Central Bank Communication and Disagreement about the Natural Rate Hypothesis[*]

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About half of professional forecasters report that they use the natural rate of unemployment (u^*) to forecast. I show that forecasters' reported use of and estimates of u^* are informative about their expectations-formation process, including their use of a Phillips curve. Those who report not using u^* have higher and less anchored inflation expectations, and seem to have found the Federal Reserve's state-based forward guidance less credible. The Federal Open Market Committee (FOMC) publishes participants' projections of longer-run unemployment in the Summary of Economic Projections. I document how and when the FOMC participants have disagreed with each other and with the private sector, discussing possible sources of disagreement and implications for credibility.

JEL Codes: E52, E58, E43, D83, D84.

1. Introduction

In the global financial crisis and Great Recession, with policy rates constrained by the zero lower bound (ZLB), central banks intensified their use of communication as a policy tool (Yellen 2012; Williams 2013b; Blinder 2018). This increase in communication-based monetary policy has been accompanied by greater efforts to understand how different economic agents form beliefs and expectations. Survey data on economic expectations reveal notable heterogeneity in the

beliefs of consumers, professional forecasters, and central bankers themselves (Mankiw, Reis, and Wolfers 2004; Boero, Smith, and Wallis 2008; Romer and Romer 2008; Patton and Timmermann 2010; Coibion and Gorodnichenko 2012; Andrade and Le Bihan 2013; Binder 2017c). Understanding the sources and nature of this disagreement could have important implications for monetary policy and central bank communication (Coibion and Gorodnichenko 2015; Detmers 2016; Falck, Hoffmann, and Hurtgen 2017).

Patton and Timmermann (2010) argue that disagreement in shorter-horizon expectations mostly reflects differences in private information, while disagreement about longer horizons reflects differences in models. Andrade et al. (2016) show that forecasters in the Blue Chip Financial Forecasts survey disagree even in very long-horizon forecasts for output, inflation, and the federal funds rate, and that this disagreement is time varying. They refer to this long-horizon disagreement as *fundamental disagreement*, as it reflects differing views about slow-moving, unobserved economic fundamentals like potential output, the natural interest rate, and the inflation target. These unobserved fundamentals can be difficult to estimate precisely in real time (Orphanides and Williams 2002; Laubach and Williams 2016; Borio, Disyatat, and Juselius 2017; Holston, Laubach, and Williams 2017).

In this paper, I use data from the Federal Reserve Bank of Philadelphia Survey of Professional Forecasters (SPF) to study forecasters' beliefs and disagreement about the economy in the long run, and related implications for central bank communication. I exploit survey questions that ask forecasters whether they use the natural rate of unemployment (u^*) to make forecasts and, if so, asks for their estimates of u^*. These questions provide explicit and previously underutilized information about forecasters' models and beliefs.

I show that forecasters' responses to these questions are informative about their expectations-formation process. Forecasters who say they use u^* to forecast do appear to do so, in the sense that they expect inflation to fall when they expect unemployment to be above their own estimate of u^*. The inflation expectations of forecasters who report *not* using u^* more closely resemble univariate forecasts and are less sensitive to the unemployment gap or output gap. These results are a novel contribution to the literature on the model

consistency of survey forecasts (Pierdzioch, Rulke, and Stadtmann 2011; Rulke 2012; Drager, Lamla, and Pfajfar 2016).[1]

These results also provide empirical support for the general premise of heterogeneous agent models with two types of private agents, distinguished by their expectations formation (Andrade et al. 2018; Beqiraj, Di Bartolomeo, and Di Pietro 2019). In several papers, the two types are "credibility believers" (also called "fundamentalists"), who trust the central bank, expect future inflation to be near the central bank's inflation target, and use a Phillips curve, and "adaptive expectations users" (also called "naive" agents), who use only past inflation to forecast future inflation (Busetti et al. 2017; Goy, Hommes, and Mavromatis 2018; Cornea-Madeira, Hommes, and Massaro 2019; Hommes and Lustenhouwer 2019). Having shown that reported u^* users appear to use a Phillips curve, I next show that they resemble credibility believers in other ways as well. Most notably, their long-run inflation expectations are closer to the Federal Reserve's inflation target and more strongly anchored. Their forecasts are also somewhat more accurate. Thus, while reported use of u^* cannot account for all differences between forecasters, it does seem to provide a useful way to roughly categorize them into these two types.

The presence of credibility believers and adaptive expectations users can have important implications for macroeconomic dynamics and policy. Goy, Hommes, and Mavromatis (2018) study forward guidance at the ZLB in a New Keynesian model with these two types, assuming that only the credibility believers respond to forward guidance.[2] With a smaller share of credibility believers,

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[1] Pierdzioch, Rulke, and Stadtmann (2011) find that professional forecasters in the G-7 make forecasts consistent with Okun's law. Rulke (2012) finds that forecasters in Asian-Pacific countries use Okun's law and the Phillips curve. Drager, Lamla, and Pfajfar (2016) show that the share of U.S. consumers and forecasters holding expectations consistent with the Fisher equation, Taylor rule, and Phillips curve is time varying and that central bank communication can facilitate understanding of these rules.

[2] As in Campbell et al. (2012), forward guidance may be Delphic or Odyssean. Delphic forward guidance conveys information about the central bank's outlook, while Odyssean forward guidance is interpreted as a commitment to deviate from the central bank's policy rule in the future, keeping rates "lower for longer" when inflation and growth later rise (Eggertsson and Woodford 2003; Campbell et al. 2019).

forward guidance is less effective. Thus, the presence of adaptive expectations users helps resolve the "forward-guidance puzzle," or the implausibly large responses of macroeconomic variables to forward guidance in standard New Keynesian models with rational expectations (Del Negro, Giannoni, and Patterson 2013; McKay, Nakamura, and Steinsson 2016).[3] To test whether the forecasters who report using u^* resemble credibility believers with respect to forward guidance, I focus on the threshold-based forward guidance issued in December 2012. I find that, indeed, forecasters who report using u^* were less likely to expect liftoff with unemployment above the 6.5 percent threshold announced in the FOMC's forward guidance.

Monetary policymakers communicate not only about the future path of the policy rate but also about their projections of future conditions and estimates of important parameters, including u^*. The quarterly Summary of Economic Projections (SEP) publishes individual FOMC participants'[4] anonymized projections for real gross domestic product (GDP) growth, the unemployment rate, and inflation at several horizons. Longer-run projections for growth, unemployment, and headline inflation were added to the SEP in February 2009, and projections of the longer-run federal funds rate were added in January 2012.[5] The longer-run inflation projections were widely interpreted as an informal inflation target until the January 2012 "Statement on Longer-Run Goals and Monetary Policy Strategy" made the 2 percent inflation target explicit (Orphanides 2019). According to Bernanke (2016b), the longer-run unemployment, output growth, and federal funds rate projections can be interpreted

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[3]Other papers that introduce departures from rational expectations, including imperfect knowledge and learning, to attempt to resolve the forward-guidance puzzle include Ferrero and Secchi (2010), Cole (2015), Honkapohja and Mitra (2015), and Eusepi and Preston (2018).

[4]Following Bernanke (2016a), I use "FOMC participants" to refer to the seven Board governors and 12 Reserve Bank presidents who contribute projections to the SEP. "FOMC members" refers to a subset of participants, the seven Board members, the president of the Federal Reserve Bank of New York, and a rotating group of 4 of the remaining 11 Reserve Bank presidents.

[5]https://www.federalreserve.gov/monetarypolicy/timeline-summary-of-economic-projections.htm.

as estimates of u^*, potential output growth (y^*), and the "neutral" federal funds rate (r^*).[6]

Faust (2016) characterizes the SEP as *decentralized* communication, as it reveals the diversity of policymakers' views without clarifying how this diversity will affect committee policy choices. In contrast, *centralized* communication, like the threshold-based forward guidance, clarifies how the FOMC intends to react to incoming information. Faust argues that decentralized communication can potentially lead to cacophony and confusion.[7] For this reason, Bernanke (2016a) judges that the SEP "remains a controversial part of the Fed's communications toolkit, and it has sometimes confused more than enlightened" (also see Thornton 2015, Olson and Wessel 2016, and Bundick and Herriford 2017).

Decentralized communications do not fit neatly into the forward-guidance model of Goy, Hommes, and Mavromatis (2018), who assume that the central bank communicates with perfect precision, though they note that this assumption is not always realistic. The final section of this paper focuses on the FOMC's longer-run unemployment projections, documenting how and when the FOMC participants have disagreed with each other and with the private sector, discussing possible sources of disagreement and implications for credibility.

This paper contributes to several other strands of literature, including strands that use survey measures of expectations to study inflation targeting and expectations anchoring (Davis 2012; Kumar et al. 2015; Binder 2017a), to measure the effects of unconventional monetary policy on private-sector expectations (Bauer and Rudebusch 2013; Swanson and Williams 2014; Engen, Laubach, and Reifschneider 2015; Andrade et al. 2018), or to analyze the nature of information rigidities and the expectations-formation process (Mankiw, Reis, and Wolfers 2004; Coibion and Gorodnichenko 2012). The paper also contributes to a literature on why monetary policymakers disagree and how they communicate disagreement. Nechio and Regan (2016) show that monetary policymakers'

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[6]FOMC participants also communicate about these estimates in speeches; e.g., see Clarida (2019).

[7]Papers that suggest that more transparency is not always optimal include Morris and Shin (2002), Thornton (2003), Stasavage (2007), and Sunstein (2017).

speeches reveal a diverse set of views among the FOMC. Hayo and Neuenkirch (2013) and Jung and Latsos (2015) show that regional economic variables affect the interest rate preferences and communications of Federal Reserve presidents.

Finally, the paper contributes to the literature on the natural rate hypothesis (NRH) and its use by policymakers. Friedman (1968) famously argued that there is no long-run tradeoff between inflation and unemployment; rather, unemployment returns to its "natural" rate in the long run. This natural rate is the rate that would be observed when prices and wages have had time to fully adjust to balance supply and demand, and depends on structural factors characterizing the labor market (Walsh 1998).

Blanchard (2018) reviews the arguments and empirical evidence for and against two subhypotheses of the NRH: the *independence subhypothesis*—that there exists a natural rate of unemployment independent of monetary policy—and the *accelerationist subhypothesis*—that monetary policy cannot sustain unemployment below u^* without higher and higher inflation. First, there is some evidence of hysteresis, or path dependence in the natural rate of unemployment, which challenges the independence hypothesis (Ball 2009; Abraham et al. 2019; Yagan 2019). Second, prolonged high unemployment after 2009 did not lead to lower and lower inflation, which challenges the accelerationist hypothesis, though alternative explanations for the "missing disinflation" have been suggested (Coibion and Gorodnichenko 2015). Farmer (2013) also critiques the usefulness of the NRH in explaining inflation dynamics.

Several authors estimate policymakers' beliefs about u^* statistically, via estimation of a model of the economy and of policymakers' learning dynamics (Orphanides and Williams 2005, 2006; Sargent, Williams, and Zha 2006; Williams 2006). Typically, these models include an IS curve and a Phillips curve, written in terms of time-varying natural rates of unemployment and interest that are unobservable to policymakers but follow some specified data-generating process, and a policymaker loss function. Policymakers' misperceptions of u^* can have important implications for inflation dynamics and may have contributed to the Great Inflation of the 1970s (DeLong 1997; Romer and Romer 2002; Reis 2003; Primiceri 2006; Ashley, Tsang, and Verbrugge 2018). Orphanides and Williams (2002) study a variety of generalized Taylor (1993)-type

monetary policy rules and show that the most robust rules under such misperceptions are "difference rules" in which the policy rate is raised or lowered from its previous level in response to inflation and changes in economic activity. In contrast to these papers, I use survey-based rather than model-derived measures of policymakers' beliefs, and examine empirically the heterogeneity in both policymaker and private-sector beliefs.

Others use a narrative approach to study policymakers' beliefs about u^* and the Phillips curve. For example, Romer and Romer (2004) examine the narrative record to show that Federal Reserve chairs since 1936 have held a variety of views about the sensitivity of inflation to labor market slack and the level of u^*. Meade and Thornton (2012) use FOMC transcripts to evaluate the role of the Phillips-curve framework in U.S. monetary policy from 1979 to 2003. Most policymakers thought that inflation should be related to the gap between aggregate demand and aggregate supply, but disagreed about the usefulness of various gap measures in predicting inflation and guiding policy. I similarly use a narrative approach to supplement my analysis of policymakers' beliefs. In addition to FOMC transcripts and materials, I also examine the financial and popular press, as my interest is in not only policymakers' beliefs but also private-sector beliefs.

2.   Forecasters' Use of u^* and Expectations Formation

The Federal Reserve Bank of Philadelphia Survey of Professional Forecasters is a quarterly unbalanced panel of approximately 60 anonymous respondents. I make use of SPF forecasts for the civilian unemployment rate (u), headline PCE inflation (π), and nominal interest rates (i) at multiple horizons. Let $x_{j,t}^{\tau}$ denote forecaster j's expectation in quarter t of variable x at time τ, where τ may be a calendar year or a quarter depending on context. SPF respondents provide forecasts for the previous quarter ("backcast"), current quarter ("nowcast"), and one, two, three, and four quarters ahead, as well as annual average forecasts for the calendar year in which the survey is conducted and the following calendar year. Beginning in 2009:Q2 and 2009:Q3, respectively, forecasters also provide unemployment and three-month Treasury-bill
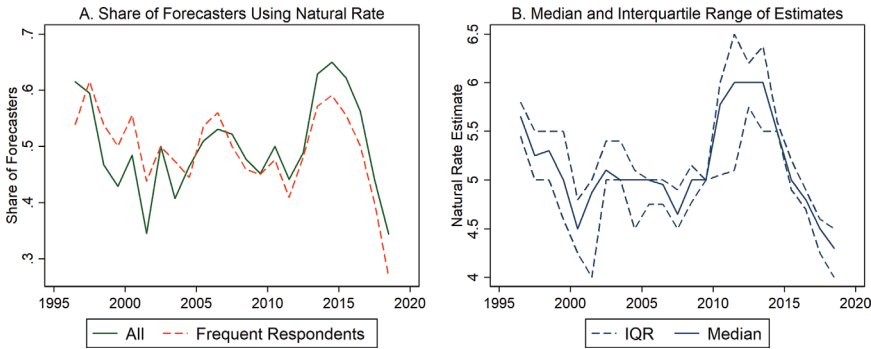
(T-bill) rate forecasts for the subsequent two calendar years. Since 2007:Q1, the SPF collects forecasts of personal consumption expenditures (PCE) inflation for an additional calendar year and averaged over the next five years (from the fourth quarter in the year before the survey year to the fourth quarter of the year that is five years beyond the survey year). SPF T-bill forecasts are for the quarterly or annual average of the underlying daily levels and unemployment forecasts for the average of the underlying monthly levels. Quarterly PCE forecasts refer to annualized quarter-over-quarter percent changes of the quarterly average seasonally adjusted price index, and annual PCE forecasts refer to inflation from the fourth quarter of the previous year to the fourth quarter of the year indicated.

A special SPF segment in 2009 asks respondents about their forecasting methods. Of the 25 forecasters who answered this optional segment, 20 say they use a model with subjective adjustments, 1 uses a model alone, and 4 use just experience and intuition. Of those using a model, 6 say they use a structural model, 3 use univariate or multivariate time-series forecasting, and 11 use some combination. Respondents to the special segment are not identified by forecaster ID, so their reported forecasting methods cannot be matched with their responses to other questions. However, another question on the survey provides information about forecasters' models and methods that can be matched with their forecasts. Namely, in the third quarter of each year since 1996, the SPF asks whether respondents use the natural rate of unemployment (u^*) in forecasting and, if so, asks for their estimate of u^*.

Panel A of figure 1 shows the share of forecasters who report using u^* to forecast over time. The share was around 50 percent during the ZLB period, peaked at 65 percent in 2014, then declined to 34 percent in 2018. While 124 forecasters have responded at least once to the question of whether they use u^*, some of these forecasters have only responded a few times. To address concerns about compositional effects, I also consider the sample of 30 forecasters who have responded to this question in at least 10 years. The share using the natural rate is similar for the full sample and frequent responders.

Panel B shows how the median and interquartile range of estimates of u^* have evolved over time. In 2009:Q3, the 25th and

Figure 1. SPF Forecasters' Use and Estimates of Natural Rate of Unemployment

Notes: Data are from SPF. Frequent respondents are those that provide at least 10 responses to the question of whether they use the natural rate of unemployment.

75th percentile SPF forecasters agreed that u^* was 5 percent. Two years later, the median rose to 6 percent, and disagreement also increased: the 25th percentile was 5.1 percent and the 75th percentile 6.5 percent. The median remained at 6 percent in 2012 and 2013, and fell to a record low of 4.3 percent in 2018:Q3. These estimates are also similar for the frequent responders. Thus, forecasters disagree about whether u^* is a useful forecasting concept, and among those forecasters who do use u^*, there is also time-varying fundamental disagreement about the level of u^*.

2.1 Short-Run Inflation Expectations

What does it mean if a forecaster reports using the natural rate of unemployment to forecast? Recall that according to Blanchard (2018), a key implication of the NRH—typically embedded in a Phillips curve—is that unemployment below u^* will lead to higher inflation. I test whether this implication is observed in forecasters' inflation expectations.

As a baseline, I consider the Phillips curve specification that Williams (2006) uses to study policymakers' beliefs about u^*, which

relates inflation (π) to its own lags and the lagged unemployment gap:[8]

$$\pi_t = \gamma_1 \pi_{t-1} + \gamma_2 \pi_{t-2} + \gamma_3 (u_{t-1} - u_{t-1}^*) + \nu_t. \tag{1}$$

For forecasters who provide an estimate $u_{j,t}^*$, I can iterate equation (1) forward one period, apply the expectations operator with respect to forecaster j in quarter t, and estimate the coefficients by regressing her one-quarter-ahead forecast of inflation ($\pi_{j,t}^{t+1}$) on her nowcast and backcast of inflation ($\pi_{j,t}^t$ and $\pi_{j,t}^{t-1}$) and her perception of the unemployment gap ($u_{j,t}^t - u_{j,t}^*$).[9] The first column of table 1 shows that the estimate of γ_3 is negative (-0.14) and statistically significant, as expected. Moreover, it is within the range of estimates that Williams (2006) obtains from rolling regressions using realized data from 1950 to 2003. The median of his rolling regression estimates is -0.23.

In the second column, I include the unemployment gap using the forecaster's own estimate $u_{j,t}^*$ as well as using the Congressional Budget Office (CBO) estimate $u_{CBO,t}^*$. Only the coefficient on $u_{j,t}^t - u_{j,t}^*$ is negative and statistically significant (though of course $u_{j,t}^t - u_{CBO,t}^*$ and $u_{j,t}^t - u_{j,t}^*$ are highly correlated). Thus forecasters do appear to use the estimate of u^* that they personally report.

In columns 3 and 4 I compare the expectations formation of forecasters who claim to use the natural rate with those who claim not to. Since the latter do not provide estimates of u^*, I use $u_{j,t}^t - u_{CBO,t}^*$ as the measure of the unemployment gap in both columns for the sake of comparability. The coefficient on the unemployment gap is less than half the magnitude of that for the forecasters who

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[8]Williams (2006) includes several additional lags of inflation and imposes a unity sum on the coefficients; for simplicity I just include two lags with no constraint on the coefficients. Williams's model is a version of the Rudebusch and Svensson (1999) model, but written with a time-varying u^* instead of output gap.

[9]Note that by using nowcasts and backcasts of inflation to estimate equation (1), I avoid the need to make assumptions about forecasters' real-time information about macroeconomic variables, but instead rely on their self-reported knowledge of conditions at time t and $t-1$. This is useful because inflation data are revised frequently, so analysis that assumes that ex post revised data are part of agents' information sets can be misleading (Orphanides 2001).

Table 1. The Natural Rate Hypothesis and SPF Inflation Expectations

	(1) $\pi_{j,t}^{t+1}$	(2) $\pi_{j,t}^{t+1}$	(3) $\pi_{j,t}^{t+1}$	(4) $\pi_{j,t}^{t+1}$	(5) $\pi_{j,t}^{t+1}$	(6) $\pi_{j,t}^{t+1}$	(7) $\pi_{j,t}^{t+1}$	(8) $\pi_{j,t}^{t+1}$	(9) $\pi_{j,t}^{t+1}$
$\pi_{j,t}^t$	0.28*** (0.03)	0.26*** (0.03)	0.26*** (0.03)	0.33*** (0.04)	0.24*** (0.02)	0.32*** (0.04)			
$\pi_{j,t}^{t-1}$	−0.00 (0.03)	−0.01 (0.03)	−0.02 (0.03)	−0.03 (0.02)	−0.02 (0.03)	−0.03 (0.02)			
$\pi_{j,t}^{t+4}$							0.25** (0.11)	0.25** (0.12)	0.47*** (0.15)
$u_{j,t}^t - u_{j,t}^*$	−0.14*** (0.02)	−0.22*** (0.06)					−0.15*** (0.03)		
$u_{j,t}^t - u_{CBO,t}^*$		0.06 (0.06)	−0.13*** (0.02)	−0.05*** (0.01)				−0.13*** (0.02)	−0.07*** (0.01)
Output Gap					0.13*** (0.02)	0.04** (0.02)			
Constant	1.43*** (0.07)	1.48*** (0.08)	1.52*** (0.08)	1.49*** (0.09)	1.57*** (0.06)	1.51*** (0.10)	1.39*** (0.18)	1.41*** (0.21)	1.11*** (0.35)
N	827	720	720	679	847	696	822	838	673
R_w^2	0.28	0.25	0.25	0.30	0.26	0.30	0.08	0.10	0.09
R_b^2	0.47	0.43	0.43	0.45	0.32	0.46	0.35	0.31	0.46
Sample	Use u^*	Use u^*	Use u^*	No u^*	Use u^*	No u^*			

Notes: Standard errors are in parentheses. ***, **, and * denote p < 0.01, p < 0.05, and p < 0.10, respectively. Time sample is 2007:Q1 through 2018:Q3. Data are from the Survey of Professional Forecasters (SPF). Dependent variable is forecast for next-quarter PCE inflation. $u_{i,t}^*$ is the respondent's estimate of natural rate and $u_{CBO,t}^*$ is the CBO estimate. In columns 4 and 6, sample is the respondents who report that they do not use u^*.

use u^*.[10] Also note that the coefficient on inflation is 0.33, compared with 0.26 for the u^* users. Quarterly PCE inflation has an AR(1) coefficient of 0.30 since 1996 and 0.36 after 2008.

It is possible that respondents who report not using u^* do use a Phillips curve to forecast, but with the output gap in place of the unemployment gap. Columns 5 and 6 are analogous to 3 and 4, but with the output gap in place of the unemployment gap.[11] The coefficient estimate on the output gap for the reported nonusers of u^* users is again less than half of that for reported u^* users. Results are robust to alternative specifications of the Phillips curve in (1), including forward-looking specifications. For example, the final three columns are analogous to columns 1, 3, and 4 but include $\pi_{j,t}^{t+4}$ as a regressor in place of $\pi_{j,t}^{t}$ and $\pi_{j,t}^{t-1}$, and results are similar.

In summary, forecasters who report using versus not using u^* appear to be distinct in how they form short-run inflation expectations, and in particular in their beliefs about the Phillips curve. The u^* users seem to rely more on a Phillips curve to forecast short-run inflation, much like the "credibility believers" in the models of Goy, Hommes, and Mavromatis (2018), Cornea-Madeira, Hommes, and Massaro (2019), and others.[12] The non-users do not *perfectly* resemble the "adaptive expectations" or "naive" agents, as their inflation forecasts do rely somewhat on their unemployment forecasts, but their inflation backcasts do explain a much larger share of the variance in their inflation forecasts,[13] so their beliefs can be more reasonably approximated as following a univariate model.

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[10]This difference is statistically significant. If I instead run the regression with both groups of forecasters, and interact the unemployment gap with a dummy variable indicating that the forecaster uses u^*, the coefficient on the interaction term is negative and statistically significant.

[11]The output gap is defined as $100\frac{y-y^*}{y^*}$, where y^* is the CBO estimate of potential real GDP (Federal Reserve Economic Data (FRED) series GDPPOT) and y is real GDP (FRED series RGDPC1).

[12]In these models, the Phillips curve is specified in terms of marginal cost; since SPF respondents do not provide marginal cost forecasts, I instead use the output or unemployment gap.

[13]Regression of $\pi_{j,t}^{t+1}$ on $\pi_{j,t}^{t-1}$ has an R^2 value about three times higher for non-users than for users.
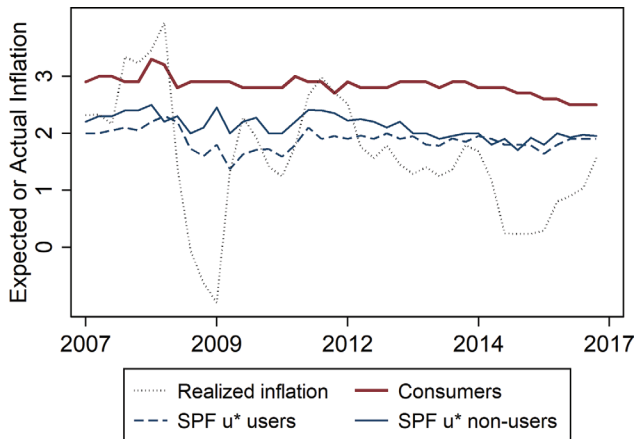
2.2   Long-Run Inflation Expectations

Another important feature of the credibility believers in the models of Cornea-Madeira, Hommes, and Massaro (2019) and others is that they expect future long-run inflation to be equal to the inflation target of the central bank. Busetti et al. (2017) and Hommes and Lustenhouwer (2019) use models with credibility believers and naive agents specifically to study inflation targeting.

January 2012 marked the first explicit announcement of a quantitative inflation target by the Fed, though the Fed had been influenced by the inflation-targeting framework long before this announcement (Bernanke 2003; Thornton 2012). Forecasters who use u^* were more aware that the Fed had an informal inflation target before the 2012 announcement, possibly inferring this from the longer-run inflation projections in the SEP. In a 2007:Q4 special questionnaire, among SPF respondents who have reported at least once that they use u^* in forecasting, 57 percent believed that the Fed had a numerical target for inflation, compared with just 30 percent of other respondents.

Figure 2 plots the median five-year-ahead inflation expectations of each group as well as the longer-run inflation expectations of respondents to the Michigan Survey of Consumers and realized inflation. On average, the u^*-users' long-run inflation expectations are 23 basis points lower than the non-users' expectations, are closer to the inflation target, and fell more in the Great Recession. Non-users' expectations are closer to and more correlated with the consumers' expectations: the correlation between non-users' and consumers' inflation expectations is 0.46, and between users' and consumers' expectations 0.23.

The communication of a numerical target for long-run inflation is intended to make long-run expectations more anchored, or less responsive to shocks. In particular, if expectations are well anchored, long-run inflation expectations should be minimally responsive to changes in shorter-run expectations (Bernanke 2007; Davis 2012). In table 2, I regress forecasters' revisions to five-year-ahead inflation forecasts ($\Delta\pi_{j,t}^{5y} = \pi_{j,t}^{5y} - \pi_{j,t-1}^{5y}$) on revisions to forecasts for the current quarter ($\Delta\pi_{j,t}^{t} = \pi_{j,t}^{t} - \pi_{j,t-1}^{t}$). The sample in the first column is forecasters who report using the natural rate at least once ($NR_j = 1$), and in the second column is forecasters who never report

Figure 2. Long-Run Inflation Expectations of Consumers and Professional Forecasters by Use of u^*

Notes: The figure shows median 5- to 10-year inflation expectations of Michigan Survey of Consumers respondents and median 5-year PCE inflation expectations of SPF forecasters who report using or not using the natural rate of unemployment to forecast. Realized inflation refers to the percent change in the PCE price index from one year previous.

using the natural rate ($NR_j = 0$). The natural rate users revise their long-run expectations up 3 basis points for each percentage-point increase in their expectations of current-quarter inflation, compared with 10 basis points for non-users. The R^2 is also much higher for the non-users. Column 3 uses the full sample of forecasters but includes an interaction of $\Delta\pi_{j,t}^t$ and NR_j. The coefficient on the interaction term is negative and statistically significant.

In the fourth column, I consider whether the expectations of the natural rate users became more anchored relative to those of the non-users after the announcement of the inflation target in 2012. This is a diff-in-diff-in-diff specification with the interaction term $Post_t * NR_j * \Delta\pi_{j,t}^t$, where $Post_t$ denotes that t is after the announcement. The coefficient on the three-way interaction term is negative and statistically significant, suggesting that the announcement may have been more effective at anchoring the expectations of forecasters who use the natural rate.

**Table 2. Belief in the Natural Rate Hypothesis and
Anchoring of Long-Run Inflation Expectations**

	(1) $\Delta\pi_{j,t}^{5y}$	(2) $\Delta\pi_{j,t}^{5y}$	(3) $\Delta\pi_{j,t}^{5y}$	(4) $\Delta\pi_{j,t}^{5y}$
$\Delta\pi_{j,t}^{t}$	0.03***	0.10***	0.10***	0.07***
	(0.01)	(0.02	(0.02)	(0.02)
NR*$\Delta\pi_{j,t}^{t}$			−0.08***	−0.05**
			(0.02)	(0.02)
Post*NR*$\Delta\pi_{j,t}^{t}$				−0.11***
				(0.04)
Post*NR				−0.00
				(0.02)
Post*$\Delta\pi_{j,t}^{t}$				0.12***
				(0.04)
N	1,005	204	1,209	1,209
R^2	0.02	0.13	0.05	0.06
Sample	Use u^*	No u^*	All	All

Notes: Standard errors are in parentheses. ***, **, and * denote $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. Time sample is 2007:Q1 through 2018:Q3. Data are from the SPF. Dependent variable is revision in forecast for five-year-ahead PCE inflation. "Post" denotes that the survey date is after the January 2012 inflation target announcement. "NR" denotes that the respondent has reported at least once that she uses the natural rate of unemployment to forecast. Regressions include a constant term and forecaster fixed effects.

2.3   Credibility of Forward Guidance

At the ZLB, central banks' ability to influence private-sector expectations is important; a central bank can conduct monetary easing if it can generate expectations that it will keep the policy rate low to allow above-target inflation and above-trend output in the future (Krugman 1998; Eggertson 2006; Boneva, Harrison, and Waldron 2018). Forward guidance can thus be interpreted as communication about future deviations from the central bank's policy rule (Campbell et al. 2019).

In Goy, Hommes, and Mavromatis (2018), only the credibility believers respond to the central bank's forward guidance. I test whether the reported u^* users resemble credibility believers in this respect. I focus on the "threshold-based" forward guidance of

December 2012 which announced that an "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." This guidance was intended to be less ambiguous, and hence better able to guide expectations, than the open-ended guidance issued in December 2008 (Woodford 2012; Williams 2013a).

Swanson and Williams (2014) use multi-horizon forecast data from Blue Chip to infer when private forecasters expected "liftoff" from the ZLB. Before the start of calendar-based forward guidance, the median Blue Chip forecaster expected liftoff in about four quarters. Expected time to liftoff increased in the calendar-based guidance period. Since the Blue Chip data has a maximum horizon of six quarters, for part of the calendar-based forward-guidance period they can only infer that the median forecaster expects liftoff in seven or more quarters. I conduct a similar exercise using the SPF data. Since the SPF data are available at longer horizons, I avoid the top-coding issue and can observe not only the median but also nearly the full distribution of expected liftoff dates. See the appendix for details.

I also compute expected unemployment at expected liftoff for each forecaster and survey date. If an SPF forecaster expects liftoff within the next four quarters, I use her quarterly forecast for unemployment in the corresponding quarter as an estimate of her expected liftoff conditions. If she expects liftoff at a later date, I linearly interpolate between her annual average unemployment forecasts to construct estimates of her expectations of unemployment at each quarterly horizon, and use the interpolated unemployment and inflation forecasts corresponding to my estimate of her expected liftoff date.[14]

In 2013, among forecasters who did not report using u^*, only 33 percent expected unemployment below 6.5 percent at liftoff, compared with 70 percent of forecasters who did report using u^*.

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[14]I focus on expected unemployment rather than expected inflation at expected liftoff since the PCE inflation forecasts are available for one less calendar year than the unemployment and T-bill forecasts, and since the 6.5 percent unemployment threshold is clearer that the inflation-related thresholds.

Table 3. Mean Squared Forecast Errors by Use of u^*

	u^{1Q}	u^{4Q}	r^{1Q}	r^{4Q}	π^{1Q}	π^{4Q}
Non-users of u^*	0.15	1.11	0.30	2.17	3.64	3.79
Users of u^*	0.11	0.84	0.22	1.85	4.09	3.61
p-value	0.001	0.01	0.02	0.06	0.50	0.79

Notes: Data are from the SPF. The table shows forecasters' mean squared forecast error by reported use of u^* for unemployment, interest rate (T-bill), and PCE inflation forecasts at the one-quarter and four-quarter horizons. The final row shows the p-value for the test of statistically significant difference in mean between the non-users and users of u^*. Unemployment and interest rate forecast data are available 1996:Q3 to 2018:Q3; inflation forecast data are available 2007:Q1 through 2017:Q3.

Thus, this aspect of forward guidance was more credible among the reported u^* users.

2.4   Forecast Accuracy and Composition of Types

Dragar, Lamla, and Pfajfar (2016) show that "model-consistent" forecasters—those who make forecasts consistent with the Fisher equation, Taylor rule, and Phillips curve—tend to have greater forecast accuracy. I check whether forecasters who report using u^* likewise make more accurate forecasts. Table 3 reports the mean squared forecast error for unemployment, nominal interest rate, and inflation forecasts at the one-quarter-ahead and four-quarter-ahead horizons by reported use of u^*. The forecasters who report not using u^* have larger forecast errors, on average, for unemployment and interest rates at both horizons. The difference in accuracy is statistically significant for unemployment at both horizons and for interest rates at the one-quarter horizon, and marginally significant (p-value $= 0.06$) for interest rates at the four-quarter horizon. The average difference in inflation forecast accuracy is not statistically significant.

The models with credibility believers and naive agents make no assumptions about which type makes more accurate forecasts. Rather they assume, as in Brock and Hommes (1997) and Branch et al. (2004), that agents switch heuristics based on "relative fitness," or some history of relative forecasting performance.[15] That

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[15]This assumption formalizes Simon's (1984) suggestion that decisionmaking can be modeled as a rational choice between a set of different heuristics.

is, if the forecasts made by credibility believers become relatively less accurate than the adaptive expectations forecasts, then a larger share of agents will use adaptive expectations.

In Cornea-Madeira, Hommes, and Massaro (2019), agents switch between being credibility believers and adaptive expectations users based strictly on the relative inflation-forecasting performance of the two heuristics. Cornea-Madeira, Hommes, and Massaro estimate the share of credibility believers over time using aggregate data (without survey data on expectations) and a New Keynesian model. They find that the average share of credibility believers has declined in recent years, and posit that in the aftermath of the financial crisis, prolonged below-target inflation has improved the relative forecast accuracy of simple univariate ("naive") forecasts, reducing the share of credibility believers. (See Busetti et al. 2017 for a similar discussion.)

Recall from panel A of figure 1 that the share of u^* users has also declined in recent years. The share of u^* users, which has mean 0.5 and standard deviation 0.08, is not as volatile as the estimated share of credibility believers in Cornea-Madeira, Hommes, and Massaro (2019), which has mean 0.33 and standard deviation 0.27. Part of the difference in mean and volatility may reflect the difference in sample periods, as the sample in Cornea-Madeira, Hommes, and Massaro (2019) starts in 1964 and mine starts in 1996. But it is also possible that forecasters' choice of model depends on more than just inflation forecast accuracy. Forecasters may consider the accuracy of forecasts for multiple variables, or type may be "sticky" due to switching costs (cognitive or otherwise). Forecasters may also evaluate the relative ease of using different models. For example, if u^* becomes highly variable and difficult to precisely estimate, they may switch away from using models that rely on u^*.[16] Forecasters may also be influenced by central bank communications or media narratives about how the economy works.

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[16]The absolute number of forecasters that switch from reportedly using to not using the natural rate or vice versa is fairly small: since 1997, only 39 forecasters have switched from not using to using, and only 34 have switched from using to not using. Thus it is difficult to test statistically for possible predictors of switching behavior.

3. Federal Reserve Communication and Disagreement about u^*

The previous section showed that forecasters who report using versus not using the natural rate of unemployment are distinct in how they forecast short- and long-run inflation. The u^* users seem to resemble "credibility believers," including with respect to forward guidance at the ZLB. Thus the time-varying share of u^* users may have important implications for central bank credibility and expectations formation. But recall from figure 1 that even among reported u^* users, estimates of u^* and disagreement about u^* are also time varying. These variations are worth understanding for several reasons.

First, section 2.1 showed that forecasters use their *own* estimates of u^* to form inflation forecasts. The negative estimate of γ_3 in equation (1) implies that, all else equal, forecasters with higher estimates of u^* should have higher expectations of future inflation. Thus disagreement about u^* contributes to disagreement in inflation expectations. This is also true for longer-run inflation expectations. Panel regressions of five-year-ahead inflation expectations on $u^*_{j,t}$ with time fixed effects have a coefficient estimate of 0.23 on $u^*_{j,t}$, which is statistically significant with $p < 0.05$.[17]

Second, the quarterly Summary of Economic Projections publishes FOMC participants' estimates of u^*. The SEP is a decentralized form of Fed communication (Faust 2016). Substantial disagreement about u^* *among* SPF forecasters, or *between* SPF forecasters and FOMC participants, despite publication of the SEP, might point to weaknesses in Federal Reserve communication, and might be related to the subsequent reduction in reported u^* users. As I will show, both types of disagreement were especially high from 2011 through 2013, when many SPF forecasters became more pessimistic than many FOMC participants about u^*. Third, and relatedly, recall from section 2.3 that in 2013:Q3, 33 percent of u^* non-users and 70 percent of u^* users expected unemployment below 6.5 percent at liftoff. Among forecasters with an estimate of u^* less than 6 percent (the highest FOMC projection) in that quarter, 83 percent expected

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[17]If the regression includes forecaster fixed effects, the coefficient is 0.19, which is statistically significant with $p < 0.01$.

unemployment below 6.5 percent at liftoff. For those with an estimate of u^* at least 6 percent, only 50 percent expected unemployment below 6.5 percent at liftoff.[18] Thus forecasters who were more pessimistic about u^* than most of the FOMC were less likely to have expectations consistent with the threshold-based forward guidance.

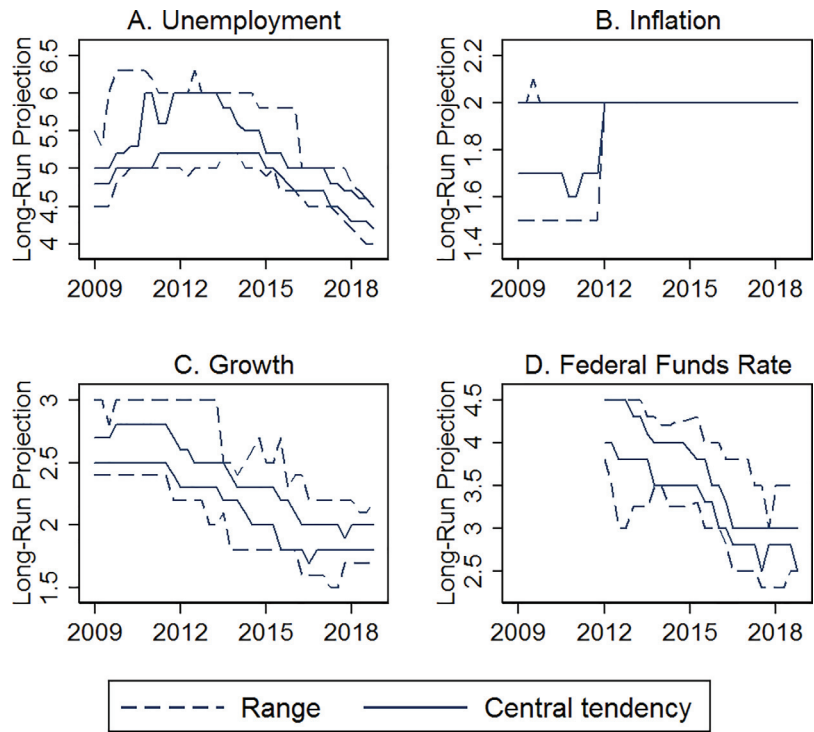### 3.1 FOMC Projections of Longer-Run Unemployment

In the SEP, the five Board members and 12 presidents provide projections for several macroeconomic variables for the current calendar year and up to three subsequent years, as well as for the "long run." The projections are not unconditional expectations, but are conditional on appropriate monetary policy. Responses are anonymized and cannot be linked from one meeting to the next.

Panel A of figure 3 summarizes FOMC projections of longer-run unemployment from the SEP, which are available since 2009. In 2009, the FOMC projections in 2009 displayed minimal disagreement, with the central tendency from 4.8 to 5 percent. The width of the central tendency of the FOMC projections subsequently rose, and the midpoint of the central tendency increased. Since projections are conditional on appropriate monetary policy, the increasing width of the central tendency could reflect growing divergence in assumptions about appropriate policy.

These patterns are similar to those for the SPF: panel B of figure 1 shows that in 2009:Q3, the majority of SPF respondents who reported using u^* also estimated that u^* was 5 percent. In fact, for forecasters that said they used u^*, 57 percent reported an estimate of 5 percent, and all estimates were between 4 percent and 6 percent. The median estimate and the interquartile range (disagreement) both rose the next year and remained elevated throughout the ZLB period. But most FOMC projections increased by less than most SPF estimates of u^*. As figure 4 shows, by 2011 through 2013, the SPF median was around 50 basis points higher than the FOMC midpoint. In 2013:Q3, the central tendency of the FOMC long-run unemployment projections was 5.2 to 5.8 percent, and 55 percent of SPF estimates of u^* were *above* 5.8 percent.

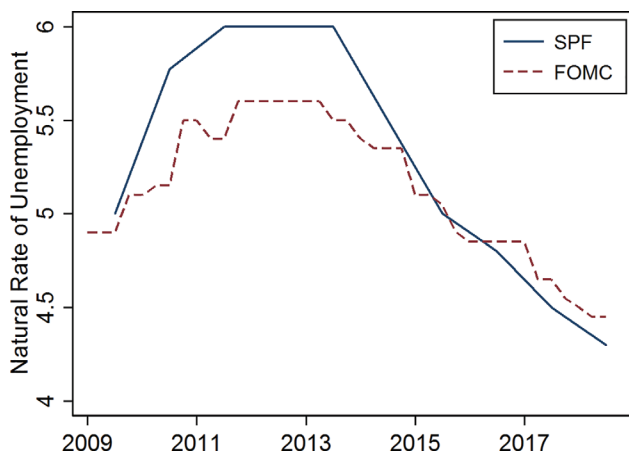[18]This difference is statistically significant at the 10 percent level.

Figure 3. FOMC Longer-Run Projections

Notes: Summary of Economic Projections data accessed from FRED. The central tendency excludes the three lowest and three highest projections. Variable codes: UNRATERLLR, UNRATECTLLR, UNRATECTHLR, PCECTPIRHLR, PCECTPIRLLR, PCECTPICTLLR, PCECTPICTHLR, PCECTPIRHLR, GDPC1RHLR, GDPC1RLLR, GDPC1CTLLR, GDPC1CTHLR, GDPC1RHLR, FEDTARRHLR, FEDTARRLLR, FEDTARCTLLR, FEDTARCTHLR, and FEDTARRHLR.

The other panels of figure 3 summarize FOMC longer-run projections of PCE inflation, growth, and the federal funds rate, while figure 5 shows the width of the central tendency and the range for each longer-run projection over time. Notice that there is no disagreement about longer-run inflation since the 2012 announcement of a 2 percent target. Disagreement about longer-run growth did not increase with disagreement about longer-run unemployment, but rather stayed nearly constant as the midpoint longer-run growth

**Figure 4. SPF Estimates and FOMC Projections of
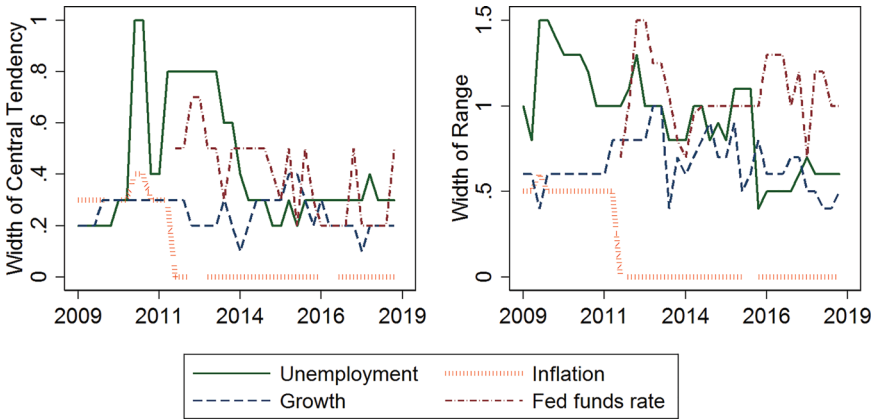Natural Rate of Unemployment**

Notes: The solid line is the median SPF estimate of u^*. The dashed line is
the midpoint of the central tendency for the SEP longer-run unemployment
projection.

estimate gradually declined. The longer-run federal funds rate projections, published since 2012, show substantial disagreement about the longer-run policy rate as the midpoint estimate has fallen, which may reflect the documented low precision in estimates of the natural interest rate (Laubach and Williams 2016).

3.2 Definitions of u^*

Why did FOMC and SPF estimates of u^*, which were so similar in 2009, subsequently diverge? One possibility is that forecasters and FOMC participants use different definitions of "natural rate of unemployment." Bernanke (2016b) says that the longer-run unemployment projections in the SEP "can be viewed as estimates of the 'natural' rate of unemployment, the rate of unemployment that can be sustained in the long run without generating inflationary or deflationary pressures." The SPF respondents are not provided with a definition of "natural rate of unemployment."

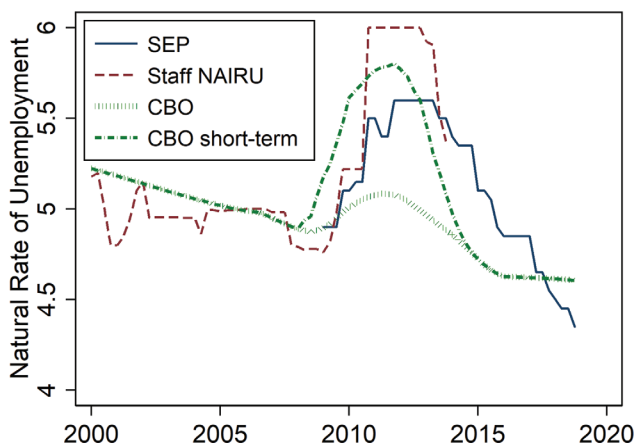**Figure 5. FOMC Disagreement in Longer-Run Projections**

Notes: Summary of Economic Projections data accessed from FRED. The central tendency excludes the three lowest and three highest projections. Variable codes: UNRATERLLR, UNRATECTLLR, UNRATECTHLR, PCECTPIRHLR, PCECTPIRLLR, PCECTPICTLLR, PCECTPICTHLR, PCECTPIRHLR, GDPC1RHLR, GDPC1RLLR, GDPC1CTLLR, GDPC1CTHLR, GDPC1RHLR, FEDTARRHLR, FEDTARRLLR, FEDTARCTLLR, FEDTARCTHLR, and FEDTARRHLR.

The natural rate of unemployment is often treated as synonymous with the NAIRU (non-accelerating inflation rate of unemployment), though the two concepts are distinct and play different roles in monetary policy (Estrella and Mishkin 1999). The NAIRU is the unemployment rate consistent with steady inflation in the near term, and thus plays a more direct role in policy conduct because it helps with forecasting inflation and achieving an inflation target. However, its high variability and difficulty to measure (Staiger, Stock, and Watson 1997; Tasci and Verbrugge 2014) can make the NAIRU problematic to use when explaining policy actions to the public. See Espinosa-Vega and Russell (1997) for a detailed history of economic thought surrounding the NAIRU and the natural rate hypothesis. Meanwhile the natural rate, which is slower moving, serves as the appropriate benchmark for unemployment stabilization objectives (Walsh 1998).

The distinction between the natural rate and the NAIRU may have been minimal in 2009 but larger in the subsequent years.

**Figure 6. SEP, Greenbook, and CBO Estimates of
Natural Rate of Unemployment or NAIRU**

Notes: The solid line is the midpoint of the central tendency for the SEP longer-run unemployment projection. The dashed line is the real-time NAIRU estimate from the Board of Governors, accessed from the Federal Reserve Bank of Philadelphia Greenbook Data Sets. CBO estimates of u^* are accessed from FRED (series NROU and NROUST).

Indeed, until recently, the CBO published a single series they referred to as the "natural rate of unemployment (NAIRU)" (implicitly treating the natural rate and NAIRU as synonyms). But in 2008, the CBO began distinguishing between a "long-run natural rate" and a "short-run natural rate." The latter, which incorporates temporary factors, is more akin to the NAIRU in that it is used to gauge labor market slack in the CBO projections of inflation.

Figure 6 displays both of these CBO series over time. In 2009, the longer-term and shorter-term CBO estimates were 4.9 percent and 5.2 percent, respectively. But the longer-term estimate remained near 5 percent, while the shorter-term estimate peaked at 5.8 percent in 2011:Q4. Figure 6 also plots the midpoint of the SEP longer-run unemployment, which rose much more than the longer-term CBO estimate but less than the shorter-term CBO estimate.

The Federal Reserve Bank of Philadelphia Real-Time Data Research Center provides the "NAIRU Estimates from the Board of
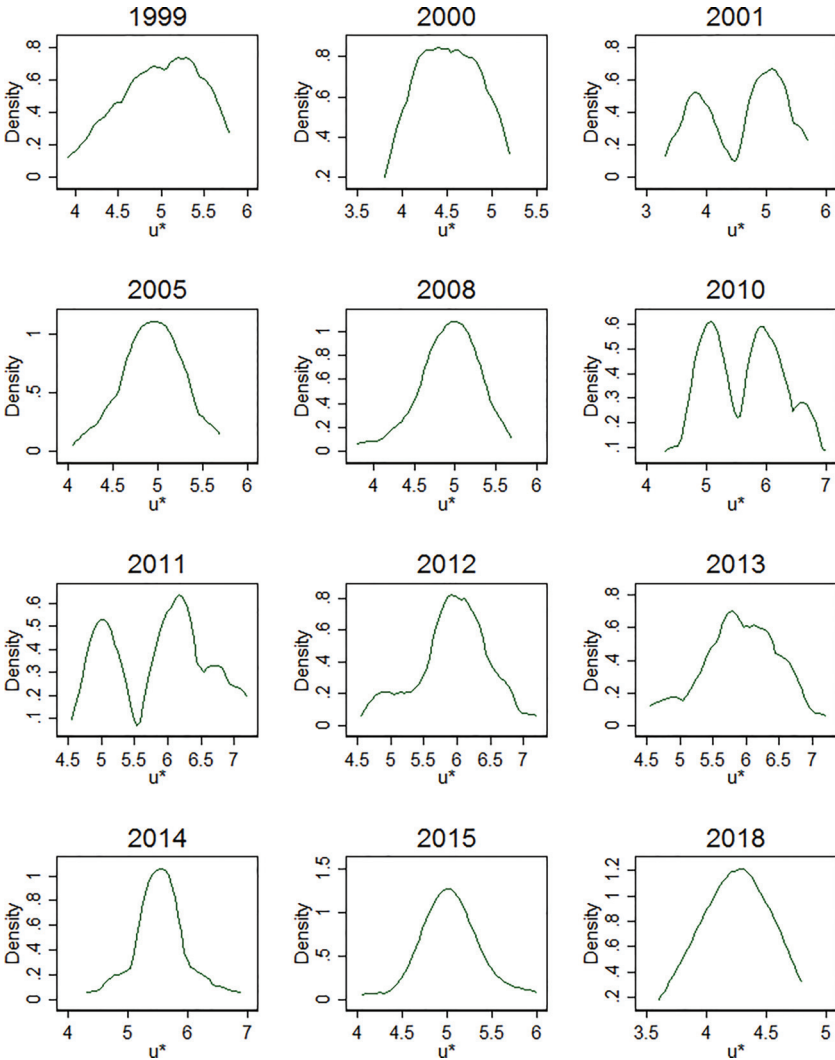
Governors," which contains the Federal Reserve staff's real-time estimates of the NAIRU from the Greenbooks.[19] The data are released with a lag of at least five years; as of August 2019, the NAIRU data are available through December 2013. This NAIRU estimate is also plotted on figure 6. The staff NAIRU estimates rose from 5.0 percent in 2009:Q3 to 6.0 percent in 2010:Q4, and remained at 6.0 percent (well above the SEP midpoint but similar to the SPF median) through 2012:Q4. By 2013:Q3, both the staff NAIRU estimate and the SEP longer-run unemployment midpoint were 5.5 percent. Thus, the SEP longer-run unemployment projections appear to be similar to the staff NAIRU estimates in normal times, but the NAIRU is a shorter-run concept that may rise more than the natural rate of unemployment in recessions.

It is possible that some SPF respondents report estimates of the (short-run) NAIRU while others report the (long-run) natural rate of unemployment. Figure 7 plots kernel density estimates of SPF u^* estimates in different years. The distribution of u^* estimates is unimodal in all years (including the years not displayed) except for 2001, 2010, and 2011, when it is clearly bimodal. In 2001, a recession year with a sharp rise in unemployment, the modes are at 4 percent and 5 percent, while in 2010 and 2011, the two modes are near 5 percent and 6 percent, perhaps corresponding to a group of respondents reporting the natural rate and another group reporting the NAIRU. By 2012 and 2013, though the kernel density appears unimodal, the popular responses are 5.5 percent, 6 percent, and 6.5 percent. The lower estimates may still correspond to respondents reporting the natural rate and higher estimates the NAIRU. This could explain why disagreement among SPF forecasters and between the SPF and the FOMC were both heightened in 2010 through 2013.

However, even among the FOMC participants, disagreement about longer-run unemployment was especially high from 2010 through 2013. Moreover, as FOMC and SPF estimates of u^* have been repeatedly revised downward, the share of reported u^* users

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[19]Data are available at https://www.philadelphiafed.org/surveys-and-data/ real-time-data-research. For comparative analysis of staff and FOMC members' forecasts, see Romer and Romer (2008) and Binder and Wetzel (2018).

Figure 7. Kernel Density Estimates by Year of SPF Estimates of u^*

Notes: Data are from SPF. Kernel density estimates for forecasters' estimate of the natural rate of unemployment by year for select years. Epanechnikov kernel with bandwidth 0.2.

has also fallen. The final subsection discusses other potential contributors to disagreement and uncertainty about the natural rate based on narrative evidence.
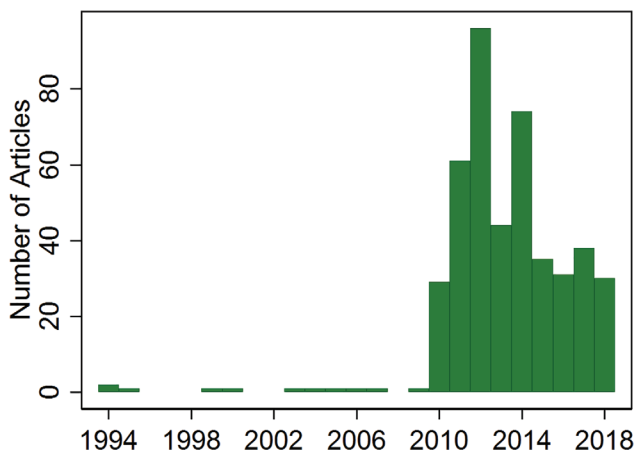
3.3   Narrative Evidence and Discussion

FOMC transcripts and speeches, media coverage, and the academic literature provide some additional insights into the patterns that appear in figures 1, 3, and 4. The rise in median or midpoint estimates and disagreement about u^* for both the SPF and the FOMC corresponds to the timing of the "missing disinflation" puzzle. This puzzle refers to the fact that inflation fell relatively little despite sustained high unemployment in the aftermath of the Great Recession. This missing disinflation led to uncertainty and disagreement about whether the Phillips curve was "alive and well," and about the extent to which a rise in u^* was the cause (Coibion and Gorodnichenko 2015).

Abraham (2015) notes that the idea that the labor market is suffering from "skills mismatch" often becomes popular during prolonged periods of high unemployment. This does appear to be the case following the Great Recession. Paul Krugman describes a consensus by the news media that the high unemployment during and after the Great Recession was structural, resulting from skills mismatch.[20] He argues that the media presented the skills mismatch story as the known truth, despite weak evidence to support it. I searched U.S. publications in the Nexis Uni database for the terms "skill mismatch" or "skills mismatch" and "unemployment." As shown in figure 8, the volume of news coverage of skill mismatch did indeed rise dramatically beginning in 2010 and peaking in 2012.

Reports of skill mismatch often accompanied discussions of the unconventional policies introduced by the Fed at the ZLB, including the quantitative easing (QE) programs (see Blinder 2010). Some drew the conclusion that monetary policy, particularly QE3, would have limited ability to reduce unemployment. For example, on Bloomberg TV, John Ryding, Chief Economist and Founding Partner at RDQ Economics, said, "Let's remember that there's certain

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[20]Paul Krugman, "Structural Unemployment: Yes, It Was Humbug," *New York Times*, August 4, 2017.

Figure 8. News Coverage of Skill Mismatch

Notes: Number of search results in U.S. publications in Nexis Uni database for terms "skills mismatch" or "skills mismatch" and "unemployment." There are 450 results from 1994 to 2018. Results can be viewed at https://advance.lexis.com/api/permalink/03d4429d-c5b8-4af6-8eb4-61062b9ed157/?context=1516831.

things that monetary policy can't achieve. ... We have a relatively high level of job openings given the unemployment rate. So why aren't we filling those job vacancies at a faster pace? Is it all about lack of demand, or is it about a skill mismatch?"[21] Some news coverage around the announcement of QE3 also directly or indirectly criticized the Fed's model of the economy. The September 19, 2012 edition of *Forbes* said, "The mistaken belief that a central bank can increase employment is the result of ... persistent theoretical errors. ... One is the so-called 'Phillips curve'. . ."[22]

Forecasters may have differed in the extent to which they believed the skills mismatch narrative, and thus in how much they revised their u^* estimates. FOMC participants, likewise, may have differed in these respects. FOMC transcripts show that as early as 2010,

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[21]Source: Interview by Tom Keene, Sara Eisen, and Scarlet Fu on July 25, 2012.

[22]https://www.forbes.com/sites/markhendrickson/2012/09/19/the-wages-of-bernanke-winners-and-losers-from-qe3.

FOMC participants were highly attentive to the possibility of rising structural unemployment, and were relying on their staffs to evaluate this possibility. For example, at the January 2010 FOMC meeting, Janet Yellen, then president of the Federal Reserve Bank of San Francisco, noted that her forecasts were "strikingly optimistic relative to most private-sector forecasters."[23] Yellen also noted that the median FOMC forecast for 2009 unemployment was 1.5 percentage points too low, explaining that Okun's law would have predicted 8 percent (rather than the realized 10 percent) unemployment. But her staff could not find evidence that the NAIRU had jumped enough to reconcile the 2009 output and unemployment data with Okun's law. Instead, she attributed the deviation from Okun's law to a surge in labor productivity, implying that slack in the economy was higher than in the Greenbook estimates.

At the June 2010 meeting, Chairman Bernanke remarked, "I am still sympathetic to the staff view that the NAIRU—or the natural rate, or however you want to describe it—has probably not permanently increased at this point."[24] He recommended research by economists at the Federal Reserve Banks of San Francisco and New York, finding that the rate of outflow from unemployment was not industry dependent and was much higher than experienced in the European hysteresis episode in the 1980s (Elsby, Hobijn, and Sahin 2010). Board member Daniel Tarullo also cited Elsby, Hobijn, and Sahin (2010) when he concluded that there were few signs of increasing structural unemployment, and that the severity of longer-term unemployment problems could be limited.[25] Note that FOMC transcripts are released with a five-year lag, but participants could discuss their interpretations of economic conditions in speeches.

In 2012, additional research from Federal Reserve economists continued to find little evidence of skill mismatch or rising structural unemployment (Altig 2012; Fabermand and Mazumder 2012). Jeffrey Lacker, president of the Federal Reserve Bank of Richmond and the only dissenter to the 2012 FOMC statements, viewed structural unemployment and skill mismatch as a larger problem than

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[23]January 27, 2010 FOMC transcript, pages 137–39.
[24]June 23, 2010 FOMC transcript, pages 124–25.
[25]April 27–28, 2010 FOMC transcript, pages 130–31.

most other FOMC participants. Lacker publicly remarked that "the healing in the labor market has been limited by a very real sense of skill mismatch," and that unemployment "could well be above 7%" when the Fed raised rates.[26] He made similar comments in speeches throughout the year. For example, in October 2012 he was quoted in Reuters saying that "improvement in labor market conditions appears to have been held back by real impediments that are beyond the capacity of monetary policy to offset."[27] Note that Lacker gave 28 speeches in 2012 and 2013,[28] the same as the average among voting presidents on the FOMC. But he received 22 percent more news coverage than the average voting president and 47 percent more than the average Board member (table 4), as media coverage, including monetary-policy-related coverage, tends to focus on negative news and stories of division and conflict (Binder 2017b).

More recently, inflation has risen relatively little as unemployment has fallen; in other words, there is a "missing inflation" puzzle (Bobeica and Jarocinski 2019). FOMC participants have revised their u^* estimates downward, while SPF forecasters have either revised their estimates downward or stopped using u^* altogether. The repeated downward revisions and "missing inflation" may have contributed to skepticism about the usefulness of models based on the natural rate, reflected in the declining share of SPF respondents who reportedly use u^* to forecast. This skepticism may also extend to some politicians. During Chairman Jerome Powell's July 2019 Congressional testimony, Representative Alexandria Ocasio-Cortez criticized the Fed for its repeated downward revisions to the natural rate estimates and the failure of higher inflation to materialize.[29]

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[26]May 1, 2012. Bloomberg Panel Word from the Federal Reserve Bank of Richmond. SEC Wire. Retrieved from Nexis Uni.

[27]https://www.reuters.com/article/us-usa-fed-lacker/feds-lacker-says-inflation-fears-underpin-policy-dissent-idUSBRE89P0IF20121026.

[28]Federal Reserve Bank of Richmond Speeches Archive at https://www.richmondfed.org/press_room/speeches/jeffrey_m_lacker?mode=archive.

[29]Her comments were widely publicized, e.g., see http://nymag.com/intelligencer/2019/07/aoc-is-making-monetary-policy-cool-and-political-again.html.

Table 4. News Coverage of FOMC Members

Name	Position	News Items 2012–13
Ben S. Bernanke	Chair	144,442
Janet L. Yellen	Vice Chair	4,514
William C. Dudley	New York	815
Jeffrey M. Lacker	Richmond	812
Dennis P. Lockhart	Atlanta	730
Sandra Pianalto	Cleveland	381
John C. Williams	San Francisco	606
Elizabeth Duke	Board	247
Jerome H. Powell	Board	442
Sarah Bloom Raskin	Board	490
Jeremy C. Stein*	Board	651
Daniel K. Tarullo	Board	942
President Average		669
Board Average (Excluding Chair and Vice Chair)		554

Notes: Data collected by the author from Nexis Uni. I searched for articles including the name (with or without middle initial) and the terms "Federal Reserve" or "FOMC": e.g., ("Jeffrey M. Lacker" OR "Jeffrey Lacker") AND ("Federal Reserve" OR "FOMC"). I limit the date range to January 1, 2012 through December 31, 2013 and the location to the United States.
*Stein joined the FOMC in May 2012.

4.   Conclusion

This paper has shown that forecasters who report that they use the natural rate of unemployment to make forecasts are different from forecasters who report that they do not in several key ways. Specifically, the reported users and non-users of u^* seem to resemble the "credibility believers" and "adaptive expectations users," respectively, in the models of Goy, Hommes, and Mavromatis (2018) and others. Forecasters who report using u^* do appear to believe more strongly in the accelerationist hypothesis than those who report not using it, and their reported estimates of u^* are meaningful in the sense that they help predict their forecasts of unemployment and inflation in a model-consistent way. They have longer-run inflation forecasts that are closer to the Fed's target and more strongly

anchored, in the sense of being less responsive to changes in short-run inflation expectations. Users of u^* also seem more likely to find forward guidance credible. In other words, I show that differences in forecasters' *self-reported* characterizations of the models they use contribute to forecast disagreement.

The recent large decline in the share of forecasters who report using u^* could potentially increase the communication challenges faced by the Fed. More generally, central bank efforts to influence private-sector expectations may be complicated if private forecasters disagree with the central bank about the model of the economy or key model parameters. Central bankers communicate about their models and forecasts in addition to communicating about policy decision and goals. The Federal Reserve has experimented in recent years with a variety of communication tools, both collective and decentralized. This paper has explored the disagreement about longer-run unemployment reflected in the the Summary of Economic Projections, and how this decentralized communication may have interacted with private-sector beliefs about u^*.

Powell (2016) has noted that "too many voices saying too many different things" contributes to a "cacophony problem" in central bank communication. Future research should consider how central banks can more effectively communicate the models and assumptions underlying their projections to the public, and examine the optimal level and type of transparency when market participants and committee members disagree about fundamentals.

Appendix. Inferring Expected Liftoff Timing

I use multi-horizon nominal interest rate forecast data from the SPF to infer expectations about the timing of liftoff from the ZLB. Since SPF respondents provide quarterly average and annual average instead of year-end forecasts, it is somewhat complicated to infer whether they expect liftoff by the end of a particular calendar year. Suppose that in quarter t, a forecaster expects the interest rate hike of 25 basis points to occur in quarter $t+1$. Each quarter is approximately 13 weeks long, with an FOMC meeting in the third and ninth week. So if she expects the rate hike in the second meeting of the quarter, her quarterly average forecast for the federal funds rate in quarter $t+1$ will be approximately 4 basis points above the ZLB
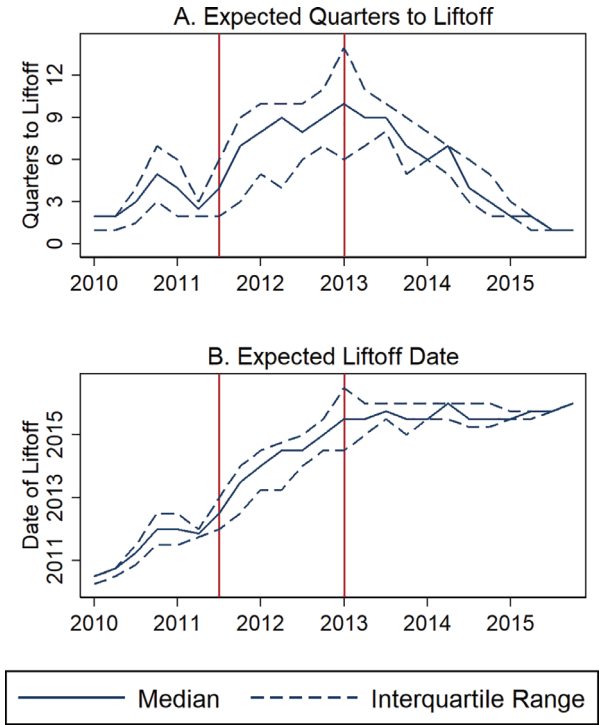
rate. Since the T-bill rate is the average of the expected federal funds rate over the next 91 days, she should expect the T-bill rate to rise a very small amount in quarter t and by around 14 basis points in quarter $t + 1$. The difference between her forecast for quarter $t + 1$ and her backcast for quarter $t - 1$ will be around 14 basis points. If she expects a rate hike in the first meeting, or at both meetings, the difference will of course be greater. With the calendar-year forecasts, an even smaller increase in the T-bill forecast can potentially indicate expected liftoff: by similar reasoning, if she expects liftoff by the last meeting of the calendar year, the annual forecast should be at least 4 basis points above the backcast.

Since a small difference of a few basis points between the backcast and forecast could also indicate uncertainty (a small chance that the rate hike will occur) or expectation that the T-bill rate will rise for some other reason, to be conservative I require her quarterly forecast $i_{j,t}^{\tau}$ to be more than 16 basis points above $i_{j,t}^{t-1}$, *and* that her forecast for the subsequent period $(i_{j,t}^{\tau})$ be at least 25 basis points above $i_{j,t}^{t-1}$, to determine that she expects liftoff in quarter τ. If I do not find that a forecaster in quarter t expects liftoff in quarters t, $t + 1, \ldots, t + 4$, then I record expected liftoff in year y if the corresponding annual forecast is more than 10 basis points above the backcast and the forecast for the subsequent calendar year is at least 25 basis points above the backcast.[30]

Figure A.1 shows that in 2010 and prior to the calendar-based guidance in 2011, the median SPF forecaster expects liftoff in two to three quarters. Note that the Blue Chip forecasts are for the quarterly average of the federal funds rate over the quarter indicated. Since Swanson and Williams require this forecast to be above 25 basis points to determine that a forecaster expects liftoff, they

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[30]The modal difference between $i_{j,t}^{t+1}$ and $i_{j,t}^{t-1}$ in 2012 and 2013 is 0, so most of the time, if forecasters expect no change in the policy rate, they also forecast no change in the T-bill rate. Thus results are not very sensitive to the exact cutoff choices (figure A.2). Results are also unchanged if, instead of the backcast, I use the actual T-bill rate in the current or previous quarter, or a fixed rate of 10 basis points, the approximate T-bill rate at the ZLB. If expected liftoff is in the last reported horizon, I do not require that the forecast for the subsequent year (which is not provided) be at least 25 basis points above the backcast. If the annual forecast is at least 25 basis points above the backcast, I record that her expected liftoff date is in quarter 2 of the indicated calendar year, otherwise quarter 4 of the indicated calendar year.
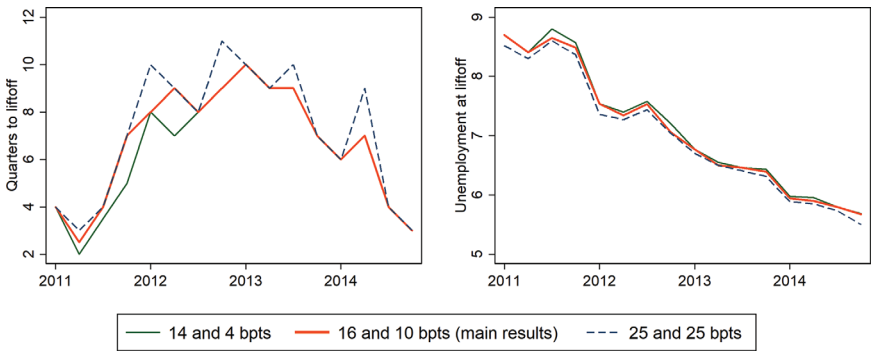
Figure A.1. Quarters to Expected Liftoff Date

A. Expected Quarters to Liftoff

B. Expected Liftoff Date

Median   ------ Interquartile Range

Notes: Data are from SPF. The sample includes forecasters who provide expectations of three-month T-bill rate at all quarterly and annual horizons. Vertical lines indicate the starts of calendar-based and threshold-based forward guidance.
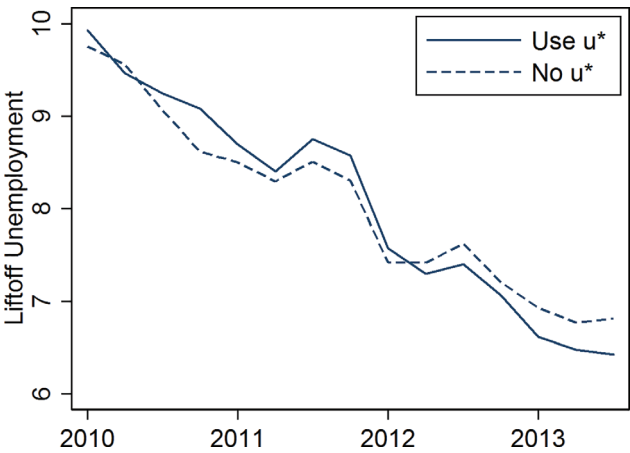
may slightly overestimate the time to expected liftoff. As discussed above, a 25 basis point rate hike near the middle or end of the quarter will be reflected in a quarterly average forecast of less than 25 basis points above the ZLB rate. Indeed, in figure A.2, which shows estimates of expected quarters to liftoff under different cutoffs, my results are more similar to those of Swanson and Williams (2014) when I use a 25 rather than 16 basis points cutoff to infer that a forecaster expects liftoff in a particular quarter. In the entire ZLB period, there are only three observations in which a forecaster expects liftoff beyond the longest forecast horizon. Moreover, there are only nine observations corresponding to expected liftoff in 2017 and two in 2018.

Figure A.2. Estimates of Expected Liftoff Timing and Unemployment under Alternative Cutoffs

Notes: Data are from SPF. The thick solid lines are the estimates used in this paper. See the text of appendix B for computational details.

Figure A.3. Estimates of Expected Liftoff Unemployment by Reported Use of u^*

Notes: Data are from SPF. The solid line shows mean expected unemployment at time of first rate hike by forecasters who report using the natural rate of unemployment to forecast. The dashed line shows mean expected unemployment at time of first rate hike by forecasters who report not using the natural rate of unemployment to forecast.

Figure A.3 shows expected unemployment at liftoff over time for the mean forecaster who reports using or not using the natural

rate of unemployment to forecast. The u^* users had slightly higher average liftoff unemployment expectations until 2012. By the end of 2012, when the FOMC introduced threshold-based forward guidance, the average u^* user's liftoff unemployment expectations were lower than that of the average non-user, and were quicker to drop below the 6.5 percent threshold.

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