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When Might the Federal Funds Rate Lift Off?

Computing the Probabilities of Crossing Unemployment and Inflation Thresholds (and Floors)

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The Federal Open Market Committee has been providing guidance to help markets anticipate when it will begin raising the federal funds rate target. The most recent guidance suggests that the target will not change at least until after an unemployment or inflation threshold is breached. We use a forecasting model to estimate when these thresholds are likely to be breached. We also consider how an inflation floor would affect the timing of liftoff.

At its December 2012 meeting, the Federal Open Market Committee (FOMC) changed its forward guidance for the federal funds rate. Previously, the FOMC used date-based guidance, suggesting that the funds rate target would remain unchanged until a particular date was reached. The FOMC replaced this date-based guidance with guidance based on thresholds for unemployment and inflation. Put simply, the new guidance—which the FOMC has continued to use—suggests that the funds rate target will not change at least until after a threshold is breached.

When might the thresholds be breached? In this *Commentary*, we use a forecasting model to provide answers to this question. Based on our model, the single most likely scenario is for the unemployment rate to cross its threshold by the third quarter of 2015, well before the inflation threshold is likely to be breached. However, that outlook is only one possibility identified in the forecasting model: a wide range of outcomes is possible beyond this single scenario. After accounting for the spectrum of potential outcomes, we show that there is greater than a 50 percent probability that at least one threshold will be breached two quarters earlier, in the first quarter of 2015.

Using our framework, we also consider the suggestion that an inflation floor might be a valuable addition to the FOMC's forward guidance—in essence, promising not to raise the funds rate target if inflation is below some value, even if unemployment crosses its threshold. We show that in this model an inflation floor of 1.5 percent would delay by one quarter the most likely point at which both the floor would be satisfied and at least one threshold crossed. By contrast, an inflation floor of 1.75 percent would create a much longer delay of four quarters.

Interpreting the Thresholds

As of the FOMC's October 2013 meeting, the forward guidance for the federal funds rate target was as follows:

> "[T]he Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored…."

The unemployment threshold is expressed in terms of current conditions, and the unemployment rate for the previous month is published regularly by the Bureau of Labor Statistics on the first Friday of the month. As a result, we can simply monitor whether the quarterly average unemployment rate falls below 6.5 percent in our model to determine whether the unemployment rate threshold has been breached.

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The conditions related to inflation do not have the same simplicity because they are forward-looking. Forward-looking inflation conditions give policymakers the opportunity to head off future inflation while looking past transitory price changes, though it makes it harder for us to determine when the thresholds might be breached. Consider first the clause concerning inflation expectations. There are a variety of measures of inflation expectations that come from surveys, financial markets, and statistical models. In addition, there are a variety of ways to interpret "longer-term" and "well anchored." To simplify the analysis, we assume that longer-term inflation expectations are fixed and equal to the FOMC's 2 percent longer-run objective throughout the forecast part of the exercise.

We thus focus on the other inflation threshold. The FOMC has said that it evaluates whether "inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal." To implement this threshold in the model, we monitor whether the model's one-year/one-year forward projected inflation rate—that is, the four-quarter rate of inflation starting four quarters in the future and ending eight quarters in the future—exceeds 2.5 percent. For simplicity, we call this simply "projected inflation."

A Forecasting Model

Our exercise uses a common statistical model for macroeconomic forecasting called a Bayesian vector autoregression (BVAR). Our particular BVAR is one example of the small- and medium-scale models that are used at the Cleveland Fed to help inform forecasting and policy analysis, and it includes seven variables: real GDP, real personal consumption expenditures (PCE), the unemployment rate, unit labor cost growth, PCE inflation, core PCE inflation, and the federal funds rate.[1]

Our two inflation measures, PCE and core PCE inflation, are modeled as deviations from a slow-moving long-run inflation trend.[2] We estimate the model using quarterly macroeconomic data from 1959:Q1 through 2013:Q3.

Because the model includes the federal funds rate, we need to carefully consider how monetary policy should be captured, both in the past and in the future. Taylor-type rules have been widely used to model the historical conduct of monetary policy. So when estimating the model on past data, we impose a Taylor rule by assuming that the federal funds rate depends only on its own lag, lagged core inflation, and the lagged unemployment rate, rather than all of the variables in the model.[3] However, when constructing forecasts for 2013:Q4 and beyond, we wish to consider when the thresholds would be crossed conditional on the funds rate remaining at its present level. Furthermore, the "at least as long as" language in the FOMC statement makes clear that actual liftoff may not occur immediately when a threshold is breached. Based on these considerations, we explicitly set the federal funds rate to 13 basis points in each forecasted quarter starting with 2013:Q4.[4]

Constructing Point Forecasts

Constructing a forecast using our BVAR model is relatively standard and straightforward. After estimating the model, we generate a large number of potential future paths for the variables in our model through simulations, where each simulation reflects different future shocks that might occur (along with a particular realization from the estimated distribution of coefficients). The average of the different simulated forecast paths for each variable is the point forecast of the respective variable; it represents the modal, or single most likely, future outcome. The forecast for one-year/one-year forward inflation is simply the four-quarter inflation rate point forecast starting four quarters ahead.

Figure 1. Forecasts and Thresholds

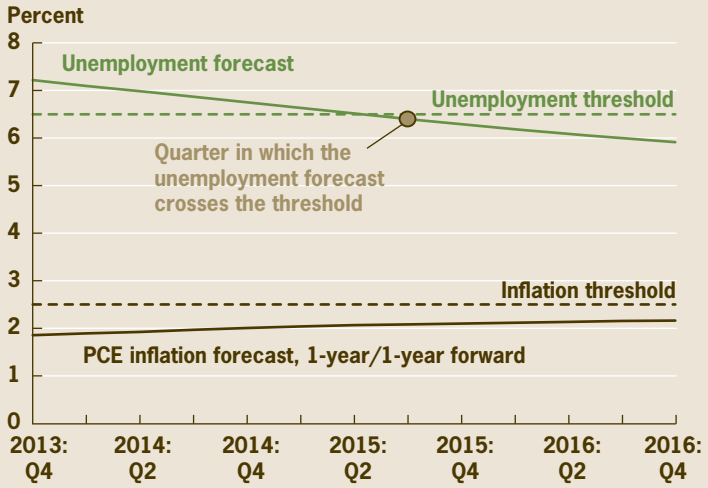
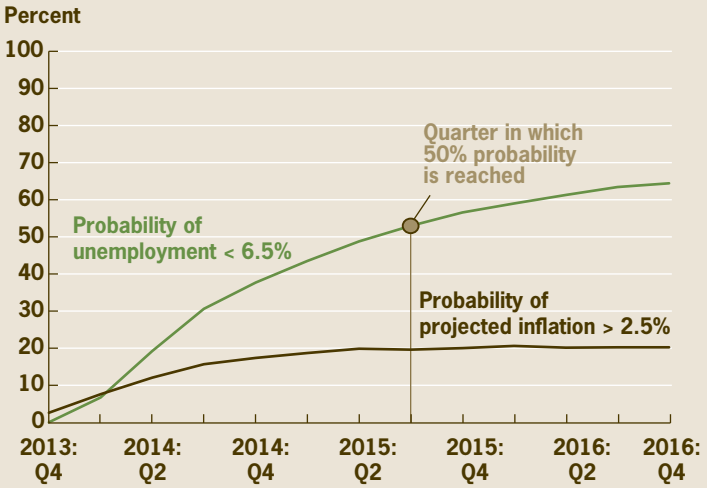


Figure 2. Probabilities of Breaching Thresholds



While our model is simple, it appears to generate plausible point forecasts. Figure 1 shows the point forecasts for the unemployment rate and PCE inflation one-year/one-year forward. Comparing those forecasts with the September 2013 *Summary of Economic Projections* (SEP) released by the FOMC, we see that the model's unemployment rate forecast of 6.8 percent in 2014:Q4 is within the SEP's central tendency of 6.4 to 6.8 percent. The model's 2014:Q4 point forecast for PCE inflation one-year/one-year forward is 2 percent. Note that the SEP's central tendency for PCE inflation as of 2016:Q4 over the preceding four quarters is 1.7 to 2.0 percent, so once again the model's forecast is within the central tendency.

As the figure shows, the forecast for the unemployment rate falls below 6.5 percent by 2015:Q3. The projection for PCE inflation one-year/one-year forward rises to 2 percent by 2014:Q3 and then slowly moves up to 2.1 percent by 2016:Q4. Thus, based on our point forecasts, the unemployment rate threshold is breached in 2015:Q3, before the projected inflation threshold would be breached. We term this the modal outlook, or the single most likely scenario.

Constructing Distributions of Forecasts

Point forecasts are useful and provide the simplicity of a single value for a variable at a future date. However, the modal outlook captures only one possible way that unemployment and inflation may move over time. These (and other) variables in the model may not follow the modal outlook, so it helps to consider the entire distribution of potential future outcomes—in essence, many alternative forecasts beyond the modal outlook. Accounting for this uncertainty is important when considering the question of when a threshold might first be breached.

Constructing forecast distributions for the two variables involved in the FOMC's thresholds requires different approaches. The distribution of future possible unemployment rates comes directly from the model simulations. But because the inflation threshold is specified in terms of projected inflation, we need to construct distributions of projected inflation rather than distributions of inflation outcomes. We clarify this concept in the accompanying box.

Figure 2 plots two lines, one providing the probability of unemployment rate outcomes falling below 6.5 percent and the other the probability of projected inflation being greater than 2.5 percent. The vertical line highlights the point at which there is greater than a 50 percent chance that the unemployment threshold will be breached. Consistent with the point forecast in figure 1, the date corresponds to 2015:Q3. Also consistent with figure 1, in most cases projected inflation remains below 2.5 percent.[5]

But figure 2—and, by extension, the modal outlook—essentially treats the probabilities separately. The area under each line provides the probability of that outcome, regardless of the outlook for the other variable. To obtain a complete picture of when at least one threshold might be crossed and policy might change, we need to consider the range of possible outcomes jointly.

Figure 3 divides the possible outcomes into four cases and displays their respective probabilities. The first case describes the current state of the economy: unemployment is above 6.5 percent, and projected inflation is less than 2.5 percent. The second case contains all the outcomes with an unemployment rate less than 6.5 percent and projected inflation less than or equal to 2.5 percent. For example, if a simulation forecasts 6.3 percent unemployment and projected one-year/one-year forward inflation of 2 percent as

Figure 3. Probabilities of Breaching Thresholds

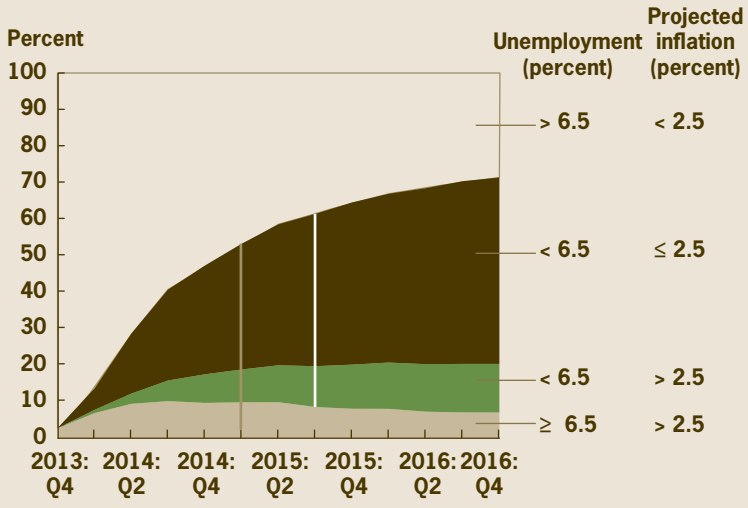
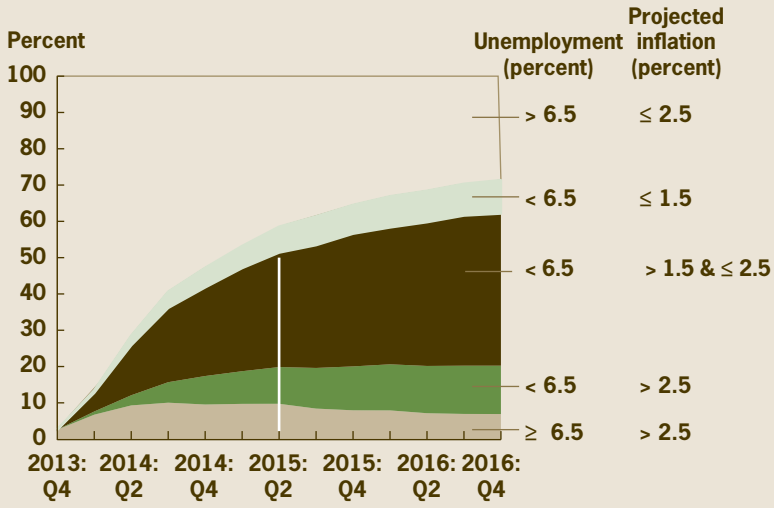


Figure 4. Probabilities of Breaching Thresholds, with a 1.5% Inflation Floor



of 2014:Q4, it would fall into this area in that quarter. The third case contains all the outcomes with an unemployment rate less than 6.5 percent and projected inflation greater than 2.5 percent. The fourth case contains the outcomes in which the unemployment rate is greater than or equal to 6.5 percent but projected inflation exceeds its 2.5 percent threshold.

The sum of the second and third areas equals the area under the "Probability of unemployment < 6.5%" line in figure 2. Similarly, the sum of the third and fourth areas equals the area under the "Probability of projected inflation > 2.5%" line in figure 2. Note that the modal outlook is the point at which the sum of the second and third areas exceeds a 50 percent probability, given by the white vertical line in figure 3.

Once we jointly account for these three latter cases, the first point at which there is greater than a 50 percent probability that at least one threshold will be crossed comes in 2015:Q1. Put differently, the most likely joint outcome based on our model is that at least one threshold for raising the funds rate will be satisfied as of 2015:Q1.

Adding an Inflation Floor

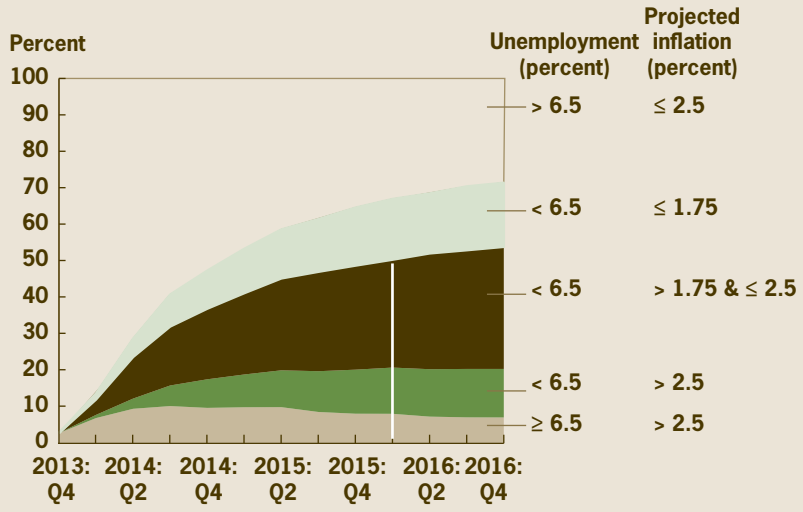
Recently, some discussion has focused on introducing an inflation "floor" into the forward guidance.[6] The current forward guidance essentially incorporates an inflation "ceiling," specifying that the funds rate target will remain unchanged provided that projected inflation remains below 2.5 percent. An inflation floor, by contrast, might specify that the funds rate will remain unchanged if projected inflation is below a certain value—regardless of whether the unemployment threshold is breached.

Our model can assess how adding an inflation floor impacts the joint probabilities of breaching the thresholds. We investigate two different inflation floors: 1.5 percent and 1.75 percent. Both floors rely on projected inflation, as in the current guidance.

An inflation floor of 1.5 percent would impose some symmetry around the FOMC's 2 percent longer-run goal, given that 2.5 percent already forms the inflation ceiling. Figure 4 shows the probabilities of our cases after incorporating the inflation floor. The dark brown area from figure 3, which showed the probabilities of unemployment below 6.5 percent and projected inflation below 2.5 percent, now has been split into two: one area in which projected inflation is below the floor (the light-green area), and one in which projected inflation is above the floor (the dark brown area). If inflation is below the floor, the funds rate would remain unchanged, so the relevant probabilities to consider for liftoff are all the colored areas in the figure save the light green one. Combining the areas, the joint probability of breaching either the unemployment threshold or the projected inflation threshold and at the same time satisfying the inflation floor first crosses 50 percent by 2015:Q2, a one-quarter delay compared with the case without an inflation floor.

An inflation floor of 1.75 percent might be viewed as an alternative that ensures inflation is heading closer to the FOMC's 2 percent longer-run goal in the near term, given the one- to two-year-ahead window for projected inflation. The higher floor has a bigger impact on the probabilities coming from the model; the light-green region in which the inflation floor is not satisfied grows in size in figure 5. As a consequence, the joint probability of breaching either the unemployment threshold or the inflation threshold and at the same time satisfying the inflation floor first crosses 50 percent by 2016:Q1, a four-quarter delay compared with the case without an inflation floor.

Figure 5. Probabilities of Breaching Thresholds, with a 1.75% Inflation Floor



Distributions for Projected Inflation and Potential Future Inflation Outcomes

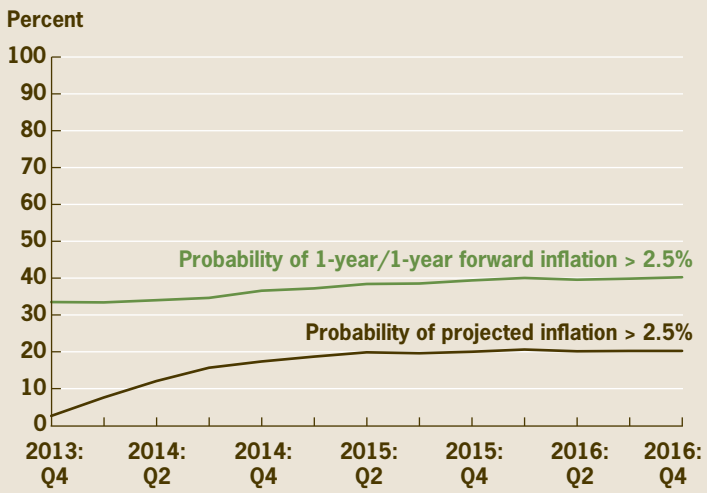
To construct a point forecast for inflation, we generate a large number of potential future inflation outcomes using model simulations and then take the average of those simulations. The one-year/one-year forward inflation point forecast is simply the four-quarter inflation rate point forecast starting four quarters in the future.

The simulations show the range of potential inflation outcomes. The model allows future inflation to move around for a variety of reasons, ranging from changes in underlying economic conditions to short-lived bursts of inflation related to energy price spikes. At any point in time, there is a considerable chance that realized inflation one-year/one-year forward will end up exceeding 2.5 percent because of temporary shocks, as illustrated in the green line in Figure A.

However, the probability that *realized inflation* one to two years ahead will be greater than 2.5 percent is different from the probability that the *forecast for inflation* one to two years ahead—that is, projected inflation—is greater than 2.5 percent. To generate a distribution for projected inflation at each point in time, we take each model simulation and then run a large number of subsimulations. The average of the subsimulations provides a single projected inflation rate one to two years ahead for that simulation, analogous to our original exercise. Looking across simulations, we construct the distribution of projected inflation rates at each point in time.

The brown line in Figure A shows that the probability that projected inflation will exceed 2.5 percent tends to be lower than the probability that actual inflation will exceed 2.5 percent. In fact, the distribution of projected inflation rates clusters near 2 percent. This result is intuitive: while there is a good chance that inflation could actually be higher due to transitory shocks or a stronger-than-expected recovery, there is also a good chance it could be lower from falling energy prices or a weaker recovery. Inflation is volatile at short horizons, whereas inflation forecasts tend to be relatively smooth and more closely related to longer-term inflation expectations. Such a finding highlights the importance of keeping inflation expectations well anchored.

Figure A. Inflation Probabilities



Conclusion

This *Commentary* considers the question of when the FOMC's unemployment and inflation thresholds might be breached. After taking into account the range of possible outcomes, the most likely outcome based on our model is that at least one threshold for raising the funds rate will be satisfied as of 2015:Q1. We show that this is two quarters earlier than if we were to look at the outlook for unemployment and projected inflation separately.

Our model can also consider the impact of changes to the forward guidance, such as introducing an inflation floor. An inflation floor of 1.5 percent would have a modest impact on the probability of satisfying both the floor and at least one of the thresholds, while an inflation floor of 1.75 percent could delay the point at which both the floor is satisfied and a threshold is crossed by about one year. This exercise suggests that the choice of an inflation floor could exert a considerable delay on the liftoff of the federal funds rate from the zero lower bound.

Footnotes

1. Real GDP and real PCE enter the model in log levels, while all other variables are in levels. Unit labor cost growth is defined as growth in the employment cost index for private workers less growth in nonfarm business sector labor productivity.

2. The long-run trend for core PCE inflation is defined as the survey-based long-run (5- to 10-year-ahead) PCE inflation expectations series from the Federal Reserve Board of Governor's FRB/US econometric model. For PCE inflation, we use core PCE inflation for the long-run trend. In autoregressive models, specifying inflation as a deviation from trend has been found to improve forecast accuracy (see, for example, Kozicki and Tinsley 2001, Clark 2011, and Zaman 2013).

3. That is, we impose:
$$(\text{fed funds rate})_t = 0.8 \times (\text{fed funds rate})_{t-1} + 0.2 \times \{2 + (\text{four-quarter core inflation})_{t-1} + 0.5 \times [(\text{four-quarter core inflation})_{t-1} - 2] + 2 \times [6 - (\text{unemployment rate})_{t-1}]\}.$$

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Clark (2012) provides details of how to impose the necessary restrictions on these types of models to obtain the desired policy reaction function.

4. Specifically, we use an intercept-adjustment approach, in which the condition of 0.13 percentage point for the federal funds rate is achieved by adjusting the intercept of the federal funds rate equation in each forecasted quarter and accounting for its effect on other variables.

5. Obviously, the model's assumption that inflation expectations are and will remain stable at 2 percent is a key factor in the stability of projected inflation.

6. As two examples, James Bullard, president of the St. Louis Fed, raised the idea of an inflation floor in August 2013 (Robb 2013), and Chairman Bernanke responded to a question about an inflation floor at his press conference in September 2013.

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