# Explaining Low Inflation: Model-Based Decomposition

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After falling below 2 percent in early 2012, inflation as measured by the price index for personal consumption expenditures (PCE) has averaged 1.2 percent on a four-quarter trailing basis. Over the last four quarters, PCE inflation has been just 0.3 percent. A number of analysts have attributed much of the weakness in inflation to a sharp decline in energy prices and a strengthening of the dollar. But inflation excluding volatile food and energy components (core PCE) has also been running quite low, averaging 1.5 percent over the last four years and 1.3 percent over the last year. These readings are significantly below the Federal Open Market Committee's (FOMC) long-run goal of 2 percent for PCE inflation.

In this article I use a statistical forecasting model—called a Bayesian vector autoregression or BVAR—to explain the factors responsible for the stubbornly low levels of core inflation over the past four years. The model-based decomposition allows us to see the contribution of the different factors. I focus on core inflation to abstract from temporary variations in the PCE that may arise due to volatile food and energy prices. The model characterizes the relationship between core inflation and the factors that have been shown to have some influence on core inflation, such as labor costs, energy prices, the exchange rate, labor market indicators, economic activity, and monetary policy. The analysis presented here extends and updates Clark and Zaman (2013).

Figure 1. US Inflation over the Last 10 Years

Four-quarter percent change
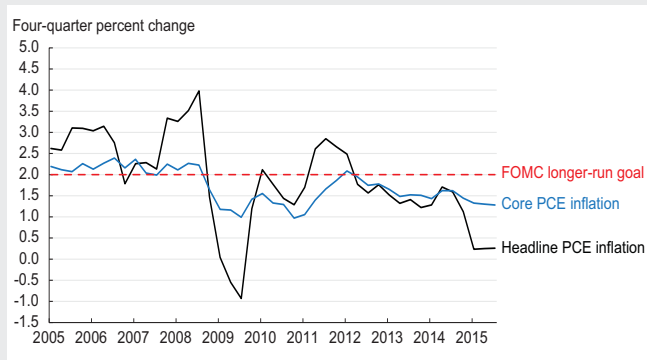
Source: Bureau of Economic Analysis; PCE (Personal Consumption Expenditures Price Index), Core PCE (PCE excluding food and energy components)

From late 2012 to mid-2013, the factors contributing to low inflation were a weaker-than-expected recovery in the labor markets and weaker-than-expected energy prices. Thereafter, the labor market recovered more rapidly than expected, which put upward pressure on core inflation. However, over the past year, the sharp decline in energy prices and the stronger dollar have exerted significant downward pressure on core inflation, equal to about a 0.9 percentage point drag on average, which has more than offset the upward pressure coming from improving labor markets.

We begin by estimating the model using data from 1967:Q2 to 2012:Q1 to forecast core PCE inflation from 2012:Q2 to 2015:Q3 (the period characterized by low inflation). We stop at 2012:Q1, because that is when core PCE inflation peaked. The figure below shows the core inflation forecast (i.e. the model's projection of the most likely path of inflation over the forecast period), along with the 70 percent confidence bands to characterize the normal level of uncertainty around the forecast. Also plotted in the figure is the path that inflation actually followed.

The baseline projection of core inflation very gradually moves up, crossing 1.9 percent by 2015:Q3. Although the baseline forecast tracked the path of actual inflation quite well up through the first quarter of 2013:Q1, from then on it generally came in above it. The unexpected falloffs in 2012:Q3, 2013:Q2, the second half of 2014, and 2015: Q1 were of sizable magnitude, but they were not very big in a historical sense, because those readings were within the model's forecasted 70 percent confidence bands.

It is important to recognize that the baseline forecast of core inflation depends on the forecasts of the other variables in the model. By examining the various shocks that have affected inflation and some of its key determinants, it is possible to identify the potential source of differences between the original forecast and actual inflation.

Accordingly, we next generate a conditional forecast of core PCE inflation. This forecast is conditioned on the actual evolution of all the model's variables except core inflation over the forecast period 2012:Q2 to 2015:Q3. The conditional forecast of core PCE inflation closely tracks the actual evolution of core PCE inflation, suggesting that most of the falloff of core inflation that occurred over the 2012:Q2 to 2015:Q3 period could be explained by movements in the other variables of the model, that is, by unexpected developments in the determinants of inflation.

Figure 2. Baseline Forecast of Core PCE Inflation
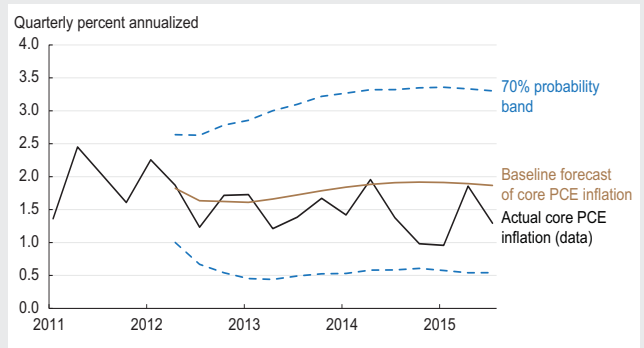
Note: Estimated through 2012:Q1.
Source: Bureau of Economic Analysis; author's calculations.

Figure 3. Conditional Forecast of Core PCE Inflation
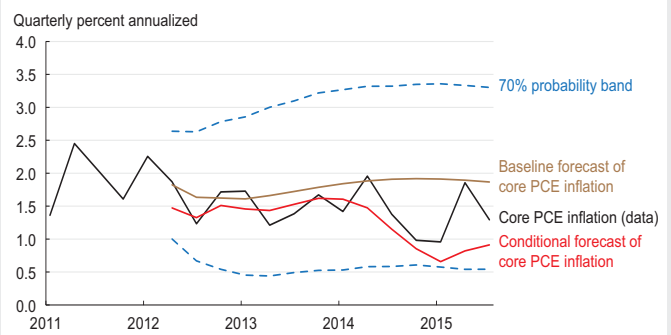
Note: Estimated through 2012:Q1.
Source: Bureau of Economic Analysis; author's calculations.

Next we decompose which specific realized developments in the economy, as captured by the model's variables, have driven inflation lower. Specifically, we use our forecasting model to identify the unique contributions of each variable to the unexpected realized path of core PCE inflation from 2012:Q2 to 2015:Q3.

From the second half of 2014 to 2015:Q1, energy prices declined by 20 percent. (Alternatively, the cumulative decline was 80 percent on an annualized basis over the three quarters). At the same time, the US nominal broad dollar rose by 12 percent. The model posits that these two disinflationary developments generated a significant falloff in core inflation. The forecast path that takes into account the evolution of both energy prices and exchange rate (i.e., the baseline forecast into which only the information on the evolution of energy prices and the exchange rate is incorporated) generally does a decent job of tracking the actual evolution of core inflation. Throughout the forecast period, the actual evolution of energy prices turned out to be below the model's expectations, and so these misses acted as a dampening force on core inflation.

The exchange rate for most of the period under analysis played a marginal role in applying downward pressure on core inflation until third quarter of 2014. Thereafter, it has been acting to push core inflation significantly lower as evidenced by the forecast path with exchange rate developments lying well below the baseline forecast.

One unusual feature of this economic recovery is that labor market slack has been diminishing much more rapidly (especially over the past two years or so) than in previous recoveries, despite very modest growth in real GDP. Over the past four years, the unemployment rate has declined from 8.2 percent to 5.1 percent, while GDP growth has averaged just 2 percent over this period. Not surprisingly, the model's forecast for real GDP growth made using data up to 2012:Q1 is generally higher than the actual path, which has weighed on core inflation. This is evidenced by the forecast path for core inflation that incorporates the evolution of real GDP growth mostly falling below the baseline forecast (with the exception of three quarters in 2013).

On the other hand, the model's expectations for labor market variables have been worse than what actually transpired over the last two years—lower for payroll employment and labor costs, higher for the unem-

Figure 4. Core PCE Inflation Forecast Decomposition
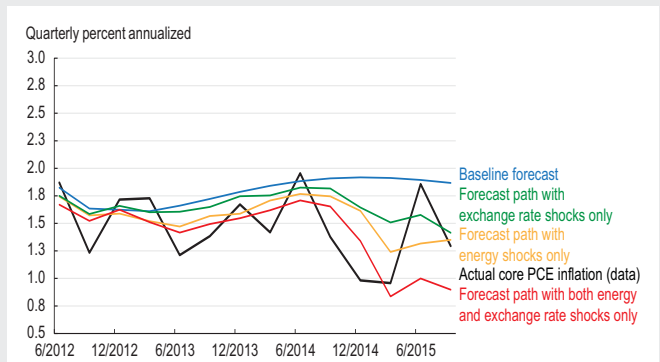
Note: Estimated through 2012:Q1.
Source: Bureau of Economic Analysis; author's calculations

Figure 5. Core PCE Inflation Forecast Decomposition
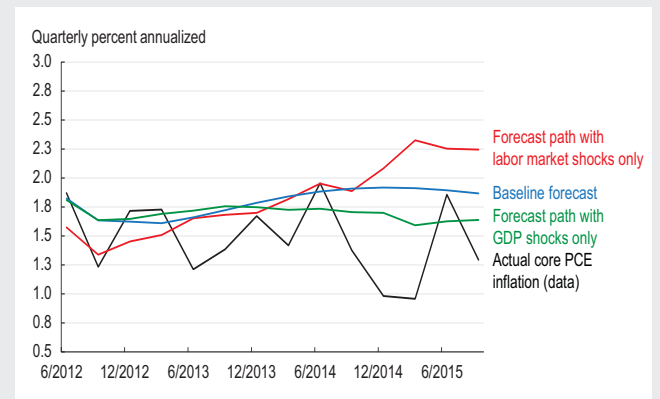
Note: Estimated through 2012:Q1.
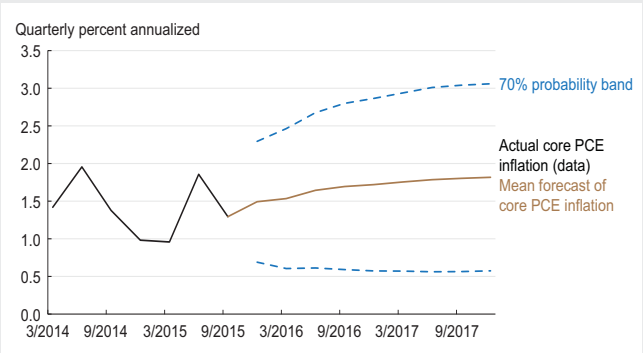Source: Bureau of Economic Analysis; author's calculations.

ployment rate. As a result, the rapid improvement in the labor markets has been putting upward pressure on core inflation as evidenced by the forecast path with labor market developments lying well above the baseline forecast over the last two years or so. This is in contrast to 2012 and early 2013 when the unemployment rate declined slowly relative to the model's expectations and the growth rate of labor costs came in well below expectations. Not surprisingly, from 2012 to the first half of 2013, developments in the labor markets exerted sizable downward pressure on core inflation.

Thus, over the last two years the downward pressure from underperforming real GDP growth has been more than offset by upward pressure from the rapid recovery in labor markets, resulting in small upward pressure on core inflation.

Lastly, to get a sense of this model's projection for core inflation going forward, we use the model to generate a forecast of core inflation over the next two years. Specifically, we estimate it with data from 1967:Q2 through 2015:Q3, to generate a forecast trajectory of core PCE inflation from 2015:Q4 to 2017:Q4. The model projects that core PCE inflation very gradually rises toward the FOMC's long-term inflation goal of 2 percent, ending 2017 at 1.8 percent. As with any inflation forecast, there is considerable uncertainty around this forecast, as shown by the 70 percent confidence bands.

While simple, the forecasting model used in this analysis was able to explain most of the falloff in core PCE inflation over the past four years as a response to other developments in the economy. According to the model, the sluggish pace of labor market recovery in 2012 and 2013 had been restraining core inflation along with lower energy prices. But over the past year or so, the sharp falloff in energy prices and the rapid appreciation of the nominal dollar have acted to significantly restrain core inflation, while the labor market has been putting some upward pressure on inflation. Historical experience suggests that the impact of both temporary energy and dollar shocks on core inflation is usually short-lived. Therefore, to the extent we are confident that economic activity will continue to increase moderately and slack in labor markets will continue to diminish, these factors should put upward pressure on inflation during the next few years, as we forecast inflation to rise at a very gradual pace.

Figure 6. Forecast of Core PCE Inflation Going Forward

Note: Estimated through 2015:Q3.
Source: Bureau of Economic Analysis; author's calculations.