Reconsidering the Fed's Inflation Forecasting Advantage

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Abstract

Previous studies show the Fed has a forecast advantage over the private sector for inflation, either because it devotes more resources to forecasting or because it has an informational advantage. We evaluate the Fed's forecast advantage to determine how much of it results from the Fed's knowledge of future monetary policy. We develop two tests—an instrumental variable encompassing test and a path-dependent encompassing test—to equalize the Fed's information set with the private sector's. We find that Fed forecasts do not encompass those of the private sector when the latter has knowledge of the future of monetary policy. Further, we find that between 20 and 30 percent of the difference between the Fed's and the private sector's mean squared forecast error can be explained by monetary policy.

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1 Introduction

Because monetary policy is inherently forward-looking, the Federal Reserve devotes substantial resources to forecasting macroeconomic variables. One set of forecasts produced by the Fed is contained in the Greenbook.[1] A voluminous literature has arisen studying the accuracy and efficiency of these forecasts [e.g., Faust and Wright (2009); Patton and Timmermann (2012); Del Negro and Schorfheide (2013); Wolters (2015); and many others]. A number of these papers have focused on the accuracy of Greenbook forecasts relative to their private sector counterparts [see, for example, Romer and Romer (2000); henceforth RR]. In general, the broad conclusion from this literature is that private sector forecasts of inflation are *encompassed* by the Greenbook forecasts—that is, once the Greenbook forecasts are taken into account, private sector forecasts provide little or no additional predictive power. This result has been taken to imply that the Fed has some forecasting advantage, stemming from better information or from the use or availability of more resources devoted to forecasting. RR described the issue:

> The key idea is that information the Federal Reserve has about the economy that is not known to market participants is likely to be reflected in the Federal Reserve's internal forecasts. Because the Federal Reserve makes its forecasts public only after five years, the forecasts can contain information that is not known contemporaneously by market participants. [p. 429]

The more recent literature, however, has suggested that the Fed's forecasting advantage—in particular, for inflation forecasts—has weakened over time. Two possible explanations have been posited for this result: (i) the use and/or credibility of an inflation target has sufficiently anchored expectations to make inflation easier to forecast using simple models [see, for example, Atkeson et al. (2001); Stock and Watson (1999); Faust and Wright (2013)] or (ii) more Fed transparency has reduced market uncertainty about the future path of monetary

[1] In 2010, the Greenbook was retired. Since then, staff forecasts have been published in the Tealbook. Regardless, to align ourselves with the existing literature, we reference the Greebook as the source for the staff forecasts.

policy (Sims, 2002; Gamber and Smith, 2009; El-Shagi et al., 2016). Examining why/how the Fed's forecast advantage changed may be informative about the source of the advantage.

In the first case, the Fed's resources and skills makes it a superior forecaster in the years before adoption of a credible inflation target. However, once a credible inflation target is adopted, market participants know the Fed conducts monetary policy to keep inflation around the target. Thus, complex forecasting models for inflation have little advantage over simple models. As a result, the Fed's forecasting advantage diminishes.

In the second case, the Fed's forecasts are conditioned on an assumed future path of monetary policy. In contrast, market participants must also predict the future path of policy. Beginning in 1994, the Fed became increasingly transparent, issuing statements about the expected future path of policy, holding press conferences, and, inevitably, providing explicit forward guidance. As a result, market expectations about the future path of policy converged to the Fed's. Prior to the increased transparency, the market had to forecast both economic shocks and the Fed's policy, while the Fed knew with relative certainty what it would do. More recently, the market's uncertainty about the Fed's path has diminished with increased transparency.

We investigate these two hypotheses about the Fed's forecasting advantage relative to forecasts from the Blue Chip Survey. Using standard encompassing tests, we replicate previous findings: (i) prior to the transparency period, private sector forecasts are encompassed by Greenbook forecasts and (ii) after the Fed became more transparent, the Fed's forecast advantage dissipates. We then propose a test that explicitly accounts for the fact that the Fed may have more information than the market. We find that, after equalizing the two forecaster's information sets, the Fed's forecasts no longer encompass the private sector's, regardless of the subsample used for estimation.

We then narrow our focus to identify the additional information coming from knowledge of the path of monetary policy. Specifically, we use data from Eurodollar futures markets and other sources to identify dates when the market's expectation of future policy coincide with the Greenbook's conditioning path. Our hypothesis is that if (1) market expectations

of future policy are aligned with the Greenbook's path and (2) the main source of the Fed's informational advantage is knowledge of this path, then the Fed forecasts during these periods should no longer encompass the private sector's. Indeed, we find that the Fed seems to possess no informational advantage when the market's expectations of future policy are synched to the Fed's.

The remainder of the paper is laid out as follows: In Section 2, we describe the forecast data—both from the Greenbook and the private sector forecasts—and the realizations to which they are compared. We outline both encompassing tests, the standard test which assumes that the Fed and the private sector have access to the same conditioning information and our new test that allows the Fed to have additional information about the conditioning path. In Section 3, we present the results from a battery of tests comparing the two sets of forecasts. In Section 4, we describe the futures data used to separate the sample into periods where the conditioning sets align and periods where they do not. We then present results of some of the same tests using the sample split along these lines. In Section 5, we quantify the importance of knowledge about the conditioning path for forecasting. In Section 6, we summarize the main results and link them back to the literature on the evaluation of monetary policy.

2 Baseline Empirical Framework

A common method of comparing the accuracy of forecasts is to compute their mean squared forecast errors (MSFEs). However, even if two forecasters produce forecasts with statistically similar MSFEs, one could still have an informational advantage over the other. For example, if A's forecast has no predictive power once B's forecast is known, then B's forecast is said to encompass A's, suggesting B has an informational advantage. More formally, if we let Ω^A and Ω^B denote their respective information sets, we would conclude that $\Omega^A \subset \Omega^B$.

Identifying the source of the informational advantage, on the other hand, is complicated if one of the forecasts conditions on future information. For example, the Fed's h-step-ahead forecast of inflation, y_{t+h}, conditions on both time-t information about the economy, $\hat{\Omega}_t^f$, and

an assumed path for future values of the policy rate, r_{t+i}, where $1 \leq i \leq \bar{h}$ and $\bar{h}$ can vary from four to ten quarters.[2] As discussed in Faust and Wright (2008), this assumed path for the policy rate is taken as given prior to the construction of the forecasts. Hence, the inflation forecasts take the form $\hat{y}^f_{t,h} = \pi\left(y_{t+h}|\hat{\Omega}^f_t, r_{t+1}, ..., r_{t+\bar{h}}\right) = \pi\left(y_{t+h}|\Omega^f_t\right)$, where Ω^f_t is all of the Fed's time-t information. In contrast, the private sector forecasts takes the form $\hat{y}^p_{t,h} = \pi\left(y_{t+h}, r_{t+1}, ..., r_{t+h}|\Omega^p_t\right)$, where Ω^p_t denotes the private sector's time-t information. The notation emphasizes that the private sector has to forecast the policy rate, r_{t+i}, as well as inflation, y_{t+h}.

In this framework, there are two types of informational advantages that the Fed can have: an advantage through $\hat{\Omega}^f$, time-t information about the economy, or r_{t+i}, future values of the policy rate. Clearly, if $\Omega^p \subset \hat{\Omega}^f$, we would conclude that the Fed forecasts encompass those from the private sector. Even if $\hat{\Omega}^f \subseteq \Omega^p$, though, the Fed forecasts can still encompass if it has superior knowledge of the future path of monetary policy, r_{t+i}. This is true even if that knowledge is imperfect, meaning that r_{t+i} is better considered as a future value subject to measurement error.[3] If we could perfectly characterize Ω^f and Ω^p, then identifying the source of the informational advantage would be easy. However, the only information we have access to are $\hat{y}^f_{t,h}$ and $\hat{y}^p_{t,h}$ (and other publicly available information), making identifying the source of the advantage more difficult as we will see below.

2.1 Conventional Encompassing Tests

Using data from the Greenbook as the Fed's forecast, RR use OLS to estimate an encompassing regression suggested by Fair and Shiller (1989):

$$y_{t+h} = \alpha + \beta^p \hat{y}^p_{t,h} + \beta^f \hat{y}^f_{t,h} + \eta_{t+h}. \tag{1}$$

[2]The Greenbook provides the future paths of various conditioning variables. These "Key Background Factors Underlying the Baseline Staff Projection" include the future paths of the federal funds rate, the long-term interest rate, and other variables. While the Greenbook forecasts are constructed conditional to these variables, we do not know the way they are conditioned.

[3]While the conditioning path of the Fed is fixed, it might not be correct due to shocks likely unanticipated by the Fed and the market. We will consider the accuracy of the conditioning path in Section 4.

In most applications, a formal test of encompassing is straightforward: jointly test the null hypothesis that $(\beta^p, \beta^f)' = (0, 1)'$.[4]

RR find that, in general—and, in particular, for inflation—their estimate of β^f is close to one and statistically different from zero, and their estimate of β^p is close to zero and statistically insignificant. They interpret these results as supporting the idea that private sector forecasts provide no additional information above what is already contained in the Greenbook forecasts. While RR do not formally test the joint null hypothesis that $(\beta^p, \beta^f)' = (0, 1)'$, their results *suggest* that the Greenbook forecasts encompass the private sector forecasts.

Yet, as we noted above, explaining the origin of the Fed's forecast advantage is more complicated. RR argue that the quality of the Fed's forecasts are indicative of "the vast resources that it devotes to forecasting" and not due to any inside information about government statistics or future monetary policy (p. 430; i.e., $\Omega^p \subseteq \hat{\Omega}^f$). In contrast, Sims (2002) posits that the Fed's informational advantage might arise from the fact that the Greenbook forecasts are constructed conditional on an assumed path for future monetary policy. Unfortunately, if we fail to reject the null hypothesis, the test does not allow us to distinguish between these two sources of the Fed's forecasting advantage.

2.2 Conditional Encompassing Tests

To understand our alternative test of encompassing, it is instructive to first delineate a stylized example of how the Fed's conditional forecast can differ from its unconditional forecast. For this illustration, assume that the Fed's conditional forecast is conditional on past and future information ($\hat{\Omega}^f$ and r_{t+i}, respectively) and the Fed's unconditional forecast is conditional on past information only ($\hat{\Omega}^f$). Specifically, let y_t be the forecasted variable, let r_t denote the policy rate, and define the Fed's time-t information set $\hat{\Omega}^f_t = \{y_{t-j}, r_{t-j}; j \geq 0\}$. In the context of a Gaussian vector autoregression (VAR) of $(y_t, r_t)'$, Waggoner and Zha (1999) show that the minimum MSE *conditional* forecast $\hat{y}^f_{t,h} = \pi\left(y_{t+h}|\hat{\Omega}^f_t, r_{t+1}, ..., r_{t+h}\right)$ is the sum of its

[4] Previous studies have found that forecasts of inflation and output growth are biased [see Caunedo et al. (2020)]. If so, the joint hypothesis could be rejected because $\alpha \neq 0$ rather than any differences in information sets. Our tests of encompassing therefore omit the unbiasedness condition.

unconditional forecast $\hat{y}^{(u)}_{t,h} = \pi\left(y_{t+h}|\hat{\Omega}^f_t\right)$, and a weighted combination of the deviations of the conditioning information, r_{t+i}, from its unconditional forecasts $\hat{r}^{(u)}_{t,i} = \pi\left(r_{t+i}|\hat{\Omega}^f_t\right)$. Thus, the conditional forecast depends explicitly on, $r_{t+i} - \hat{r}^{(u)}_{t,i}$ which is (in large samples) the value of the time $t+i$ shock to the policy rate equation in the VAR.

Now, reconsider the encompassing regression in equation (1). If conditioning is present, $\hat{y}^f_{t,h}$ is an endogenous regressor and OLS is inconsistent for the parameters α, β^f, and β^p, making interpretation of the results even more complicated.[5] We propose estimating the encompassing regression by instrumental variables (IV) using a set of time-t instruments that are correlated with the Fed's unobservable unconditional forecast, $\hat{y}^{(u)}_{t,h}$, but also uncorrelated with the future shocks, $r_{t+i} - \hat{r}^{(u)}_{t,i}$, that are unpredictable given information available to the private sector at time-t.

Given said instruments (we discuss the selection and applicability of the instruments below), we can then derive a test for encompassing with conditional forecasts that is similar to the standard encompassing test. Using a vector of instruments, z_t, that includes a constant, we run a first-stage regression

$$\hat{y}^f_{t,h} = \delta^{z\prime} z_t + \delta^p \hat{y}^p_{t,h} + u_t \tag{2}$$

to obtain an estimate of what the Fed's forecast would be without information about the path of future policy. We then run the encompassing regression

$$y_{t+h} = \alpha + \beta^p \hat{y}^p_{t,h} + \overline{\beta}^f \overline{y}^f_{t,h} + \overline{\eta}_{t+h}, \tag{3}$$

where we have replaced the actual forecast, $\hat{y}^f_{t,h}$, with the fitted values from the first stage regression, $\overline{y}^f_{t,h} = \hat{\delta}^{z\prime} z_t + \hat{\delta}^p \hat{y}^p_{t,h}$. The conditional encompassing test then amounts to testing the null hypothesis $(\beta^p, \overline{\beta}^f)' = (0, 1)'$.

Fortunately, obtaining valid instruments is straightforward, because—apart from the conditioning path—the information set available to private sector agents overlaps—if not coincides—

[5] This issue was also also observed by Faust and Wright (2009) when evaluating the efficiency of the Greenbook forecasts.

with that available to the Fed. For example, if we are comparing the Greenbook to the Blue Chip—i.e., if we set $\hat{y}^p_{t,h} = \hat{y}^{BC}_{t,h}$ —forecasts from the Survey of Professional Forecasters are a natural choice of instrument. In addition, if private agents form joint forecasts of multiple variables, the forecasts of these other variables can also serve as instruments. For example, private sector forecasts of the unemployment rate, the yield on the 3-month T-bill, and GDP growth—individually or collectively—could be used as instruments for evaluating an inflation forecast. Finally, the longer-horizon private sector forecast, $\hat{y}^{BC}_{t-1,h+1}$—a forecast of y_{t+h} formed in the previous period—could be used as an instrument. We continue this discussion later when we describe the data in Section 2.3.4.

Before proceeding to our first set of results, it's worth noting that this alternative test of encompassing has advantages as well as disadvantages. While it removes any forecast advantage the Fed has based on knowledge of future monetary policy (r_{t+i}), it can inadvertently remove other informational advantages the Fed may have in $\hat{\Omega}^f_t$ (i.e., if $\hat{\Omega}^f_t$ contains private information other than r_{t+i}). For example, if $\Omega^p_t \subset \hat{\Omega}^f_t$, the Fed's time-$t$ information set can be rewritten as $\hat{\Omega}^f_t = \Omega^p_t \cup (\Omega^p_t \perp \hat{\Omega}^f_t)$. If the instruments are orthogonal to $r_{t+i} - \hat{r}^{(u)}_{t,i}$ and $\Omega^p_t \perp \Omega^f_t$, we would expect to reject the null of encompassing without being able to separately identify the source of the Fed's forecast advantage. In short, we have just the opposite problem as the conventional test of encompassing—a rejection of the null hypothesis may not allow us to distinguish between the two sources of the Fed's forecasting advantage.[6] In Section 4, we circle back to this problem using an alternative test of encompassing based on the alignment of market expectations of Eurodollar futures to the Fed's conditioning assumptions on the stance of monetary policy.

2.3 Data

The dataset for our initial set of results contains four elements: (i) Greenbook forecasts, (ii) private sector forecasts, (iii) realizations, and (iv) instruments used to conduct the conditional encompassing tests. The full sample period for the Greenbook is 1965:11 to 2016:12, while

[6] Removing only the conditioning path information is a more difficult problem that would require an instrument that contains all other information that the Fed might know except for the conditioning path.

the Blue Chip and SPF start in 1980:01 and 1968:Q4, respectively.

2.3.1 Greenbook Forecasts

The Greenbook forecasts are predictions of various macroeconomic series at different horizons. They are prepared by the Board of Governors staff for each Federal Open Market Committee (FOMC) meeting. After a 5-year lag, the Greenbook forecasts are made available at the Federal Reserve Bank of Philadelphia.[7] The Greenbook contains a large number of forecasted variables but, like RR, we concentrate on the deflator-based measure of inflation.[8]

The Greenbook forecasts are conditional on other variables including the federal funds and other interest rates, an output gap, and exchange rates. We use the federal funds and 10-year Treasury bond rates to represent the primary conditioning information. The data for these financial assumptions are in the Greenbook (starting about page I-III) and are made available through 2014 at the Federal Reserve Bank of Philadelphia.[9] For data after 2014, figures of the conditioning paths within the Greenbook were digitally scanned and translated into numerical values.[10]

Similar to the schedule of the FOMC meetings, the Greenbook forecasts vary both in frequency and in timing over the sample period.[11] At the beginning of the sample, the Greenbook forecasts were available monthly; after 1981, the Greenbook was produced only for FOMC meetings. Thus, prior to 1981, twelve observations per year are available; after 1981, eight or nine observations per year are typically available. The maximum forecast horizon varies across Greenbooks.

[7] These data are available here: https://www.philadelphiafed.org/research-and-data/real-time-center/greenbook-data. While the Greenbook forecasts are inputs into the policy process, they do not represent the forecasts—individually or collectively—of the FOMC members.

[8] Results for output growth and the unemployment rate are provided in the Appendix.

[9] These data are available here: https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/gap-and-financial-data-set.

[10] We use graphreader.com for this exercise.

[11] The definitions of the forecasted variables also change over time. In 1992, the Greenbook changed from forecasting GNP growth to forecasting GDP growth. For inflation, the Greenbook forecasted the implicit GNP deflator through the end of 1991, the implicit GDP deflator until 1996:Q1, and the chain-weighted price index for GDP thereafter. In order to remain consistent, we change the realizations accordingly.

2.3.2 Private Sector Forecasts

To ensure that the information sets for the forecasters are comparable, we consider only the private sector forecasts that are released in the same calendar month as an FOMC meeting.[12] Similar to RR, we consider consensus-based forecasts from the Blue Chip survey and the Survey of Professional Forecasters (SPF). The former is released monthly within the first week of each month, while the latter is quarterly and is typically released the third week of the middle month of each quarter.

Much of the literature comparing Federal Reserve forecasts to private sector forecasts uses the SPF. Because of its quarterly frequency, there are relatively few compatible SPF observations that share the same calendar month as the Greenbook. On the other hand, we typically find more monthly Blue Chip forecasts per year that share the same month as Greenbook forecasts. Thus, we report our main set of results comparing the Greenbook to the Blue Chip forecasts and use SPF forecasts to assess robustness.[13]

2.3.3 Realizations

Because macroeconomic data are sometimes subject to revision, which data release forecasters target is not always obvious. Deflator-based inflation is revised a number of times, even within the first year. Importantly, the first release by the BEA occurs during the first month after the end of the quarter. The first release—also known as the advance release—is often thought to be the target for private forecasters; Stark et al. (2010) shows that SPF forecasts of output growth become increasingly less accurate as the number of revisions increase over time. In contrast, one might argue that the Federal Reserve is more interested in the true value of the variable. If revisions converge to the true value, the Fed may be targeting extensively revised data. We use the second revised value of deflator-based inflation—sometimes called first final—when evaluating the forecasts. For further discussion on this issue see Clements

[12] For some periods, the Greenbook and the private sector forecasts will target different variable definitions. This occurs near those periods when the forecasted variable changes. In these cases, we drop these datapoints. Because they are few in number, these omissions do not significantly affect our conclusions.

[13] These results are available in the Appendix.

(2019).[14]

2.3.4 Instruments

To execute our conditional forecast encompassing tests, we require a set of instruments that are likely to be correlated with the Fed's unobserved unconditional forecast but uncorrelated with any private information the Fed may have on future monetary policy. We consider three potential sets of instruments. First, we consider lags of the private sector forecasts. Second, we consider other private sector forecasts—i.e., when comparing the Greenbook inflation forecasts to the Blue Chip, we could use the SPF inflation forecasts as instruments. Finally, we consider the forecasts of other variables produced by the same private sector forecaster—e.g., when comparing the Greenbook forecast of inflation to the Blue Chip, we could use Blue Chip forecasts of unemployment and/or output growth as instruments.

Evaluation of the first stage $F-$statistics for the first set of instruments suggest that lags of the forecasts are weak instruments. Using the other private sector forecaster's predictions (i.e., SPF) requires us to drop observations, as we need all three forecasts to be observed in the same period. This limitation reduces the number of observations dramatically, especially in our split sample analysis. Instead, we opt to report results for the third instrument set, using the same forecaster's predictions of other variables. This ensures that we can maximize the number of available observations over the sample period. A side effect of this choice is that it is sensible to assume that the information set used to form the private sector inflation forecasts is the same as that used to form the instruments. This facilitates interpretation of our results - notably those associated with equalizing the information sets with the conditional encompassing test.

3 Encompassing Test Results

Based on the empirical framework outlined above, we compare the forecasts to determine if (and possibly when) the Fed has an informational advantage. In cases where the Fed

[14] For the output growth and the unemployment rate results in the Appendix, we also use the second revision.

does have an informational advantage, we assess whether the advantage is a result of its superior knowledge of the conditioning path. We compare the results of two types of forecast encompassing tests with the null hypothesis that $(\beta^p, \beta^f)' = (0, 1)'$.[15] The first is based on OLS estimates of the encompassing regression in equation (1); the second is based on the IV approach discussed in Section 2.2.

Taken together, the results of these tests have a natural interpretation summarized by four possible outcomes. First, failure to reject the null using both OLS and IV suggests that the Fed has an absolute forecasting advantage, independent of its knowledge of the conditioning path. Second, failure to reject the null using OLS but rejecting the null using IV suggests that the Fed's additional information (i.e., knowledge of the conditioning path) gives them an advantage over the private sector. Third, rejecting the null under OLS but failing to reject using IV implies that either (i) policy does not coincide with the conditioning path or (ii) the Fed misunderstands how the additional information will affect future outcomes. In either case, from an MSFE standpoint, the Fed would be better off without using the conditioning information. Finally, rejecting the null using both OLS and IV implies that the Fed has no informational advantage regardless of any conditioning information.

Previous studies have hypothesized that increased transparency starting in 1994 led to synching the Fed's and the private sector's beliefs [e.g., Poole et al. (2003)]. This, in turn, coincides with previous studies' findings that the Fed's forecasting advantage has declined [e.g., Gamber and Smith (2009) and Hoesch et al. (2020)]. If this is indeed the case, during the pre-transparency period, the Fed would have a forecasting advantage that would disappear once accounting for the informational advantage. Thus, we would expect to fail to reject encompassing using OLS but reject using IV. Moreover, during the transparency period, we would expect to reject encompassing even without accounting for the Fed's knowledge of the conditioning path.

[15] Results for the joint test $(\alpha, \beta^p, \beta^f)' = (0, 0, 1)'$ are in the Appendix.

3.1 Conventional Encompassing Tests

We first execute the conventional encompassing test, eq (1), using Greenbook and private sector forecasts for a common sample and various forecast horizons. As indicated above, we consider three time samples: (i) the full sample, (ii) the pre-1994 period, and the post-1994 increased-transparency period.[16]

Table 1: Conventional Encompassing Test Inflation

Table 1 shows the results for the conventional encompassing tests for inflation using the Blue Chip as our private sector forecaster. The three panels contain results for the full sample (left); the pre-1994 period (center), and the post-1994 period (right). Each panel is comprised of five columns. The first three columns in each panel report the estimated values of the coefficients—α, β^p, and β^f—with the $p-$value for the individual HAC-robust Wald statistic that the coefficient is zero (for α and β^p) or one (for β^f) in the parentheses. The fourth column in each panel reports the HAC-robust Wald statistic and associated $p-$value for the conventional encompassing test of the null $(\beta^p, \beta^f)' = (0, 1)'$. The final column reports the number of observations used in the estimation. Each row of the table reports a different (quarterly) forecasting horizon.

The results in the center panel (pre-1994) are the most comparable to—and are broadly consistent with—those in RR. Based on the Wald tests, we reach more formal but similar conclusions. At horizon zero, the Fed does not have an informational advantage for inflation. At intermediate horizons, Fed forecasts encompass the private sector forecasts. At long horizons, the Fed's informational advantage again disappears. Given our hypothesis that the Fed's knowledge of the conditioning path is the source of its advantage, these results have a straightforward interpretation. The Fed has no informational advantage at very short horizons because only past monetary policy—known to both the Fed and the private sector forecasters—matters. At intermediate horizons, the Fed's knowledge of the conditioning path

[16] Romer and Romer (2000) end their sample in 1991 due to changes in the definition of the forecasted inflation series. We consider this sample in our series of robustness checks.

becomes relevant. At very long horizons, deviations from the conditioning path and possible unanticipated shocks make knowledge of the conditioning path less valuable.

Previous studies cite the decline in the magnitude of β^f and the increase in the magnitude of β^p over time as evidence that the Fed's informational advantage has eroded. If the policy path is the source of the Fed's informational advantage, increased transparency might weaken that advantage. Our results support that conclusion: In the post-1994 sample, the Fed forecasts never encompass those of the private sector. The full sample results are a mix of these split-sample results: There is only one horizon at which we fail to reject encompassing at a 5-percent level and none at which we fail to reject at the 10-percent level.

3.2 Conditional Forecast Encompassing Tests

The Greenbook forecasts are constructed based on various conditioning variables including a presumed-known path of future monetary policy. If this path is informed by even partial knowledge of future monetary policy, the OLS-estimated coefficients from conventional encompassing regressions are inconsistent, and the standard encompassing tests are invalid. To account for the Fed's superior knowledge of the path, we construct a modified version of the encompassing test. Using the same forecast and realization data, we first estimate eq (2) to cleanse the Fed's information of the conditioning path and then estimate eq (3). If RR's hypothesis that the Fed is simply better at forecasting is true, correcting for the conditioning path should not materially change the encompassing results.

Table 2: Conditional Encompassing Test Inflation

We use the same-period Blue Chip forecasts of the 3-month T-bill, the unemployment rate, and output growth as instruments. These variables should be correlated with the Fed's unobservable, unconditional forecast but uncorrelated with the Fed's private information about the future path of monetary policy, which eliminates the informational advantage for the Fed. Table 2 shows the results for our two-stage procedure. As before, the table has three panels, each representing a different estimation sample. Each panel is comprised of six columns: the

first-stage $F-$statistic; the estimated values of the coefficients—α, β^p, and $\overline{\beta}^f$; the HAC-robust Wald statistic for the conditional encompassing test; and the number of observations used for the estimation. Each row again reports a different forecasting horizon.

If we believe that (i) the Fed has an informational advantage, such as knowledge of the conditioning path, and (ii) increased transparency after 1994 has reduced this advantage (i.e., by imparting knowledge of the path to the market) (Sims, 2002; Gamber and Smith, 2009; El-Shagi et al., 2016), we expect to find that the Fed's unconditional forecast should not encompass the private sector's. Indeed, results for the post-1994 period are broadly similar to the conventional encompassing results. On the other hand, for the pre-1994 period, encompassing is rejected for all but two horizons.

We take these results as evidence that a major component of the Fed's forecasting advantage vanishes if its information set is comparable to that of the private sector. Alternatively, RR postulate that the Fed is simply better at forecasting. This means that with the same information as the private sector, the Fed is able to produce better forecasts by spending more time or having better models. If this were true, then equalizing the information sets between the Fed and private sector would still leave the Fed with an advantage. However, we do not find this to be the case, as encompassing is rejected for most horizons pre- and post-1994. Based on this evidence alone, we cannot conclude that the source of the Fed's informational advantage is specifically its knowledge of the conditioning path. We can only conclude that, mostly prior to 1994, the Fed had some knowledge the market did not have and that information was beneficial to their forecasts. As Faust and Wright (2009) suggest, this could be knowledge of the future path of oil prices or exchange rates, or, in the context our framework, the other conditioning variables that are important for the Fed's forecasting advantage.

4 Formalizing Fed's Conditioning Path

Suppose that the conditioning path is the main source of the Fed's forecasting advantage. Then, during periods when the market "knows" the path, the Greenbook forecasts should

not encompass private sector forecasts. Conversely, when the market path is either wrong or uncertain, the Fed should have a forecasting advantage.

In this section, we reconsider the conventional encompassing tests, but partition the data into periods in which (i) the Fed gets the future path of policy correct but the market does not; (ii) both the Fed and the market get the path correct; and (iii) both the Fed and the market miss the path.[17]

4.1 Identifying the Market's Expectations of Future Policy

The key component of this analysis is determining when the market "knows" the path. We assume the path is "known" by the market if: (i) the market's expected path is on or close to the realized path and (ii) the expected path is relatively certain. Ideally, we would use private sector density forecasts of expected future monetary policy; instead, we use the market-implied policy path derived from options data augmented with a measure of monetary policy uncertainty.[18]

4.1.1 Futures Data

Eurodollar futures contracts can be thought of as bets on future monetary policy outcomes [see Cochrane and Piazzesi (2002); Gürkaynak et al. (2007); Piazzesi and Swanson (2008); among others] and are available for a longer time period than fed funds futures.[19] Eurodollar futures are contracts written on 3-month deposits of U.S. dollars in foreign banks at specific dates in the future. While not identical to the fed funds futures, a number of previous papers have shown that the rate implied by the Eurodollar futures generally approximates the fluctuations in the fed funds futures implied rate Swanson (2006); Rigobon and Sack (2004); Lakdawala and Schaffer (2019); De Pooter et al. (2018); Bauer and Rudebusch (2020). We can then compute the market's expected policy rate at different horizons using the appropriate maturity Eurodollar futures.

[17] Cases for which the market correctly forecasts the path but the Fed does not are too rare for proper analysis and are discarded.

[18] The options data are obtained from Fisher and Robertson (2016).

[19] Fed funds futures sample starts in 1993:01, while the Eurodollar futures sample starts in 1982:01.

To match the timing of our forecast dataset, we use Eurodollar contracts that mature around the 10th of each month—about when the Blue Chip forecasts are released. For each contract, we compute the average settlement price of days 8-12 (when available) of the current month to obtain a close approximation even when the 10th does not fall on a business day or when there is no volume for a particular contract on the 10th. For a given month, we form a path of Eurodollar future contracts maturing over the next calendar year. We linearly interpolate between observable contracts to fill in values for missing contracts that would theoretically mature in unobserved serial calendar months. In total we have observations ranging from 1982:01 through 2016:12.[20] All Eurodollar futures are obtained from Haver.

4.1.2 Uncertainty

While futures contracts provide an average path, they do not reflect the market's certainty about the path. Consider two cases: the market places (i) a 40 percent probability on a 25-basis-point increase and 30 percent each on no-change and a 50-basis-point increase or (ii) 100 percent certainty on a 25-basis-point increase. Using futures data alone, these two scenarios would be equivalent and, if the Fed moved the target 25 basis points, both cases would show the market knew the path.

One way of incorporating uncertainty is to interact the path variable with the monetary policy uncertainty index [MPU; see Baker et al. (2016)]. The MPU is a subcategory of the economic policy index and is constructed by analyzing the frequency of newspaper articles containing several key search terms and is available for the sample 1985-2018.[21]

4.2 The Market's Path

The Eurodollar futures data allows us to compute the market's expected path at a forecast origin t for a variety of horizons up through h. Let $\mathbf{r}_t = (r_{t+1}, ..., r_{t+h})'$ represent the realized path. At time t, the market-based expected path is

[20] To match the Eurodollar data to the Blue Chip forecasts, we use the quarterly average of the monthly values.

[21] See http://www.policyuncertainty.com/us_monthly.html

$$\mathbf{r}_{t,h}^{p} = (\overline{r}_{t+1}, ..., \overline{r}_{t+h})',$$

where $\overline{r}_{t+j}$ corresponds to the futures-implied rate at time $t+j$. We then construct an indicator that shows, at time t, whether the market correctly forecasts the j-period-ahead stance of monetary policy:

$$s_{t,j} = \begin{cases} 1 \quad if \quad \overline{r}_{t+j} \times (1+\tau)^j > r_{t+j} > \overline{r}_{t+j} \times (1-\tau)^j \\ 0 \qquad\qquad\qquad otherwise \end{cases}, \tag{4}$$

where $0 < \tau < 1$ allows some deviations that may result from outlier forecasts in a band that increases over the forecast horizon. Our baseline results use $\tau = 0.5$.

For a forecast horizon h, we could collect the $s_{t,j}$'s, $j = 1, ..., h$, in a vector and use this as our measure of "on-the-path." This would, however, allow forecasters to be simultaneously correct about the long-run path but incorrect about the short-run path. If instead we believe that the path *up to* h is relevant in determining the effects of monetary policy, we should evaluate whether the market was on the path for $t+1$ through $t+h$. To do so we define the market on-the-path indicator at time t for horizon h to be

$$S_{t,h} = \prod_{j=1}^{h} s_{t,j}. \tag{5}$$

Thus, the market is considered off-the-path at horizon h if it was off the path for any horizon less than h.

We then define a certainty indicator (ω_t^c) and uncertainty indicator (ω_t^u):

$$\omega_t^c = \begin{cases} 1 \quad if \quad MPU < \omega^* \\ 0 \qquad otherwise \end{cases} \quad and \tag{6}$$

$$\omega_t^u = \begin{cases} 1 \quad if \quad MPU > \bar{\omega} \\ 0 \qquad otherwise \end{cases}, \tag{7}$$

where ω^* and $\bar{\omega}$ are the MPU values associated with the bottom 40% (more certain) and top

40% (more uncertain) of observations. These indicators are logically combined with the path indicator in the results below. Note the omission of the horizon subscript; thus, during a period of uncertainty, we assume that the forecaster is uncertain for all horizons.

4.3 Results

Given our on-the-path indicators, we revisit the conventional encompassing regressions to evaluate how these results differ for periods where the Fed does and does not have an informational advantage based on the conditioning path. For each forecast horizon, we separate the sample into periods in which (i) the Fed was on the conditioning path but the market was not and (ii) the Fed and the market were both on or both off the conditioning path. The former corresponds to periods when the Fed had an informational advantage; the latter corresponds to periods when the information sets were essentially the same.[22] Because we explicitly account for knowledge of the conditioning path, we no longer split the full sample into subperiods to proxy for an increase in transparency.

Table 3: Monetary Policy Path Encompassing Test

Table 3 displays the results for these cases. As before, the rows in the table reflect the various horizons. There are four panels, each of which has four columns. The first panel shows the results from the encompassing regressions when the Fed and the market are either both on or both off the conditioning path. The second panel shows the results when the Fed is on the path and the market is not. The third panel shows the results when the Fed is on the path but the market is either off the path or uncertain. The fourth panel shows the results when either (a) the Fed is on the path, the market is on the path, and uncertainty is low or (b) the Fed is off the path and the market is either off the path or uncertain. Each panel contains the slope coefficients in the encompassing regressions (omitting the intercepts), the HAC-robust Wald statistic for the conventional encompassing test, and the number of observations.

[22] Periods in which the Fed and the market are both off the path may be subject to large shocks (e.g., after peaks) that complicate forecasting. Results splitting the same information for both on and off the path separately are available in the Appendix. Observations where the Fed does not know the path and the market knows the path are excluded from the analysis due to the very small sample size (under 12 observations).

When the market and the Fed have the same information (the first and fourth panels), we reject the null of encompassing at all horizons except the shorter horizon. On the other hand, when the Fed knows the path but the market does not (panel 2) or is uncertain (panel 3), we reject encompassing only for the nowcast and the one-period-ahead. For these short horizons, the path of monetary policy is likely irrelevant, given the lags in the effects of monetary policy. For longer horizons, when the Fed has asymmetric knowledge about the true path, the Fed's forecasts dominate the private sector's; when they have the same information, the forecasts are essentially equivalent. Therefore, the Fed forecasts encompass the private sector forecasts when the Fed has more information about the future path of monetary policy.

In the third and fourth panels of Table 3, the on-the-path indicator is interacted with the threshold uncertainty indicators. Results incorporating uncertainty are generally consistent with—and provide sometimes even stronger evidence than—our previous results controlling for whether the private sector was on or off the path.[23]

4.4 The Zero Lower Bound Period

In the previous analysis, we ended the sample prior to the first time the fed funds rate hit the zero lower bound (ZLB). At the beginning of the ZLB period, the path of future monetary policy as determined by the federal funds rate may be easier to predict because the Fed is unlikely to raise rates. Even if the market correctly assesses the future path of the funds rate, we might not conclude that it knows the future path of monetary policy, as policy was conducted through more than manipulation of the short rate. Thus, to extend our sample through the ZLB period, we need a measure of (future) monetary policy that: (i) was available to the Fed during the ZLB; (ii) was forecasted by the market either directly or via futures markets; and (iii) is in the conditioning set of the Greenbook.[24]

The literature on the ZLB offers some alternative policy instruments, including the size of

[23] Results for output are mixed, possibly due to longer lags in the effects of monetary policy. Recall that we only use a four quarter horizon for the path variable. These results are reported in the Appendix.

[24] One could naively perform the experiments in the previous section by continuing to use the short rate as the policy variable even at the ZLB. We do not believe this is a proper evaluation of whether the market knows the path. Nevertheless, we did perform such experiments (available in the Appendix). Results were similar to those found in the previous section.

the Fed's balance sheet (Bauer and Rudebusch, 2014), the shadow short rate (Wu and Xia, 2016), and longer rates such as the 10-year Treasury (Swanson and Williams, 2014). The first two instruments are not in the conditioning set of the Fed (based on page I-III of the Greenbook). The 10-year Treasury, however, is both forecasted by the Blue Chip and futures market; moreover, the 10-year Treasury is also part of the conditioning information of the Greenbook.[25]

We define the conditioning path during the ZLB period to be a function of both the short and long rates:

$$\tilde{s}_{t,j} = \begin{cases} & \overline{r}_{t+j} \times (1+\tau)^j > r_{t+j} > \overline{r}_{t+j} \times (1-\tau)^j \\ 1 \quad if & \qquad and \\ & \overline{R}_{t+j} \times (1+\widehat{\tau})^j > R_{t+j} > \overline{R}_{t+j} \times (1-\widehat{\tau})^j \\ 0 & \qquad otherwise \end{cases},$$

where R_{t+j} is the 10-year Treasury rate, $\overline{R}_{t+j}$ is the market forecast of the 10-year Treasury rate, and $\widehat{\tau}$ is the tolerance on the long rate similar to τ here and in eq (4). We then construct the horizon-h on-the-path variable as defined in eq (5) and we use the same uncertainty indicator from eq (6) and (7).[26]

Table 4: Monetary Policy Path Encompassing Test with ZLB

We report results using the 10-year Treasury futures; results using Blue Chip 10-year Treasury forecasts are qualitatively similar and appear in the Appendix. The two left columns of Table 4 provide results when separating the data by the path variable alone; the two right columns provide results when separating the data by combining the path variable with the level of uncertainty. When the Fed knows the path but the market does not (columns 2 and 3), the Fed forecasts encompass the market; when both the Fed and the market know the

[25] These data are available here: https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/gap-and-financial-data-set, and a description of the data and process can be found in Section 2.3.1.

[26] We include the long-rate path only during the ZLB period. Outside the ZLB period, we assume that monetary policy is summarized by the short rate.

path (columns 1 and 4), neither has an informational advantage. These results again suggest that a main source of the Fed's informational advantage is its knowledge of the conditioning path, even during the ZLB period.

5 How Important Is Knowing the Path?

Our results suggest that the Fed's informational advantage (for inflation forecasting) can be at least partially explained by its knowledge (and certainty of) the conditioning path. In this subsection, we investigate how the market's knowledge of the conditioning path affects private sector forecast performance.

5.1 Forecast Performance and the Conditioning Path

Table 5: MSFE Dependent on Monetary Policy Path

Forecast encompassing is a binary result that tells us whether the information set of one forecaster strictly dominates that of another forecaster. We now consider how the private sector's knowledge of the path affects its forecast performance relative to when the path is uncertain. Table 5 shows the MSFE of the Blue Chip forecasts during periods (i) when both the market and the Greenbook know the conditioning path, (ii) when the market is on the path (regardless of the status of the Greenbook), (iii) when the market is off the path (regardless of the status of the Greenbook); and (iv) when the Greenbook is on the path but the market is off the path.

We find that, at very short horizons (nowcast or one-period-ahead), knowing the conditioning path does not improve the performance of the Blue Chip forecasts; in fact, these short-horizon forecasts are often worse when the market is on the path. However, at short horizons, the effects of monetary policy may already be "baked in," and knowledge of the conditioning path may be irrelevant. At longer horizons (2-quarters-ahead or more), the Blue Chip consensus forecasts perform better when the market knows the path. These results suggest that, for horizons at which we expect monetary policy to matter, the private sector

forecasts better when it is confident about the policy path.

5.2 Quantifying Monetary Policy's Influence

Our main hypothesis is that the Fed and the private sector have similar forecasting performance once accounting for the information in the Greenbook's conditioning path. In the previous section, we asked how much better the private sector forecasts when they are certain about the conditioning path. Here, we quantify the conditioning path's contribution to the difference between the Fed's and the private sector's MSFE.

To evaluate this, we compute the Kitagawa–Blinder–Oaxaca (KBO) decomposition (Kitagawa, 1955; Blinder, 1973; Oaxaca, 1973) of the expected difference in the MSFEs. Define $D_h = E[(y_{t+h} - \hat{y}^f_{t,h})^2] - E[(y_{t+h} - \hat{y}^p_{t,h})^2]$, the mean difference between the MSFEs of the Fed and the private sector. We then regress the horizon$-h$ inflation prediction errors on a vector of state variables, $a^i_{t,h}$, that includes a constant and the squared forecast errors for output, unemployment, and the short term interest rate:

$$(y_{t+h} - \hat{y}^i_{t,h})^2 = \lambda^{i\prime}_h a^i_{t,h} + \varepsilon^i_{t,h}, \tag{8}$$

where for $i = f, p$. Then, suppressing the horizon and time subscripts, we can rewrite the mean difference in MSFEs as:

$$D = \lambda^{p\prime}[E(a^f - a^p)] + (\lambda^f - \lambda^p)'E(a^p) + (\lambda^f - \lambda^p)'[E(a^f - a^p)]. \tag{9}$$

The first term is the object of interest, indicating how differences in information (reflected by the expected difference in the state variables) would affect the MSFE difference, given the private sector's forecast "ability," the λ^p's. The second term indicates the contribution of the Fed's forecast ability over the private sector's with the private sector's information. The final term is the residual.

Table 6: Kitagawa-Blinder-Oaxaca Decomposition

Table 6 shows the results of the KBO decompositions at various horizons. The first row shows the difference in the MSFE and indicates whether this is significantly different from zero based on a (Diebold and Mariano, 1995) and West (1996) test. The next three rows show the values of the three terms in equation (9). The next three rows show the breakdown of the first term attributable to each of the state variables in the regression, eq (8). The final rows show (i) the percentage of the difference in the MSFE associated with the difference in the Fed's and the private sector's policy paths (row 5 divided by row 1) and (ii) the percentage of the Fed's superior information (rather than, say, forecast ability) attributed to the path (row 5 divided by row 2). As one might suspect from the results in previous sections, knowledge of the conditioning path does not matter much for the nowcast. For future horizons, knowledge of the future path of monetary policy accounts for between 20 to 30 percent (on average) of the difference in forecaster performance. Moreover, differences in the knowledge of the path accounts for almost all of the explained difference in the MSFEs.

6 Conclusion

The Fed appears to have a forecasting advantage over the private sector for inflation. When comparing Greenbook forecasts to Blue Chip forecasts using standard encompassing tests, we find that the Fed encompasses the private sector prior to 1994 when the Fed became more transparent. However, when we equalize the information between the Fed and the private sector, the Fed's forecasts no longer encompass the private sector's forecasts. This result contrasts with RR's preferred hypothesis that the Fed's advantage stems from its use of better or more resources devoted to forecasting and suggests the advantage is informational.

We then focus specifically on the conditioning path as the source of the Fed's advantage. Using Eurodollar futures as a measure of the market's belief about future monetary policy, we compare periods when the Fed and the private sector have essentially the same conditioning path to periods when the Fed knows the path but the private sector does not. In these cases, we find generally that the Fed's forecasts encompass those of the private sector when they have an informational advantage and fails to encompass when they do not.

The literature on the Fed's forecast advantage has implications for the identification of monetary policy shocks in VARs and their subsequent effects on macroeconomic variables. The recent literature explores the importance of the information channel in both standard VARs (Miranda-Agrippino and Ricco, 2021; Jarociński and Karadi, 2020) and using high frequency identification Nakamura and Steinsson (2018). We validate and quantify the effect of the Fed informational advantage for forecasting, which supports this literature on the information channel.

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Table 1: Conventional Encompassing Test Inflation

	Full Sample					**Pre 1994**					**Post 1994**				
h	α	β^p	β^f	χ^2	N	α	β^p	β^f	χ^2	N	α	β^p	β^f	χ^2	N
0	0.03 (0.85)	**0.33** (0.00)	**0.63** (0.00)	**24.55** (0.00)	295	−0.14 (0.63)	0.32 (0.10)	**0.67** (0.04)	**7.21** (0.03)	113	0.33 (0.27)	0.21 (0.31)	**0.60** (0.00)	**17.36** (0.00)	182
1	0.25 (0.17)	0.07 (0.64)	0.81 (0.19)	**7.16** (0.03)	295	0.22 (0.56)	−0.22 (0.35)	1.12 (0.50)	2.06 (0.36)	113	0.90 (0.10)	0.14 (0.71)	**0.38** (0.00)	**15.95** (0.00)	182
2	**0.42** (0.03)	−0.06 (0.75)	0.88 (0.54)	**10.04** (0.01)	295	0.47 (0.29)	−0.28 (0.27)	1.11 (0.61)	4.17 (0.12)	113	**1.25** (0.02)	0.10 (0.82)	**0.22** (0.00)	**21.12** (0.00)	182
3	**0.41** (0.05)	−0.16 (0.39)	0.99 (0.95)	**8.80** (0.01)	295	0.29 (0.53)	−0.35 (0.19)	1.22 (0.32)	2.54 (0.28)	113	**1.62** (0.00)	0.01 (0.97)	**0.11** (0.00)	**29.38** (0.00)	182
4	0.53 (0.05)	−0.07 (0.72)	0.83 (0.53)	5.98 (0.05)	291	0.30 (0.66)	−0.32 (0.25)	1.18 (0.55)	1.71 (0.43)	109	**2.05** (0.00)	−0.19 (0.45)	**0.10** (0.00)	**46.12** (0.00)	182
5	**0.71** (0.01)	0.07 (0.79)	0.54 (0.21)	**12.60** (0.00)	217	0.58 (0.44)	−0.23 (0.55)	0.93 (0.87)	3.44 (0.18)	81	**2.54** (0.00)	−0.17 (0.52)	**-0.25** (0.00)	**72.16** (0.00)	136
6	**0.76** (0.00)	**0.50** (0.01)	**-0.07** (0.00)	**73.91** (0.00)	134	0.48 (0.40)	**0.48** (0.02)	**0.03** (0.00)	**32.87** (0.00)	46	**2.67** (0.00)	−0.35 (0.30)	**-0.15** (0.00)	**43.49** (0.00)	88
7	0.63 (0.05)	**0.55** (0.01)	**-0.17** (0.00)	**63.58** (0.00)	69	0.82 (0.27)	0.29 (0.06)	**0.10** (0.00)	**29.63** (0.00)	26	1.02 (0.31)	**0.74** (0.03)	**-0.66** (0.00)	**16.01** (0.00)	43

Table 1: Conventional Encompassing Test Inflation: Pre 1994 refers to a sample up to and including 1993:12, while post 1994 refers to a sample that begins in 1994:01. Values of α, β^p, and β^f are OLS estimated coefficients from eq (1). χ^2 denotes a HAC-robust Wald statistic associated with testing the null $(\beta^p, \beta^f)' = (0, 1)'$. N and h denote the sample size and horizon, respectively. Parentheses indicate p-values associated with HAC-robust Wald tests. The null is zero for α and β^p but is one for β^f. Bold means that we reject at the 5% level. There are definitional changes over the sample: Blue Chip: GNP deflator (1980:01 - 1991:12); GDP implicit deflator (1992:01 - 1995:12); GDP deflator, chain-weighted (1996:01 - 2016:12) and Greenbook: GNP implicit deflator (1968:11 - 1991:11), GDP implicit deflator (1991:12 - 1996:03), GDP deflator, chain-weighted (1996:05 - 2016:12).

Table 2: Conditional Encompassing Test Inflation

	Full Sample						**Pre 1994**						**Post 1994**					
h	F	α	β^p	$\overline{\beta}^f$	χ^2	N	F	α	β^p	$\overline{\beta}^f$	χ^2	N	F	α	β^p	$\overline{\beta}^f$	χ^2	N
0	2.36	0.19	0.02	0.88	3.93	288	1.44	−0.10	0.51	0.46	**7.88**	106	1.21	−0.62	3.06	−1.87	1.35	182
	(0.07)	(0.47)	(0.97)	(0.83)	(0.14)		(0.24)	(0.92)	(0.68)	(0.59)	(0.02)		(0.31)	(0.68)	(0.42)	(0.37)	(0.51)	
1	**13.99**	0.09	**1.16**	**-0.34**	**13.43**	288	**6.31**	0.52	−0.40	1.23	4.79	106	**14.76**	0.29	**1.72**	**-1.04**	**18.08**	182
	(0.00)	(0.70)	(0.02)	(0.01)	(0.00)		(0.00)	(0.31)	(0.45)	(0.63)	(0.09)		(0.00)	(0.55)	(0.00)	(0.00)	(0.00)	
2	**40.02**	**0.53**	0.34	0.38	**17.09**	288	**38.86**	0.84	−0.45	1.20	**7.95**	106	**9.25**	0.80	1.96	**-1.65**	**12.12**	182
	(0.00)	(0.01)	(0.34)	(0.11)	(0.00)		(0.00)	(0.07)	(0.19)	(0.57)	(0.02)		(0.00)	(0.31)	(0.14)	(0.03)	(0.00)	
3	**37.47**	0.45	−0.10	0.90	5.35	288	**42.61**	0.23	−0.46	1.37	2.09	106	**11.46**	**1.58**	0.21	−0.09	**18.78**	182
	(0.00)	(0.07)	(0.77)	(0.79)	(0.07)		(0.00)	(0.68)	(0.22)	(0.36)	(0.35)		(0.00)	(0.00)	(0.81)	(0.21)	(0.00)	
4	**32.85**	**0.69**	0.00	0.67	**21.47**	288	**32.82**	0.78	−0.28	0.99	**7.97**	106	**22.30**	**2.21**	−0.73	0.65	**31.82**	182
	(0.00)	(0.00)	(0.99)	(0.38)	(0.00)		(0.00)	(0.10)	(0.41)	(0.98)	(0.02)		(0.00)	(0.00)	(0.10)	(0.47)	(0.00)	
5	**28.49**	**0.98**	0.30	**0.14**	**48.73**	214	**31.25**	**1.46**	−0.18	0.62	**44.75**	78	**20.04**	**2.68**	−0.65	0.26	**45.55**	136
	(0.00)	(0.00)	(0.42)	(0.05)	(0.00)		(0.00)	(0.01)	(0.64)	(0.35)	(0.00)		(0.00)	(0.00)	(0.16)	(0.14)	(0.00)	
6	**24.65**	**0.74**	**0.65**	**-0.24**	**65.67**	134	**19.34**	0.47	**0.55**	**-0.04**	**23.50**	46	**20.10**	**2.84**	−0.98	0.54	**21.28**	88
	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)		(0.00)	(0.42)	(0.04)	(0.00)	(0.00)		(0.00)	(0.00)	(0.12)	(0.43)	(0.00)	
7	**11.82**	**0.74**	0.15	0.28	**44.16**	69	**10.41**	0.76	**0.46**	**-0.08**	**23.78**	26	**13.12**	1.32	−0.28	0.46	3.93	43
	(0.00)	(0.02)	(0.71)	(0.12)	(0.00)		(0.00)	(0.32)	(0.05)	(0.00)	(0.00)		(0.00)	(0.20)	(0.71)	(0.49)	(0.14)	

Table 2: Conditional Encompassing Test Inflation: Pre 1994 refers to a sample up to and including 1993:12, while post 1994 refers to a sample that begins in 1994:01. Values of α, β^p, and $\overline{\beta}^f$ are 2SLS estimated coefficients from eqs. (2) and (3). We use the Blue Chip forecasts of the 3-m Treasury bill yield, the unemployment rate, and real GDP as instruments. F is the first-stage F-statistic. χ^2 denotes a HAC-robust Wald statistic associated with testing the null $(\beta^p, \overline{\beta}^f)' = (0,1)'$. N and h denote the sample size and quarterly horizon, respectively. Parentheses indicate p-values associated with HAC-robust Wald tests, except for the first-stage F-statistic. The null is zero for α and β^p but is one for $\overline{\beta}^f$. Bold means that we reject at the 5% level. There are definitional changes over the sample: Blue Chip: GNP deflator (1980:01 - 1991:12); GDP implicit deflator (1992:01 - 1995:12); GDP deflator, chain-weighted (1996:01 - 2016:12) and Greenbook: GNP implicit deflator (1968:11 - 1991:11), GDP implicit deflator (1991:12 - 1996:03), GDP deflator, chain-weighted (1996:05 - 2016:12).

Table 3: Monetary Policy Path Encompassing Test

	Both on Path & Both off Path				**Fed on Path & Market off Path**				**Fed on Path & Market off Path/Uncertain**				**Both on Path with Certainty & Both off Path/Uncertain**			
h	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N
0	0.00	0.81	4.39	92	0.14	**0.69**	**12.00**	114	0.09	**0.74**	**11.64**	149	0.25	0.76	1.55	42
	(0.99)	(0.15)	(0.11)		(0.28)	(0.00)	(0.00)		(0.42)	(0.01)	(0.00)		(0.37)	(0.23)	(0.46)	
1	−0.05	0.83	5.88	109	0.26	**0.44**	**6.15**	90	0.21	**0.50**	5.10	98	−0.03	0.77	**9.85**	104
	(0.78)	(0.37)	(0.05)		(0.15)	(0.03)	(0.05)		(0.25)	(0.05)	(0.08)		(0.86)	(0.23)	(0.01)	
2	0.07	0.65	**12.15**	140	0.02	0.70	2.92	62	0.08	0.65	2.31	67	0.13	0.57	**12.90**	137
	(0.70)	(0.14)	(0.00)		(0.95)	(0.48)	(0.23)		(0.74)	(0.35)	(0.32)		(0.50)	(0.09)	(0.00)	
3	0.02	0.69	**6.68**	148	−0.02	0.56	4.10	52	−0.03	0.58	3.76	57	0.03	0.68	**6.68**	144
	(0.90)	(0.19)	(0.04)		(0.95)	(0.40)	(0.13)		(0.94)	(0.38)	(0.15)		(0.88)	(0.22)	(0.04)	
4	0.09	0.61	**6.95**	160	0.10	0.54	2.15	42	0.18	0.48	2.24	46	0.05	0.66	**6.25**	157
	(0.64)	(0.13)	(0.03)		(0.82)	(0.29)	(0.34)		(0.64)	(0.19)	(0.33)		(0.81)	(0.24)	(0.04)	

Table 3: Monetary Policy Path Encompassing Test: The first panel shows the results from the encompassing regressions when the Fed and the market are either both on or both off the path. The second panel shows the results when the Fed is on the path and the market is not. The third panel shows the results when the Fed is on the path but the market is either off the path or uncertain. The fourth panel shows the results when either (a) the Fed is on the path and the market is both on the path, and uncertainty is low or (b) the Fed is off the path and the market is either off the path or uncertain. χ^2 denotes a HAC-robust Wald statistic associated with testing the null $(\beta^p, \beta^f)' = (0, 1)'$. N and h denote the sample size and quarterly horizon respectively. Parentheses indicate p-values associated with HAC-robust Wald tests. The null is zero for β^p and is one for β^f. Bold means that we reject at the 5% level. The path variable for the private sector is determined from the Eurodollar ($\tau = 0.05$), and the path variable for the Fed is determined from the GB assumptions for the FFR ($\tau = 0.05$). The sample for the two left-hand side panels is from 1982:01 - 2008:09, and the sample for the two right-hand side panels is from 1985:01 - 2008:09.

Table 4: Monetary Policy Path Encompassing Test with ZLB

	Both on Path & Both off Path				**Fed on Path & Market off Path**				**Fed on Path & Market off Path/Uncertain**				**Both on Path with Certainty & Both off Path/Uncertain**			
h	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N	β^p	β^f	χ^2	N
0	0.12	**0.65**	**11.71**	122	**0.22**	**0.65**	**19.42**	147	0.16	**0.70**	**16.80**	184	0.34	0.52	5.62	68
	(0.51)	(0.05)	(0.00)		(0.02)	(0.00)	(0.00)		(0.06)	(0.00)	(0.00)		(0.26)	(0.06)	(0.06)	
1	0.19	**0.56**	**11.54**	151	0.30	**0.46**	5.91	105	0.26	**0.51**	4.95	113	0.23	**0.49**	**18.94**	148
	(0.32)	(0.04)	(0.00)		(0.05)	(0.02)	(0.05)		(0.11)	(0.03)	(0.08)		(0.22)	(0.01)	(0.00)	
2	0.22	**0.50**	**15.84**	184	0.17	0.55	3.02	77	0.22	0.51	2.78	82	0.29	**0.41**	**17.44**	182
	(0.25)	(0.03)	(0.00)		(0.51)	(0.24)	(0.22)		(0.36)	(0.17)	(0.25)		(0.16)	(0.02)	(0.00)	
3	0.12	**0.58**	**9.11**	194	0.03	0.53	**6.69**	64	0.03	0.55	**6.52**	69	0.13	0.56	**8.65**	191
	(0.46)	(0.05)	(0.01)		(0.92)	(0.33)	(0.04)		(0.94)	(0.31)	(0.04)		(0.47)	(0.07)	(0.01)	
4	0.14	**0.51**	**14.18**	206	0.07	0.59	3.41	53	0.16	0.51	3.27	57	0.11	0.55	**12.92**	204
	(0.45)	(0.05)	(0.00)		(0.86)	(0.33)	(0.18)		(0.68)	(0.20)	(0.19)		(0.61)	(0.11)	(0.00)	

Table 4: Monetary Policy Path Encompassing Test: The first panel shows the results from the encompassing regressions when the Fed and the market are either both on or both off the path. The second panel shows the results when the Fed is on the path and the market is not. The third panel shows the results when the Fed is on the path but the market is either off the path or uncertain. The fourth panel shows the results when either (a) the Fed is on the path and the market is both on the path, and uncertainty is low or (b) the Fed is off the path and the market is either off the path or uncertain. χ^2 denotes a HAC-robust Wald statistic associated with testing the null $(\beta^p, \beta^f)' = (0, 1)'$. N and h denote the sample size and quarterly horizon respectively. Parentheses indicate p-values associated with HAC-robust Wald tests. The null is zero for β^p and is one for β^f. Bold means that we reject at the 5% level. The path variable for the private sector is determined from the Eurodollar ($\tau = 0.05$) and 10 year Futures (during ZLB, where $\tau = 0.1$). The path variable for the Fed is determined from the GB assumptions for the FFR ($\tau = 0.05$) and 10 year Tbills (during ZLB, where $\tau = 0.1$). The sample for the two left-hand side panels is from 1982:01 - 2016:12, and the sample for the two right-hand side panels is from 1985:01 - 2016:12.

Table 5: MSFE Dependent on Monetary Policy Path

	Both on Path			**BC on Path**			**BC off Path**			**Fed on & BC off**		
h	BC	GB	N	BC	GB	N	BC	GB	N	BC	GB	N
0	1.05	0.68	97	1.17	0.75	105	0.76	0.68	172	0.68	0.53	147
1	1.45	0.87	33	1.47	1.15	54	1.04	0.92	223	0.88	0.73	105
2	0.86	0.71	25	0.72	0.61	41	1.35	1.09	236	1.14	0.89	77
3	0.76	0.63	19	0.74	0.64	38	1.62	1.17	239	1.47	1.14	64
4	1.20	0.62	16	1.45	0.96	34	1.63	1.16	243	1.54	1.22	53

Table 5: MSFE Dependent on Monetary Policy Path: Table shows MSFE for four permutations of being on or off the path, where BC refers to the Blue Chip forecasts and GB refers to the Fed forecasts. N and h denote the sample size and quarterly horizon, respectively. The sample is 1982:01 to 2016:12. The path variable for the private sector is determined from the Eurodollar ($\tau = 0.05$) and 10 year Futures (during ZLB, where $\hat{\tau} = 0.1$). The path variable for the Fed is determined from the GB assumptions for the FFR ($\tau = 0.05$) and 10 year Tbills (during ZLB, where $\hat{\tau} = 0.1$)

Table 6: Kitagawa–Blinder–Oaxaca Decomposition

		h = 0	h = 1	h = 2	h = 3	h = 4
(1)	D	**-0.224** (0.112)	−0.153 (0.109)	**-0.270** (0.115)	**-0.396** (0.134)	**-0.540** (0.145)
(2)	$\lambda^p[E(a^f) - E(a^p)]$	**-0.101** (0.029)	**-0.116** (0.034)	**-0.093** (0.041)	**-0.168** (0.062)	**-0.227** (0.071)
(3)	$(\lambda^f - \lambda^p)E(a^p)$	**2.665** (0.622)	−0.010 (0.120)	−0.227 (0.119)	**-0.287** (0.128)	**-0.476** (0.144)
(4)	$\left(\lambda^f - \lambda^p\right)[E(a^f) - E(a^p)]$	**-2.788** (0.616)	−0.028 (0.062)	0.050 (0.051)	0.060 (0.044)	**0.163** (0.064)
(5)	policy path SFE	**-0.0541** (0.021)	**-0.110** (0.032)	**-0.0941** (0.032)	**-0.161** (0.056)	**-0.222** (0.071)
(6)	unemployment SFE	**-0.043** (0.0187)	−0.005 (0.0112)	−0.008 (0.0107)	−0.009 (0.0149)	−0.003 (0.00799)
(7)	output SFE	−0.004 (0.014)	−0.002 (0.008)	0.009 (0.015)	0.001 (0.005)	−0.002 (0.010)
	(5)/(1)	0.242	0.719	0.349	0.407	0.411
	(5)/(2)	0.536	0.948	1.012	0.958	0.978
	N	691	691	691	691	691

Table 6: Kitagawa–Blinder–Oaxaca Decomposition: These are the results for the Kitagawa-Blinder-Oaxaca decomposition for inflation estimated using OLS across different horizons (h) with N total observations. All variables in the regression are in squared forecast errors (SFE) and standard errors are reported in the parentheses. D refers to the MSFE difference between the Greenbook and the Blue Chip forecasts. The next three lines decomposes D into three components. The middle panel decomposes the $\lambda^p[E(a^f) - E(a^p)]$ part of the decomposition into parts of the state vector, a, attributed to knowledge of the path, SFE of the unemployment rate, and the SFE of output. The bottom panel shows fractions as designated by the row numbers. Bold means the coefficient is statistically significant at the 5% level. The sample is 1982:01 to 2016:12. The path variable for the private sector is determined from the Eurodollar and 10 year Futures. The path variable for the Fed is determined from the GB assumptions for the FFR and 10 year Tbills.