

# Asymmetries in Monetary Policy Uncertainty: New Evidence from Financial Forecasts\*

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February 13, 2017

PRELIMINARY

## Abstract

We obtain measures of monetary policy uncertainty from the Blue Chip Financial Forecasts. The uncertainty associated with the federal funds rate captures conventional monetary policy uncertainty, while we use the uncertainty associated with the yields on 10-year Treasury notes to capture the unconventional monetary policy uncertainty. Our results show that monetary policy tightening and easing periods are distinctly associated with downside and upside uncertainty, respectively. Moreover, quantitative easing has not been successful in reducing monetary policy uncertainty, while forward guidance has been fairly successful in that. We subsequently analyze the effects of uncertainty conditional on being in a monetary tightening or easing cycle. Though in both cases the uncertainty has recessionary effects, the effects are stronger in easing relative to tightening. This is due to the fact that the expectations are relatively better anchored in tightening relative to easing.

*JEL classification:* C18; C32; E02; E43; E52

*Keywords:* interest rates, term structure, uncertainty, survey forecasts, monetary policy

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\*The views expressed in this paper are those of the authors and do not represent the views of the Bank of Canada.

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*“Uncertainty is not just an important feature of the monetary policy landscape; it is the defining characteristic of that landscape.” Alan Greenspan, 2003*

## 1 Introduction

The literature has long been concerned about uncertainty surrounding monetary policy making (see, for instance, Stulz, 1986, Barro, 1986, among others). In the context of this literature, monetary policy uncertainty was mainly linked to a tendency towards opacity of central banks. Agents can be uncertain about monetary policy for a variety of reasons: informational asymmetries, central banks’ possible lack of credibility or commitment, unknown central bank preferences, etc.

However, in recent years, this trend has been reversed as the conduct of monetary policy became more transparent. Central banks across the globe came to recognize the potentially valuable role that communication can play in achieving monetary policy goals. For example, in the US, the Federal reserve started releasing a statement describing policy actions in regards to the Federal Funds Rate after the FOMC meetings in the mid-1990s, which was followed by a number of changes in the communication strategy in the subsequent years. A notable example of it is forward guidance: an explicit communication from the Federal Reserve about the likely future course of monetary policy, which has been in use since 2004 and has been one of the unconventional monetary policy tools in the post-financial crisis zero lower bound (ZLB) period of policymaking.<sup>1</sup>

At the same time, the financial crisis and the Great Recession have sparked interest in quantifying the effects of uncertainty. This initiated a large empirical literature, see for instance Bloom (2009), Scotti (2016), Jurado et al. (2015), Rossi and Sekhposyan (2015) and Rossi and Sekhposyan (2016), that focuses on measuring macroeconomic uncertainty and its effects on the economy. There is also a nascent and much narrower literature concerned with measuring monetary policy uncertainty directly. Some recent contributions on this are Baker et al. (2016), Creal and Wu (2016), Fontaine (2016), Husted et al. (2016), Istrefi and Mouabbi (2017) and Sinha (2015). Monetary policy uncertainty is peculiar in some sense, since, relative to other sources of uncertainty, the central bank could be one of the main sources driving it. Moreover, understanding the dynamics of monetary policy uncertainty

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<sup>1</sup>See Blinder et al. (2008) for a the discussion of central bank communication over time.

conditional on central banks' monetary policy tools could help us evaluate the effectiveness of those tools.

Our paper contributes to this relatively nascent, yet growing, literature aimed at understanding monetary policy uncertainty along several dimensions. First, we rely on the Blue Chip Financial Forecasts (BCFF) of the Federal funds rate and the 10-year Treasury yield to obtain our measures. This survey is one of the longest ones available and contains forecasts for the term structure of interest rates but has remained largely unexplored in macroeconomics. Second, we provide a detailed analysis of the dynamics of forecasts errors and their relation to both conventional as well as unconventional monetary policy. Lastly, we identify strong asymmetries in our measure of monetary policy uncertainty and discuss their distinct economic implications.

To measure monetary policy uncertainty, we choose the Federal Funds Rate forecast since it has been the conventional monetary policy instrument used by the Federal Reserve in the past. Once the ZLB was binding, other instruments became relevant, such as forward guidance and quantitative easing (QE). The literature has shown that these unconventional monetary policies affect interest rates and in particular influenced the 10-year Treasury yield (see Gagnon et al., 2011, Krishnamurthy and Vissing-Jorgensen, 2011, Neely, 2015, and Hamilton and Wu, 2012, among many others). Thus, we use the federal funds rate forecasts to obtain a measure of conventional monetary policy uncertainty. Throughout the ZLB, we look at the 10-year Treasury bond yield to provide a measure of unconventional monetary policy uncertainty. Away from the ZLB, longer maturities are usually beyond the direct control of the central banks, thus less indicative of monetary policy uncertainty.

More specifically, our uncertainty measure is based on forecast errors. Thus, similar to Jurado et al. (2015), we think of an economy being uncertain when there is less predictability. In the course of constructing the uncertainty indices we provide interesting and novel facts about the dynamics of the forecasts errors from the BCFF. We show that the distribution of the forecast errors changes with monetary policy interventions. Notably, while the variance is rather stable over monetary policy cycles, the mean and skewness markedly differ across cycles.

The behavior of the forecast errors motivates our choice for the uncertainty index. In particular, we introduce the Rossi and Sekhposyan (2015) uncertainty index for the federal

funds rate and 10-year Treasury note forecasts, since this is an index that utilizes the information in the whole forecast error distribution as opposed to only the first and second moments. In addition to describing the monetary policy uncertainty in terms of probabilistic statements, this measure gives an opportunity to distinguish between upside and downside uncertainty: uncertainty associated with higher than expected positive versus negative outcomes, respectively.

In particular, we find that monetary policy tightening is associated with downside uncertainty, while expansionary policy is associated with upside uncertainty. This suggests that conventional monetary policy is generally implemented more aggressively than anticipated from historical episodes, resulting in uncertainty surrounding the policy rate. Interestingly, we find the opposite to be true for the months prior to the lift-off of the federal funds rate in October 2015. Agents expected the Federal Reserve to increase rates earlier. Concerning our uncertainty measure for the 10-year Treasury yield, it seems that the use of unconventional monetary policy tools have resulted in episodes of uncertainty that are not widely different from the historical episodes. Further, we show that most QE-related policy interventions seem to be linked to high levels of uncertainty while forward guidance related policies are less so. Finally, we assess the macroeconomic implications of monetary policy uncertainty by analyzing its effects conditional on being in a monetary tightening or easing cycle. Though in both cases the uncertainty has recessionary effects, the effects are stronger in easing relative to tightening. This is due to the fact that the expectations are relatively better anchored in tightening relative to easing.

The paper proceeds as follows. In Section 2, we briefly lay out the construction of the uncertainty index. Section 3 discusses the BCFF data. Section 4 considers the properties of the interest rate forecasts and their relationship to monetary policy cycles, while Section 5 considers the uncertainty series. Section 6 discusses the macroeconomic impact of monetary policy, while section 7 concludes.

## 2 The Uncertainty Index

We construct the monetary policy uncertainty index in the framework of Rossi and Sekhposyan (2015). The uncertainty index is based on the conditional distribution of the forecast errors and captures the ex-ante probability that one would assign to the forecast error, given

the historical distribution of the forecast errors. The further away from the (theoretical) mean, i.e., 0.5, the higher the uncertainty. Moreover, we can distinguish between upside and downside uncertainty, i.e., identify situations where a forecast error is above or below the mean of the distribution.

More formally, let the forecast error at time  $t+h$  be denoted by  $e_{t+h} = y_{t+h} - E_t(y_{t+h})$ , i.e., this is the forecast error associated with the  $h$ -step-ahead forecast formed with all the available information at time  $t$ , and  $t$  refers to the forecast origin date. Let  $f(e)$  denote the probability density function (PDF) of the forecast errors,  $e_{t+h}$ . Given  $e_{t+h}$  and  $f(e)$ , the index at time  $t+h$  is defined as  $U_{t+h} = \int_{-\infty}^{e_{t+h}} f(e) de$ . In order to capture upside and downside uncertainty and have them directly comparable to each other in magnitudes, we consider the index  $U_{t+h}^+ = \frac{1}{2} + \max\{U_{t+h} - \frac{1}{2}, 0\}$  for upside uncertainty and  $U_{t+h}^- = \frac{1}{2} + \max\{\frac{1}{2} - U_{t+h}, 0\}$  for downside uncertainty.  $U_{t+h}^* = \frac{1}{2} + |U_{t+h} - \frac{1}{2}|$ , on the other hand, would be the measure of overall uncertainty. Note that, by construction, the overall measure of uncertainty, as well as the upside and downside ones fluctuate between 0.5 and 1.

We provide an illustrative example below. Consider Figure 1. Figure 1 has 3 panels. The first one shows the probability density of the forecast errors associated with the 6-month ahead federal funds rate forecasts. Let us consider two distinct episodes. The first one is in February of 2007, when Chairman Bernanke assumed the governorship of the Federal Reserve, while the second episode pertains to August of 2008, i.e., a month before Lehman declared bankruptcy. As it can be seen, the forecast error associated with the Chairman Bernanke's assumption of governorship is positive. On the other hand, the forecast errors associated with August of 2008 are negative and much more unlikely ex-ante than those associated with February of 2007. Panel B shows the CDF corresponding to the PDF, i.e.  $U_{t+h}$ . Panel C shows the resulting upside and downside uncertainty indices: there is high positive uncertainty associated with 2008:8, while the uncertainty associated with 2007:2 is a downside one and lower. In constructing the figure and throughout the paper we follow the notion that interest rates above expectations constitute to downside uncertainty, since higher interest rates are typically deterrents for growth. On the other hand, forecast errors below expectations are linked to upside uncertainty, since they typically stimulate economic activity.

### 3 Data

The Blue Chip Financial Forecasts (BCFF) provide monthly forecasts of U.S. interest rates with different maturities as well as forecasts for real output growth and inflation. Since 1982, the BCFF survey is conducted monthly, covering approximately fifty analysts ranging from broker-dealers to economic consulting firms. We focus on forecasts of interest rates with short-term and long-term maturities. In particular, at the short end we use the forecasts of the federal funds rate - the Fed's policy rate, while for the long-term horizon we use the forecasts of the 10-year Treasury yield.

The BCFF is published on the first day of each month and presents forecasts from a survey conducted during two consecutive business days one to two weeks earlier. The precise dates of the survey vary and are not generally noted in the publication. Since April 1983, each month the BCFF provides the forecasts of the average interest rate over a particular quarter, beginning with the current quarter and up to four or five quarters into the future.<sup>2</sup> For example, in January, the forecast of the current quarter is given by the average expected realization over January, February and March, and the 1-quarter ahead forecast is given by the average expected realization over April, May, and June.

Therefore, the monthly BCFF forecasts are fixed-event forecasts of interest rates over the quarter, implying that their forecast horizon changes with each month in the quarter. We construct fixed-horizon forecasts by weighting the two given fixed-event forecasts following Chun (2011) (or see Dovern et al. (2012) for an application to the survey data of GDP and prices). We define the three-month ahead forecast as follows. In the first month of the quarter, the three-month ahead forecast is simply the forecast of the current quarter. In the second month of the quarter, the three-month-ahead forecast is obtained by taking the average of the current and one-quarter-ahead forecasts with weights equal to  $2/3$  and  $1/3$ , respectively. The three-month ahead forecast for the final month of the quarter is the weighted average of forecasts over the current and one-quarter ahead forecast with weights equal to  $1/3$  and  $2/3$ . The six-month-ahead forecasts are calculated as the weighted average of the one-quarter and two-quarter-ahead forecasts given by the survey with weights similar to the ones discussed above. The 9-month, and 12-month ahead forecasts are defined accordingly.

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<sup>2</sup>Before 1983, forecasts only exist for the current and then every other quarter.

Forecast errors are obtained by subtracting the consensus forecasts (mean across all fifty analyst forecasts) from the realizations which are available from the Federal Reserve Board’s H.15 website. In addition, we also use the top-10 average and the bottom-10 average forecasts to obtain a measure of disagreement (see Andrade et al., 2016).

## 4 Interest Rate Forecasts and Monetary Policy

In this section, we present novel facts about analysts’ interest rate forecasts across short-term and long-term maturities and their relation to monetary policy, both conventional and unconventional. Conventionally, the Fed used the federal funds rate (FFR) as their main policy instrument. However, with the FFR reaching its lower bound in the late 2000s, two other dimensions of monetary policy became relevant: changes in forward guidance and quantitative easing, i.e. large scale asset purchases.<sup>3</sup> (Changes in the effective federal funds rate are not a significant component of monetary policy during this period because of the zero lower bound constraint on the FFR.) These unconventional policies are assumed to affect longer term interest rates. Therefore, we investigate the characteristics of forecasts errors for the federal funds rate and the 10-year Treasury yield.

### 4.1 Federal Funds Rate Forecasts

Figure 2 plots the forecast errors of the BCFF for the federal funds rate over time. Forecasts error are shown for several forecast horizons, i.e., 3-month ahead, 6-month ahead, 9-month ahead and 12-month ahead. A few characteristics stand out. First, forecast errors across different horizons co-move strongly and move in cycles. However, errors are small during the ZLB period. Second, swings are generally larger at longer forecast horizons which is also apparent from the increasing variance with longer horizons (see also in Table 1). Third, while the 3-month ahead forecast errors seem to be quite noisy, the forecast series become smoother with the increase in forecast horizon. Fourth, on average forecast errors are negative, implying that over the full sample analysts overestimate the federal funds rate more than they underestimate it. Finally, the distribution of forecast errors is asymmetric and skewed to the left, a fact that was summarized in Figure 1 and can also be seen in

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<sup>3</sup>While the FOMC introduced forward-looking language in mid-1999, forward guidance became more explicit once the FFR reached the ZLB in 2008:12.

Table 1.

Furthermore, by looking at Figure 2, it is apparent that forecast errors in the federal funds rate are tightly linked to the Federal funds target rate. Errors are generally negative when the target rate is decreasing, i.e., during easing cycles, and positive when the target rate is increasing, i.e., during tightening cycles. Thus, the Fed policy rate is commonly lower than expected during easing cycles and higher than expected in periods of tightening. One could interpret this as the Federal Reserve implementing rate hikes or cuts more aggressively than anticipated.

Interestingly, there seems to be one exception to this relationship related to the lift-off of policy rates following the ZLB. Starting in early 2015 forecast errors of the federal funds rate were negative. Analysts' expected consistently a higher policy rate implying that they expected the Fed to increase rates sooner.

Table 1 reports the sample moments of forecast errors across easing and tightening subsamples. We identify easing cycles by looking at periods with negative monthly changes in the FFR target rate and tightening cycles by looking at periods with positive monthly changes in the FFR target rate. As the calculations suggest, the sample mean of forecast errors in easing cycles is negative while the one in tightening cycle is positive. Moreover, the forecast errors are in absolute value less in tightening relative to the easing. This may suggest some asymmetric monetary policy behavior by the Fed. Analyst are surprised by the Fed since the policy rate generally changed more than expected in both easing and tightening cycles. However, during times of tightening analysts underestimate the rate changes by less indicating that the Fed might be behaving more cautiously in those periods.

Table 1 further suggests that the standard deviation seems to be invariant to the monetary policy stance, while skewness of the forecast error distribution seems to become more severe during tightening cycles when looking at the 6-month ahead and 9-month ahead forecasts. Thus, though large mistakes are more likely in the monetary tightening, the asymmetry in the conditional mean results in an unconditional distribution (reported in Figure 1) that is skewed to the left.

Finally, we evaluate the link between FFR forecast errors and monetary policy by run-



ning a few simple univariate regressions of the following form:

$$e_{t+h} = \alpha + \beta x_t + \epsilon_t, \tag{1}$$

where  $x_t$  stands for one of the following three regressors, changes in the FFR target rate, a QE dummy (taking on a value of 1 in case there was a QE-related announcement in month  $t$ ) and a forward guidance dummy (taking on a value of 1 in case there was a QE-related announcement in month  $t$ ). A list of key unconventional monetary policy interventions is given in Table 3.

Table 2 shows the regressions results for two samples: the pre-ZLB and ZLB period. Before the ZLB, FFR forecasts errors are positively and significantly related to changes in the FFR target. At the ZLB, there is no significant link between FFR forecast errors and forward guidance or LSAPs since forecast errors in that period are small, and the corresponding sample period is also relatively small for reliable inference.

## 4.2 Long-term Interest Rate Forecasts

While the Fed can set a target for the FFR, longer maturity interest rates are usually not under the direct control of the central bank. However, with the short-term interest rates being at the ZLB and the use of more unconventional tools, such as forward-looking language or quantitative easing by the Fed, long-term interest rates could be increasingly linked to monetary policy. Therefore, while forecast errors of the FFR seem to be strongly associated with the conventional monetary policy, the distribution of forecast errors of long-term interest rates may be linked to more unconventional monetary policies once the zero lower bound is binding. We discuss forecast errors of the 10-year Treasury yield and its potential link to monetary policy (conventional as well unconventional) in what follows.

To start, Figure 3 shows the evolution of forecast errors for the 10-year Treasury yield. Forecasts errors are shown for several forecast horizons, i.e., 3-month ahead, 6-month ahead, 9-month ahead and 12-month ahead. Errors of different forecast horizons co-move strongly. In contrast to the FFR forecast errors, errors made for the long-term interest rate are less clustered and do not exhibit any apparent relation to the FFR target (compared to the federal funds rate in the Figure 2 above). This is confirmed by looking at the univariate

regression results (see Table 2). The changes in the FFR target cannot be related to forecast errors of the 10-year Treasury yield since the coefficient is not statistically significant. Further, the 10-year Treasury forecast errors seem to behave countercyclical when compared to industrial production growth.

The 10-year Treasury forecast errors show strong variations at the ZLB. As discussed above, at the ZLB forecast errors are potentially linked to unconventional monetary policies, i.e., forward guidance and QE. To assess this statistically we perform simple regressions as described in the former subsection (see Table 2). During the ZLB period there seems to be a relation between QE announcements and long-term interest rate forecast errors. Forecast errors seem to be particularly large at the month of key QE related announcements. Interestingly, we could not find any link to key forward guidance statements by the FOMC.

## 5 Measuring Monetary Policy Uncertainty

### 5.1 Uncertainty Indices

As highlighted in the former section, forecast errors of interest rates and monetary policy seems to be strongly related. At times of easing or tightening agents seem to be more uncertain about FFR. Also, at the ZLB forecast errors of the 10-year Treasury yield seem to be related key QE interventions. To formalize the idea of uncertainty surrounding monetary policy, we introduce the measure of uncertainty described in section 2 for the Fed's policy rate (FFR) and the 10-year Treasury yield. We focus on the uncertainty measure obtained from the 6-month ahead forecast errors. This choice is supported by the finance literature using the BCFF focusing generally on 6-month ahead forecasts (see Chun, 2011 and Kim and Orphanides, 2012).

Figure 4 plots the real-time uncertainty index obtained from FFR forecast errors. We use five years of monthly data (from 1983:4 till 1988:4) to approximate the conditional distribution of forecast errors in the beginning of the sample period. We further update the distribution with monthly observations as they become available. Blue bars indicate periods of downside uncertainty and green bars periods of upside uncertainty. Since our measure is based on the forecast errors distribution, the findings related to the forecast errors directly translate into the characteristics of the uncertainty index.

Upside and downside uncertainty are strongly clustered. Tightening cycles are associated with downside uncertainty (i.e., interest rates are higher than expected) and easing cycles with upside uncertainty (i.e., interest rates are lower than expected). As before, one possible explanation is that the FED generally did rate cuts or hikes more aggressively than anticipated. There is no historic evidence for uncertainty related to the Fed intervening less aggressively than anticipated. There is one exception: while uncertainty is generally low over the ZLB period, upside uncertainty started to increase in late 2014, immediately after the Fed ended purchases in October 2014. This particular episode of upside uncertainty at the end of our sample seems to be related to the uncertainty surrounding the lift-off of the FFR. Agents overestimated the FFR consistently over that particular period implying that they expected the Fed to increase rates sooner.

Figure 5 shows the real-time uncertainty index obtained from the 10-year Treasury bond yield forecast errors. As is the case with the uncertainty index for the FFR, upside and downside uncertainty occur in clusters. However, in contrast to the FFR uncertainty index, these clusters do not relate to the FFR target rate. Once the ZLB is binding the uncertainty index for the 10-year Treasury yield peaks around QE related announcements (see Figure 6). We identify high levels of uncertainty when the Fed first announced sterilized purchases of \$600 billion in MBS, around the QE1 and QE2 announcement, around the Operation Twist announcement, the Bernanke testimony in May 2013, and the end of Fed purchases. The uncertainty index takes on relatively low values at the QE3 announcement and the start of Fed tapering. Interestingly, a clear pattern of whether upside or downside uncertainty links to these key QE policy interventions does not arise. For example, while the QE1 and QE2 announcements are associated with downside uncertainty, Operation Twist is associated with upside uncertainty. We also identify a period of high downside uncertainty at the Bernanke testimony when the former Fed chairman announced the possibility of tapering the Fed's asset purchases in the future. Uncertainty seems to be generally lower at forward guidance related announcements.

## 5.2 Comparison to Alternative Uncertainty Indices

In Figure 7, we compare our uncertainty indexes for the federal funds rate and the 10-year Treasury bond with the news-based measure of monetary policy uncertainty (MPU) by

Baker et al. (2016) (BBD hereafter) and a measure of disagreement across analyst forecasts as in Andrade et al. (2016).

The upper left panel of Figure 7 displays our measure of uncertainty in the FFR and compares it to the BBD MPU. Both series are positively correlated with a coefficient of 0.28 over the whole sample. The MPU exhibits spikes during the Fed easing cycles in the early 1990s and 2000s as well as the one following the financial crisis of 2007. In contrast to our measure of uncertainty, during Fed tightening episodes, the BBD MPU is generally not elevated. A possible link to the monetary policy stance is not as apparent when looking at the behavior of the BBD MPU than it is when looking at the FFR uncertainty index. Also, by construction the MPU fluctuates around the ZLB period while the FFR uncertainty index does not. Interestingly, our index captures the heightened uncertainty surrounding the lift-off of the FFR while the BBD MPU remains at historically low levels.

Further, the lower left graph plots our FFR uncertainty index against disagreement in the BCFF FFR forecasts. Both uncertainty measures are positively correlated with a coefficient of 0.29. Disagreement is high at the beginning of our sample and decreases continuously strongly reflecting the dynamics of the FFR. For example, when the level of FFR is high, disagreement is high, too. Therefore, disagreement may not provide a sensible measure of monetary policy uncertainty.

Let us now compare the uncertainty index for the 10-year Treasury yield to the BBD MPU index (upper right panel of Figure 6). The two series are weakly correlated with a coefficient of 0.03 over the whole sample. Since the 10-year Treasury bond uncertainty index seems to be linked to QE-related interventions (see Section 4), its correlation with BBD MPU index could be higher over the ZLB period. While the correlation coefficient increases slightly (0.10) over the ZLB period, the two uncertainty indexes are, nevertheless, only weakly correlated. It is worth mentioning that our uncertainty measure based on the 10-year Treasury bonds yields identifies the Bernanke testimony as a period of high uncertainty whereas the BBD exhibits very low levels of uncertainty.

Finally, the lower right panel of Figure 6 shows the 10-year Treasury bond yields uncertainty and Disagreement in the BCFF forecasts of the 10-year Treasury bond yields. The series seem rather unrelated and correlate at -0.01.

## 6 Macroeconomic Effects of Monetary Policy Uncertainty

To assess how uncertainty surrounding monetary policy affects macroeconomic dynamics, we estimate a vector autoregression containing key macroeconomic variables and a measure of uncertainty. We, then, study the dynamic responses to innovations of monetary policy uncertainty. The VAR model has the following representation:

$$y_t = A_0 + A_1 y_{t-1} + \dots + A_p y_{t-p} + \epsilon_t, \quad (2)$$

for  $t = 1, \dots, T$  and  $y_t$  is a  $K \times 1$  vector endogenous variables.  $\epsilon_t$  represents reduced-form errors. Similar to Bloom (2009),<sup>4</sup>

$$y_t = [\log(S\&P500)_t U_t^* \Delta^2(\log(Wages)_t) Hours_t \log(Employment)_t \log(IndProd)_t]'$$

As standard in the literature we identify the structural innovations of uncertainty using a Cholesky scheme (see, e.g., Bloom, 2009 and Jurado et al., 2015).

Figure 7 shows the impulse responses of macroeconomic variables to a positive FFR uncertainty shock. We plot the point estimates along with their 95% confidence bands obtained by bootstrapping. A one standard deviation increase in FFR uncertainty, decreases stock prices although not significantly. Hours, employment and industrial production all significantly decline following the uncertainty shock. Moreover, the decrease real activity seems to be quite persistent with employment and industrial production not returning to pre-shock levels for at least twenty months. These results are comparable to the findings of the literature assessing the real impact of macroeconomic uncertainty.

As discussed in the former sections, our uncertainty index for the Federal funds rate exhibits substantially different dynamics across the monetary policy cycle. These asymmetries could indicate non-linear dynamics in the responses of macroeconomic variables. As a first path, we split our sample in tightening and easing episodes and estimate a VAR model in each of these subperiods. Figure 9 shows impulse responses to a FFR uncertainty shock in easing and tightening periods. Indeed, there seem to be differences in the impulse responses of macroeconomic variables and stock prices. In particular, industrial production

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<sup>4</sup>Bloom (2009) includes prices and the Federal funds rate.

and employment respond more to an uncertainty shock in periods of easing than they do in periods of tightening. This is in line with our earlier finding concerning the behavior of the skewness of the FFR forecast error distribution. Agents seem to be more surprised by Fed policy actions during easing cycles than they are during tightening. Therefore, the macroeconomic impact of an increase in uncertainty is more pronounced during easing cycles.

For completeness, we also Figure 10 shows the macroeconomic responses of a one-standard-deviation shock to the 10-year Treasury bond uncertainty. The macroeconomic and financial responses are not statistically significant. As discussed formerly, the 10-year Treasury bond uncertainty index seems to proxy unconventional monetary policy uncertainty only in the period of the zero lower bound— a period that is too short to do a stand alone analysis.

## 7 Conclusion

This paper measures monetary policy uncertainty and its impact on the macroeconomy. We obtain measures of monetary policy uncertainty from the Blue Chip Financial Forecasts for the Federal funds rate and the 10-year Treasury yield. The uncertainty associated with the federal funds rate captures conventional monetary policy uncertainty, while we use the uncertainty associated with the yields on 10-year Treasury bonds to capture the unconventional monetary policy uncertainty.

In the course of constructing the uncertainty indices we provide interesting and novel facts about the dynamics of the forecasts errors from the BCFF. We show that the distribution of the forecast errors changes with monetary policy interventions. Notably, while the variance is rather stable over conventional monetary policy cycles, the mean and skewness markedly differ across cycles. Further, our results show that monetary policy tightening and easing periods are distinctly associated with downside and upside uncertainty, respectively. Moreover, quantitative easing has not been successful in reducing monetary policy uncertainty, while forward guidance has been fairly successful in that.

We subsequently analyze the effects of uncertainty conditional on being in a monetary tightening or easing cycle. Though in both cases the uncertainty has recessionary effects, the effects are stronger in easing relative to tightening. This is due to the fact that the

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## A Tables and Figures

**Table 1: Moments of FFR Forecast Errors**

Full				
	3-month	6-month	9-month	12-month
Nr.	400	397	394	391
Mean	-0.04	-0.15	-0.31	-0.50
Median	-0.03	-0.07	-0.15	-0.28
Std.	0.30	0.65	0.95	1.23
Skewness	-1.79	-1.06	-0.71	-0.49
Easing				
	3-month	6-month	9-month	12-month
Nr.	63	63	63	63
Mean	-0.41	-0.77	-1.11	-1.39
Median	-0.36	-0.73	-1.21	-1.66
Std.	0.43	0.79	1.06	1.36
Skewness	-1.77	-1.00	-0.19	0.36
Tightening				
	3-month	6-month	9-month	12-month
Nr.	61	61	61	61
Mean	0.18	0.20	0.22	0.29
Median	0.13	0.21	0.35	0.52
Std.	0.27	0.80	0.99	1.29
Skewness	0.24	-1.49	-1.63	-1.34

Notes: Tightening (easing) episodes are defined as periods with positive (negative) changes in the FFR target.

**Table 2: Relation between Monetary Policy and Forecast Errors**

		FFR Errors	10-year Errors
Pre-ZLB	$\Delta$ FFR target	1.38 (0.00)	-0.09 (0.58)
ZLB	Forward Guidance	-0.02 (0.54)	-0.03 (0.89)
	LSAPs	0.04 (0.24)	0.3 (0.08)

Notes: Univariate regressions of monetary policy (changes in the FFR target, forward guidance dummy or LSAPs dummy) on forecast errors. The forward guidance and LSAPs dummies take values of one at key forward guidance and QE related announcements (listed in Table 3), respectively. P-values are reported in the parenthesis.

**Table 3: List of Key Unconventional Monetary Policy Interventions**

QE related announcements	
2008:11	sterilized purchases of \$600B in MBS
2009:03	QE1
2010:11	QE2
2011:09	Operation Twist
2012:09	QE3
2012:12	\$45B of longer-term Treasuries per month for indefinite future
2013:05	Bernanke testimony
2013:12	Tapering start
2014:10	End of purchases
Forward guidance related announcements	
2008:12	“exceptionally low for some time”
2009:03	“low for extended period of time”
2011:08	“low at least through mid-2013”
2012:01	“low at least through late 2014”
2012:09	“low at least through mid-2015”
2012:12	“low at least as long as unemployment reaches above 6.5 and inflation expectations remain subdued.”
2014:12	“can be patient in beginning to normalize the stance of monetary policy”

Notes: FOMC announcements can be found on the following website: <https://www.federalreserve.gov/newsevents/press/monetary/2008monetary.htm>

**Figure 1: Illustrative Example for the Uncertainty Series**

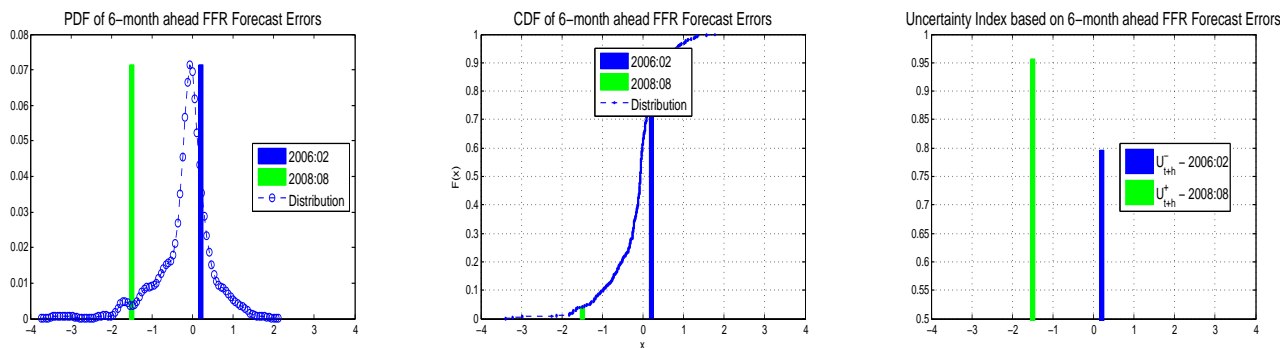
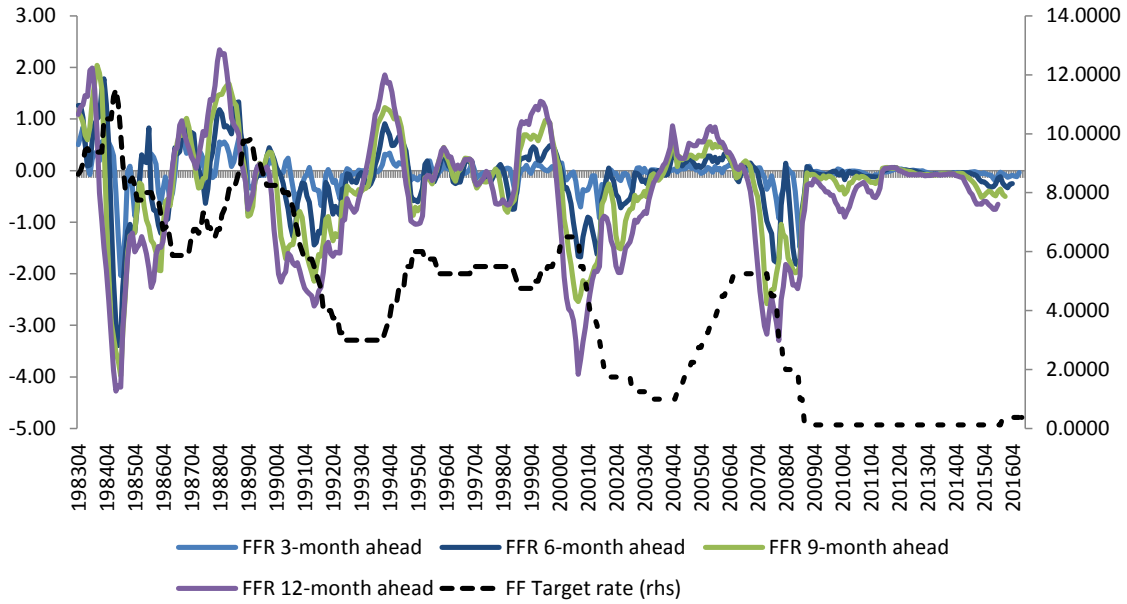
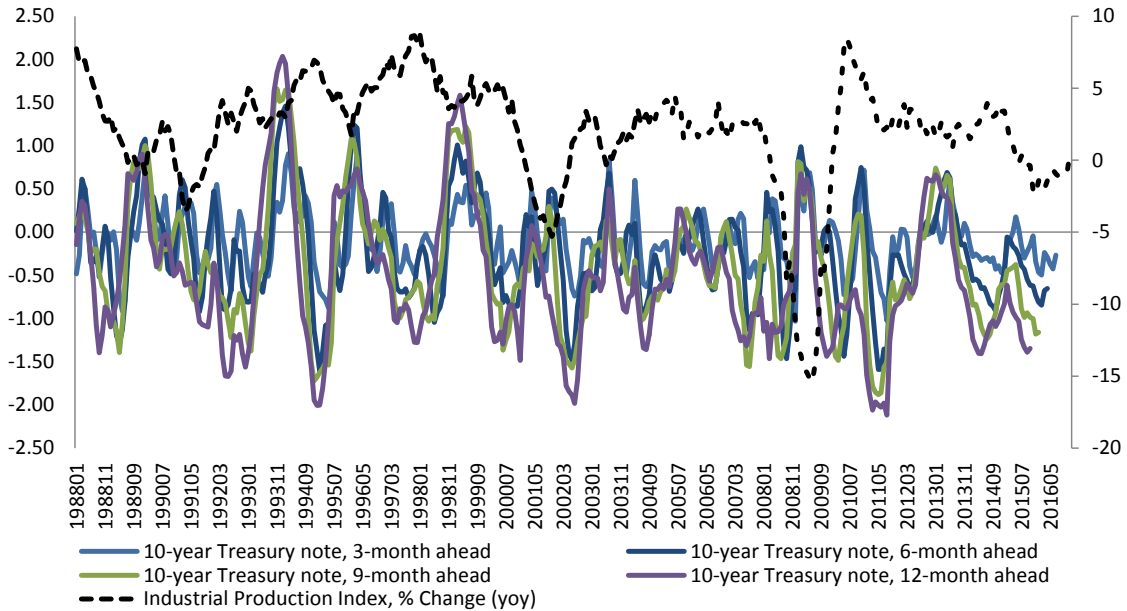


Figure 2: *Forecasts Errors for the federal funds rate*



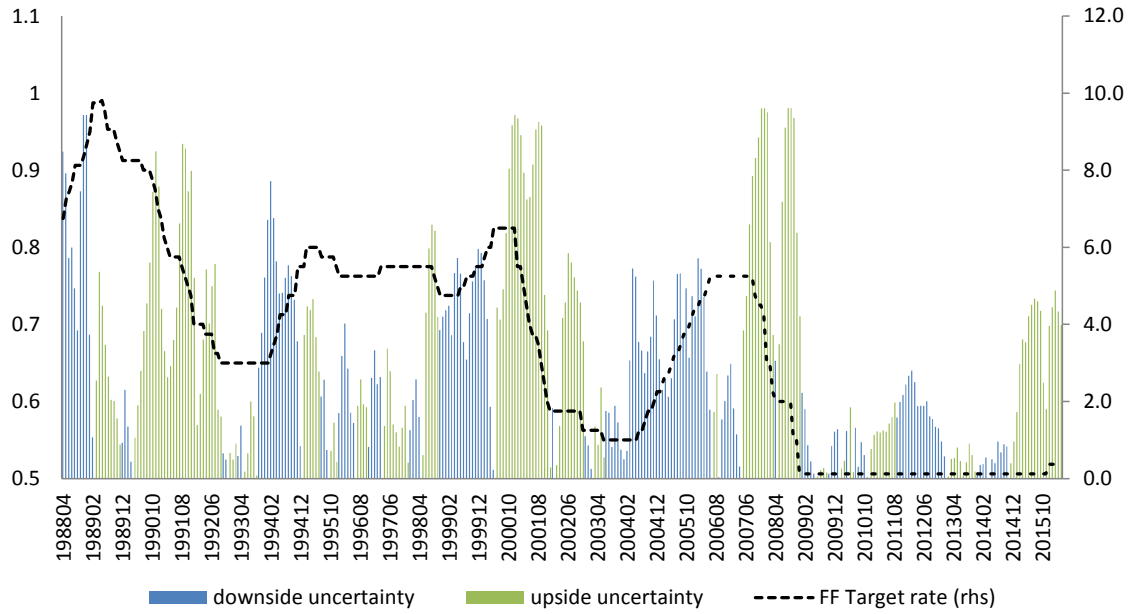
Note: This Figure plots forecast errors for the federal funds rate at the 3-month, 6-month, 9-month, and 12-month ahead horizons.

Figure 3: *Forecasts Errors for the 10-year Treasury bond*



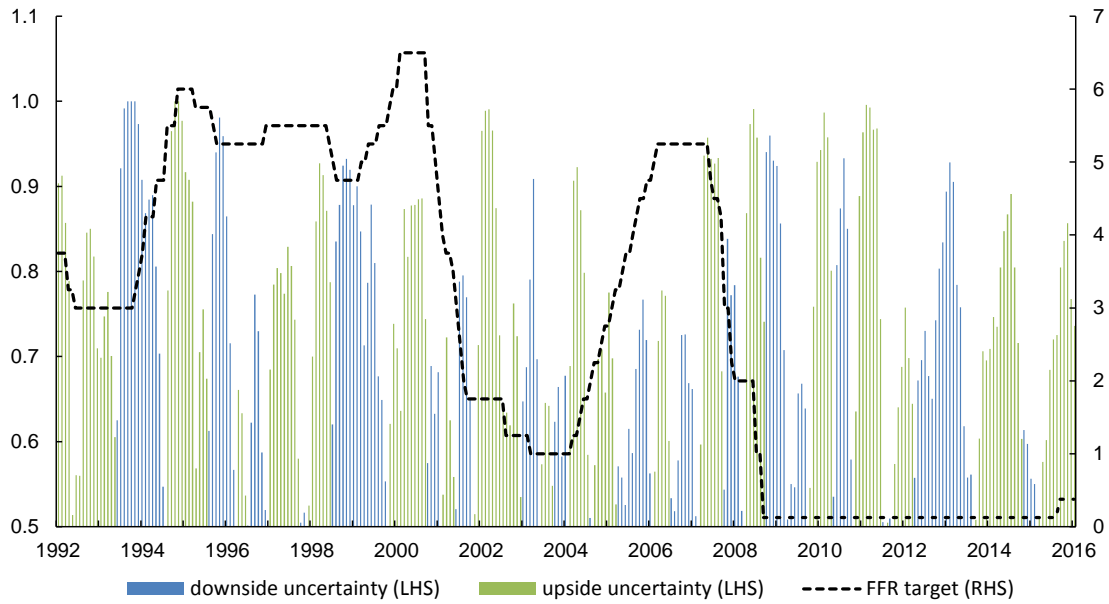
Note: This Figure plots forecast errors for the 10-year Treasury bond at the 3-month, 6-month, 9-month, and 12-month ahead horizons.

Figure 4: *Uncertainty Index for the federal funds rate*



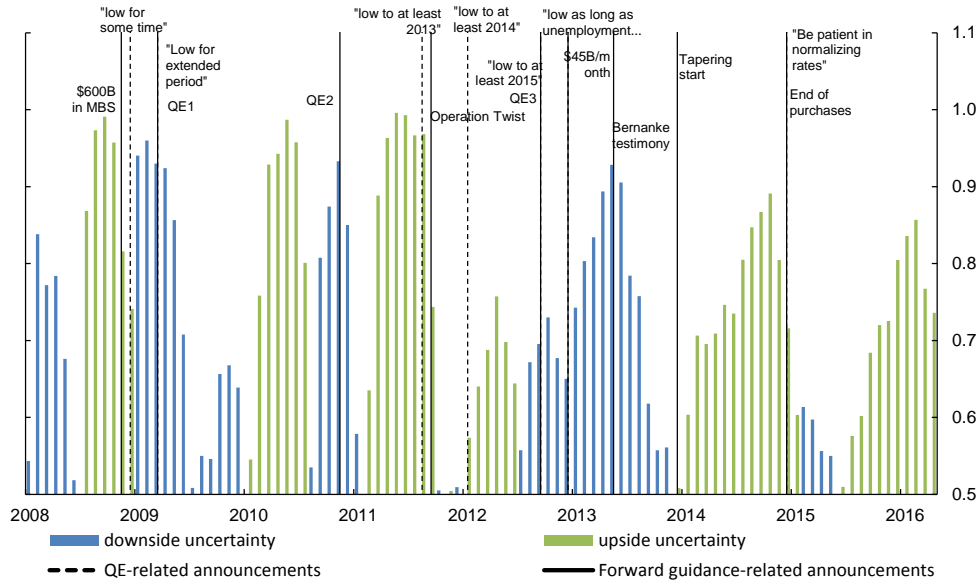
Note: This Figure plots upside and downside uncertainty obtained from the 6-month ahead FFR forecast errors.

Figure 5: *Uncertainty Index for the 10-year Treasury Yield*



Note: This Figure plots upside and downside uncertainty obtained from the 6-month ahead 10-year Treasury bond forecast errors.

**Figure 6: Uncertainty Index for the 10-year Treasury Yield and Key Unconventional Policy Announcements**



*Note: This Figure plots upside and downside uncertainty obtained from the 6-month ahead 10-year Treasury bond forecast errors with key unconventional policy announcements over the zero lower bound period.*

**Figure 7: Comparison with Alternative Uncertainty Indices**

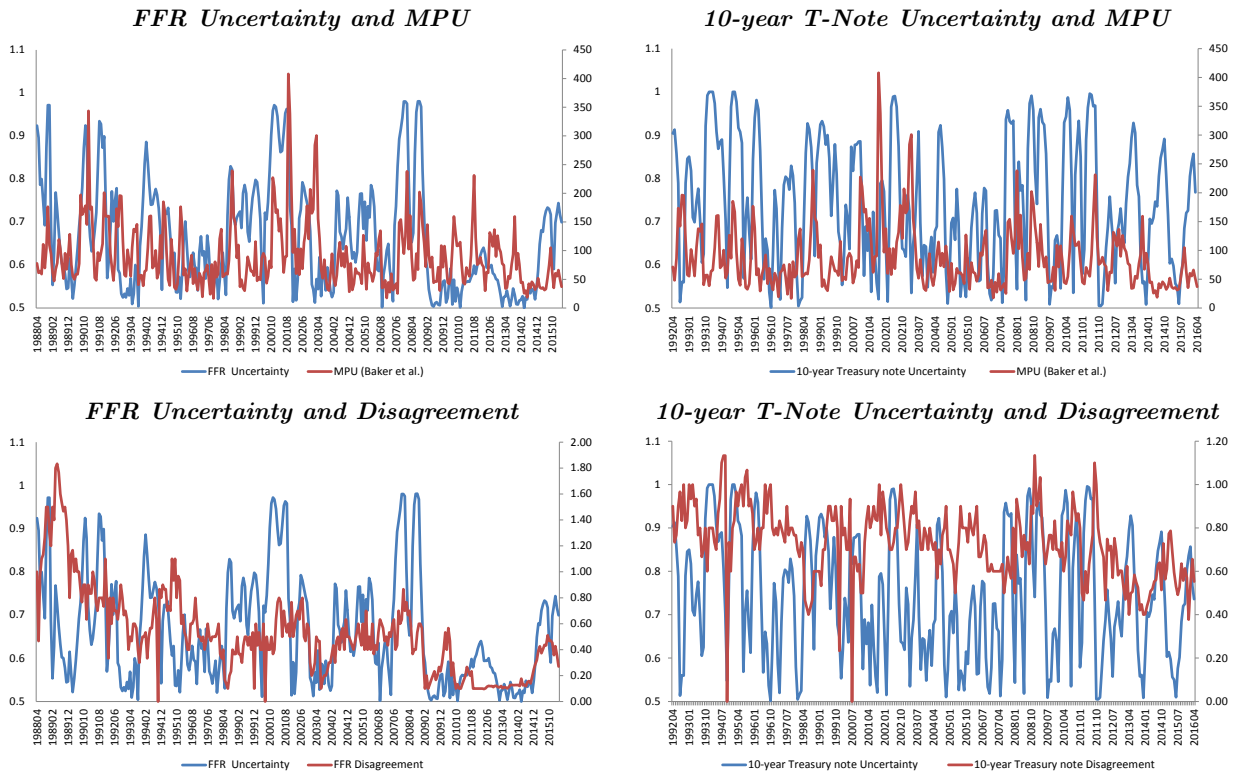
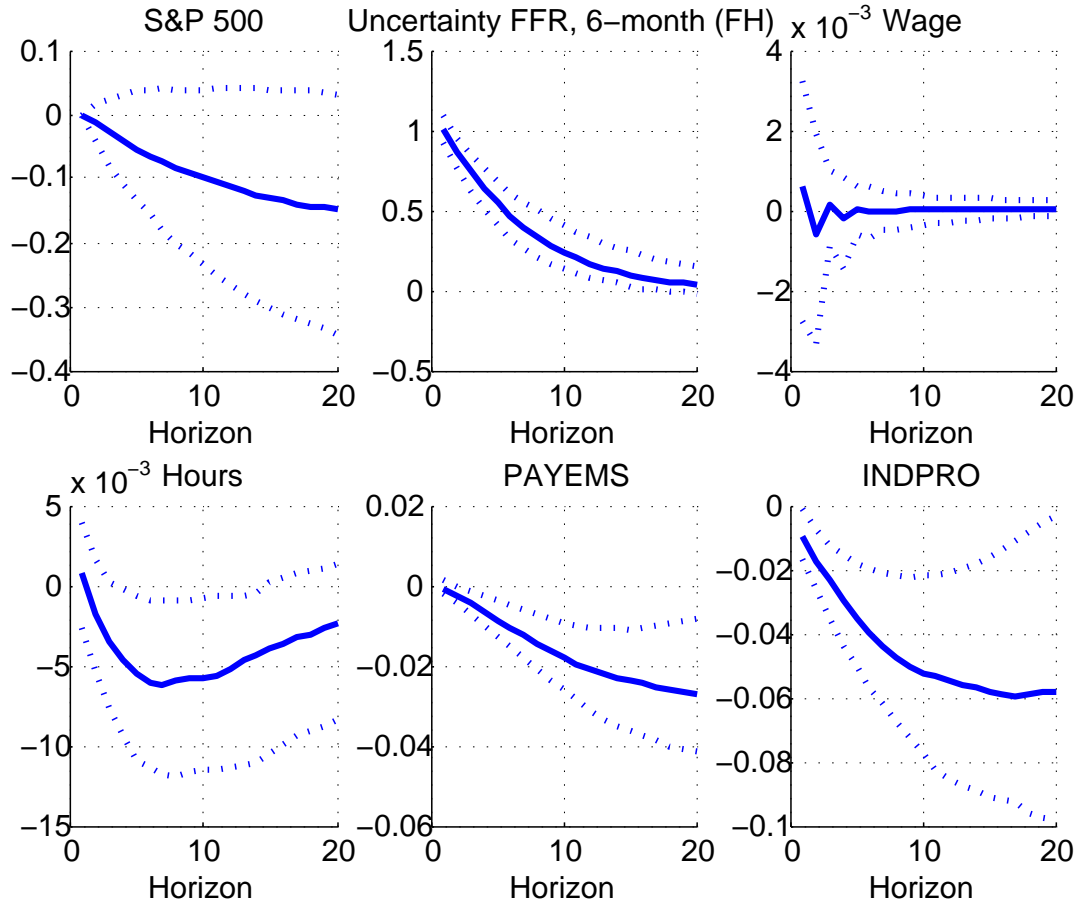
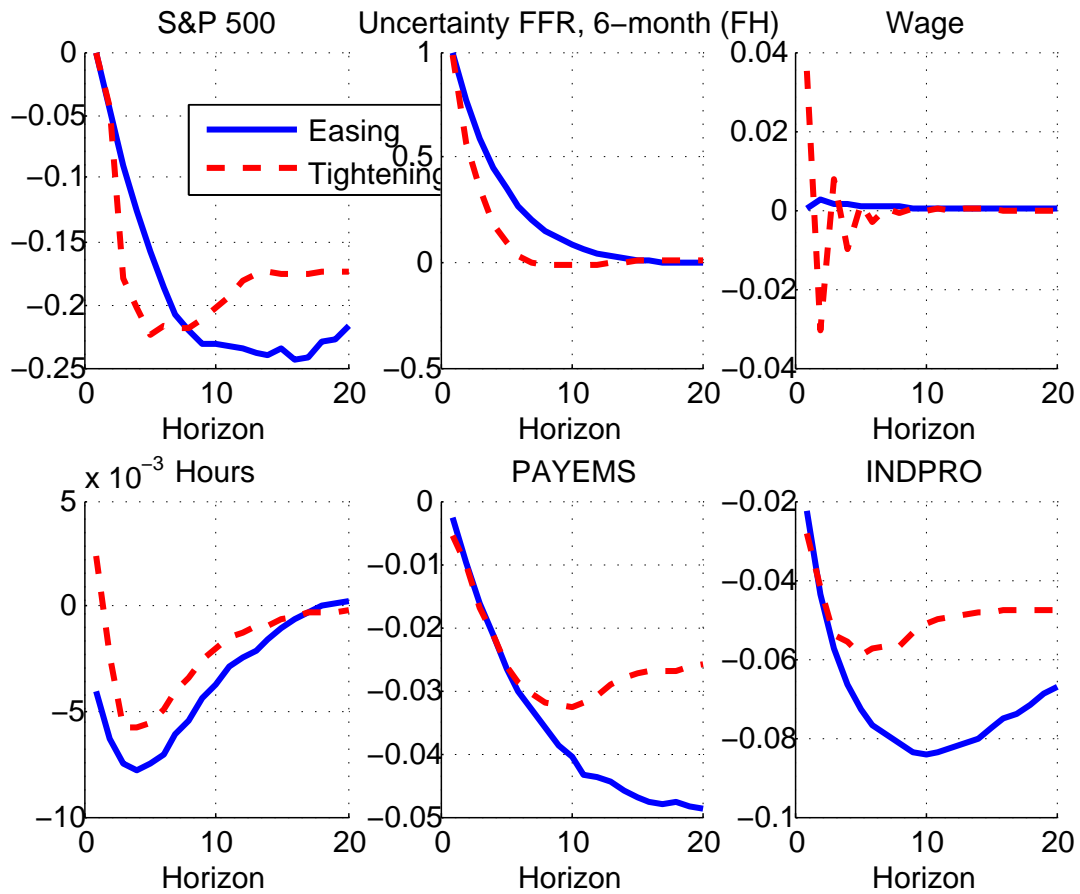


Figure 8: *Impulse Responses to a FFR Uncertainty Shock*



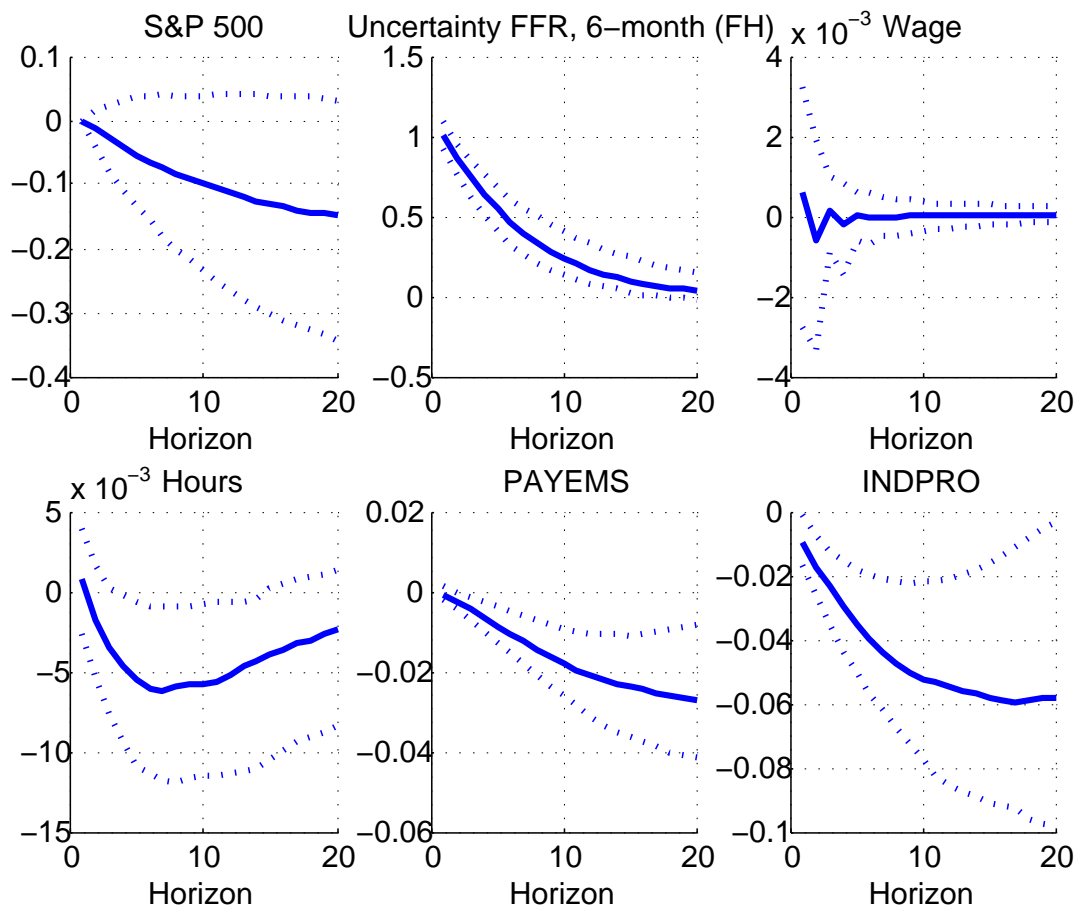
Note: This Figure plots the impulse responses of the S&P 500, FFR uncertainty, wages, hours, employment and industrial production to a one-standard-deviation FFR uncertainty shock. Solid lines are the point estimates and dashed lines the 95% confidence bands obtained by bootstrapping.

Figure 9: Impulse Responses to a FFR Uncertainty Shock conditional on the Monetary Policy Cycle



Note: This Figure plots the impulse responses of the S&P 500, FFR uncertainty, wages, hours, employment and industrial production to a one-standard-deviation FFR uncertainty shock. Red (blue) lines are the point estimates obtained from the tightening (easing) sub-sample.

Figure 10: *Impulse Responses to a 10-year Treasury bond Uncertainty Shock*



Note: This Figure plots the impulse responses of the S&P 500, 10-year Treasury uncertainty, wages, hours, employment and industrial production to a one-standard-deviation 10-year Treasury bond uncertainty shock. Solid lines are the point estimates and dashed lines the 95% confidence bands obtained by bootstrapping.