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## **Long-term Inflation Expectations and Risks to the Inflation Outlook**

Thomas Laubach, John Roberts, Jae Sim, and Brad Strum

In many economic models, inflation expectations of price and wage setters are an important determinant of realized wage and price inflation. In the empirical framework that informs the staff's inflation projection, survey measures of consumer price inflation expected over long horizons (generally after applying some level adjustment) serve as attractors for actual inflation.<sup>1</sup> However, considerable uncertainty surrounds the mechanisms by which long-term inflation expectations are affected by the evolution of both real activity and inflation, as well as by policymakers' communications about their inflation objective – especially in light of the apparent stability of these expectations for the past decade and a half. Monetary policy must be formulated in light of this uncertainty.

There are several reasons why examining uncertainty related to inflation expectations is particularly pertinent at this time. Over the past few years, the economy has experienced substantial resource underutilization, which has been accompanied by core consumer price inflation running, on average, a little lower than it had been prior to the onset of the last recession. Although a reduction in inflation in response to resource underutilization is expected, the response of long-term inflation expectations is less certain. On the one hand, the experience of Japan since the early 1990s suggests that an episode of persistent resource underutilization may lead to a lasting reduction in long-term inflation expectations, and recent events in the euro area point to a similar possibility. That said, in light of the highly accommodative monetary policy pursued by the FOMC in recent years, it seems possible that economic events might dislodge inflation expectations to the upside. In principle, the FOMC's numerical goal for inflation should help anchor these expectations. However, since the Committee's inflation objective was announced only a couple of years ago, its effects on anchoring long-term inflation expectations remain difficult to discern.

In this memo, we examine the sensitivity of the staff's inflation projection and outlook to a range of alternative assumptions about long-term inflation expectations. As explained in a memo sent to the FOMC in June, according to the staff's framework, if long-term inflation expectations remain unchanged, inflation will gravitate toward a fixed level in the absence of resource slack or other shocks.<sup>2</sup> In many macroeconomic models this resting point is numerically identical to the long-term inflation expectations of price and wage setters. In the June memo, we referred to this hypothetical resting point as “underlying inflation,” but here we call it “notional long-term inflation expectations” to help reinforce the idea that expectations are a key determinant of this level. In reality, however, this artificial construct does not correspond to observable measures of

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<sup>1</sup> For details on the staff's inflation framework, see Detmeister et al. (2014).

<sup>2</sup> See Lindner (2014). If interest rates are set according to an interest rate rule of the form used in the staff projection, this concept of “the value to which inflation would converge given current inflation expectations and absent resource slack and supply shocks” is a counterfactual that will only be reached if inflation expectations are consistent with the policymakers' inflation objective. If inflation expectations were to pull inflation to a value different from the objective embedded in the interest rate rule, the rule would continually push against inflation settling at that value.

expectations of any specific group. As discussed in the June memo, we consult a number of models to infer the level of notional inflation expectations; these models explicitly estimate a wedge between median survey expectations and the level at which inflation settles. Given the uncertainty surrounding our model estimates, the current level of notional inflation expectations is uncertain, as is their future evolution.

In the remainder of this memo, we examine the risks to the staff's inflation outlook from this particular source, by running simulations with the FRB/US model under alternative assumptions about the current value and future evolution of notional long-term inflation expectations, using the July Tealbook projection as the baseline. Our main findings can be summarized as follows:

- In the staff baseline, notional long-term inflation expectations are currently estimated to be anchored at 1.8 percent; beyond 2016, they are assumed to gradually move up to 2 percent. If, instead, these expectations are already anchored at 2 percent and remain there going forward, consumer price inflation moves up a little faster than in the baseline, peaking a little above 2 percent in 2018, and then edging down thereafter toward 2 percent.
- If notional long-term inflation expectations are currently below 2 percent and evolve according to an adaptive expectations mechanism, consumer price inflation never rises noticeably above 2 percent; if expectations were currently 1.5 percent, a value closer to the lower end of the range of estimates in the June memo, inflation would still run about 0.2 percentage point lower toward the end of the decade than in the baseline.
- With the federal funds rate assumed to follow the inertial version of the Taylor (1999) rule, the path of the unemployment rate is nearly unaffected by the alternative assumptions for inflation expectations. Instead, the undershooting of the unemployment rate below the natural rate projected in the Tealbook to occur in the second half of the decade is primarily due to the inertial response under the assumed policy rule.
- The risks to our inflation projection emanating from these alternative paths of notional long-term inflation expectations are modest in comparison to overall forecast uncertainty for inflation at a horizon several years into the future. However, this conclusion rests on a number of assumptions. Alternative mechanisms for forming inflation expectations could lead to stronger responses of both inflation and inflation expectations. Similarly, if inflation were more responsive to inflation expectations than we assume, there could be stronger feedback and consequently greater risks to the inflation outlook.

## Detailed Analysis

### *Uncertainty around the staff's assumptions for notional inflation expectations*

As discussed in the June memo, we use the historical relationship of observed core PCE inflation to economic variables including surveys of long-term inflation expectations to form a judgment about the current level of notional inflation expectations. The point estimates reported in that memo ranged from 1.3 percent to 1.8 percent, with sizeable confidence intervals around these estimates. Based on these results, the Tealbook projection assumed that notional inflation expectations are currently 1.8 percent.<sup>3</sup> However, given uncertainty surrounding these estimates, it is possible that expectations are already well-anchored at levels consistent with inflation settling at a rate of 2 percent.

Going forward, the staff's projection assumes that notional inflation expectations will remain at their current level through the end of 2016; thereafter, with tight resource utilization, they are assumed to move up gradually until they become anchored at the Committee's 2-percent inflation objective. However, our understanding of the way in which these expectations are affected by the evolution of real activity and inflation as well as by policymakers' communications about their inflation objectives is limited. For example, we do not have good understanding of why survey measures of long-term inflation expectations have been so stable over the past fifteen years. (A longer view of history suggests that inflation expectations need not remain anchored at any particular level.) Furthermore, while it is conceivable that the publicly announced inflation objective will, by itself, guide expectations to the desired place, the experience from countries with a longer history of inflation targeting suggests that it may take some time of credible pursuit of the target before the target exerts its anchoring effect on expectations.<sup>4</sup>

### *Some alternative mechanisms for the evolution of notional inflation expectations*

A number of mechanisms describing the evolution of long-term inflation expectations have been proposed. One that has a long history is adaptive expectations—that is, the notion that inflation expectations are determined by the recent historical experience of inflation. Adaptive expectations were assumed in some of the earliest work on inflation expectations—for example, Friedman (1968). Such a mechanism may have some plausibility if the public comes to doubt either the willingness or the ability of policymakers to achieve their inflation objective.<sup>5</sup>

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<sup>3</sup> The findings of Lindner (2014) do not suggest that notional inflation expectations have moved down in recent years, and hence are consistent with the view expressed in the Committee's statement that "longer-term inflation expectations have remained stable." In the earlier memo, the sample period for estimation ended in 2013:Q4. With the addition of data through 2014:Q2 to the sample period, some estimates of notional long-term inflation expectations have edged up by a tenth or two, leaving the range of model estimates running from 1.5 percent to 1.9 percent. We have maintained our assumption in the baseline projection that notional long-term expectations are currently running at 1.8 percent.

<sup>4</sup> Evidence to this effect is presented in Bernanke et al. (1999).

<sup>5</sup> Kozicki and Tinsley (2001) showed that adaptive expectations provided a reasonable approximation to survey measures of long-run inflation expectations during the 1980s and 1990s. However, this approach has proved less useful for forecasting survey measures of long-term inflation expectations in recent years since it would have implied a noticeable, lasting decline since 2008 that was not observed.

An informationally more demanding alternative is that price and wage setters update their long-term inflation expectations based on monetary policy actions. For example, as they observe the evolution of the economy and the Fed’s responses, price and wage setters could revise their views about the Fed’s inflation target (and commitment to achieving the target), as well as the Fed’s ability to guide inflation to the target.<sup>6</sup> Indeed, such behavior is consistent with the staff’s baseline assumption that inflation expectations move up during the period in which the unemployment rate undershoots the natural rate.

### *Simulation results*

We consider four alternatives to the staff’s baseline in the July Tealbook for the evolution of notional long-term expectations. In the first simulation, we assume that notional inflation expectations are currently at 2 percent and remain fixed at that level. In the remaining three simulations, we assume that expectations start at either 1.8 or 1.5 percent, and then evolve according to an adaptive mechanism, either immediately or beginning in 2017. Specifically, we assume that notional long-run inflation expectations evolve according to the adaptive rule

$$E_t \pi^{LR} = 0.9 * E_{t-1} \pi^{LR} + 0.1 * \pi_{t-1}^{core},$$

where  $E_t \pi^{LR}$  is the expected value of long-run inflation in quarter  $t$  and  $\pi_{t-1}^{core}$  is the lagged annualized value of core PCE inflation. To be clear, our use of the adaptive mechanism does *not* mean that we view it to be the most plausible paradigm for the formation of long-term inflation expectations. Rather, our objective, given the pervasive uncertainty about long-term inflation expectations, is to illustrate some alternatives that are simple and draw upon the economic literature.

Throughout the exercise, we assume that the federal funds rate is set according to an inertial version of the Taylor (1999) rule, subject to the same (implicit) unemployment threshold used in the Alternative Scenarios shown in the Tealbook. In the baseline, this threshold implies lift-off of the federal funds rate in the second quarter of 2015. The results of these simulations are shown in figure 1.

- If notional long-run inflation expectations were already pegged at the Committee’s objective of 2 percent (the blue line), core inflation would run higher than in the baseline. But the effect is small—no more than 0.1 percentage point—since the effect of inflation expectations that are initially 0.2 percentage point above baseline builds only gradually, and the gap between the alternative and the baseline path for inflation expectations diminishes beyond 2016. Inflation peaks at 2.1 percent in mid-2018, and edges down thereafter. (Implications for real activity are discussed below.)

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<sup>6</sup> For example, Erceg and Levin (2003) present a mechanism in which inflation expectations are updated based on unexpected movements in the short-term interest rate. In particular, the public is uncertain about the inflation objective embedded in the interest rate rule followed by the central bank, and rationally revises its estimate of this objective by attributing a certain fraction of any forecast error for the policy rate.

- If, as in the baseline, notional long-run inflation expectations remained at 1.8 percent through 2016 but then (in contrast to the baseline) began to evolve according to the adaptive rule (the purple line), they would initially drop slightly, because core inflation in late 2016 is running a bit below 1.8 percent. They rise thereafter, about in parallel with the baseline assumption, running just a few basis points lower. Actual inflation is virtually identical to the baseline.
- When long-run expectations begin at 1.8 percent but evolve according to the adaptive formula from the second half of this year on (the red line), they initially drift down a bit more than in the previous simulation, reflecting the fact that inflation is below 1.8 percent in the early years of the staff projection. After 2017, long-term expectations move up and reach 1.9 percent by 2020. With longer-run expectations somewhat lower than in the baseline, so is core inflation—although in this case only marginally so.
- Finally, if notional expectations were initially at 1.5 percent (the green line), the adaptive formula suggests they would stay near that level for the next several years before gradually moving up. Actual core inflation drops about 0.1 percentage point below baseline in 2015, but then begins to move up in parallel with the baseline inflation path as the effects of tighter resource utilization kick in. Nonetheless, if policy were set according to the inertial Taylor rule, which features a relatively modest response to inflation gaps, the return of inflation to 2 percent would in this case be postponed well into the next decade.

One striking feature of these simulations is that real activity—illustrated here by the unemployment rate—is nearly unchanged from the baseline in any of the scenarios. This occurs because under the inertial Taylor rule, real interest rates change only modestly and gradually in response to inflation and are little affected by the differences in inflation expectations examined in this memo. Instead, the undershooting of the unemployment rate below our estimate of the natural rate in the second half of this decade in the Tealbook baseline importantly reflects the inertial response of the federal funds rate. Thus, the adoption in the June forecast of the assumption that notional long-term inflation expectations are currently running slightly further below 2 percent than we previously assumed only marginally accentuates the unemployment rate decline projected in the baseline.

By contrast, using assumptions about policy that differ from the inertial Taylor rule—holding constant our assumptions about the evolution of long-term inflation expectations—can change the projected path of the unemployment rate more materially. For example, the undershooting of the unemployment rate can be reduced by choosing a higher path for the nominal and real federal funds rate, such as the federal funds rate path produced by the optimal control simulations presented in the July Tealbook, even with our assumptions regarding notional long-term inflation expectations.

## Further discussion

Taken at face value, the simulations we examined suggest that the risks to our inflation projection emanating from uncertainty about notional long-term inflation expectations are modest in comparison to overall forecast uncertainty for inflation at a horizon several years into the future. However, some caution should be exercised when generalizing these findings, which are conditional on the range of jump-off points for current inflation expectations, on our assumption for their evolution, and on other features of our empirical framework for forecasting inflation.

In particular, besides the significant amount of uncertainty around the jump-off points for inflation expectations, there is substantial uncertainty around our assumptions regarding the evolution of long-term inflation expectations. In the baseline, we have assumed that expectations will remain unchanged through 2016, consistent with the behavior of survey measures for the past fifteen years. While the adaptive mechanism we employed tracks the survey measures used in the FRB/US model fairly closely during the 1980s and 1990s, it would have suggested a larger decline in long-term inflation expectations since 2008 than seems consistent with survey measures. Clearly, the possibility that expectations could remain quite stable for a longer period than we are assuming, even given the economic environment we are projecting, cannot be ruled out.

We have presented two alternatives to illustrate the uncertainty about the future evolution of expectations. The adaptive updating algorithm puts no explicit weight on the FOMC's announced 2-percent objective; thus the results could be seen as a limiting case in which the FOMC's objective has no anchoring effect. Another plausible possibility is that wage and price setters used an updating mechanism that takes signal from observed departures from a pre-crisis interest rate rule to update their estimates of the FOMC's inflation objective; in that case, they might raise their perceived inflation objective substantially over the coming years.

Our results are also conditioned by the highly inertial nature of inflation built into the FRB/US model. Although this inertia, which implies that current inflation responds only gradually to changes in long-term inflation expectations, is the result of empirical estimation, it is possible that actual inflation responds more quickly to changes in inflation expectations than we assumed.<sup>7</sup> This would strengthen the feedback loop between inflation expectations and actual inflation. It should be noted, however, that stronger feedback between actual and expected inflation would presumably work symmetrically; if, for example, notional inflation expectations were currently only at 1.5 percent, these expectations would exert greater downward pressure on inflation going forward if inflation responded more rapidly to inflation expectations.

Finally, the interaction between economic circumstances and the formation of inflation expectations could be more complex still. Under the staff's baseline outlook, inflation

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<sup>7</sup> In fact, in the staff's empirical framework described in the memo sent to the Committee in January, inflation is somewhat less inertial than in FRB/US, and hence changes in long-term inflation expectations feed more rapidly through to actual inflation. Nonetheless, even when using the degree of inflation inertia assumed in the staff's framework, in the scenario in which notional inflation expectations are held fixed at 2 percent, inflation peaks just a little higher than in the corresponding scenario presented in figure 1.

expectations are not immutable and do indeed shift, but in a benign way, with notional inflation expectations eventually becoming anchored at the Committee's inflation objective and actual inflation rising gradually to 2 percent. If, by contrast, inflation expectations were not well anchored, history suggests that inflation would be more sensitive to shocks to the economy. This may explain why, for example, supply shocks in the 1970s appeared to have much more persistent effects on inflation than has been the case in the past fifteen or twenty years. If, for example, inflation expectations would become more sensitive during a period of high resource utilization, a large adverse supply shock later in the decade might lead notional long-term inflation expectations, and thus actual inflation, to climb above 2 percent for an extended period.

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Figure 1  
 Projection of Key Macroeconomic Variables under Alternative Assumptions about Notional Inflation Expectations

