

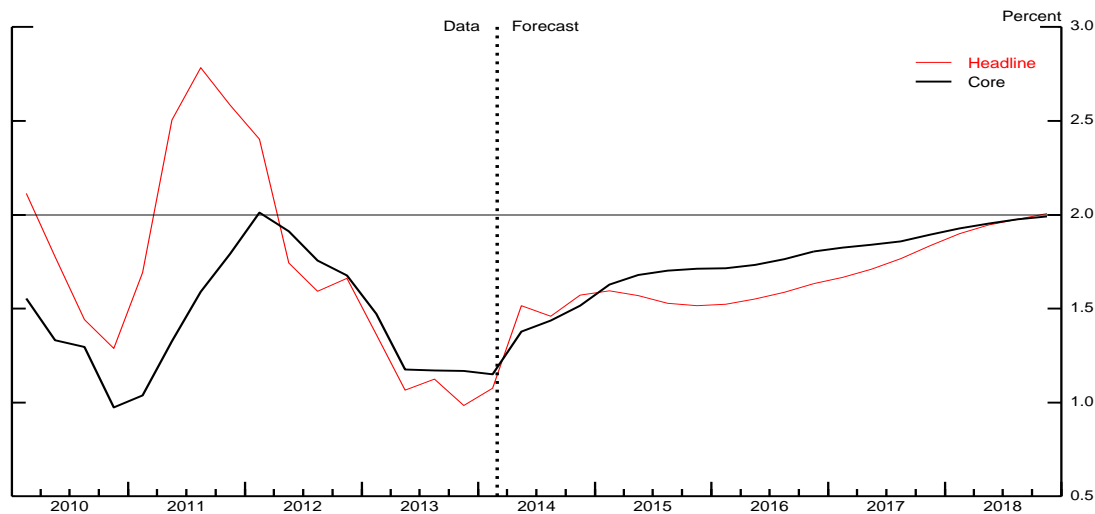
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Why is Inflation Persistently Low in the Judgmental Forecast?

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Both headline and core PCE inflation have averaged roughly 1¼ percent over the past two years, and despite the labor market having improved significantly, they are projected to move up only very gradually during the next few years. For example, in the April Tealbook, PCE inflation was forecasted to remain below 2 percent until 2018 (Figure 1). While projected headline PCE inflation is pushed lower by our anticipated path for crude oil prices, our April forecast for core PCE inflation also remained below 2 percent until 2018. Hence, in the April Tealbook, inflation was expected to fall short of the FOMC’s longer-term inflation objective for the next four years.

Figure 1
Headline and Core PCE Inflation in the April Tealbook
(4-Quarter Changes)



In the staff’s April projection, a portion of the persistent deviation of core PCE inflation from the FOMC’s objective was attributable to the presence of a small margin of product- and labor-market slack until 2016 and to a projected decline in the relative price of core imports. However, even in 2016, when the influence of these factors is small, the staff was projecting a core inflation rate below 2 percent. This is because the staff outlook assumed, as in previous Tealbooks, that the level of PCE inflation consistent with longer-run inflation expectations remaining anchored at current levels and with no slack or other shocks—what we will refer to as the “underlying” rate of PCE inflation—was 1.9 percent over the medium term.

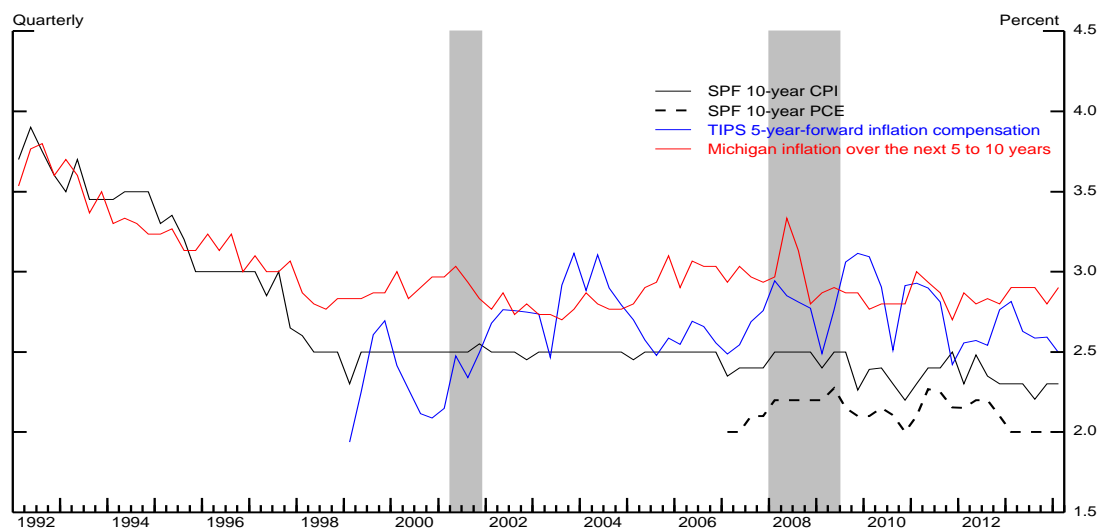
Our assumption of an underlying rate of PCE inflation that is currently below 2 percent is informed both by the reduced-form empirical models that we use for forecasting as well as by other, purely time-series estimates of trend inflation. In this memo, we review this empirical evidence and discuss how it has influenced our inflation projection. We also discuss why the extended Tealbook forecast has inflation returning to the FOMC’s 2 percent objective over the longer term.

To be sure, the effect on our forecast of assuming an underlying rate of inflation that is slightly below 2 percent is small relative to the overall forecast uncertainty that we face; nevertheless, we believe that this assumption yields a more-balanced inflation projection over the medium term. Indeed, for the June Tealbook, we plan to move a little further in this direction and reduce the estimate of underlying inflation that we use in the staff projection to 1¾ percent over the medium term. As a result, we intend to nudge down our June inflation forecast in 2015 and 2016, and to project a slower rate of convergence of inflation to 2 percent over the longer run.

Measures of underlying inflation

Since the late 1990s, survey-based measures of longer-term inflation expectations have been roughly stable even in the face of the Great Recession, outsized swings in commodity prices, and unprecedented monetary policy actions (Figure 2). Similarly, even though TIPS-based measures of longer-term inflation compensation have been much more volatile than survey-based inflation expectations, they also appear to have moved roughly sideways for a decade.

Figure 2
Measures of Inflation Expectations



Note: Prior to 2007, the SPF for PCE inflation was computed by subtracting 0.4 percentage point from the SPF for CPI inflation.

As discussed in the staff's January memo to the FOMC, this apparent anchoring of inflation expectations is a central feature of our inflation forecast in the medium term: As long as expectations remain anchored, our inflation framework implies that, in the absence of supply shocks (such as changes in the relative price of energy or imported goods), inflation will gravitate toward a fixed underlying rate as slack diminishes.¹ However, the underlying rate of PCE inflation is not directly observable. In particular, the empirical analysis on which our judgmental assessment of the underlying rate of inflation rests makes no direct connection to the FOMC's 2 percent objective. Instead, we infer the unobservable underlying rate from the actual experience of inflation and with reference to various indicators of inflation expectations and thus periodically reassess our estimate of this variable.

As shown in Table 1, measures of longer-term inflation expectations—while generally quite stable—do not necessarily agree on the level of expected consumer price inflation: On the high side, households' expectations for inflation over the next five-to-ten years, as reported in the Reuters/Michigan survey, have averaged 2.9 percent over the past 15 years.² On the low side, median expectations for PCE inflation over the next 10 years from the Survey of Professional Forecasters (SPF) have averaged 2.1 percent.

Over this 15-year period, headline PCE and CPI inflation rates were well below the Michigan measure, on average, but were quite close to the corresponding SPF measures. Some analysts use this fact to argue that the level of SPF 10-year expectations is a good indicator of underlying inflation. However, we see this result as largely serendipitous, as repeated upward surprises to crude oil prices boosted consumer energy prices over this period (importantly, these oil price surprises resulted, in our view, primarily from forces that were largely unrelated to domestic U.S. economic developments).³ By contrast, core inflation, which removes the direct influence of consumer energy and food prices and we think more closely reflects changes in domestic inflationary pressures, has remained below survey measures of longer-term inflation expectations over this entire period, with the exception of a couple of years during the mid-2000s when commodity prices surged and the economy was running close to capacity.⁴ Furthermore, an arguably more relevant measure of where SPF participants think inflation is heading in the longer run is the implied average rate of headline inflation from year 6 to year 10 of their 10-year projections. The median value of this measure across SPF participants has been more variable

¹ For a discussion, see Alan Detmeister, Jean-Philippe Laforte, and Jeremy Rudd, "The Staff's Outlook for Price Inflation," January 17, 2014.

² The definition of inflation is left unspecified in the Michigan survey, which asks respondents simply, "By about what percent per year do you expect prices to go up, on the average, during the next 5 to 10 years?"

³ Clearly, participants in futures markets were persistently surprised by the run-up in oil prices in the 2000s. In addition, there is little evidence suggesting that SPF participants anticipated the large increases in energy prices either: For example, in February 2007, the first time the SPF surveyed expectations of core inflation, the median projection for inflation that year was nearly the same for headline and core inflation (at about 2 percent for the PCE measures); by the end of that year, actual headline PCE inflation was 3.3 percent, more than a percentage point higher than for the core.

⁴ Even then, core PCE inflation averaged only one-tenth of a percentage point higher than our estimate of SPF long-run inflation expectations from 2005 to 2007.

and has run a little higher than reported 10-year expectations—and thus averages a little above 2 percent—since the data became available in the mid-2000s.⁵

Table 1. Consumer Price Inflation and Measures of Longer-Run Inflation Expectations

	5-Year Averages Ending in:				Latest 15-Year Average
	1999Q1	2004Q1	2009Q1	2014Q1	
A. Consumer Price Inflation					
Headline PCE	1.6	2.0	2.2	1.7	2.0
Core PCE	1.7	1.7	2.0	1.4	1.7
Headline CPI ¹	2.1	2.5	2.6	2.1	2.4
Core CPI ¹	2.3	2.1	2.2	1.6	2.0
B. Survey Measures of Expected Inflation					
Michigan (5-to-10 years)	3.1	2.9	3.0	2.9	2.9
SPF (PCE, 10 years) ²	2.6	2.1	2.1	2.1	2.1
SPF (CPI, 10 years)	3.0	2.5	2.5	2.3	2.4
SPF (PCE, 5-year forward) ³	---	---	2.1	2.3	---
SPF (CPI, 5-year forward) ³	---	---	2.4	2.5	---
Memo: TIPS 5-year-forward inflation compensation	---	2.5	2.7	2.7	2.7

1. Current methods CPI used. These figures are the same as published data after 1999.

2. Prior to 2007, PCE SPF was computed by subtracting 0.4 percentage point from the CPI SPF.

3. Staff calculations based on individual responses to questions about average 5-year and 10-year inflation expectations. Data begin in 2005Q3 for the CPI and 2007Q1 for PCE.

Given these data, the inflation models that we use in preparing our judgmental forecast imply that when slack is gone and there are no supply shocks, the current values of survey measures of inflation expectations are consistent with a rate of core PCE inflation that is a little less than 2 percent. (These estimates are presented in the first two lines of Table 2.) Specifically, after we control for slack and supply shocks, 10-year expected PCE inflation from the SPF has averaged ½ percentage point more than actual core PCE inflation over our sample.⁶ Our inflation models adjust for this differential and so judge the current 2 percent reading on the SPF to be consistent with 1½ percent core PCE inflation, holding everything else constant.⁷ Similarly, longer-run

⁵ Because these data only start in the mid-2000s, we cannot yet use them in our empirical models.

⁶ This result obtains whether we start our sample in 1988 (our usual model) or in the mid-to-late 1990s, when expectations flattened out and began moving sideways.

⁷ In theory, we could perform the same modeling exercise using indicators of expected inflation derived from financial-market data, such as TIPS yields or inflation swaps. However, the sample periods are still fairly short for

Michigan inflation expectations have averaged more than a percentage point above core PCE inflation over our sample, and our models judge that the 2.9 percent reading from the Michigan survey in 2014:Q1 is consistent with roughly 1¾ percent core PCE inflation when slack is absent and there are no supply shocks.⁸ Making such an adjustment to the observed survey measures has served us well in forecasting: Staff inflation models based on the SPF or Michigan survey measures of longer-run inflation expectations—whose constant term captures the average differential between the survey expectations measure and actual inflation—yield medium-term out-of-sample forecasts over the past 10 years whose mean error is very small and whose root-mean-square error is much lower than that from similar models that omit the adjustment (and thereby force the model’s underlying rate of inflation to more closely match the actual level of the survey measure).

Estimates of inflation’s stochastic trend typically have contours that are similar to survey-based measures of longer-term expected inflation, with the inflation trends declining throughout most of the 1990s and then changing little, on net, after that time (Figure 3).⁹ For core PCE inflation, these estimated trends are currently all below 2 percent: Two popular univariate time-series models—Stock and Watson’s (2007) unobserved-components stochastic-volatility (UCSV) model and Cogley and Sargent’s (2005) time-varying parameter stochastic-volatility model (TVP-SV)—imply underlying rates of core PCE inflation between 1¼ percent and 1½ percent at the end of 2013 (Table 2), while a vector autoregression with time-varying parameters and stochastic volatility (TVP-SV VAR) estimates an underlying rate of 1¾ percent.¹⁰ Although these trend models are purely statistical and incorporate no information from observed measures of inflation expectations, Clark and Doh (2014) argue that, since 1985, they do as well at forecasting core PCE inflation as an autoregressive model based on survey expectations. Nonetheless, one concern is that the current estimates of trend inflation from the univariate models are being unduly influenced by recent experience, in which a deep recession and slow recovery has held down inflation for longer than usual.

these measures; in addition, time-varying risk premia can make it difficult to infer actual inflation expectations from these data.

⁸ This result obtains when we start estimation in 1988; however, when estimation begins in the mid-1990s, the 2.9 percent average reading on Michigan expectations is consistent with roughly 1½ percent core PCE inflation when slack is absent and there are no supply shocks.

⁹ The trends in Figure 3 are estimated using core PCE inflation; trends estimated using total PCE inflation (not shown) exhibit a similar pattern and are only 0.1 to 0.2 percentage point higher at the end of 2013 than the core-based trends.

¹⁰ We follow the same approach as Bednar and Clark (2014) to compute the Stock-Watson and Cogley-Sargent trends, except that Bednar and Clark report results based on overall PCE inflation rather than core. (We thank Todd Clark for providing the computer code for these procedures.) The TVP-SV VAR model contains relative core import price inflation, relative energy price inflation, core PCE inflation, and the staff’s unemployment gap (with that ordering); the estimation procedure used for the model comes from Clark and Terry (2009).

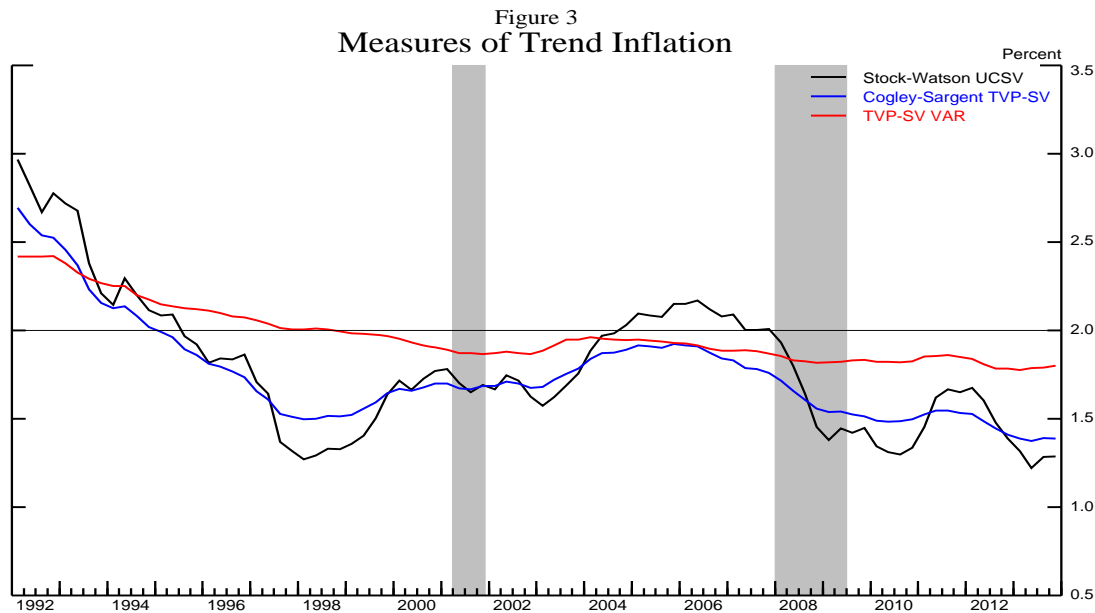


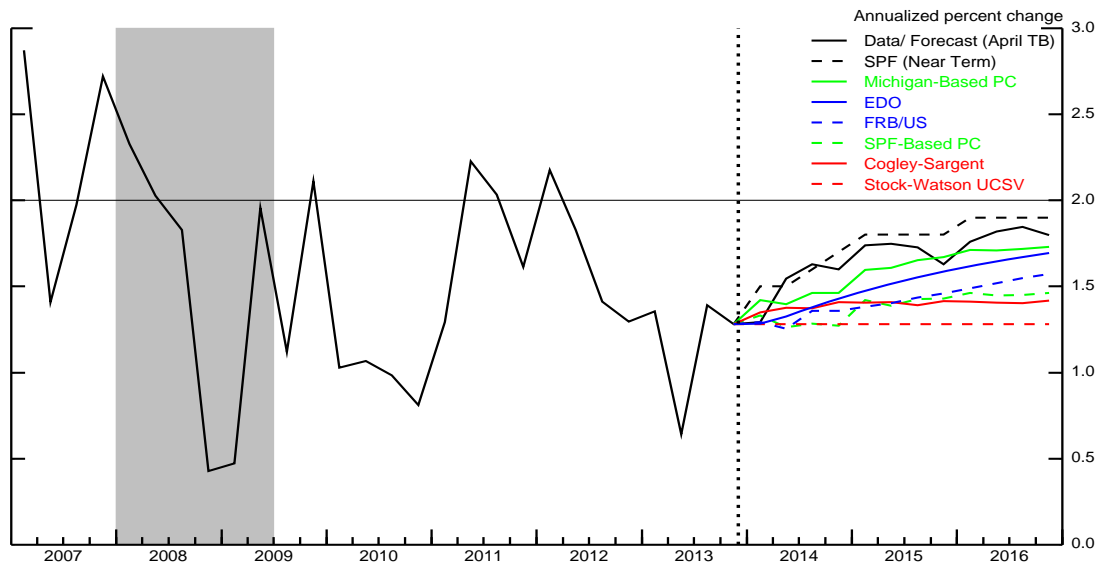
Table 2 reports the latest estimates of underlying inflation from these models along with 70 percent confidence intervals (or credible sets). The point estimates range from 1¼ percent to 1¾ percent; 2 percent is above or at the top end of the confidence intervals for all models other than the TVP-SV VAR model. This range of estimates underscores the difficulty we have in tying down a single point value of the underlying inflation trend for use in the judgmental forecast. Moreover, as a practical matter, it will likely be difficult for us to ascertain in real time whether our current estimate of the trend is correct, given the noisiness of the inflation data and various other sources of forecast uncertainty that we face.

Table 2. Indicators of the Underlying Rate of Core PCE Inflation (Percent)

Model	Current Estimate	70 Percent Conf. Interval/ Credible Set
Phillips Curve with Michigan expectations	1.8	1.7 to 2.0
Phillips Curve with SPF expectations	1.5	1.4 to 1.7
Stock-Watson UCSV trend	1.3	1.0 to 1.5
Cogley-Sargent trend	1.4	1.1 to 1.7
Time-varying parameter VAR	1.8	1.1 to 2.5

The projections implied by a number of inflation models are shown in Figure 4, together with the staff's core inflation forecast from the April Tealbook and the latest medium-term inflation projections from the SPF. For the models that include survey expectations, the projections are constructed under the assumption that expectations remain unchanged at their recent levels; in that case, projected inflation converges toward the models' estimates of underlying inflation. Similarly, for the univariate stochastic-trend models, the projections converge quickly to their estimated stochastic trends. As is evident from the figure, the staff's April Tealbook projection lies above all of the model projections. This statement is also true with respect to projections from the FRB/US and EDO models, which explicitly assume that the public's inflation expectations are anchored at 2 percent in the long run and that actual inflation must eventually move to that level (though this process can take a number of years). Finally, in contrast to the projections from our models, SPF projections for core PCE inflation over the next three years are a little higher than the staff's April Tealbook outlook but are nevertheless also below 2 percent through 2016.¹¹

Figure 4
Core PCE Inflation and Projections over the Medium Term in the April Tealbook



¹¹ The SPF projections for core PCE inflation shown in Figure 4 are based on the quarterly projections in the February release (which extended through 2015:Q1) and then on the reported 4-quarter inflation rates for 2015 and 2016. The projections from the May SPF are essentially the same as in February. Although not shown in the chart, recent observations on inflation swaps suggest that market participants do not expect CPI inflation to return to 2.3 percent (approximately consistent with PCE inflation of 2 percent) until at least 2017 (Bauer and Christensen, 2014).

Based on our reading of the available evidence summarized above, we have lowered our assessment of the medium-term underlying rate of inflation for the June Tealbook projection from just under 2 percent to 1¾ percent. By itself, this revision will lead us to slightly reduce our medium-term projection for both overall and core PCE inflation, thereby moving us closer to the center of the distribution of model forecasts shown in Figure 4.

The longer-run inflation outlook

Beyond the medium term, we continue to project that PCE inflation will move up gradually toward the FOMC's objective of 2 percent, as inflation is boosted by the modest overshooting of the unemployment rate below its natural rate and of GDP above its potential. Inflation expectations edge up in this environment, reinforcing the convergence of overall PCE inflation to 2 percent. Thus, inflation expectations, whose anchoring has been such an important feature of our inflation outlook, will eventually move higher in the economic environment we are projecting beyond the medium term. Nonetheless, we now expect the convergence of inflation to 2 percent to take somewhat longer than in previous projections. Clearly, among the many risks to the inflation outlook is the possibility that expectations could remain consistent with inflation that remains slightly lower than 2 percent for even longer than we are now projecting.

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