicle to Discuss Inflation Dynamics**

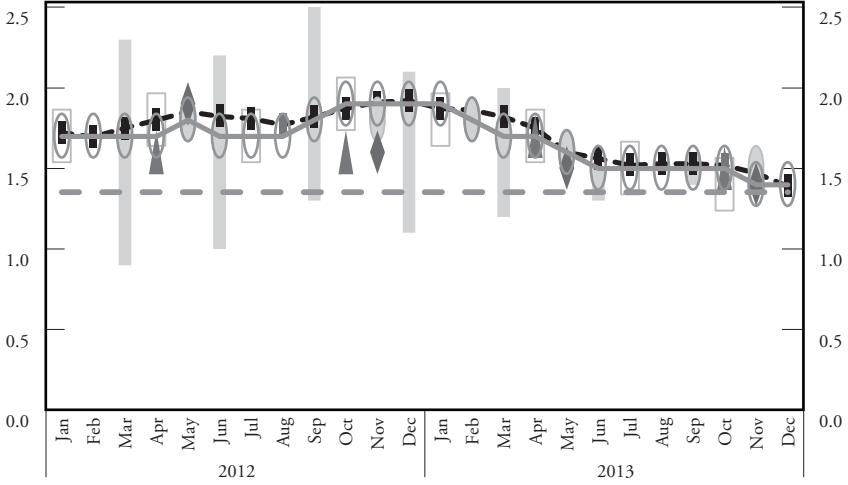
However, as policymakers we need more than just good inflation forecasts: we also need to understand the inflation process in order to better assess the role of monetary policy. We also need to be able to explain our reasoning to the public, as the management of expectations has become such an important monetary policy instrument. This is one more reason for continuing to use the Phillips curve as a tool to discuss inflation dynamics.

The current attention to the relationship between inflation and economic slack has led to an intense debate on the stability of the Phillips curve and its power to explain the twin puzzle. Empirical research, especially in the United States, shows that the slope of the Phillips curve has varied over time, with a clear tendency to flatten over the years.

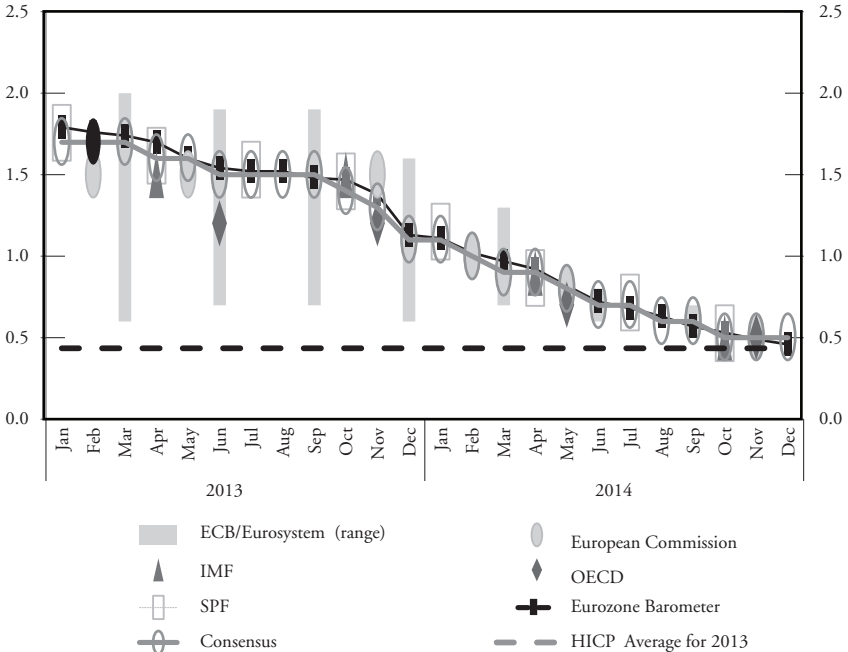
For the euro area, the evidence from several recent papers points to a steepening in recent years (see e.g. Oinonen and Paloviita 2014;

### Chart 3 Evolution of Projections of Average Euro Area HICP Inflation

#### A. 2013



#### B. 2014



Note: The dates on the x-axis indicate the publication dates of each projection. The time span between the cutoff date for the information used and the actual publication date varies across projections.

Sources: IMF, ECB, Consensus Economics, OECD and European Commission.

Riggi and Venditti 2015; and Foroni and Porqueddu 2015). This development is especially marked in those countries which experienced deeper and longer recessions and made greater efforts to reform their product and labor markets, with an impact on nominal rigidities (see, for Italy, Riggi and Santoro 2015) and, to a lesser extent, for Spain, Banco de España (2013 and 2015). When analyzing the excessive disinflation in the euro area since 2012, natural questions arise as to whether we are facing a new regime of low inflation (e.g. due to demographics, integration of low-cost countries in global trade, less powerful trade unions, dominance of a service economy), and whether the Phillips curve (and “which” Phillips curve) is still an appropriate framework of analysis.

A number of technical issues pertaining to the Phillips curve have not yet been settled in the literature.

- a. A key problem in this debate is that single-equation estimates of the Phillips curve might not correctly identify its slope, as inflation and economic slack are determined simultaneously.
- b. Moreover, economic slack is a multidimensional concept that is not directly observable and choices must be made on how to estimate or measure it.
- c. An additional problem is that inflation is also influenced by foreign shocks, either directly via imported inflation or indirectly via global economic slack, as a consequence of international integration of production. How do we account for such external shocks?
- d. Further, the standard hybrid New Keynesian Phillips curve includes agents’ inflation expectations, which are also difficult to measure. Recent work by Coibion and Gorodnichenko (2015) uses expectations from surveys, with some practical success. It highlights that the choice of the measure of inflation expectations is crucial in understanding inflation dynamics in the United States, advocating the use of surveys of household inflation expectations rather

than those of professional forecasters. Naturally, expectations from surveys or professional forecasters are not microfounded. More generally, NKPC has had many problems to predict inflation even when embedded in a DSGE model. As King and Watson (2012) highlight when using the labor income share or unit labor costs the models do not capture that the last 15 years do not show a comovement of inflation with the significant decline of those ULCs. Gürkaynak, Kisacikoglu and Rossi (2013) also illustrate the subpar performance of DSGE models to forecast inflation. In their encompassing survey Mavroeidis, Plagborg-Møller and J. Stock (2014), also conclude that without rejecting the NKPC, “we are unable to pin down the role of expectations in the inflation process sufficiently accurately for the results to be useful for policy analysis.”

- e. Finally there is the question of stability of Phillips curve parameters, in the form of nonlinearities or structural changes. As sudden decreases in forecasting ability are frequently associated with instability, a plausible explanation for the recent inflation surprises is a change in the slope of the Phillips curve. In what follows I am going to show some robustness analysis of the Phillips curve. Let us focus on slack.

Economic slack is the great unknown: it is unobservable and is highly sensitive to the assumptions used for the decomposition of economic activity into trend and cycle. Usual measures of slack can vary substantially across methods and variable inclusion, although they tend to agree on the timing of peaks and troughs.

The fact that economic activity is multidimensional suggests that there might be advantages in using large dynamic models to estimate it. For instance, ECB staff used a dynamic factor model that performs a trend/cycle decomposition of real activity variables and core inflation.<sup>3</sup> The model uses a single factor to capture common cyclical fluctuations and estimates the output gap as the deviation of output

from its trend. Different modeling assumptions, such as different sets of real activity indicators and different specifications of the trend components of the variables, lead to different estimates of the output gap (see Chart 1, Panels A and B). These differences are economically very relevant, with some models estimating an output gap that was close to zero in 2014 on average, and others estimating remaining slack of as much as -6 percent.

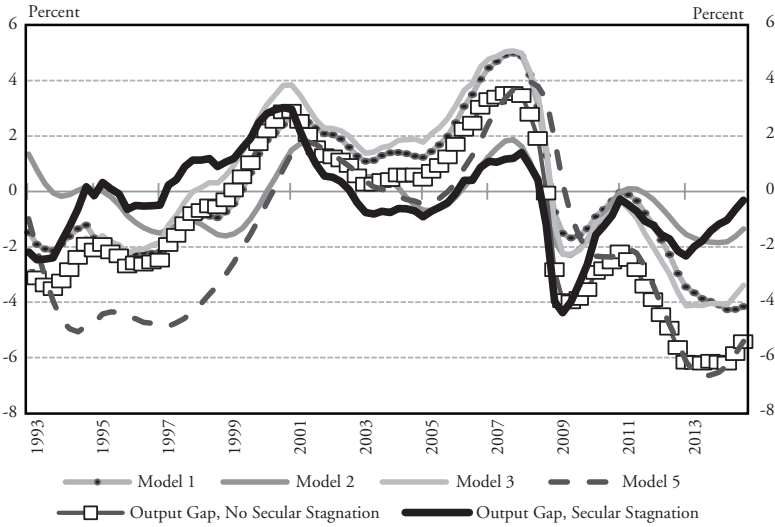
One way to discriminate among different estimates of the output gap is to check their ability to forecast inflation. It turns out that the variants associated with a continuation of a positive growth trend, implying a wider output gap, are the ones that produce better inflation forecasts. The best variant from this perspective implies that the output gap was as large as -6 percent in 2014 (Chart 4, Panel A). Assuming the opposite, namely a break in the output trend, which we could call a secular-stagnation hypothesis, leads to a much poorer forecast ability of recent inflation. The output gap estimated by the IMF and the European Commission are halfway between the extremes arising from the dynamic factor model I have described (Chart 4, Panel B).

Taking into account uncertainty over how to measure slack and inflation expectations, the Phillips curve is alive and well in the euro area (in some form). The dynamic factor model just discussed is not the only one that can explain the recent excessive disinflation. ECB staff have conducted a specification search with a hybrid NKPC using different measures of slack and of inflation expectations, and also including import prices as a measure of external shocks.

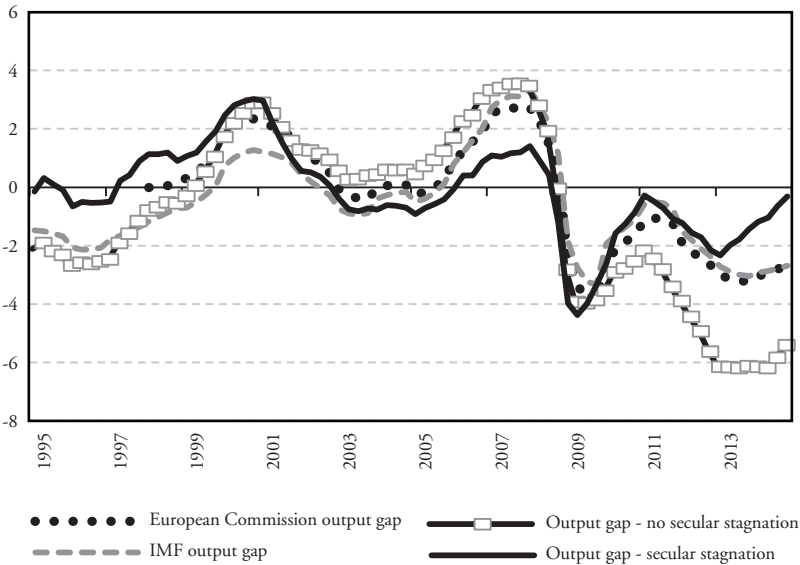
Several specifications are indeed able to track the recent disinflation. The results are shown in Chart 5, where each gray line is the conditional out-of-sample projection of inflation excluding energy and food, based on its own lag, lagged import prices, a measure of slack (lagged) and a measure of inflation expectations. The projection is based on the realized values of the explanatory variables except for lagged inflation, which is determined dynamically. While indeed many models pointed to inflation increasing faster than it did, some are able to track the disinflation quite well. These models tend to

### Chart 4

#### A. Six Variants of Output Gap from a Bayesian Dynamic Factor Model



#### B. Comparison with Traditional Measures of the Output Gap



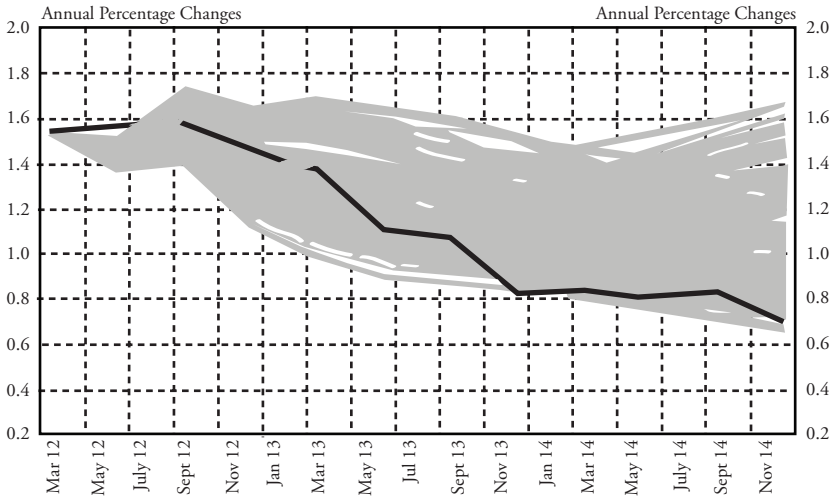
Notes: the six variants of the output gap from a Bayesian dynamic factor model are derived in “Inflation Forecasts in Bayesian Dynamic Factor Model of the Euro Area,” M. Jarocinski and M. Lenza, 2015, mimeo;

- The assumption on no secular stagnation implies continuing trend growth, large output gap. Good inflation forecasts.
- The assumption on secular stagnation implies slow trend growth, closing output gap. Less good at forecasting inflation.

The IMF and European Commission output gap measures are interpolated.

Sources: IMF WEO, AMECO and ECB staff calculation.

**Chart 5**  
**Conditional Out-of-sample Projection of HICP\***



\*Excluding energy and food

Note: The estimation starting date is 1995:Q1 depending on data availability.

Sources: ECB staff calculations.

be those that use the unemployment rate (or gap) and a short to medium-term measure of inflation expectations.

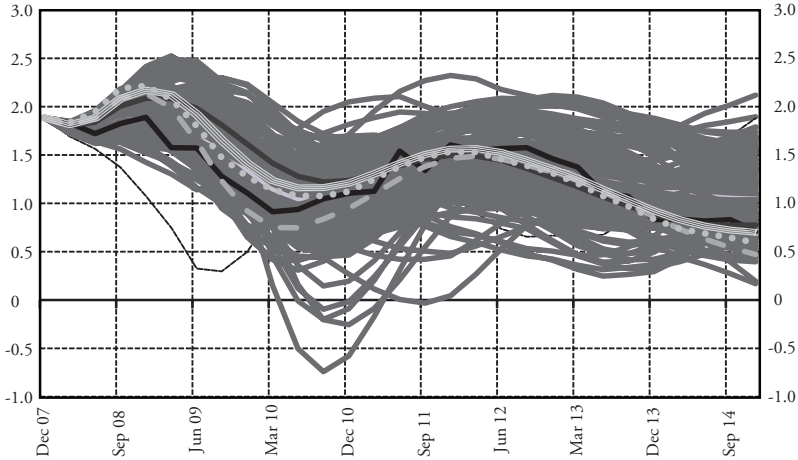
The result holds also for conditional forecasts that start earlier, through the financial crisis and since the first recovery. In fact, the best specifications of the same hybrid NKPC were evaluated by looking at out-of-sample dynamic projections of inflation over the period up to year-end 2014 based on two different estimation samples, one ending in 2007 and the other in 2009. Chart 6 shows that the results are satisfactory for both exercises.

However, as I have already hinted, the coefficients of the Phillips curve may not be stable. As I mentioned above, the slope of the Phillips curve might have increased over the period when we were overpredicting inflation. Running the same specifications just described over two samples, one stopping at the first quarter of 2012 (when we started to systematically overpredict inflation excluding food and energy) and the other covering the full sample ending in the fourth quarter of 2014, there is some evidence of an increase in the slope estimate (Chart A-2 in the Appendix). This suggests the specific possibility of nonlinearities that could be due to state-dependency

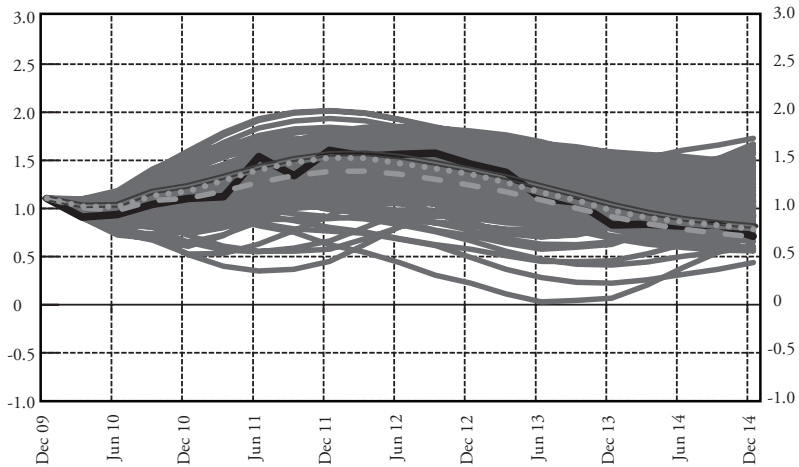


## Chart 6 Conditional Forecasting

### A. Starting in 2008:Q1



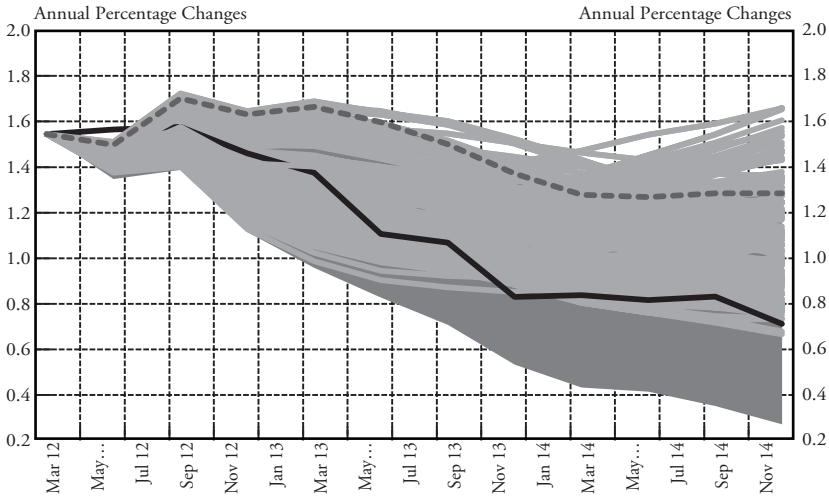
### B. Starting in 2010:Q1



- Actual HICP Excluding Energy and Food
- Unemployment Rate/Consensus Three Quarters Ahead
- - - OG, No Secular Stagnation/Consensus Two Quarters Ahead
- Unemployment Rate/Consensus Two Quarters Ahead
- Unemployment Gap/Consensus Four Quarters Ahead

Source: ECB staff calculations.

**Chart 7**  
**Conditional Projection of HICP\***



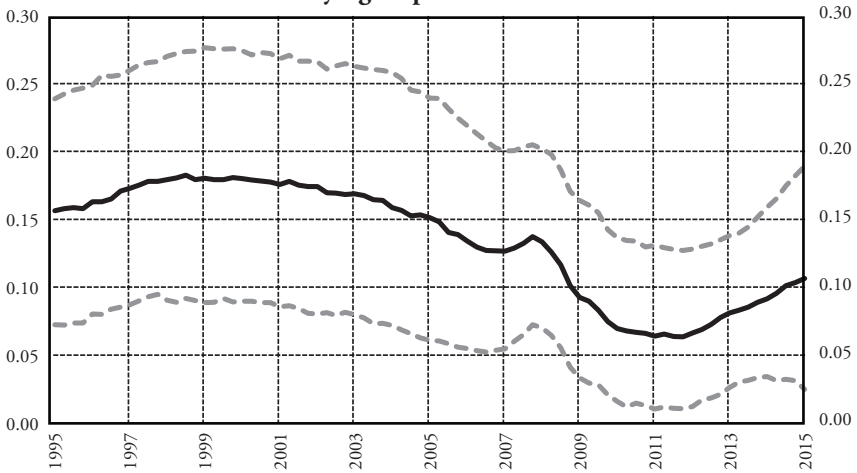
\*Excluding energy and food  
Source: ECB staff calculations.

of the Phillips curve or to structural change of some form. Indeed, regime-switching estimates, accounting for parameter change due to state-dependency on various measures of the business cycle can help to explain the “excessive” disinflation since 2012. The results are shown in Chart 7.

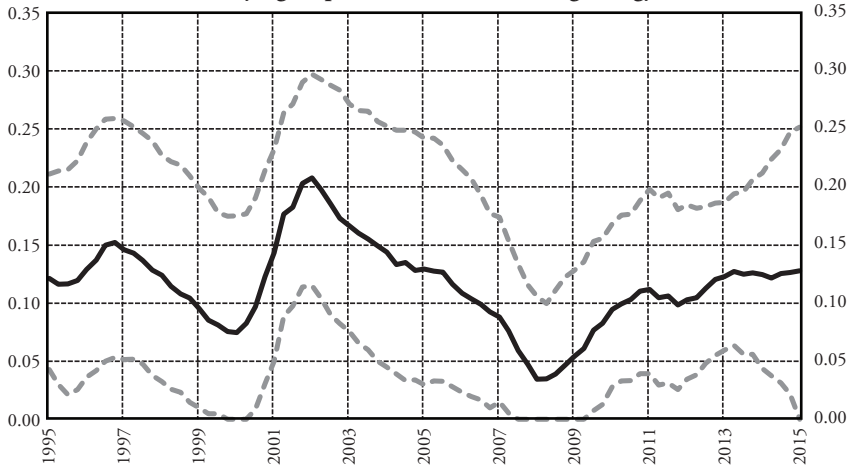
How much time variation is there in the slope of the Phillips curve, and in which direction? The discussion on the steepening or flattening of the Phillips curve brings me to recent discussions that pointed to a flattening, particularly for the United States, but also for various other advanced economies. Let us take an agnostic view on the origins of the time-variation (that is, without necessarily making it conditional upon regimes identified by a specific variable) and estimate a hybrid NKPC with time-varying parameters, similar to that in Blanchard et al. (2015). Over the sample period running from the first quarter of 1999 to the second quarter of 2015, the slope of the Phillips curve for headline inflation had a general tendency to decrease until 2011, after which it rebounded (Chart 8, Panel A). For core inflation the upward shift started earlier (Chart 8, Panel B). This is true for the euro area as a whole but particularly valid for some countries that experienced longer recessions and made greater

**Chart 8**

**A. Time-varying Slope for Headline Inflation**



**B. Time-varying Slope for Inflation Excluding Energy and Food**



Note: Annual inflation regressed against its first lag, unemployment gap, imported inflation and survey inflation expectation.

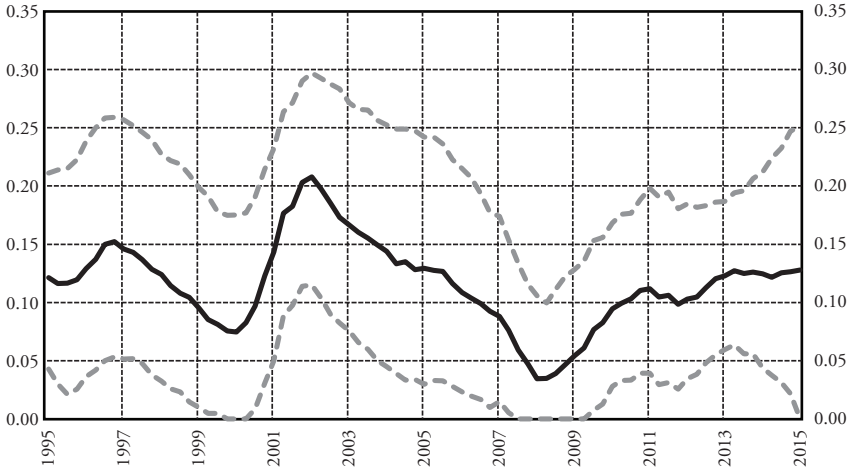
Source: ECB staff calculations.

efforts to reform their product and labor markets with an impact on nominal rigidities.

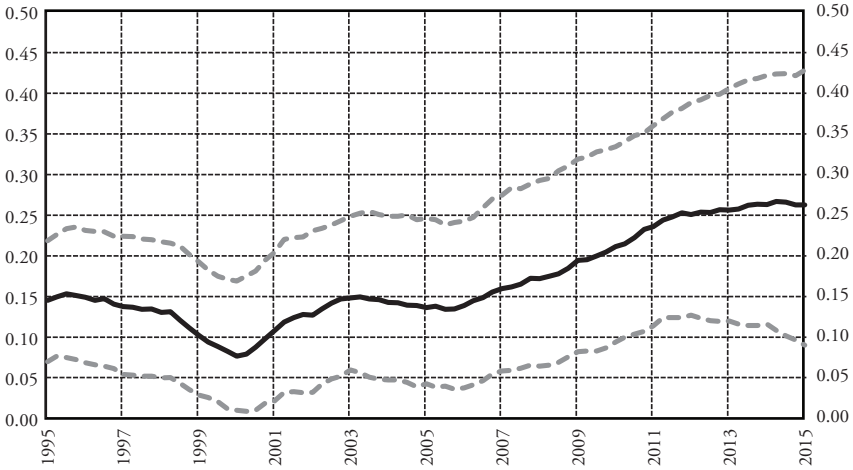
Some variation is also visible in the estimates of the other parameters (Chart 9), with the weight on expectations increasing over most of the 2000s relative to the level of persistence, and the effect of the exchange rate, but not relative to the level of import prices in euro, which slightly increased over time.

Chart 9

## A. Coefficient of Slack Measure



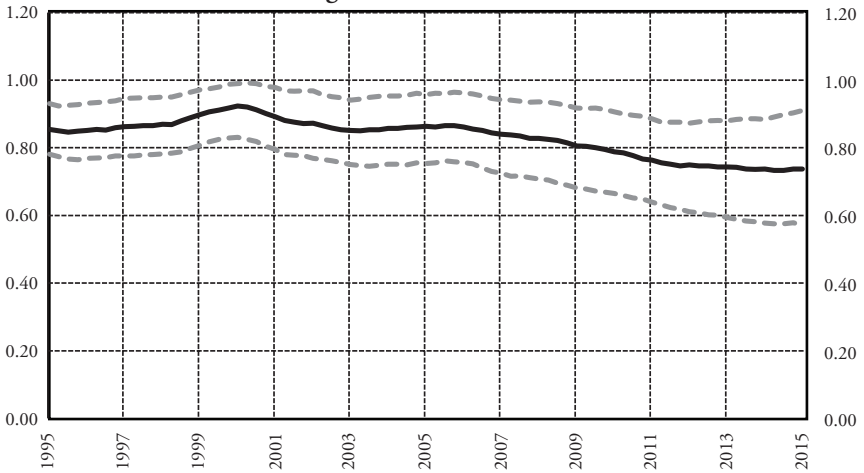
## B. Weight on Expectations



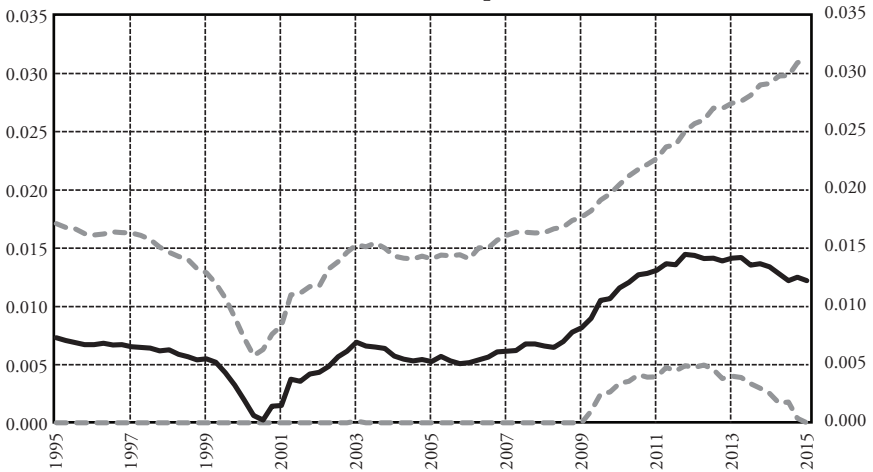
The impact of the change in the central parameter estimates on conditional predictions is not negligible. Indeed, estimating this model with constant and with time-varying parameters and feeding it with technical assumptions based on the June ECB staff macroeconomic projections for import prices, exchange rates and the measure of slack (i.e. the unemployment rate, as the gap is estimated endogenously within the model), as well as for projected inflation expectations, yields

### Chart 9 Continued

C. Weight on Inflation Persistence



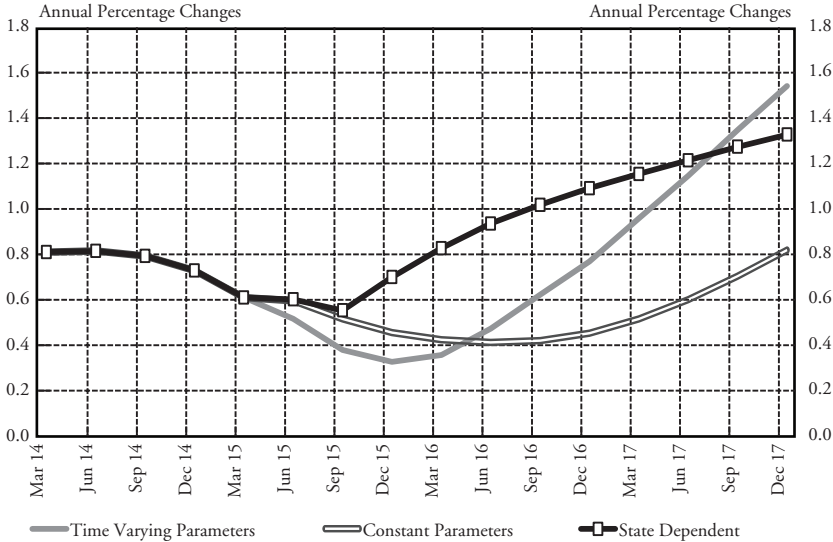
D. Coefficient of Import Prices



Source: ECB staff calculations.

a significantly steeper profile for inflation excluding food and energy over the next two-and-a-half years (Chart 10). The steepening of the Phillips curve also helps improve its ability to fit the low inflation episode, together with the use of measures that indicate wider negative slack and short- to medium-term survey inflation expectations.

**Chart 10**  
**Conditional Forecast of HICP Excluding Energy and Food:**  
**Constant versus Time-varying Parameters**  
**(state-dependent and unrestricted approach)**



Note: conditional on the expected path of the unemployment rate, import prices, exchange rate and a proxy for medium-term inflation expectations for 2015:Q2 to 2017:Q4.

Source: ECB staff calculations.

#### IV. Conclusions and Lessons for Monetary Policy

Inflation dynamics since the Great Recession have shown signs of instability that have led to a sequence of systematic forecast errors. The two puzzles of “missing disinflation” and successive “excessive disinflation” triggered a surge of new research around the Phillips curve and its possible demise, which seems to have been prematurely foretold.

There is an important common factor in inflation in the advanced economies that helps explain national inflation dynamics. The current phase of low inflation, aside from commodity price developments, is significantly influenced by negative demand shocks both at the global and national level.

In particular, the recent low inflation in the euro area was largely triggered by domestic demand weakness, which probably led to a larger degree of economic slack than was predicted by the usual methods.

The Phillips curve seems to survive the recent reassessment and is still a valid tool of analysis in the euro area, meaning that a sustained recovery in inflation is conditional upon real activity and inflation expectations.

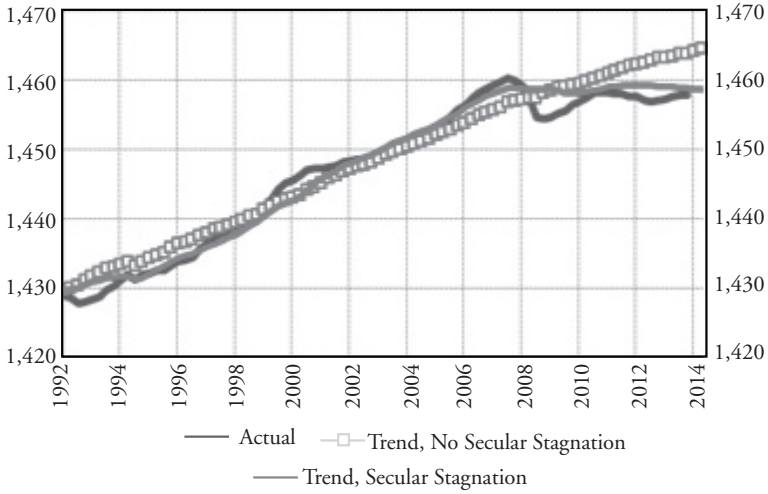
The link between inflation and real activity appears to have strengthened in the euro area recently. Provided our policies are able to significantly reduce the output gap, we can rely on a material effect to help bring the inflation rate closer to target.

---

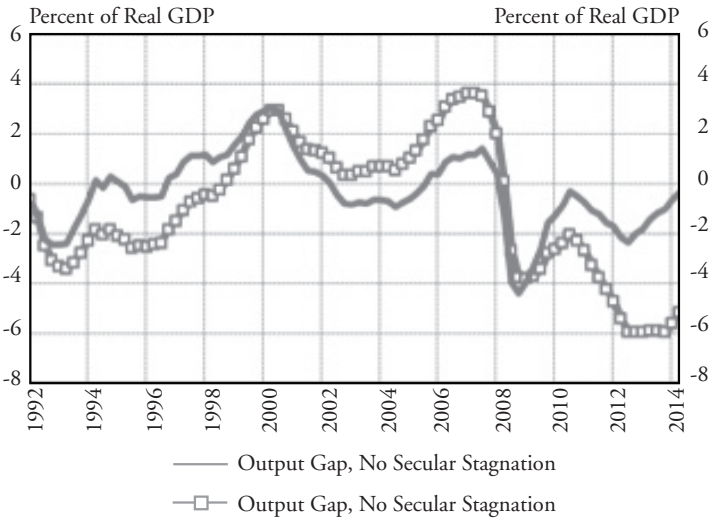
Author's note: I would like to thank the ECB staff members that have done the econometric work for this intervention, in particular, Matteo Ciccarelli, Chiara Osbat, Elena Bobeica, Marek Jarocinski, Carlos Montes-Galdon and Marco Gross.

Appendix

**Chart A-1a**  
**Two Estimates of Potential Output**



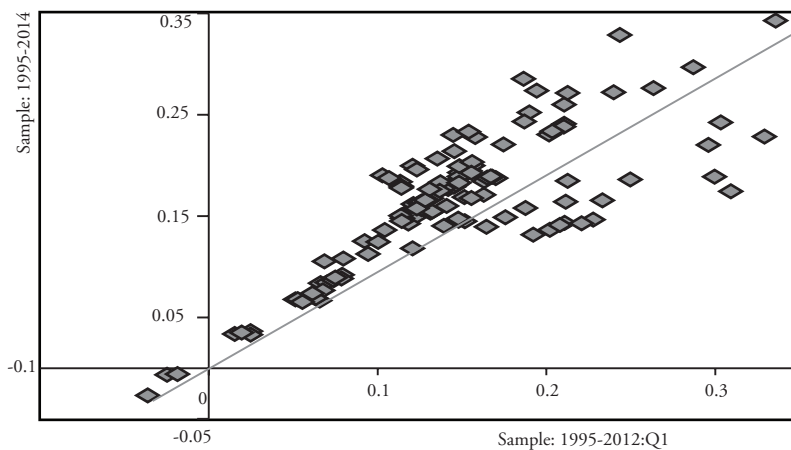
**Chart A-1b**  
**Corresponding Output-gap**



Note: Models include the same real activity indicators (real GDP and its components, unemployment rate, capacity utilization, consumer confidence) but differ in the econometric model of trends:  
 Model 1 (no secular stagnation) – restricts changes in trend output growth.  
 Model 2 (secular stagnation) – allows permanent changes in trend output growth.  
 Source: M. Jarocinski and M. Lenza (ECB WP, forthcoming).



**Chart A-2**  
**Euro Area Philips Curve Estimated Over Two Samples**



Note: Annualized quarter-on-quarter growth rates of seasonally adjusted HICP excluding energy and food regressed against its first lag, lagged slack measure, lagged imported inflation and inflation expectations. Slack measures are standardized for comparability.  
 Source: ECB staff calculations.

## Endnotes

<sup>1</sup>The methodology is similar to Jarociński and Smets (2008), “House Prices and the Stance of Monetary Policy,” Federal Reserve Bank of St. Louis *Review*, July/August, vol. 90, no. 4, pp. 339-65.

<sup>2</sup>See in particular Ball and Mazumder (2014), who use a parsimonious Phillips curve for core U.S. inflation, with only long-term inflation expectations (reduced in practice to a constant) and short-term unemployment. They get a good fit for 2000-14 and even for a long period that starts as early as 1985 (the beginning of the Great Moderation).

<sup>3</sup>Jarocinski, M., and M. Lenza, “Inflation Forecasts in a Bayesian Dynamic Factor Model of the Euro Area,” ECB WP forthcoming.

## References

- Akerlof, G.A., W.T. Dickens and G.L. Perry. 1996. "The Macroeconomics of Low Inflation," *Brookings Papers on Economic Activity*, vol. 27, no. 1, pp. 1-76.
- Ball, L., and S. Mazumder. 2014. "A Phillips Curve with Anchored Expectations and Short-Term Unemployment," NBER Working Paper 20715.
- \_\_\_\_\_, and \_\_\_\_\_. 2011. "Inflation Dynamics and the Great Recession," *Brookings Papers on Economic Activity*, vol. 42, pp. 337-405.
- \_\_\_\_\_, and N.G. Mankiw. 1994. "Asymmetric Price Adjustment and Economic Fluctuations," *Economic Journal*, vol. 104, no. 423, pp. 247-261.
- \_\_\_\_\_, \_\_\_\_\_ and D. Romer. 1988. "The New Keynesian Economics and the Output-Inflation Trade-off," *Brookings Papers on Economic Activity*, vol. 19, no. 1, pp. 1-82.
- Banco de España. 2015. "Variation in the Cyclical Sensitivity of Spanish Inflation: An Initial Approximation," *Economic Bulletin*, July-August 2013.
- \_\_\_\_\_. 2015. Annual Report.
- Bernanke, B. 2010. "The Economic Outlook and Monetary Policy," speech at the Federal Reserve Bank of Kansas City Economic Policy Symposium, Jackson Hole, Wyo.
- Blanchard, O., E. Cerutti and L. Summers. 2015. "Inflation and Activity: Two Explorations, and Their Monetary Policy Implications," presented at the 2015 ECB Forum on Central Banking.
- Christiano, L.J., M.S. Eichenbaum and M. Trabandt. 2014, "Understanding the Great Recession," NBER Working Paper 20040.
- Ciccarelli, M., and B. Mojon. 2010. "Global Inflation," *The Review of Economics and Statistics*, vol. 92, no. 3, pp. 524-535.
- Clark, P., D. Laxton and D. Rose. 1996. "Asymmetry in the U.S. Output-Inflation Nexus: Issues and Evidence," *IMF Staff Studies*, vol. 46.
- Coibion, O., and Y. Gorodnichenko. 2015. "Is the Phillips Curve Alive and Well after All? Inflation Expectations and the Missing Disinflation," *American Economic Journal: Macroeconomics*, vol. 7, no. 1, pp. 197-232.
- Daly, M.C., and B. Hobijn. 2014. "Downward Nominal Wage Rigidities Bend the Phillips Curve," *Journal of Money, Credit and Banking*, vol. 46, (S2), pp. 51-93.
- Del Negro, M., M.P. Giannoni and F. Schorfheide. 2015. "Inflation in the Great Recession and New Keynesian Models," *American Economic Journal: Macroeconomics* 2015, vol. 7, no. 1, pp. 168-196.

- Eisner, R. 1997. "A New View of the NAIRU," in *Improving the Global Economy: Keynesian and the Growth in Output and Employment*, P. Davidson and Jan A. Kregel, eds. Cheltenham, U.K.; Lyme, N.H., U.S.: E. Elgar.
- Ferroni, F., and B. Mojon. 2014, "Domestic and Global Inflation," mimeo.
- Fisher, T.C.G. 1989. "Efficiency Wages: A Literature Survey," Bank of Canada Working Paper No. 89-5.
- Foroni, C., and M. Porqueddu. 2015. "Inflation Dynamics in the Euro Area: The Role of Inflation Expectations and Nonlinearities in the Phillips Curve," mimeo.
- Gilchrist, S., R. Schoenle, J. Sim and E. Zakrajšek. 2015. "Inflation Dynamics During the Financial Crisis," Finance and Economics Discussion Series 2015-012, Washington: Board of Governors of the Federal Reserve System.
- Gordon, R.J. 2013. "The Phillips Curve Is Alive and Well: Inflation and the NAIRU During the Slow Recovery, NBER Working Paper 19390.
- \_\_\_\_\_. 2007. "Phillips Curve Specification and the Decline in U.S. Output and Inflation Volatility," presented at Symposium on The Phillips Curve and the Natural Rate of Unemployment, Institut für Weltwirtschaft Kiel, Germany.
- Iakova, D. 2007. "Flattening of the Phillips Curve: Implications for Monetary Policy," IMF Working Paper No. 07/76.
- International Monetary Fund. 2013. "The Dog That Didn't Bark: Has Inflation Been Muzzled or Was It Just Sleeping?" *World Economic Outlook*, Chapter 3.
- \_\_\_\_\_. 2006. "How Has Globalization Changed Inflation?" *World Economic Outlook*, Washington, D.C.: IMF, April, 97-134.
- Jarocinski, M., and M. Lenza. 2015. "Output Gap and Inflation Forecast in a Bayesian Dynamic Factor Model of the Euro Area," forthcoming ECB Working Paper.
- Krueger, A., J. Cramer and D. Cho. 2014. "Are the Long-Term Unemployed on the Margins of the Labor Market?" *Brookings Papers on Economic Activity*, vol. 48, no. 1, pp. 229-280.
- Macklem, T. 1997. "Capacity Constraints, Price Adjustment, and Monetary Policy," Bank of Canada *Review*, spring, pp. 39-56.
- Medel, C., M. Pedersen and P. Pincheira. 2014. "The Elusive Predictive Ability of Global Inflation," Banco Central de Chile, Working Paper 725.
- Murphy, R. 2014. "Explaining Inflation in the Aftermath of the Great Recession," *Journal of Macroeconomics*, vol. 40, pp. 228-244.

- Oinonen, S. and Paloviita, M. (2014), "Updating the Euro Area Phillips curve: the Slope has Increased," Bank of Finland Research Discussion Papers.
- Riggi, M. and Santoro S. 2015. "On the Slope and Persistence of the Italian Phillips Curve," *International Journal of Central Banking*, vol. 11, no. 2, pp. 157-197.
- \_\_\_\_\_, and F. Venditti. 2015. "Failing to Forecast Low Inflation and Phillips Curve Instability: A Euro-area Perspective," *Journal of International Finance*, vol. 18, no. 1, pp. 47-68.
- Roberts, J.M. 2006. "Monetary Policy and Inflation Dynamics," *International Journal of Central Banking*, vol. 2, no. 3, pp. 193-230.
- Stella, A., and J.H. Stock. 2012. "A State-Dependent Model for Inflation Forecasting," Board of Governors of the Federal Reserve System International Finance Discussion Papers No 1062.
- Stiglitz, J. 1986. "Theories of Wage Rigidity," in *Keynes' Economic Legacy: Contemporary Economic Theories*, J.L. Butkiewicz, K.J. Koford and J.B. Miller, eds., pp. 153-222. New York: Praeger.
- Stock, J.H., and M.W. Watson. 2010. "Modeling Inflation After the Crisis," NBER Working Papers 16488.
- Williams, J.C. 2010. "Sailing into Headwinds: The Uncertain Outlook for the U.S. Economy," Speech 85, Federal Reserve Bank of San Francisco.

