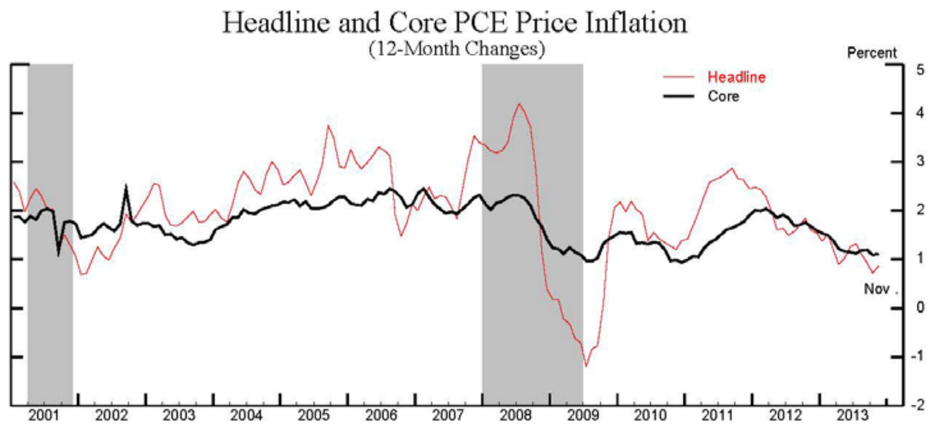
The Staff's Outlook for Price Inflation

Alan Detmeister, Jean-Philippe Laforte, and Jeremy Rudd
January 17, 2014

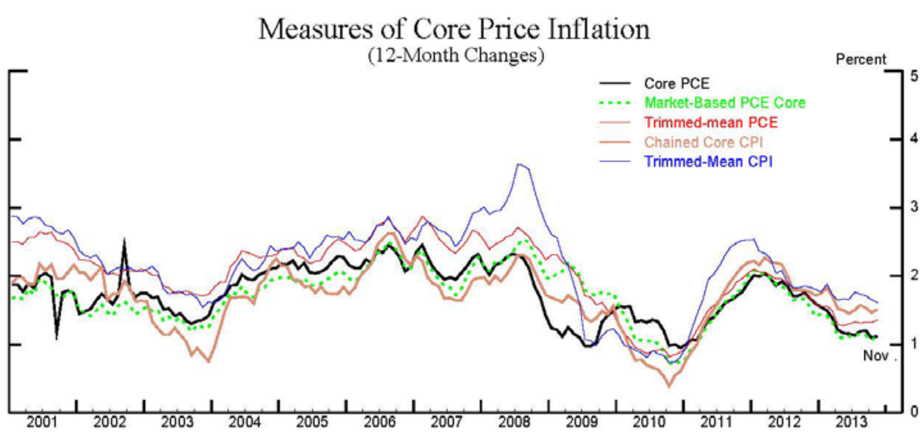
Both total and core PCE inflation have declined noticeably over the past two years, with core PCE inflation currently near the low end of the range of readings seen since the last recession began (Figure 1). The recent downtrend in core PCE inflation has been broadly mirrored by a number of other measures of underlying inflation, including the trimmed-mean and core market-based PCE price indexes and the core chained and trimmed-mean CPIs (Figure 2).

Figure 1



Note: The shaded bars indicate a period of business recession as defined by the National Bureau of Economic Research

Figure 2



Despite this recent deceleration in core prices, in the December Tealbook the staff expected core PCE inflation to increase gradually over the next several years, rising from 1.1 percent in 2013 to 1.7 percent in 2016. The projected contour of headline PCE inflation was broadly similar, with headline inflation rising from 0.9 percent in 2013 to 1.6 percent in 2016. We expect that the projections in the January Tealbook will be substantially the same.

The purpose of this memorandum is to explain the rationale for the staff's baseline inflation forecast and to identify some of the issues and questions that surround our outlook for price inflation. We begin with a brief description of the conceptual framework that the staff uses to interpret historical movements in inflation and that underpins our judgmental inflation projection.

How the staff thinks about inflation dynamics

The staff produces a baseline projection for headline PCE inflation by combining forecasts for consumer food and energy prices with a projection for core inflation.[1] While the various empirical models of core inflation that we consult differ in important ways, our basic starting point for thinking about and modeling inflation developments is an expectations-augmented Phillips curve of the form

$$\pi_t = \pi^e_{t-1} + \alpha\left(\pi_{t-1} - \pi^e_{t-1}\right) + \beta X_t + \zeta Z_t + \varepsilon_t \qquad (0 < \alpha < 1). \qquad (1)$$

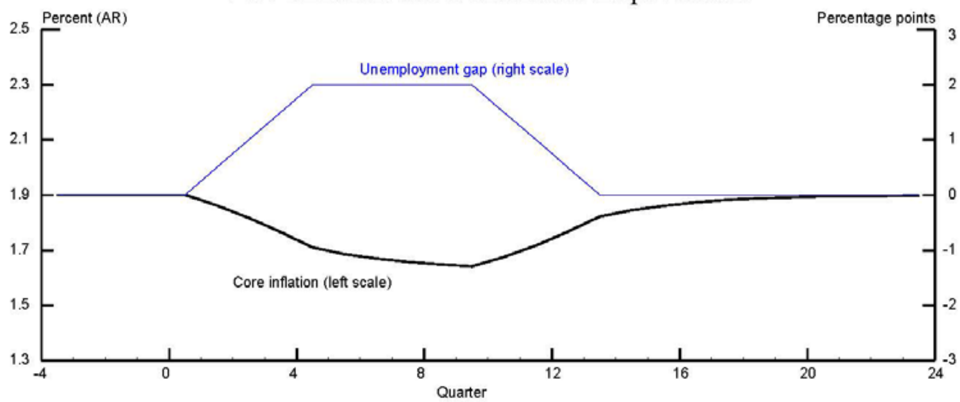
Here, π is core inflation; π^e is the staff's judgmental estimate of the public's long-run inflation expectation (which is informed by survey and financial-market measures); X is a measure of slack (for example, the staff's estimate of the unemployment gap); Z is a set of supply shocks (such as changes in the relative price of energy or imported goods); and ε is a residual, which captures sources of inflation variation (for example, unusual movements in nonmarket core PCE prices) that are unrelated to the model's other determinants of inflation. To capture the sluggish adjustment of inflation to changes in expected inflation, slack, and other factors, the framework allows for a lag (in practice, multiple lags) of core inflation; eventually, however, permanent changes in expected inflation pass through one-for-one into actual inflation.

In this framework, the effect of slack or other factors on core inflation depends importantly on whether these influences also affect long-run inflation expectations. All else equal, an increase in slack will push inflation lower. If long-run inflation expectations are well anchored, inflation will remain at this lower level as long as the unemployment gap persists; as slack diminishes, inflation will move back up toward its long-run expected level (see Figure 3, which provides a stylized example of such a scenario). Similarly, a transitory supply shock, such as a temporary decline in import price inflation, will yield only a temporary reduction in core inflation if inflation expectations are unaffected by the shock. These results stand in contrast with those from a traditional "accelerationist" Phillips curve, where inflation expectations are implicitly assumed to be formed as a distributed lag of actual past inflation with lag coefficients that sum to one. In such a model, when a temporary increase in economic slack—or some other transitory shock—reduces inflation, inflation remains *permanently* lower, because the initial decline in inflation leaves a permanent imprint on inflation expectations.

[1] Our projection for consumer food and energy prices is importantly informed by our outlook for commodity prices, which is in turn largely based on the price forecasts implied by futures markets for farm products and energy goods.

Figure 3

Effect of a Temporary Increase in Slack on Core Inflation under Anchored Expectations



At present, the staff's interpretation of observed inflation dynamics leans heavily on the notion that inflation expectations are well anchored (that is, essentially constant). We have adopted this hypothesis both because it seems consistent with recent observed inflation behavior and because survey measures of longer-term expected inflation have changed little in recent years despite the financial crisis and subsequent deep recession; significant swings in energy, commodity and import prices; and important changes in the conduct of monetary policy. Nevertheless, even with fully anchored inflation expectations, the staff's framework implies that inflation can be affected by slack, and that significant year-to-year swings in inflation can result from supply shocks or idiosyncratic changes in inflation.

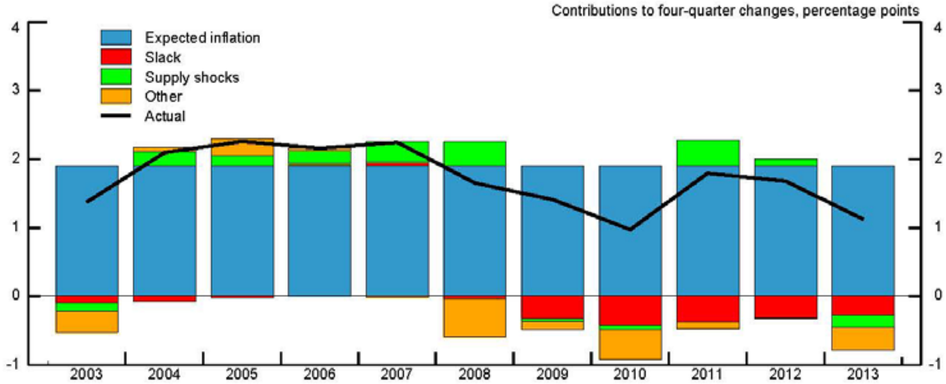
Figure 4 provides a rough quantitative idea of how important these various determinants of inflation have been in recent years using a calibrated version of equation (1) and under the assumption of fully anchored expectations.[2] According to this equation, since the recession began slack has made a modest negative contribution to core inflation that has gradually diminished as the unemployment gap has narrowed. However, in some years the contribution of supply shocks has been just as large (for example in 2011, when imported goods prices rose sharply).[3] Moreover, some years have seen noticeable movements in inflation that are unrelated to supply shocks or changes in slack, including 2008 (when nonmarket price inflation fell sharply), 2010 (which appears largely attributable to noise), and 2013 (which we discuss below). Thus, this decomposition highlights a key point: For all the attention given to slack, it represents only one of several determinants of inflation.

[2] For the purposes of this decomposition, the contribution of each component includes the effect that it has on lagged inflation. Note that because this decomposition is retrospective (it uses actual past values of the slack and supply-shock terms, rather than the staff's real-time forecasts of these terms), the "other" component shown here will not necessarily line up with historical Tealbook forecast errors.

[3] The measure of imported goods prices that the staff uses in our inflation equations excludes petroleum, natural gas, computers, and semiconductors.

Figure 4

Estimated Contributions to Core PCE Inflation



Note: 2013 observation uses staff forecasts for 2013:Q4

While the framework described above underpins the judgmental baseline projection for core inflation over the medium term, two other models—FRB/US and EDO—are also employed at the Board for forecasting and policy evaluation; in particular, the FRB/US model is used to construct the extended projection and alternative simulations that are shown in Book A of the Tealbook. Besides being general-equilibrium in scope, the FRB/US model can be run under a variety of expectational assumptions, including VAR-based or model-consistent (rational) expectations. In addition, the inflation block of FRB/US is more closely tied to a specific theoretical model of price determination (the new-Keynesian Phillips curve), while EDO, a medium-scale DSGE model, is even more explicitly new Keynesian in nature. (Later in this memo, we compare the medium-term inflation projections from these models with the staff baseline forecast.)

Explaining the baseline inflation outlook

Table 1 presents the staff's medium-term PCE inflation projection from the December Tealbook, together with our quantitative assessment of the factors contributing to inflation over the forecast period. In contrast to the estimates shown in Figure 4, the values in the table are judgmental—in particular, they are not derived from a single model. In addition, for this exercise we have broken out the contribution of lagged inflation—as summarized by the gap between actual past inflation and expected inflation, $\alpha(\pi_{t\text{-}1}-\pi^e)$ in equation (1)—as a separate item in the table, rather than spreading it across the contributions of the various other determinants as was done in Figure 4. (In the table, this term is called the "inflation gap.")

Table 1. Decomposition of the December Tealbook Inflation Forecast
(Percentage point contributions to Q4-over-Q4 changes)

	2013	2014	2015	2016
Headline PCE inflation	**0.9**	**1.4**	**1.4**	**1.6**
Contribution of relative food and energy prices:	*−0.2*	*−0.05*	*−0.15*	*−0.1*
Core PCE inflation	**1.1**	**1.4**	**1.6**	**1.7**
Contribution to core inflation of:				
Expected inflation, π^e	1.9	1.9	1.9	1.9
Inflation gap, $\alpha(\pi-\pi^e)$	−0.05	−0.1	−0.05	−0.05
Slack, βX	−0.35	−0.25	−0.15	−0.1
Supply shocks, ζZ	−0.15	0.0	0.0	0.0
Other factors, ε	−0.2	−0.1	−0.05	0.0

Notes: Detail may not sum to totals because of rounding. The "other factors" line includes the contribution of core nonmarket inflation, as well as the contributions of factors that are unrelated to other fundamentals.

Under the staff's interpretation, supply shocks (specifically, a decline in imported goods prices) and the continued presence of a sizeable margin of slack have together pushed down core PCE inflation over the past year by about ½ percentage point relative to the level implied by long-run expected inflation. However, as the table's "other factors" line indicates, core PCE inflation over the past year has come in somewhat lower than can be explained by import prices and slack. About 0.1 percentage point of this additional recent softness in PCE price inflation is attributable to medical services prices, which in turn reflect the effects of the federal budget sequestration and a slowdown in Medicare reimbursement rates. (While we do not expect the sequestration-related reductions in medical prices to be repeated, we do anticipate below-trend growth in these prices over the next couple of years as tight government budgets continue to put downward pressure on Medicare and Medicaid reimbursement rates; the contribution of these prices in 2014 and beyond is shown in the "other factors" line.) In addition, the nonmedical portion of core nonmarket PCE prices rose at a below-average pace over the past year.[4]

Over the remainder of the medium term, core PCE inflation is projected to move higher as the unemployment gap closes, core import price inflation returns to a modest positive rate of increase, and a portion of 2013's transitory weakness in core inflation unwinds. (Our projection for core import prices is informed by futures prices for commodities, which suggest a relatively flat trajectory of these prices in coming years, and by our assumed pace of dollar depreciation, which puts upward pressure on import prices.) As actual inflation begins to move closer to expected inflation, the contribution of the inflation "gap" also becomes less negative, albeit with a lag (in particular, 2013's low inflation results in a slightly *more* negative contribution of this term in 2014).[5] In 2016, the contemporaneous and lagged effect of slack keeps core inflation slightly below the level of long-run expected inflation, which is assumed to be constant at 1.9 percent throughout the medium term.[6] The contour of headline PCE inflation is broadly similar to that of core; headline inflation runs slightly below core as futures markets imply a downtrend in crude oil prices (with corresponding declines in consumer energy prices) through 2016. Beyond the medium term, long-run expected inflation is projected to edge up toward the FOMC's objective of 2 percent, and PCE inflation itself reaches 2 percent by the end of 2019.[7]

Uncertainty around the baseline projection and recent staff forecast errors

Figure 5 plots the staff baseline projection through 2015 for headline inflation (panel A) and core PCE inflation (panel B) from the December Tealbook, together with 70 percent confidence intervals derived from the staff's historical forecast errors.[8] The relatively wider interval around the headline inflation projection indicates the greater unpredictability of consumer energy and

[4] The nonmarket component of the PCE price index can be quite erratic, and historically nonmarket inflation has tended to be mean-reverting. Hence, the staff typically assumes that unusual movements in nonmarket inflation are transitory.

[5] Less mechanically, the contribution of this term reflects the combined lagged contributions of fundamentals such as slack and supply shocks, whose full effects are typically spread over more than one year.

[6] Prior to last summer's comprehensive revision to the National Accounts, the staff assumed long-run expected inflation of 2 percent. The comprehensive revisions incorporated a change in methodology for measuring unpriced financial services (a nonmarket component) that lowered measured core PCE inflation over the past 25 years by 0.1 percentage point per year on average. Hence, in the September 2013 Tealbook the staff adjusted down their estimate of expected inflation by an equal amount to reflect the lower rate of trend inflation seen over history.

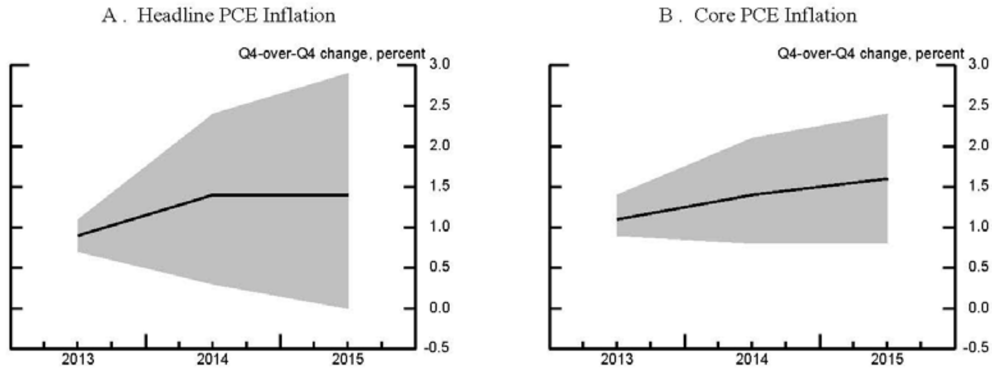
[7] After the medium term, long-run inflation expectations are projected by an FRB/US equation that allows these expectations to gradually move toward the FOMC's 2 percent inflation objective.

[8] Stochastic simulations from FRB/US computed over the same period generate 70 percent confidence intervals two years ahead that are a little narrower; specifically, they range from 0.5 percent to 2.3 percent for headline inflation and from 1.0 percent to 2.1 percent for core inflation.

food prices. Nevertheless, significant uncertainty attends the core inflation projection as well, with the 70 percent confidence interval two years ahead ranging from 0.8 percent to 2.4 percent.[9]

Figure 5

Uncertainty Around the Baseline Inflation Projection

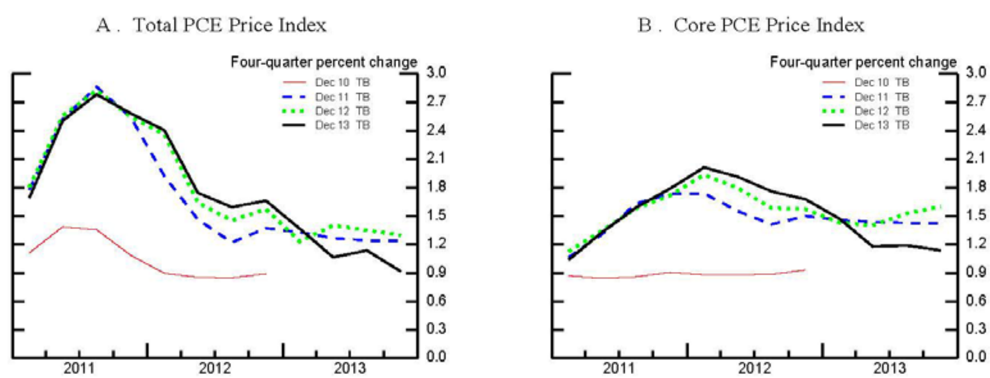


Note: Shaded region gives 70 percent confidence interval derived from 1993-2012 Tealbook errors

Figure 6 shows the evolution of the staff's PCE inflation forecast since the December 2010 Tealbook. An important point to take from this figure is that recent forecast errors have been two-sided: In 2011, for example, inflation came in considerably higher than the staff projected; more recently, inflation has surprised us to the downside. While it is difficult to know with much certainty, part of the 2011 forecast error appears to be attributable to an unexpected supply shock (an increase in energy and imported goods prices). In addition, in 2010 the staff was still putting some weight on the forecasts from accelerationist-style Phillips curves, which led us to predict a reduction in trend inflation (especially after seeing 2010's low core inflation read). The more-recent downward surprise to inflation reflects, in our view, lower-than-expected import price inflation, together with the unexpected softness in medical services prices and nonmedical nonmarket prices discussed above.

Figure 6

Evolution of Staff Inflation Forecast



[9] Using historical forecast errors and the December Tealbook projection, the probability of seeing a negative core PCE inflation rate by the end of 2014 is 3 percent (by the end of 2015, the probability is 6 percent).

Comparison of the staff inflation forecast with FRB/US and EDO

Table 2 reports the December Tealbook core PCE price forecast along with the forecasts from the FRB/US and EDO models.[10] The relatively low rate of inflation projected by FRB/US at present largely reflects the model's use of actual past inflation to generate expectations of future inflation, rather than a different forecast for economic conditions and the markup; if instead the model's expectations are forced to be more fully anchored (not shown), the resulting forecast is much closer to the Tealbook baseline. By contrast, the EDO model's projection is very close to the Tealbook forecast; here, the small difference arises because the model's measure of slack (real marginal cost) returns to its long-run level somewhat more slowly than the unemployment gap closes in the Tealbook projection. At present, the differences between the staff's judgmental inflation outlook and the two model-based projections are easily encompassed within the likely confidence intervals that surround these forecasts.

Table 2. Comparison of the December Tealbook Inflation Forecast with FRB/US and EDO
(Q4-over-Q4 changes, percent)

	2013	2014	2015	2016
Core PCE inflation, staff	**1.1**	**1.4**	**1.6**	**1.7**
FRB/US	1.1	1.1	1.1	1.3
EDO	1.1	1.3	1.5	1.6

Note: The FRB/US and EDO projections shown here were computed at the same time as the December 2013 staff forecast.

Some key issues surrounding the inflation outlook

The observed evolution of the empirical inflation process over time, the difficulty we often have in explaining historical inflation developments in terms of fundamentals, and the lack of a consensus theoretical or empirical model of inflation all contribute to making our understanding of inflation dynamics—and our ability to reliably predict inflation—extremely imperfect. The remainder of this memo provides an overview of some of the key issues we are currently struggling with in thinking about the inflation outlook.

The role of inflation expectations

As noted above, inflation expectations are a key element of the framework we employ to analyze and project inflation developments. However, a number of issues surround how we use and forecast these expectations.

[10] In line with the FRB/US forecasts presented each round in the Tealbook, the FRB/US forecast shown in the table uses VAR-based expectations.

- One issue is that economic theory does not clearly identify *whose* inflation expectations should matter—those of households, businesses, financial-market participants, or professional forecasters. In practice, this issue has not been of great consequence during the past fifteen years or so because all the main measures that we monitor have been roughly stable during this period. However, the issue could become important if some measures of inflation expectations were to become unhinged.[11,12]

- A second issue is that theory suggests that short-term expectations should be more relevant to price setting than long-term expectations.[13] However, the staff has had little success in modeling or forecasting inflation with measures of short-term inflation expectations.[14] In contrast, models that use survey-based measures of longer-term expected inflation provide a relatively good description of observed inflation dynamics; the reason for this empirical success appears to be that these survey measures provide a reasonable characterization of inflation's stochastic trend, which some researchers argue is critical for producing accurate forecasts of inflation (Clark and Doh, 2011; Faust and Wright, 2012).

- A third issue is that the survey-based measures of longer-run expected inflation that the staff follows most closely have been roughly constant for the past fifteen years (see Figure 7). As a result, if the sample period is confined to recent history, the task of constructing a meaningful empirical model *of inflation expectations* is rendered essentially impossible. If the sample period is extended backward in time to include earlier periods of instability in long-run expectations, the resulting model tends to predict large counterfactual declines during the most recent recession.[15]

---

[11] Surveys of businesses (specifically, of persons within firms whose job it is to set prices), such as the Atlanta Fed's business inflation expectations survey, might eventually prove to be a useful complement to currently available measures. (Like other measures, the Atlanta Fed series—which starts in late 2011—suggests little sustained movement in inflation expectations during the past few years.) In addition, data from the New York Fed's Survey of Consumer Expectations (which will start to be reported this year) should provide useful additional information on medium-term consumer inflation expectations and uncertainty.

[12] The staff also keeps close tabs on inflation expectations measures derived from financial market data. However, such measures can be difficult to interpret. In their raw form, measures such as breakeven inflation rates implied by yields on nominal and inflation-indexed Treasuries (TIPS) can be affected by conditions idiosyncratic to the Treasury market (such as market liquidity). Thus, models are often used to back out measures of "true" inflation expectations from these yields—or from a broader array of financial-market variables, as is done by Cleveland Federal Reserve Bank staff. (Neither the TIPS-based or Cleveland Fed measures of long-run expected inflation have moved much, on net, since the end of the last recession.)

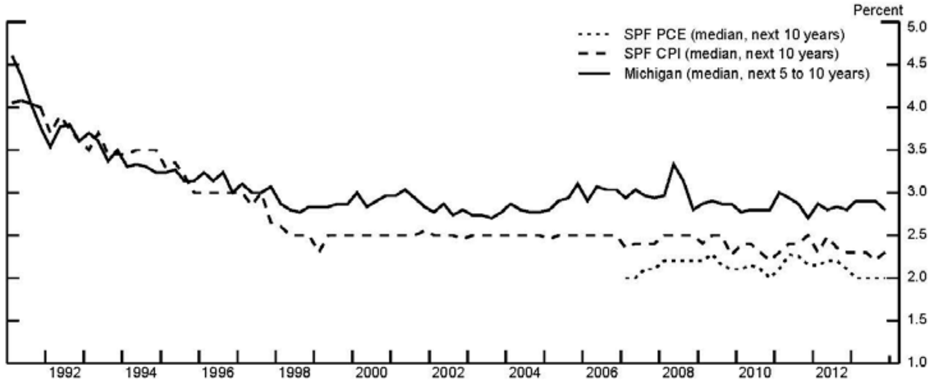
[13] For example, in the original Phelps-Friedman characterization of the expectations-augmented Phillips curve, the relevant expected inflation term is $E_{t-1}\pi_t$, while most of the commonly used new-Keynesian Phillips curve models include an expected inflation term that is given by $E_t\pi_{t+1}$. Both of these represent short-horizon inflation forecasts.

[14] Coibion and Gorodnichenko (2013) argue that a model using a survey measure of short-term inflation expectations fits recent inflation behavior well; however, minor modifications to their timing assumptions significantly weaken their results. (Intuitively, much of the quarterly variation in short-term inflation expectations reflects movements in actual food and energy prices; hence, while time-*t* expectations can explain much of the variation in time-*t* headline inflation—as Coibion and Gorodnichenko find—the relationship is not robust to using lagged expectations, nor is it particularly useful for forecasting.)

[15] A challenge closely related to the lack of a satisfactory empirical model of inflation expectations is that neither we nor anyone else has been able to provide a structural account of why these expectations have become more anchored

Figure 7

Survey Measures of Long-Run Expected Inflation



We perceive two main risks related to our handling of inflation expectations. The first stems from the fact that, absent a workable model of the determinants of long-run inflation expectations, we assume in putting together the inflation forecast that these expectations will remain anchored. This situation exposes us to the danger that we could fall "behind the curve" if expectations were to become unanchored: In practice, it seems unlikely that we would significantly revise our estimate of long-run expected inflation until the measures we follow had consistently and persistently moved outside the ranges in which they have fluctuated over the past several years. (In addition, without a way to predict future trends in expected inflation, any revisions to our expected inflation assumptions would—at least at first—probably take the form of a random walk, with the current observed level extrapolated over the forecast period.)

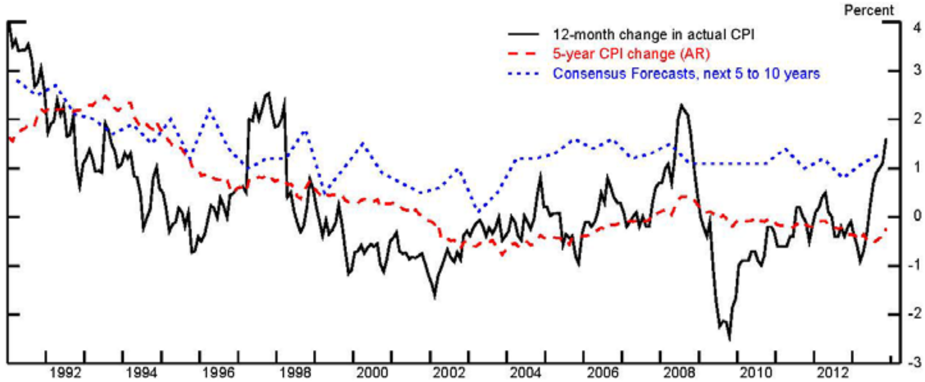
A second important risk is that even if the measures of long-run inflation expectations that we rely on were to remain stable, those expectations could become detached from actual inflation, just as seems to have happened in Japan. As Figure 8 shows, over the past decade actual inflation in Japan has fallen persistently short of a survey-based indicator of long-run expected inflation by a noticeably larger margin than had been seen prior to that date.

---

of late—though we presume that improved Federal Reserve credibility has played a role. (Using a VAR-based approach, Clark and Davig, 2011, attribute most of the observed decline in the overall volatility of a measure of longer-term inflation expectations—obtained from a survey of forecasters—to the reduced variance of shocks to long-run expectations themselves. They interpret this finding as *consistent* with a shift in the conduct of monetary policy to more-systematic behavior, which would allow agents to better infer the central bank's inflation goal.)

Figure 8

Actual and Expected Inflation in Japan



The nature and role of economic slack

As noted above, our accounting implies that slack has made a modest negative contribution to core inflation since the recession began, while the projected reduction in slack contributes to a gradual uptrend in inflation over the forecast period. For these estimates, slack is defined as the difference between the actual unemployment rate and the staff's estimate of its natural rate (the "unemployment gap").[16]

While the use of an unemployment gap to measure slack is intuitively appealing—and has a long history in the literature on empirical inflation modeling—it is at odds with the new-Keynesian models of price setting that have become standard in many analyses. In these models, prices are determined by real marginal costs, which—under certain assumptions—can be measured by real unit labor costs (equivalently, labor's share of income). As an empirical matter, labor's share of income has not proven to be a more-reliable gauge of inflationary pressures than the unemployment gap; moreover, its large secular decline since the early 2000s appears inconsistent with the relative stability of actual inflation (King and Watson, 2012), and real-time estimates of the measure are unreliable (Koenig, 2003).[17] Thus, whatever imperfections might attend the unemployment gap as a measure of slack, the problems surrounding the use of labor's share of income seem at least as severe.[18] Nevertheless, the current low level of the labor share could

[16] The staff also measures slack as the difference between actual and potential GDP (the "output gap"). As Fallick and Rudd (2012) discuss, the staff's estimates of the output and unemployment gaps are closely related in practice (over the estimation period used by many of our inflation forecasting models, the two gaps have a correlation coefficient of around 0.95), and for the most part are not intended to convey independent information about economic slack.

[17] As a result, models that feature a role for the labor income share (such as FRB/US) must first detrend it. Similarly, the EDO model removes trend movements from the observable series it uses to infer its estimate of (unobserved) real marginal cost.

[18] The staff has also had little success in using other measures of real marginal cost in our reduced-form inflation forecasting models. A related question is whether movements in labor compensation more broadly influence price inflation in a way that is not captured by the staff's estimates of slack; empirically, the answer appears to be no, as it has become increasingly difficult over time to find evidence of significant passthrough of labor costs to price inflation. (See Katia Peneva's May 21, 2012 nonfinancial briefing to the Board for additional discussion.)

pose a downside risk to the inflation outlook if it actually is better capturing the amount of slack in the economy.

Even if one does believe that the unemployment gap provides a conceptually sound way to measure slack, the fact remains that it is very difficult to estimate.[19] In addition, the staff might be mistaken about how to define the unemployment gap, or about the effect the gap is having on inflation.

- Regarding the proper definition of the gap, some researchers have argued that recent inflation behavior can be better explained if the unemployment gap is defined in terms of the short-term unemployment rate (that is, the share of the labor force unemployed for 26 weeks or less), because the long-term unemployed seem to put less (or no) downward pressure on inflation.[20]

- Regarding the influence of the gap on inflation, some observers believe that a nonlinearity exists that is related to downward nominal wage rigidity. Specifically, they contend that the presence of downward nominal wage rigidity has propped up aggregate wage inflation to an unusual degree in recent years, which has in turn led price inflation to decline by less than would be expected given the size and persistence of the unemployment gap.[21]

The consequences for the inflation outlook of a failure on our part to correctly apprehend the connection between slack and inflation are likely to be limited so long as we are correct in our twin assumptions that inflation expectations are a key determinant of actual inflation *and* that those expectations will remain fully anchored. If it is true that the long-term unemployed put relatively little downward pressure on inflation, then the natural rate (defined relative to *total* unemployment) is likely higher than what the staff is assuming, given the unusually large contribution of the long-term unemployed to total unemployment at present. If so, the unemployment gap will be narrower. Nevertheless, if inflation expectations stay anchored, there should be no long-term effect on price inflation once the gap (however defined) is finally closed.

Likewise, because the staff's estimate of the Phillips curve's slope is constrained to be linear—and thus reflects the average relationship between slack and price inflation over the course of

[19] See Staiger, Stock, and Watson (1997) for a comprehensive attempt to gauge the uncertainty surrounding estimates of the natural rate of unemployment. (For additional discussion in the context of the staff's estimates of slack, see Fallick and Rudd, 2012.)

[20] See Gordon (2013); in addition, a recent piece by Macroeconomic Advisers (*Macro Focus*, January 14, 2013) comes to a similar conclusion. *A priori*, it does seem plausible that the long-term unemployed put less downward pressure on *wage* inflation. However, to the extent that the slack term in a price inflation equation describes the effects of *product*-market slack on inflation, it is unclear why an unemployment gap based on the short-term unemployment rate should be superior: Presumably, the long-term unemployed—who have suffered a relatively larger and more persistent shock to their permanent income—would reduce their contribution to aggregate demand to a larger degree than would the short-term unemployed.

[21] Paul Krugman has made this type of argument, for instance. Formal modeling suggests that the effects of downward nominal wage rigidity on wage dynamics could be more complicated: In Daly and Hobijn's (2013) theoretical analysis, downward nominal wage rigidity props up wage inflation in a recession; as the economy recovers, however, the existence of "pent-up" wage cuts causes wage inflation to initially decline further even as the unemployment rate is falling.

several business cycles—we may have overestimated the negative contribution of slack in recent years if the presence of downward nominal wage rigidity has been affecting price inflation. Again, however, so long as we are correct about the role of long-run expectations in determining price inflation (and in assuming that those expectations remain anchored going forward), the main risk from this source to our inflation forecast would appear to be one of timing: As the unemployment gap closes, inflation could return to its long-run level at a pace that is initially slower (and then faster) than we have projected.

A more problematic possibility, however, is that by mismeasuring slack the staff has overemphasized the role of anchored expectations in describing recent inflation behavior. In particular, Gordon (2013) argues that a traditional accelerationist Phillips curve fits well recently if short-run unemployment is used, which would imply that there is no need to appeal to anchored expectations to explain observed inflation behavior.[22] Similarly, if downward nominal wage rigidity is causing slack to put even less downward pressure on inflation than we have estimated, then we might be placing too much emphasis on the importance of anchored expectations in keeping inflation from declining in the face of a persistent unemployment gap. If that is the case, then it is possible that the low actual inflation readings or the declines in import prices seen over the past year could prove to have a more-durable effect on inflation than we have assumed in our baseline projection.

Supply shocks

The staff attributes a nontrivial portion of the recent variation in core PCE inflation to the passthrough of energy and import price shocks (recall Figure 4). But projecting these prices is exceedingly difficult. To a large extent, the Tealbook forecasts of energy and other imported commodity prices are based on futures prices; our import price forecast is also conditioned on our projected path for the foreign exchange value of the dollar. Staff work suggests that it is difficult to improve on futures-based forecasts (Reeve and Vigfusson, 2011); nevertheless, there have been periods (such as during the sustained uptrend in oil prices in the mid-2000s) when such forecasts have missed badly. As we have emphasized, given our basic inflation framework with stable expectations, such errors in projecting supply shocks ought to imply only transitory errors in our inflation projection. However, the possibility that a sustained period of higher or lower inflation driven by supply shocks could influence inflation expectations represents an important source of risk to the projection (in either direction).

A related complication is that the effect of these relative price shocks—particularly energy shocks—on core inflation has varied over time.[23] After declining in magnitude to nearly zero after the 1980s, the effect of an energy price shock on core inflation appears to have increased

[22] Note that staff work to date finds little evidence that short-term and long-term unemployment have differential effects on price inflation in our Phillips curve models that condition on survey measures of longer-term inflation expectations, suggesting that a description of recent inflation behavior based on anchored expectations is at least as compelling as Gordon's characterization.
[23] See Jeremy Rudd's January 28, 2013, nonfinancial briefing to the Board, which applies a methodology developed by Clark and Terry (2010) to examine time variation in the passthrough of supply shocks to core inflation.

modestly following the rolling oil shock of the mid-2000s.[24] The source of this variation is not well understood, however.

Idiosyncratic variation in prices

Because the FOMC has couched its longer-term inflation goal in terms of the PCE price index, we focus on this measure in preparing the Tealbook forecast and analyzing recent inflation developments. However, the PCE price index, like any price measure, has idiosyncratic features that can importantly affect its short-run behavior.

- For example, nonmarket prices account for roughly 10 percent of the overall index. While these prices might do a reasonable job of capturing long-run trends in the cost of certain components of PCE that are not purchased in market transactions, at higher frequencies they are often quite erratic and difficult to forecast.

- Likewise, because it captures more than just out-of-pocket expenditures on medical care, the PCE price index places a considerably larger weight on the prices of medical services than does the CPI (and many of the PCE medical prices are "administered" prices). In contrast, the PCE price index places a smaller weight on owners' equivalent rent than the CPI (though essentially the same imputed price measure is used in both indexes).

In the short run, the idiosyncratic features of a particular price index can obscure the signal that it provides of underlying price trends (and can cause alternative price measures to manifest noticeably different near-term inflation swings). In the long run, however, these issues have been less problematic: Many measures of underlying inflation have tended to move together over long intervals (recall Figure 2); more formally, many aggregate inflation measures appear to be co-integrated (Elmendorf, *et al.*, 2005).

[24] The passthrough of imported goods prices into core inflation has also varied, but as best we can tell has moved roughly in line with the rising share of imports in consumption in recent years (hence, the coefficients on share-weighted measures of import prices in our core inflation models appear to be more stable). We have found little empirical evidence that direct measures of foreign slack (such as a rest-of-world output gap) affect U.S. inflation once we have taken account of import price inflation (Ihrig, *et al.*, 2010). That said, the possibility that economic conditions abroad could influence U.S. inflation through such a channel (Borio and Filardo, 2007) certainly represents another risk to the projection.

References

Borio, Claudio and Andrew Filardo (2007). "Globalisation and Inflation: New Cross-Country Evidence on the Global Determinants of Domestic Inflation." BIS Working Paper No. 227 (May).

Clark, Todd E. and Troy Davig (2011). "Decomposing the Declining Volatility of Long-Term Inflation Expectations." *Journal of Economic Dynamics and Control*, 35(7), pp. 981–999.

Clark Todd E. and Taeyoung Doh (2011). "A Bayesian Evaluation of Alternative Models of Trend Inflation." Federal Reserve Bank of Cleveland Working Paper 11-34 (December).

Clark, Todd E. and Stephen E. Terry (2010). "Time Variation in the Inflation Passthrough of Energy Prices." *Journal of Money, Credit, and Banking*, 42(7), pp. 1419–1433.

Coibion, Olivier and Yuriy Gorodnichenko (2013). "Is the Phillips Curve Alive and Well After All? Inflation Expectations and the Missing Deflation." National Bureau of Economic Research Working Paper 19598.

Daly, Mary C. and Bart Hobijn (2013). "Downward Nominal Wage Rigidities Bend the Phillips Curve." Federal Reserve Bank of San Francisco Working Paper 2013-08 (June).

Elmendorf, Douglas, Deborah Lindner, David Reifschneider, John Roberts, Jeremy Rudd, Robert Tetlow, and David Wilcox (2005). "Considerations Pertaining to the Establishment of a Specific, Numerical, Price-Related Objective for Monetary Policy." Memorandum to the FOMC (January 21).

Fallick, Bruce and Jeremy Rudd (2012). "The Staff's Assessment of Economic Slack." Memorandum to the FOMC (August 28).

Faust, Jon and Jonathan Wright (2012). "Forecasting Inflation." Draft chapter for the *Handbook of Forecasting* (July 27).

Gordon, Robert J. (2013). "The Phillips Curve is Alive and Well: Inflation and the NAIRU During the Slow Recovery." National Bureau of Economic Research Working Paper 19390.

Ihrig, Jane, Steven B. Kamin, Deborah Lindner, and Jaime Marquez (2010). "Some Simple Tests of the Globalization and Inflation Hypothesis." *International Finance*, 13(3), pp. 343–375.

King, Robert G. and Mark W. Watson (2012). "Inflation and Unit Labor Cost." *Journal of Money, Credit, and Banking*, 44(2), pp. 111–149.

Koenig, Evan F. (2003). "Is the Markup a Useful Real-Time Predictor of Inflation?" *Economics Letters*, 80, pp. 261–267.

Reeve, Trevor A. and Robert J. Vigfusson (2011). "Evaluating the Forecasting Performance of Commodity Futures Prices." Board of Governors of the Federal Reserve System, International Finance Discussion Paper 1025.

Staiger, Douglas, James H. Stock, and Mark W. Watson (1997). "How Precise are Estimates of the Natural Rate of Unemployment?" In Christina D. Romer and David H. Romer (eds.), *Reducing Inflation: Motivation and Strategy*, pp. 195–242. Chicago, IL: University of Chicago Press.