Monetary Policy Uncertainty*

Lucas Husted                John Rogers                Bo Sun
Columbia University          Federal Reserve Board    Federal Reserve Board

*We thank workshop participants at American University, Bank of England, Central Bank of Ireland, Federal Reserve Board, Georgetown University, Hong Kong Monetary Authority, International Monetary Fund, Notre Dame, UNC-Chapel Hill, Oxford-FRBNY conference on Monetary Economics, and FRB-Chicago System Committee Meeting on Macroeconomics. We thank Scott Baker, Nick Bloom, and Steve Davis for hosting our index on their Economic Policy Uncertainty website. The views expressed here are solely our own and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or of any other person associated with the Federal Reserve System.
Monetary Policy Uncertainty

Abstract

We construct new measures of uncertainty about Federal Reserve policy actions and their consequences, monetary policy uncertainty (MPU) indexes. Positive shocks to MPU raise credit spreads and reduce output. These effects are as large as those of conventionally identified monetary policy shocks. We also construct an index that captures uncertainty about monetary policy over the short term. Shocks to short-run MPU are estimated to have significantly smaller transmission effects. We also evaluate the usefulness and information content of our MPU indexes, examine the influence of Fed communication, and relate our work to prevailing theory on uncertainty and monetary policy transmission.

Keywords: Monetary policy uncertainty, VAR identification, FOMC communication

JEL Classifications: E40, E50.
“The Federal Reserve’s experiences over the past two decades make it clear that uncertainty is not just a pervasive feature of the monetary policy landscape, it is the defining characteristic of that landscape.”
— Alan Greenspan

1 Introduction

As the Federal Reserve poised itself in 2015 to lift off from the zero interest rate policy in place since 2008, the intentions of monetary policymakers and effects of their actions again faced increased scrutiny. Reflecting this monetary policy mise-en-scene, the Financial Times proclaimed on the day after the October 2015 Federal Open Market Committee (FOMC) meeting, “Fed Speaks Plainer English on Rates: A clearer marker has been laid down for a December increase, though divisions remain.” In December 2015, the Federal Reserve lifted the policy rate off its effective lower bound in a 25 basis point hike that has been repeated several times. Although the December 2015 Fed liftoff removed the prevailing uncertainty about when rates would finally be raised, it is less clear more generally what effect liftoff had on uncertainty about policy, including its transmission (Brainard (2017)). Estimating the transmission effects of monetary policy uncertainty is the focus of this paper.

Recently, there has been a surge of interest in economic policy uncertainty. Baker, Bloom, and Davis (2016) develop an index of overall economic policy uncertainty (EPU), including fiscal, monetary, trade, healthcare, national security, and regulatory policies, based on the occurrence of certain keywords in newspaper coverage. The existing literature on monetary policy uncertainty per se predominantly utilizes market-based proxies such as implied volatility computed from interest rate option prices and realized volatility computed from intraday prices of interest rate futures. As made evident below, our measure is complementary to derivative-based measures but differs in three important dimensions, because the market-based measures: (1) reflect the perception of only the households participating in the options market, (2) may have a component driven by time-varying risk aversion and/or state-dependent marginal utility rather than uncertainty and (3) are essentially all about (policy) interest rate uncertainty. Our analysis suggests that there exists a significant degree

1See references at http://www.policyuncertainty.com/research.htm, as well as Fischer (2017).

Our paper is also related to a rapidly growing literature using textual analysis to measure economic variables. The news-based search has been recently adopted to construct new measures for a broad economic policy index (Baker, Bloom, and Davis (2016)), partisan conflict (Azzimonti (2017)), geopolitical risk (Caldara and Iacoviello (2017)), and corporate news.\footnote{For example, Tetlock (2007), Engelberg (2008), Tetlock, Saar-Tsechansky and Macskassy (2008), Demers and Vega (2010), Hoberg and Phillips (2010), Feldman, Govindaraj, Livnat and Segal (2010), Loughran and McDonald (2011), and Davis, Piger, and Sedor (2012).} A number of papers use variables generated from publicly released FOMC documents to study FOMC communication, including Boukus and Rosenberg (2006), Ehrmann and Fratzscher (2007), Meade and Stasavage (2008), Schonhardt-Bailey (2013), Acosta and Meade (2015), and Acosta (2015). We update some of these measures. Our paper suggests that text searches can deliver useful proxies of uncertainty tracing back decades.

Specifically, we do three things in this paper. First, we construct a news-based index of monetary policy uncertainty to capture the degree of uncertainty that the public perceives about central bank policy actions and their consequences. We use an approach similar to Baker, Bloom, and Davis (2016), and highlight some important advantages of ours. We also detail our large-scale “human audit” that assesses accuracy. We focus on the Fed starting in 1985.\footnote{In Husted, Rogers, and Sun (2016b), we construct these indexes for the ECB and central banks of Canada, England, and Japan.} As shown below, large spikes occurred around the September 11 attacks, the March 2003 invasion of Iraq, prior to the September 2015 FOMC meeting when “liftoff uncertainty” peaked, Brexit, and the November 2016 elections. Our MPU index closely tracks a computer-free index created using human intelligence, and exhibits close comovements with a direct measure of monetary policy uncertainty constructed from a survey of primary dealers. In addition, we construct an index that captures uncertainty about monetary policy in the short run, using both computer-automated and human-audited approaches. The short-run MPU index spikes much more sharply around FOMC meeting days than baseline MPU does.
Second, we estimate the effect of shocks to monetary policy uncertainty in VARs. This includes “external instruments” cases in which the identified MPU shock is by construction orthogonal to monetary policy shocks. We find that positive shocks to MPU raise credit spreads and lower output with about the same dynamic pattern as contractionary monetary policy shocks found in, e.g., Gertler and Karadi (2015). Shocks to short-run MPU, however, are estimated to have significantly smaller transmission effects than shocks to overall MPU.

Last, we provide further discussion to facilitate understanding of what our MPU index captures. We examine co-movements of our index with several alternative proxies. Ours fluctuates substantially during the period when policy rates were at the effective lower bound, unlike most competing measures. We investigate whether our MPU index is influenced by institutional measures of central bank policy actions such as voting behavior and newly-constructed measures of FOMC communication, and wrap up by linking the discussion to the related theoretical literature.

2 Measuring Monetary Policy Uncertainty

2.1 Construction

Our approach to constructing the baseline MPU index is to track the frequency of newspaper articles related to monetary policy uncertainty. Using the ProQuest Newsstand and historical archives, we construct the index by searching for keywords related to monetary policy uncertainty in major newspapers. We search for articles containing the triple of (i) “uncertainty” or “uncertain,” (ii) “monetary policy(ies)” or “interest rate(s)” or “Federal fund(s) rate” or “Fed fund(s) rate,” and (iii) “Federal Reserve” or “the Fed” or “Federal Open Market Committee” or “FOMC”. We do this for every day’s issue of the Washington Post, Wall Street Journal, and New York Times.

Importantly, we control for the changing volume of total news articles over time and the possibility that some newspapers naturally cover monetary policy more than others by first dividing the raw count of identified articles by the total number of news articles mentioning “Federal Reserve”, or more precisely, any of the words in category (iii), for each newspaper in a given period. This scaling choice also helps address issues related to time-varying popularity and increased coverage of the Fed due to improved transparency in its communication strategy. The share of articles is subsequently normalized to have a unit
standard deviation for each newspaper over the sample period. Each of our monetary policy uncertainty indexes is aggregated by summing the resulting series and scaling them to have a mean of 100 over the sample. We construct the index at both a monthly frequency and FOMC meeting-interval frequency.

We display our baseline MPU index in Figure 1. The sample is January 1985 to May 2017. The index spikes notably at the time of Black Monday, the September 11 attacks, the March 2003 invasion of Iraq, the lead-up to the global financial crisis, the Taper Tantrum, prior to the October 2015 FOMC meeting (when “liftoff uncertainty” seemed to have peaked), and around the Brexit vote that followed liftoff. Our index thus fluctuates substantially during the period the Federal Funds rate was at the zero lower bound.  

We examine the sensitivity of our baseline index by considering several adjustments to its construction. In one refinement, we narrow our search to articles in which the word uncertainty/uncertainties is in close proximity to Federal Reserve or monetary policy. Specifically, we restrict “uncertainty” or “uncertainties” to be within either 5, 10, or 20 words of the phrase “Federal Reserve” or “The Fed” or “monetary policy.” In order to better understand the trade-offs associated with using the proximity refinement and as part of a more general auditing of our automated search, we extracted and read a randomly selected sample of the search results (see Appendix A). The proximity search does appropriately filter out articles that mention all the keywords but do not really discuss monetary policy uncertainty per se.  

The trade-off, however, is that the proximity search misses articles that discuss issues related to monetary policy uncertainty but have a somewhat large gap between keywords. We conclude from these readings that the proximity search has smaller type II error but greater type I error relative to the baseline strategy, as it filters out more of both “false” articles and “correct” articles. The correlation between the baseline index and that constructed using the 10-word proximity search is 0.83 (see Husted, Rogers, and Sun (2016a)).

5Consistent with the large spike in March 2003, Bernanke (2015) recalls, “U.S. forces had invaded Iraq a few days before the (March 2003) meeting. Businesses and households were reluctant to invest or borrow until they saw how the invasion would play out. My colleagues and I were also uncertain about the economic consequences of the war, especially its effect on energy prices. At Greenspan’s urging, we decided to wait before considering further action. In our post-meeting statement, we said uncertainty was so high that we couldn’t usefully characterize the near-term course of the economy or monetary policy. That unprecedented assertion probably added to the public’s angst about the economy.” 

6For example, in articles that mention monetary policy or interest rate, “uncertainty” shows up in sentences like the following: “Concerns over Europe have also intensified, as political upheaval has bred uncertainty over whether the euro zone will be able to implement controversial austerity measures.”
2.2 Human auditing

To address concerns about automated news-based computer search, we conduct an audit based on human readings. We begin with randomly-selected 6000 articles and construct a human index based on the count of articles that we code as discussing high or rising monetary policy uncertainty. To concentrate on articles that are likely relevant, we draw from the set of articles that meet our criterion (iii), that is, containing “Federal Reserve” or “the Fed” or “Federal Open Market Committee” or “FOMC”. We compare the evolution of the human index with the computer-automated index, including calculating the Type II error rate. We also characterize the nature of monetary policy uncertainty, quantifying the number of articles on uncertainty concerning Fed actions versus uncertainty about the consequences of those actions. We then read an additional 1500 randomly-selected articles contained in our computer-automated MPU index in order to estimate the Type I error rate associated with our baseline MPU index. Our MPU index shows a remarkably high correlation with the index constructed by human intelligence, and its Type I and Type II error rates are reasonably small and do not exhibit large time-series variation.\footnote{The human audit was crucial in reassuring us about what’s in the sausage. For example, reading articles captured by our computer search during the spike in MPU around Brexit assured us that they were not discussing simply how much uncertainty \textit{per se} resulted from the vote, but rather uncertainty about whether the Fed would follow through on the post-liftoff planned further rate hikes in 2016.}

2.2.1 A human index

Each month the newspapers used to construct our MPU index contain about 30,000 articles on average. Of these, 0.17\% meet our computer-automated criteria to be included in the MPU index. We label this set \((M)\). In constructing our human index, we restrict our reading to articles containing one of the words listed in category (iii). This set, labelled \((E)\), accounts for about 2\% of the universe of newspaper articles. We choose this set \((E)\) to draw articles from because (i) a pilot audit (human reading of 300 articles) suggests that the mention of Fed is at the heart of relevant discussions, significantly more so than the mention of monetary policy, for example; and (ii) the human index can also be normalized in a way consistent with the computer-generated index, i.e., scaled by the number of articles in set \(E\), which could help minimize the effect of sampling uncertainty.

We randomly select about 5\% of the newspaper articles in set \(E\) and read the full text
of all 6000 articles. Following a detailed auditing guideline, we identify phrases that likely indicate true positives as well as likely false positives. We repeat this process and refine the search words until additional adjustments bring only minor improvements in the error rates (detailed below). For example, although in some instances articles use words such as “anxiety” and “fear” to discuss uncertainty related to monetary policy, including these additional words in the search also generates additional false positives, which on balance does not improve our index.

An article is coded as 1 if it contains references to high or rising uncertainty in monetary policy actions and/or their consequences. Articles are coded as -1 if they contain references to low or declines in such uncertainty, and 0 if there are no references to relevant uncertainty. About 26 percent of articles in set $E$ are coded as 1 from our reading. Figure 2 displays the human index against the computer-generated MPU index. The correlation is 0.84.

2.2.2 Type I vs Type II error

To further evaluate the statistical properties of our MPU index, we analyze the rate of Type I (false positives) and Type II (false negatives) errors. In the second stage of our audit, we randomly select 1500 articles from those contained in our MPU index. This accounts for over 10% of set $M$. From our human reading of these articles belonging to our MPU index, about 85 percent are classified as mentioning high or rising uncertainty related to monetary policy. The month-to-month variation of this fraction of false positives is minimal, alleviating concerns about time-varying biases. One might be particularly concerned about articles on low or declining monetary policy uncertainty getting included in the MPU index. In our sample, only 3.7% of the articles in set $M$ (those included in the computer-generated MPU index) discuss falling uncertainty. Figure 3 shows the time-series variation in the Type I error rate. The error rate is quite flat, and clearly uncorrelated with our MPU index itself or with other macroeconomic variables.

---

8For details of our sampling technique, please see our audit guide at: https://sites.google.com/site/bosun09/monetary-policy-uncertainty-index. The reading is done either by one of the authors or a Fed research assistant.

9In our pilot human audit, we noticed for instance that articles in the 1980s and early 1990s use “discount rate” to refer to the monetary policy instrument, while such reference disappeared in recent years. With this in mind, we produced an “MPU 2.0” adding the following words in category (i) of our search: concern(s), or concerned or fear(s) or nervous or worry (worries) or speculate(s) or scare(s) or scared. We also added a proximity constraint that word(s) in category (i) must be within 10 words of those in category (ii) or (iii). MPU 2.0 shows a significantly lower correlation with the human index than does our baseline index.
Given the time-varying writing styles in newspapers, we are mindful that the ratio of false negatives could also vary systematically over time. We thus calculate the Type II error every month as follows. We first identify the articles in our sample of set $E$ that would be included in the computer-automated index (set $M$, which is a strict subset of $E$), i.e., containing the triple of key words we search for. In the remaining sample (set $E - M$), we count the number of articles that contain references to high or rising monetary policy uncertainty, which gives us the Type II error rate. Our Type II error rate is on average 0.24 per year, with a standard deviation of 0.05. This indicates that false negatives are also not a major concern for our index. Figure 4 plots the Type II error rate, which is also very flat and uncorrelated with our MPU index and other macroeconomic indicators.

### 2.2.3 Actions or consequences?

In our sample reading of (1500) articles belonging to the benchmark, computer-generated MPU index, we also audit whether the uncertainty pertains to Fed actions or their consequences. Among those articles that are coded as 1, we code an article as “A” if the uncertainty discussion is about the Fed’s actions and “B” if about the consequences of Fed actions. Articles that discuss both are coded “A and B”. We find that our index mainly captures uncertainty about the Fed’s actions: among the true positives, only 10.6% are about consequences (including the ones on both actions and consequences). The remainder are about uncertainty concerning Fed actions themselves. During the earlier part of the Zero Lower Bound period (ZLB), newspaper articles were mostly discussing uncertainty about economic implications of the ZLB, while uncertainty about Fed actions took center stage in the 2013 Taper Tantrum and in the second half of 2015.

### 2.3 Short-run MPU

As part of our human audit, we also classify all the true positive articles (i.e., those coded as 1) as to whether the uncertainty pertained most to (i) the very near term, that is, the upcoming FOMC meeting or within one month, (ii) the near term, that is, beyond the upcoming meeting but within one year, or (iii) the medium to long run, that is, beyond a year. Every article that has been coded as 1 has one of the three classifications.

In Figure 5 we show two bar charts: in dark grey the number of very near term articles
as a fraction of the total true positive articles \(\frac{\# \text{ articles coded as (i)}}{\# \text{ articles coded as 1}}\), and in light grey the share \(\frac{\# \text{ articles coded as (i) or (ii)}}{\# \text{ articles coded as 1}}\). Both measures are displayed aggregated to an annual frequency. The bar charts make clear that for most of our sample period the majority of the uncertainty discussed in newspapers concerns time horizons of one year or less. Very near-term uncertainty was high during the interest rate hikes of the mid-1990’s through Y2K, nearly tripled from 2005 to the onset of the financial crisis, and then rose consistently from 2009 until liftoff materialized.

Guided by our time-horizon human audit, we select additional search terms to add to our existing algorithm to construct a computer-automated short-run MPU index. Keeping the triple of search terms used for the overall MPU index, we also require at least one of the following two conditions to be met: (a) the mention of Fed (any category (ii) word) must be within 5 words of one of the following phrases: “soon” or “today” or “tomorrow” or “this week” or “this month” or “next week” or “next month”; and (b) “this / next / upcoming / coming (FOMC) meeting” appears in the article. That is, for an article to be included in our computer-generated short-run MPU index, it has to contain the triple of key words used in constructing the baseline MPU index and satisfy at least one of the two conditions above.

The short-run MPU index is normalized to be a stand-alone index in a way consistent with our overall MPU index.\(^\text{10}\) We construct the index at both a monthly frequency and at FOMC meeting intervals. The short-run MPU index is plotted in Figure 6 at a meeting frequency. It spikes up during the Iraq Invasion and Taper Tantrum episode, for example. For comparison, this figure overlays the computer-automated short-run MPU index on top of the bar charts of Figure 5. The computer index tracks the share of very near-term and near-term articles from the human audit closely.

To get a sense of what the short-run MPU index conveys differently from the baseline index, we examine how each evolves on the days before and after FOMC meeting days. It is natural to expect that monetary policy uncertainty would decline after the FOMC meets, assuming that policy (in)actions and the associated explanations help mitigate near-term uncertainty.

\(^\text{10}\)That is, we scale the raw count of identified articles by the total number of news articles mentioning “Federal Reserve”, or more precisely, any of the words in category (iii) in our baseline search, for each newspaper in a given period. The share of articles is subsequently normalized to have a unit standard deviation for each newspaper over the sample period. Our short-run monetary policy uncertainty index is aggregated by summing the resulting series and scaling them to have a mean of 100 over the sample.
uncertainty about monetary policy.\textsuperscript{11} The event-study results are depicted in Figure 7. There is a rise in both MPU indexes in the days before the typical FOMC meeting. Short-run uncertainty rises much more steeply though, leading to a peak effect on FOMC meeting day—the last day of newspaper coverage before the FOMC meeting—that is well above that reached by the baseline index. Similarly, the decline in short-run MPU is much sharper than for overall MPU. This comparison bolsters the notion that our short-run index is indeed capturing uncertainty about monetary policy at short horizons.

3 Responses to Monetary Policy Shocks

To obtain a benchmark for gauging the importance of monetary policy uncertainty shocks, we begin by estimating the effects of monetary policy shocks. Our strategy is to take a VAR model that is considered conventional in the literature and add MPU to it (see Ramey (2016) for a recent review). We choose as benchmark Gertler and Karadi (2015) (hereafter GK) and follow them in undertaking a high frequency identification of the policy shocks.\textsuperscript{12}

Let $Y_t$ be a vector of economic and financial variables, $A$ and $C_j \forall j \geq 1$ conformable coefficient matrices, and $\epsilon_t$ a vector of structural shocks. The general structural form of the VAR we consider is given by

$$AY_t = \sum_j C_j Y_{t-j} + \epsilon_t$$  \hspace{1cm} (1)

Multiplying each side by $A^{-1}$ yields the reduced form VAR

$$Y_t = \sum_j B_j Y_{t-j} + u_t,$$  \hspace{1cm} (2)

where $u_t = S \epsilon_t$ is the reduced form shock, with $B_j = A^{-1} C_j$, $S = A^{-1}$.

Let $s$ denote the column in matrix $S$ corresponding to the impact on each element of the vector of reduced form residuals $u_t$ of the structural shock $\epsilon_t$. To compute the impulse responses to a structural shock, we estimate

\textsuperscript{11}It is also natural to believe that newspaper coverage of monetary policy also rises in the days proceeding FOMC meetings and declines afterward. Hence the importance of our dividing the raw count of identified articles by the number mentioning “Federal Reserve”.

\textsuperscript{12}GK note of their findings, “Shocks produce responses in output and inflation that are typical in monetary VAR analysis”. See also Stock and Watson (2012) and Rogers, Scotti, and Wright (2016) (RSW).
\[ Y_t = \sum_j B_j Y_{t-j} + s\epsilon_t \] (3)

As is well-known, the necessary timing restriction that all the elements of \( s \) are zero except the one that corresponds to the policy indicator of interest is in general problematic, especially when financial variables are included in the VAR such as in our application and GK’s. The external instrument approach is well-suited to address this problem. Denoting \( Z_t \) as a vector of instrumental variables and \( \epsilon_t^q \) a vector structural shocks other than the policy shock, the identification approach requires that:

\[ E \left[ Z_t \epsilon' \right] = \psi, E \left[ Z_t \epsilon_t^q \right] = 0 \] (4)

That is, \( Z_t \) must be correlated with \( \epsilon_t \), the structural shock of interest, but orthogonal to all of the other shocks.

To estimate the elements in \( s \), we first estimate \( u_t \) from the ordinary least squares regression of the reduced form VAR (2). Second, let \( u_t \) be the reduced form residual from the equation for the policy indicator of interest and let \( u_t^q \) be the reduced form residual from the equation for variables \( q \) other than the policy indicator. Let \( s_t^q \in s \) be the response of \( u_t^q \) to a unit increase in the policy shock \( \epsilon_t \). Then obtain an estimate of the ratio \( s_t^q / s \) from the two stage least squares regression of \( u_t^q \) on \( u_t \), using the instrument set \( Z_t \).

We follow GK in employing high frequency measures of policy surprises as external instruments, in order to identify the structural monetary policy shocks. To isolate the impact of news about monetary policy, the surprises in futures rates are measured within a tight window around the FOMC decision. The key identifying assumption is that news about the rest of the economy within that window on FOMC day is orthogonal to the policy surprise. One additional benefit of this approach, as illustrated in GK and RSW among others, is that the policy surprise measure can include shocks to forward guidance.\(^{13}\) This is accomplished by incorporating in the instrument set surprises in fed funds futures for contracts that expire at a subsequent date in the future. These surprises in principle reflect revisions in beliefs on FOMC dates about the future path of short-term rates. Thus, the HFI approach identifies

\(^{13}\)Campbell, Evans, Fisher, and Justiniano (2012) and Campbell, Fisher, Justiniano, and Melosi (2016) discuss the complications associated with interpreting such surprises as pure monetary policy shocks. Their focus is on distinguishing between “Delphic” and “Odyssean” forward guidance.
exogenous monetary policy surprises and the full VAR traces out the dynamic responses of real and financial variables.

3.1 VAR data and instruments

We analyze monthly data over the period 1985:01 to 2015:12. The end point is chosen to coincide with the precise ending of the ZLB period. We use the baseline VAR model of GK in the log industrial production, log consumer price index, one-year government bond rate, and the Gilchrist and Zakrajsek (2012) (GZ) excess bond premium. In addition, we add monetary policy uncertainty. We follow GK in taking the one-year government bond rate, rather than the commonly-used Federal Funds rate, as the relevant monetary policy indicator. Using a safe interest rate with a longer maturity than the Fed Funds rate allows us to consider shocks to forward guidance in the overall measure of monetary policy shocks: a component of the reduced form VAR residual for the one-year government bond rate is a monetary policy shock that includes exogenous surprises not only to the current Fed Funds rate but also exogenous surprises in the forward guidance about the path of future rates.

The GZ excess bond premium is the component of the remaining spread between an index of rates of return on corporate securities and the rate on a government bond of a similar maturity after the default risk component is removed. GZ and GK show that the excess bond premium has strong forecasting ability for economic activity, outperforming every other financial indicator and thus providing a convenient summary of much of the information from variables left out of the VAR that may be relevant to economic activity.

The instrument used by GK is the surprise in the monthly fed funds futures contract FF4 within a 30 minute window of the FOMC announcement.14 As argued by RSW and others, during the ZLB period monetary policy was aimed at rates of longer maturity, through forward guidance and quantitative easing. Even away from the ZLB, forward guidance surprises have been important, as the FOMC has long tried to manage expectations of future changes to the target fed funds rate. Thus, to construct our instrument for updating GK’s results, we splice the surprises used in GK onto those of RSW: GK instruments for 1991:01–1994:12 and RSW instruments for their full sample period 1995:01–2015:12.

---

14GK establish this as their preferred external instrument for the one-year government bond rate, their monetary policy indicator.
RSW identify three separate measures of U.S. monetary policy surprises: target rate, forward guidance, and asset purchase. These are respectively,

1. **Target.** The surprise component of the decision about the target fed funds rate based on the change in yield on the current- or next-month federal funds futures contracts from 15 minutes before the FOMC announcement to 1 hour and 45 minutes afterwards. The target surprise was effectively zero during the ZLB.

2. **Forward Guidance.** The residual from a regression of the change in the yield for the fourth Eurodollar futures contract from 15 minutes before the announcement to 1 hour 45 minutes afterwards onto the target surprise.

3. **Asset Purchase.** The residual from a regression of the change in the ten-year Treasury futures yield from 15 minutes before the FOMC announcement to 1 hour and 45 minutes afterwards onto the target and forward guidance surprises. This measures the jumps in long-term interest rates that are associated with FOMC announcements related to large-scale asset purchases. This is computed only over 2008:09–2015:12.

In months with no monetary policy announcements, the surprises associated with each type of announcement are set to zero. In months with more than one monetary policy announcements, the surprises are the sum of those from each announcement in that month. Because it is not the focus of the present paper to distinguish among the effects of these different types of monetary policy surprises, we simply use the sum of the three RSW surprises as our “monetary policy” surprise.

### 3.2 Impulse responses to monetary policy shocks

Figure 8 displays the impulse responses to an identified monetary policy shock in the five-variable VAR estimated over the period 1985:1-2015:12.\(^\text{15}\) In each case, the panels report the estimated impulse responses along with 68 percent confidence bands, computed using bootstrapping methods. The impulse responses are very similar to those of GK: a surprise monetary tightening induces a roughly 20 basis point increase in the one-year government bond rate. There is a significant decline in industrial production that reaches a trough a

---

\(^{15}\)We replicate GK for their sample period prior to beginning our exercises; see Table 1.
year after the shock. Also consistent with GK and with standard theory, there is a decline in the consumer price index though it is not statistically significant. The excess bond premium increases by 25 basis points on impact and returns to trend after roughly a year. This increase in the excess bond premium following the monetary policy tightening is consistent with a credit channel effect on borrowing costs. Finally, there is no significant response of MPU. This is interesting in its own right and also somewhat reassuring: conceptually, MPU is a “second-moment” variable that should be mostly orthogonal to the first-moment movement in monetary policy. Our no-response result, at a minimum, indicates that our measure of monetary policy uncertainty captures information that is distinct from what is contained in contemporaneous monetary policy shocks.

4 Transmission of MPU Shocks

We now turn to the central question: how do economic and financial variables respond to exogenous shocks to monetary policy uncertainty? We address this with both Cholesky and external instruments identifications, again using the period 1985:01–2015:12. Our estimates consistently indicate that monetary policy uncertainty shocks tighten credit costs and reduce output. Comparison with the results above indicates that the contractionary effects of positive shocks to overall MPU are as large as those of monetary policy tightenings, while shocks to short-run MPU are smaller.\(^\text{16}\)

4.1 Cholesky decomposition

We start with the most commonly used identification method, a standard Cholesky decomposition.\(^\text{17}\) We assume the following recursive structure of the VAR:

\[ Y_t = [i_t, cpi_t, mpu_t, i_t, ebp_t] \] (5)

Under the assumed ordering, innovations in the interest rate and excess bond premium do not affect MPU contemporaneously, which is consistent with our findings in Section 3. Here,\(^\text{16}\) In Table 1, we summarize the results from the various cases. Related to our analysis of this section, and with similar conclusions, Creal and Wu (2016) also examine the transmission of (overall) monetary policy uncertainty shocks, using very different uncertainty measures and estimation framework. They do not distinguish between overall and short-run uncertainty.\(^\text{17}\) GK also utilize results from Cholesky decompositions as a comparator. Baker, Bloom, and Davis (2016) rely exclusively on this identification scheme.
we are interested in identifying shocks to MPU and their transmission effects, and so impose as few restrictions as possible. The current specification allows the policy rate and the excess bond premium to respond simultaneously to MPU, which we consider plausible given how financial markets work.\textsuperscript{18}

Figure 9 shows the impulse responses following a surprise increase in MPU of one standard deviation, about 36 points. The excess bond premium rises on impact, suggestive of increased borrowing costs in response to higher monetary policy uncertainty. There is a drop in the one-year government bond rate, perhaps induced by the central bank responding to the increased uncertainty and higher credit spreads by lowering the policy rate. Finally, despite the loosening of interest rates, industrial output and inflation fall on impact and reach a trough around month 17.

We note that the relationship between monetary policy uncertainty and interest rate is ambiguous conceptually. Consider the one-year bond rate to be the expectation of future (overnight) policy rates plus a term premium. During the ZLB period, it is likely that higher MPU raises term premiums without affecting expectations of future policy rates and hence raises the one-year bond rate. Away from the ZLB, however, higher MPU could lead to lower interest rates as expected future policy rates fall.\textsuperscript{19}

### 4.2 External Instruments

We turn to estimating the transmission of MPU shocks using the external instruments approach, described in section 3 for the case of identifying monetary policy shocks. Here, we will use as our instrument the “monetary policy uncertainty surprise”. This is constructed as the uncertainty (volatility) on FOMC meeting days, \textit{orthogonalized with respect to the monetary policy surprise} of section 3. Denote the daily implied volatility of the 1-year swap rate at a 1-month horizon $\sigma_t$. This is a measure of uncertainty about future monetary policy.

\textsuperscript{18}We find similar results in Cholesky identifications with MPU ordered first or last.

\textsuperscript{19}Consistent with this, when we estimate using external instruments over 1994-2015, thereby with a larger fraction of the sample being ZLB years, the interest rate response to MPU is indeed more positive compared to the full-sample case, as displayed in Figure F.5 in Appendix F and marked in Table 1.
We regress this on the monetary policy surprise on FOMC meeting days,$^{20}$

$$\sigma_t = \gamma \text{policy surprise}_t + \eta_t.$$ 

The residual from this regression, $\eta_t$, is the monetary policy uncertainty surprise.$^{21}$ This instrument series has the interpretation as the amount of volatility due to monetary policy announcements on FOMC meeting days that is unexplained by the change in futures rates themselves. The orthogonalization is important because at the ZLB, a downward shift in the expected path of policy will mechanically lower interest rate uncertainty. Our approach thus provides instruments using high-frequency data, with the key identifying assumption that shocks to the economy and monetary policy (within narrow windows around FOMC announcements) are uncorrelated with the residual.

Figure 10 displays the impulse responses estimated using external instruments. Once again, we observe that positive shocks to MPU are contractionary: EBP remains elevated for over a year before reverting to trend; there is a fairly rapid decline in IP which reaches a trough in about 20 months; the CPI response is insignificant, as in the GK replication analysis, while the interest rate response eventually becomes negative in order to offset the contractionary effects on IP and EBP. We also estimate the external instruments VAR with the human index replacing the baseline MPU index. We find very similar results to the baseline case, as seen in the comparison exercise of Table 1.

### 4.3 Shocks to short-run MPU

The previous section indicates that shocks to monetary policy uncertainty are statistically significant and economically large, at least on the order of conventionally-identified monetary policy shocks. Intuition suggests that the transmission effects of uncertainty shocks should depend on the time horizon over which the uncertainty prevails. Uncertainty that is purely short term should have smaller effects, as agents wait until a resolution before making consumption and production decisions.

$^{20}$Note that this amounts to a timing assumption about MPU and MP shocks, whereby the former are contemporaneously uncorrelated with the latter. This seems reasonable on a priori grounds, and is also buttressed by our IRFs showing the insignificant response of MPU to GK monetary policy shocks.

$^{21}$This is in the spirit of Akkaya, Gurkaynak, Kisacikoglu, and Wright (2015). We tried several measures of high-frequency monetary policy surprises on the right hand side, including surprises on instruments at horizons from 1-quarter ahead to 8. All produced essentially the same results. We choose the spliced GK/RSW instrument for comparability with the results above.
In this section, we examine shocks to short-run MPU. We estimate VARs that simply replace overall MPU with short-run MPU in the models above. The results in both the Cholesky case (displayed in the online appendix Figure F.6) and the external instruments VAR displayed in Figure 11, show that a positive shock to short-run MPU significantly raises credit costs, as measured by EBP, and generates a contractionary effect on output, with a trough of about 2 years. The responses to shocks to short-run MPU are significantly smaller, however, as Figure 12 makes clear.

4.4 Comparison across cases

The VAR analysis suggests that monetary policy uncertainty shocks lead to tightened credit conditions and weaker macroeconomic performance. In Table 1, we compare the size of the impulse responses for MPU, interest rate, EBP, and IP at different horizons.

4.4.1 Monetary Policy Shocks (magnitude)

The first two columns display results for monetary policy shocks under GK’s external instruments identification VAR in two different sample periods: GK’s original 1979:07–2012:06 and our updated sample period 1985:01–2015:12, and now with MPU in the VAR and updated RSW monetary policy surprises. As seen in row 2, interest rates rise on impact by about 20 basis points. IP declines following the contractionary monetary policy shock, with a peak effect occurring between one and two years. Notice that the decline in IP is larger in the updated estimation compared to GK’s initial results.

4.4.2 MPU Shocks (magnitude)

The remaining columns of Table 1 report the effects of MPU shocks. In each case, the shock is normalized to a rise in MPU of around 36 points, approximately one standard deviation of the reduced-form VAR residuals. Examining column 3, the Cholesky case depicted in Figure 9, we see declines in IP that are essentially equal to those reported by GK for identified monetary policy shocks.

Turning to the external instruments cases and overall MPU shocks (Columns 4-6), we see very large contractionary transmission effects of MPU shocks, estimating respectively with

---

22Column 2 thus corresponds to the case reported in Figure 8. The results are nearly identical to those from estimating without MPU in the VAR.
the baseline MPU index, the human index, and the baseline MPU index over the sub-sample 1994-2015. The rise in MPU (normalized) produces a decline in IP that is larger than the drop observed in response to monetary policy shocks. Consistent with this, the impact rise in EBP is roughly double that of the responses to monetary policy shocks.

However, notice from the final column that the effects of shocks to short-run MPU are significantly smaller. The impact rise in EBP and interest rates following a shock to short-run MPU is about one-fifth to one-third the size of responses to overall MPU. The effects on output are also much smaller in response to short-run MPU shocks. This indicates that agents wait for a resolution of short-run uncertainty—even that which spikes more dramatically around FOMC meeting days, as seen in section 2—before making consumption and production decisions.²³

5 Further Discussion of MPU

In order to provide a deeper understanding of what our MPU index captures, in this section we compare our MPU index to alternative measures of monetary policy uncertainty, and examine the evolution of our index both during FOMC meeting cycles and over the full sample. In addition, to provide a theoretical underpinning for our VAR results, we illustrate a potential transmission mechanism of monetary policy uncertainty in an extended version of McKay, Nakamura, and Steinsson (2016).

5.1 Alternative measures of monetary policy uncertainty

We compare our baseline MPU index to alternative measures that are used as proxies for monetary policy uncertainty. The first is from the Federal Reserve Bank of New York’s Survey of Primary Dealers, conducted one week before each FOMC meeting. The Survey has the appealing feature of asking respondents to directly report both their forecasted policy rates and their forecast uncertainty. We use the dealers’ responses to the following question, over the time period for which this question was relevant and hence asked (through late 2012): “Of the possible outcomes below (−50 bps, −25 bps, +0 bps, +25 bps, +50 bps),

²³New work by Barrero, Bloom, and Wright (2017) measures short-run and long run uncertainty from firm level implied volatility measures over different horizons. They find that investment is significantly more sensitive to long-run uncertainty, while employment responds equally to short- and long-run uncertainty.
please indicate the percent chance you attach to the indicated policy move at each of the next three FOMC meetings”. To gauge the respondents’ perceived uncertainty regarding monetary policy, we calculate the average within-respondent standard deviation of forecasted policy rates.

Our baseline MPU index tracks the survey-based measure closely prior to 2008, with a correlation of 0.75 for the one-meeting ahead forecast and progressively slightly less for each of the next two meeting-ahead forecasts (Figure 13). In the months preceding actual liftoff, a major component of monetary policy uncertainty centered on the timing of liftoff. We construct from the Primary Dealers Survey a measure of *liftoff uncertainty* in a manner similar to the interest rate uncertainty above. The Survey began asking about the likelihood of liftoff over a pre-defined horizon consisting of 6 - 11 time periods. Our MPU index moves quite closely with liftoff uncertainty during 2015 (Figure 14), consistent with the notion that in that year monetary policy uncertainty was primarily about expectations concerning the timing of liftoff. These two findings again indicate that our news-based search results capture uncertainty over both near-term and longer-term horizons, with a relatively stronger focus on the near-term.

Second, we compare our MPU index to two market-based indicators of monetary policy uncertainty. In Figure 15 we display our measure against the implied volatility of options on one-year swap rates (swaptions), taken from Carlston and Ochoa (2016). Note that as the short-term policy rate approached zero, the market-based indicator fell quickly and remained extremely low during the ZLB period. This suggests that the market-based measures do not fully capture monetary policy uncertainty in a broad sense. Episodes such as the Taper Tantrum in 2013 and financial market turmoil prior to the October 2015 FOMC meeting suggest that uncertainty regarding the timing and pace of policy rate normalization was far from zero. Our MPU measure is more strongly correlated with one-year swaption volatility, shown above, than the ten-year (not shown), reinforcing the notion that even our overall MPU measure captures more of the near-term course of policy.\(^{24}\)

Compared to these measures based on survey data and market volatility, our measure therefore has the advantage of (1) being available in countries and during time periods when

\(^{24}\)We also compare our index to the VIX, the stock market options-based implied volatility measure that has been widely used as a proxy for uncertainty (Bloom, 2009). Our baseline MPU is positively correlated with the VIX, but only weakly so. See Husted, Rogers, and Sun (2016a).
market or survey data are not available and (2) better capturing uncertainty in periods of unconventional monetary policy when the policy rate is at or near the lower bound. In addition, our measure in principle represents uncertainty perceived by a different and potentially broader segment of the population, compared to the alternative measures.\(^{25}\)

We compare in Figure 16 our MPU indexes with the Baker, Bloom, and Davis’ (2016) Monetary Policy sub-index of EPU, which is only correlated with our overall (SR) MPU index at 0.49 (0.26). Our index construction differs from theirs along three dimensions. First, they use the Access World News database of over 2,000 newspapers while we focus on three leading newspapers that are tailored to national economic and financial news. Second, our keyword search features a more refined focus on monetary policy in the U.S., while Baker, Bloom, and Davis (2016) include a considerably broader set of words in a string of “or”s that potentially include discussions of other central banks or Fed chairman, for example, “Bernanke”, “Volker”, “Greenspan”, “central bank”, “Fed chairman”, “Fed chair”, “European Central Bank”, “ECB”, “Bank of England”, “Bank of Japan”, “BOJ”, “Bank of China”, “Bundesbank”, “Bank of France”, “Bank of Italy”. Third, they scale the total number of identified articles by the total number of articles rather than the number mentioning “Federal Reserve” (broadly).

In order to understand the importance of these different index construction strategies, we conduct a “reconciliation analysis” in Appendix C. We conclude from this that in order of importance, the factors explaining the weak correlation between MPU-HRS and MPU-BBD can be ranked: (1) Newspapers, (2) Keywords, and (3) Scaling. Given their significantly larger set of search terms and newspapers, it is likely that theirs captures a relatively larger global factor while ours is more U.S. centric.\(^{26}\)

### 5.2 MPU around FOMC meetings, before and after Fall 2008

To see if enhanced FOMC communication policies such as the forward guidance that the FOMC relied upon increasingly during the ZLB may have affected uncertainty, we repeat

\(^{25}\)In principle, the survey measure reflects the opinion of the 20 primary dealers participating in the survey, and the market measure reflects the opinion of individuals participating in the option market. The news-based approach implicitly assumes that newspapers reflect readership and at the same time can also have an effect of influencing and shaping public opinions.

\(^{26}\)We also repeat the VAR analysis for these alternative measures of monetary policy uncertainty and report similar results in Appendix F.
the event-study analysis of Section 2 by comparing baseline MPU around FOMC meetings in two sub-periods: February 1994-November 2008 and December 2008-January 2016. The results are depicted in Figure 17. In both sub-periods, there is a rise in MPU in the days prior to FOMC meetings. In the earlier sub-period, MPU peaks on the day after the FOMC meeting, the first day of newspaper coverage. Comparing the two lines, we see that in the latter sub-period, when the FOMC began to rely increasingly on forward guidance, this rise in MPU is greatly muted and uncertainty peaks one day sooner. Checking articles’ time-stamping indicates that this finding is not a mechanical result of earlier on-line availability of news in the latter sub-period. The evidence is thus consistent with the notion that enhanced communications policies helped ease uncertainty regarding monetary policy.27

5.3 Does FOMC Communication Influence MPU?

Commentators on central banking have long emphasized factors such as transparency and credibility. Bernanke (2015) recently opined: “I hope that the Fed’s increased transparency will help it maintain its independence, even as it remains democratically accountable. The chair’s press conferences, the expanded economic and interest rate projections by FOMC participants, and the lively debate evident in Fed policymakers’ speeches continue to provide the Congress, the public, and the markets with considerable information about the Fed’s strategy and its rationale. The days of secretive central banking are long gone. The Federal Reserve is not only one of the world’s most transparent central banks, it is also one of the most transparent government agencies in Washington.”

Indeed, it wasn’t always this way. Goodfriend (1986) notes that the Federal Reserve formerly held a strong penchant for secrecy. In an influential theoretical paper, Cukierman and Meltzer (1986) examine the implications of a central bank’s informational advantage for policymaker credibility and inflation. They establish conditions under which ambiguity and imperfect credibility are preferable to explicit formulation of objectives from the point of view of the policymaker. In an extension, Faust and Svensson (1999, 2001) study central bank transparency, credibility, and reputation. They derive the endogenously determined

---

27Our index rises on the day after FOMC meetings in the earlier subperiod. We learned from reading these articles that newspaper coverage on the day after meetings often centers on uncertainties in (1) economic consequences of the Fed decision and/or (2) future monetary policy actions even though current uncertainty has abated.
degree of transparency, show that an equilibrium with low transparency is a likely outcome of the model, and assert that it is (was) appropriate to characterize the Federal Reserve and Bundesbank in that way. However, the 1990s elicited fresh analysis from central banking theory, and was accompanied by a sea change of monetary policy making across the globe (Inflation Reports, inflation targeting). Woodford (2013) and Bianchi and Melosi (2012) both find advantages for a central bank that communicates explicitly about its future policy.28

In Table 2, we characterize the relationship between our indexes of monetary policy uncertainty and variables that proxy for the considerations noted above. These variables are discussed in detail in online Appendix D. We focus on institutional or procedural features, including newly-constructed measures of “FOMC statement persistence” and “FOMC-revealed uncertainty” (displayed in Appendix D). We also include a dummy variable for the crisis period of 2008H2, as well as separate dummies for the terms of different FOMC Chairs.

To allay concerns about endogeneity, we also control for U.S. macroeconomic uncertainty (Jurado, Ludvigson, and Ng (2015)), financial uncertainty (Ludvigson, Ma, and Ng (2016), and global geopolitical risk (Caldara and Iacoviello (2017)).

We estimate regressions of the form

\[ MPU_t = \alpha + \beta X_{t-1} + \gamma Z_t + u_t, \]

where \( X_{t-1} \) includes the prior-meeting values of the institutional variables statement persistence and FOMC-revealed uncertainty. Similarly, \( Z_t \) represents current-period values of the control variables: macroeconomic uncertainty, financial uncertainty, and geopolitical risk. We pay close attention to the timing, e.g., associating Statement persistence at the current meeting with MPU over the following inter-meeting period.29

As seen in Table 2, the regression coefficients are mostly of the anticipated sign. Statement Persistence is negative and significant while FOMC-revealed uncertainty is positive and significant. Greater similarity in the language used by the FOMC from meeting to meeting

---

28Milton Friedman (1990) is perhaps most blunt about the FOMC and the long gone days referred to by Bernanke: “From revealed preference, I suspect that by far and away the two most important variables in their loss functions are avoiding accountability on the one hand and achieving public prestige on the other” (quoted in Fischer, 1990, footnote 52). More recently, in “The Fed’s Communication Breakdown,” Project Syndicate, November 13, 2015, Ken Rogoff echoes Faust-Svensson’s theoretical finding, remarking, “however good its intentions, the net effect of too much Fed speak has been vagueness and uncertainty.”

29We also tried several other controls, e.g., natural disaster and Ramey fiscal policy shocks, as well as dissenting votes at each FOMC meeting and Committee member turnover, but found them to be insignificant. Appendix D describes all of the variables used in this analysis.
is followed by lower MPU, while greater uncertainty expressed by Committee members in the inter-meeting period is followed by higher uncertainty. Notice that these coefficients are significantly higher in the regressions for short-run MPU than overall MPU. We also find that greater financial uncertainty and geopolitical risk are robustly followed by higher MPU.

This analysis indicates that there is some significant effect of FOMC communications on MPU. However, at a deeper level the conceptual underpinning of our MPU index is potentially quite encompassing. Consider the increased importance of forward guidance, especially as interest rates hit the effective lower bound. Gurkaynak, Sack, and Swanson (2005) show that much of the surprise news about monetary policy at the time of FOMC announcements arises from signals about the central bank’s intentions about future monetary policy. Far future forward guidance has also been shown to be extremely powerful (e.g., Eggertsson and Woodford (2003), Del Negro, Giannoni, and Patterson (2012), Carlstrom, Fuerst, and Paustian (2015)): promises about far future interest rates have huge effects on current economic outcomes, and these effects grow with the horizon of the forward guidance. However, uncertainty also grows with the horizon of central bank promises, given limited central bank credibility and imperfect communication strategies. Episodes of financial turmoil, for example, made apparent that a great deal of uncertainty exists regarding things like the timing of liftoff. Our MPU index is able to capture such uncertainty.

There is also a theoretical literature examining the effects of uncertainty on central bank communication and policy rules. An earlier part of the literature modeled uncertainty about the interest rate rule. Rudebusch (2001, 2002) considers uncertainty about the parameters in the central bank’s policy rule, as well as real-time data uncertainty. Ehrmann and Smets (2003) examine implications of optimal monetary policy when the central bank follows a Taylor Rule but there is uncertainty about potential output. One result is that it is optimal to appoint a more “hawkish” central bank. Levin, Wieland, and Williams (2003) consider optimal monetary policy when the central bank does not know the “true” model of the economy and so considers several alternatives. They identify the key characteristics of policy rules that are robust to such uncertainty. In Eusepi and Preston (2010), agents have uncertainty about the interest rate path that the central bank will follow, while the central bank has uncertainty about the economic state. They show that, absent communication, the Taylor principle is not sufficient for macroeconomic stability, and analyze several different commu-
nunciation strategies for the central bank. More recently, Bianchi and Melosi (2012, 2016) model monetary policy under the assumption that agents have uncertainty about whether the central bank is following “passive” or “active” inflation stabilization. Taking a cue from the literature above, in Appendix E we provide a concrete example of what, conceptually, our MPU captures and its potential effects on the real economy. In an extension of McKay, Nakamura, and Steinsson (2016) that allows for uncertainty in forward guidance, we show that household discounting of, e.g., a promised future rate cut results in a muted effect of the policy.

6 Conclusion

We develop new measures of uncertainty that the public perceives about Federal Reserve monetary policy actions and their consequences. We compare these new measures to existing proxies and argue that there are good reasons to prefer ours, especially over medium term horizons such as FOMC meeting intervals. Empirically, we note for example that market-based measures were well subdued—close to zero—during the ZLB while ours were elevated and fluctuating. Conceptually, differences exist between our measure and the market-based indicators. In theory, the latter reflect the average perception of individuals participating in options markets. Our news-based index reflects the average opinion of people reading newspapers (assuming that newspapers reflect the readership). Since relatively few households participate in options markets, the prices in these markets may not be particularly representative. In addition, in market-based indicators the perceived degree of uncertainty is contaminated with time-varying risk aversion and state-dependent marginal utility.\(^{30}\) Although we acknowledge (and try to control for) the potential state-dependency in newspaper coverage of central bank actions, we believe that our index is a preferable measure of monetary policy uncertainty, at least over the sample period and for the frequency we study.

We examine transmission of monetary policy uncertainty, showing that greater uncertainty raises credit costs and lowers output by at least as much as identified contractionary monetary policy shocks that are regarded as standard in the literature. These results are

\(^{30}\)The market-based measures are presumed to reflect the price individuals are willing to pay for insurance against future rate fluctuations. Willingness to substitute resources from one possible future to another depends on the relative scarcity of resources in those futures. Therefore, a household may be willing to pay a lot to insure against the possibility of a rate increase even if it sees the outcome as highly unlikely.
robust to alternative measures of monetary policy uncertainty that have been proposed in the literature (Appendix F). Consistent with this, we make a simple theoretical argument why forward guidance could be less stimulative when households perceive some uncertainty about whether promised rate cuts will materialize. However, we also show that shocks to our newly-constructed measure of short run monetary policy uncertainty have much smaller transmission effects, both to financial conditions and output. Our findings are thus in line with others that illustrate negative economic effects of uncertainty shocks, but with the notable caveat that the magnitude of transmission effects depends on the time horizon over which the uncertainty prevails.

References


<table>
<thead>
<tr>
<th></th>
<th>GK Paper</th>
<th>GK with MPU</th>
<th>Cholesky</th>
<th>Baseline MPU</th>
<th>Human MPU</th>
<th>Baseline ’94-'15</th>
<th>Short-run MPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPU (impact)</td>
<td>...</td>
<td>-3.42</td>
<td>36.60</td>
<td>36.60</td>
<td>36.60</td>
<td>36.60</td>
<td>36.60</td>
</tr>
<tr>
<td>EBP (impact)</td>
<td>0.11</td>
<td>0.25</td>
<td>0.015</td>
<td>0.34</td>
<td>0.30</td>
<td>0.27</td>
<td>0.08</td>
</tr>
<tr>
<td>Interest rate (impact)</td>
<td>0.22</td>
<td>0.17</td>
<td>-0.01</td>
<td>0.07</td>
<td>0.06</td>
<td>0.10</td>
<td>0.02</td>
</tr>
<tr>
<td>Max drop in IP</td>
<td>-0.34</td>
<td>-0.70</td>
<td>-0.28</td>
<td>-1.36</td>
<td>-1.19</td>
<td>-0.73</td>
<td>-0.30</td>
</tr>
<tr>
<td>Month of max drop in IP</td>
<td>23</td>
<td>12</td>
<td>17</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>IP at horizon 12</td>
<td>-0.13</td>
<td>-0.70</td>
<td>-0.17</td>
<td>-1.15</td>
<td>-1.01</td>
<td>-0.57</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

Impulse responses under the following VAR identification schemes.
Column 1: monetary policy shock in the GK four-variable VAR and GK sample period.
Column 2: monetary policy shock with MPU added to the GK VAR, updated VAR estimation period, and updated monetary policy surprise instruments of RSW.
Column 3: shock to overall MPU using Cholesky identification.
Column 4: shock to overall MPU using external instruments identification.
Column 5: shock to human MPU using external instruments identification.
Column 7: shock to short-run MPU using external instruments identification.
Table 2: *Does FOMC Communication Influence MPU?*

<table>
<thead>
<tr>
<th></th>
<th>MPU</th>
<th>SR MPU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Statement/Minute Uncertainty</td>
<td>0.118*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.18)</td>
<td></td>
</tr>
<tr>
<td>Statement Persistence</td>
<td>-39.56+</td>
<td>-33.67+</td>
</tr>
<tr>
<td></td>
<td>(-1.92)</td>
<td>(-1.92)</td>
</tr>
<tr>
<td>Financial Uncertainty</td>
<td>17.87</td>
<td>112.7</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(1.25)</td>
</tr>
<tr>
<td>Macro Uncertainty</td>
<td>-192.3+</td>
<td>-116.2</td>
</tr>
<tr>
<td></td>
<td>(-1.77)</td>
<td>(-1.15)</td>
</tr>
<tr>
<td>Geopolitical Risk Index</td>
<td>0.182+</td>
<td>0.299**</td>
</tr>
<tr>
<td></td>
<td>(1.70)</td>
<td>(5.14)</td>
</tr>
<tr>
<td>Constant</td>
<td>260.5**</td>
<td>96.02</td>
</tr>
<tr>
<td></td>
<td>(3.00)</td>
<td>(1.05)</td>
</tr>
<tr>
<td>Chair Dummies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dummy 2008H2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>84</td>
<td>128</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.108</td>
<td>0.227</td>
</tr>
</tbody>
</table>

Dependent variable: MPU at FOMC meeting interval, 1999-2015; Statement Persistence (1-meeting lag): the similarity of statements between the previous and the current FOMC meeting (Acosta, 2015); Statement/Minute Uncertainty: percentage of words meaning uncertainty in FOMC statements and minutes over the inter-meeting period; Macro Uncertainty: Jurado, Ludvigson, and Ng (2015) measure of Macroeconomic Uncertainty (12 month horizon); Financial Uncertainty: Ludvigson, Ng, and Ma (2016) measure of financial uncertainty; Geopolitical Risk Index: Caldara and Iacoviello (2017) measure of geopolitical conflict and terrorism based on news releases.
Figure 1: Monetary Policy Uncertainty Index

MPU index, monthly frequency (January 1985 - June 2017)

Figure 2: Human index vs. Computer index

MPU index against human index
Figure 3: Type I error rate

Figure 4: Type I error rate

Type I and Type II error rates in MPU index

Figure 5: Near Term and Very Near Term MPU (human audit)
Figure 6: Short-run MPU Index

Figure 7: Overall vs short-run MPU around FOMC Meetings
Figure 9: MPU Shock, Cholesky

- **IP**: The graph shows the impact on IP with a shaded area indicating the range of the effect.
- **CPI**: The graph displays the change in CPI, with a shaded area to represent variability.
- **MPU**: The graph illustrates the MPU effect, with a shaded area for the range of outcomes.
- **1 Year Rate**: The graph depicts the 1-year rate trend, with a shaded area for uncertainty.
- **EBP**: The graph shows the EBP changes with a shaded area indicating the range.

The data points are marked with numerical values to highlight specific changes over time.
Impulse responses to a MPU shock, identified using external instruments.
Impulse responses to a short-run MPU shock, identified using external instruments.
Impulse responses to a short-run MPU shock (in green) and a MPU shock (in red), identified using external instruments.
Figure 13: MPU vs. Survey (FFR)  
MPU index against uncertainty measures from FRBNY Survey of Primary Dealers

Figure 14: MPU vs. Survey (liftoff)  
MPU index against uncertainty measures from FRBNY Survey of Primary Dealers

Figure 15: MPU index vs. Market-based Measure (1 year)  
MPU index against swaptions volatility, from Carlston and Ochoa (2016)
Baseline MPU index against monetary policy sub-index of Baker, Bloom, and Davis (2016).

Daily MPU before and after FOMC meetings. Average during the sub-periods.
Online Appendix

A Baseline Index Construction

The MPU index reflects automated text-search results for the newsstand edition of three major newspapers: New York Times, Wall Street Journal, and Washington Post. We use the ProQuest Newsstand database to search the electronic archives of each newspaper from January 1985 to January 2016 for terms related to monetary policy uncertainty. In particular, the search identifies articles containing the triple of (i) “uncertainty” or “uncertain,” (ii) “monetary policy” or “interest rate” or “Federal funds rate” or “Fed fund rate,” and (iii) “Federal Reserve” or “Fed” or “Federal Open Market Committee” or “FOMC”. Based on these search criteria, we count in each newspaper how many articles contained the search terms above every day.

To deal with changing volume of newspapers over time, we normalize as follows. First, we divide, for each newspaper, in every inter-meeting period, the raw count of articles related to monetary policy uncertainty by the total article count mentioning the Fed. For each newspaper \( i \) in period \( t \), we calculate the share of articles containing monetary policy uncertainty terms as

\[
\frac{\text{mpu articles}(i,t)}{\text{Fed articles}(i,t)}.
\]

We then normalize the share of articles so that, for each newspaper, the resulting series has a standard error of one over the sample period. This normalization controls for the possibility that different newspapers mention monetary policy uncertainty with different frequency over time. That is, we denote the normalized share of articles using

\[
nn(i,t) = \frac{n(i,t)}{\text{stdev}(n(i,1985:2015))}.
\]

Finally, we sum the \( \text{nn}(i) \) series across newspapers and scale them so that the average value is 100 over the sample period. The scaling produces our monetary policy uncertainty index, denoted as MPU:

\[
	ext{MPU}(t) = \left[ \frac{\sum_i \text{nn}(t)}{\text{avg}(\sum_i \text{nn}(1985:2015))} \right] \times 100.
\]

A human reading of a sample of the articles suggests that the news-based approach used to construct the index can provide a reasonable indicator of monetary policy uncertainty. Newspapers typically cite uncertainties related to monetary policy in one of the following cases:

- Newspaper articles comment on the uncertainty resulting from Federal Reserve actions. For example, “FOMC reserve injection during the day is reversed at the overnight closing time to achieve an artificial 5.25%. This target Fed funds chicanery leaves the financial market with considerable uncertainty.”
Newspaper articles discuss the implications of uncertainty regarding the Federal Reserve actions for the real economy and stock markets. For example, “Traders last week blamed uncertainty about the FOMC for the sharp ups and downs on the New York Stock Exchange.”

Newspaper articles analyze uncertainties at home and abroad that affect monetary policy. For example, “Given the inherent uncertainty about future developments, policy actions often importantly depend on the flow of new information and the FOMC’s judgment about its implications.” “There are significant uncertainties about the Fed moving to boost the cost of borrowing in the U.S. as China’s economy has run into trouble and as financial markets have suffered significant losses.”

Newspaper articles quote policy-makers, economists, political leaders, or industry experts who refer to uncertainties in relation to monetary policy in their speeches or interviews. For example, “The Federal Open Market Committee, the central bank’s top policymaking group, blamed the slowdown in growth largely on falling stock prices and ‘heightened uncertainty related to problems in corporate reporting and governance’.”

**B Additional data checks**

Saiz and Simonsohn (2013) propose a number of data checks to examine whether an index is a useful proxy for the phenomenon of interest. We follow these conditions and check the validity of our index below.

1. Do the different queries maintain the phenomenon and keyword constant?

   Following Saiz and Simonsohn (2013), two data checks are used to assess the validity of this premise. First, we verify that our MPU index is expressed in terms of a relative frequency. Second, the keyword chosen be more likely to be employed following the occurrence than the non-occurrence of the phenomenon of interest. We verify this by calculating that 85% of the randomly selected articles from set \( M \) (i.e., those included in our computer-automated index).

2. Is the variable being proxied a frequency?

   Our index is a frequency.

3. After sampling the contents of documents found: is the keyword employed predominately to discuss the occurrence rather than non-occurrence of phenomenon?

   We verify this in our human auditing: 85% of the randomly selected articles from set \( M \) (i.e., those included in our computer-automated index).
4. Is the average number of documents found large enough for variation in document-frequency to be driven by factors other than sampling error?

We verify this in two ways. First, we gain confidence in our human audit that (i) the average number documents found is sufficiently large for meaning variations and (ii) our index spike up on the days of notable events that are associated with rising monetary policy uncertainty, for example, 2003 Iraq invasion, 2013 Taper Tantrum, and 2015 December liftoff uncertainty, not only on the monthly basis but also on a daily frequency.

5. Is the expected variance in the occurrence-frequency of interest high enough to overcome the noise associated with document-frequency proxying?

Saiz and Simonsohn (2013) argue that one likely source of measurement error is keywords with multiple meanings leading to false positives; that is, to documents that do contain the key words but which are not actually about the phenomenon of interest. This can be easily fixed by replacing a keyword for a synonym with fewer other meanings. Our human audit and, in particular, our analysis of the error rate, show small measurement errors in our index and help alleviate this concern. In fact, our reading of both set \( M \) (those articles included in MPU index) and set \( E \) (a larger set that contains only words in category (iii)) suggests that our MPU index is rather conservative because of relatively restrictive search criteria.

6. After inspecting the content of the documents found: does the chosen keyword have as its primary or only meaning the occurrence of the phenomenon of interest?

The final aspect of data checks deals with a possible correlation of the index with covariates of other variables of interest: conditioning on occurrence-frequency, document-frequency should be uncorrelated with the covariates of interest (Saiz and Simonsohn (2013)). We address this by (i) scaling our index by the number of articles mentioning Fed (see more details in data check #8) and (ii) showing that our index is not correlated with other major economic outcome variables.

7. After inspecting the content of the documents found: does the chosen keyword also result in documents related to the covariates of the occurrence of interest?

See our response for data check #8.

8. Are there plausible omitted variables that may be correlated both with the document-frequency and its covariates? If so, control for the omitted variable with an additional placebo document-frequency variable.

We control for the potentially time-varying public attention on Federal Reserve (that may or may not be unrelated to uncertainty) by scaling our index by the total number of
articles each month mentioning the Fed. In so doing, we control for the time variation in the volume of newspaper articles as well as that in concerns about the Federal Reserve in general. This is also a key difference between our index and that constructed by Baker, Bloom, and Davis (2016).

C Baker-Bloom-Davis Monetary Policy sub-index

We begin by noting the relatively low correlation between MPU-HRS and MPU-BBD, which is .49 over the full sample and .31 after 2008. Their index has more pronounced spike-ups than ours early in the sample, remained well below average throughout 2014 and into 2015, and is subdued relative to our index during the October 2015, December 2015, and January 2016 FOMC meeting intervals.

To try and understand this, we first examine the role of scaling. The correlation between MPU-HRS and MPU-(HRS terms, HRS papers, BBD scaling) is .85 (.92, post-2008). The correlation between MPU-BBD and MPU-(HRS terms, HRS papers, BBD scaling) is .46 (.46). These two cases, against the backdrop of the weak correlation between MPU-HRS and MPU-BBD, indicate that scaling does not matter much: in the former, we see that changing MPU-HRS only by adopting the BBD scaling maintains a high correlation with MPU-HRS, while the latter case indicates that this same strategy change leaves the resulting index weakly correlated with MPU-BBD.

Second, we examine the role of the keyword search. The correlation between MPU-HRS and MPU-(BBD terms, HRS papers, HRS scaling) is .75 (.76), while that between MPU-BBD and MPU-(BBD terms, HRS papers, HRS scaling) is .42 (.57). These two cases tell us that changing terms matters a little bit more than scaling. That is, the former says that changing MPU-HRS only by using the BBD keyword search leaves a decently high correlation with MPU-HRS, though not super high, while in the latter case we learn that changing MPU-HRS only to use the BBD keywords leaves the resulting index weakly correlated with MPU-BBD (though notably higher post-2008).

Third, and finally, we examine MPU-HRS vs. MPU-(BBD terms, HRS papers, BBD scaling), and find correlations of .62 (.68), and MPU-BBD vs. MPU-(BBD terms, HRS papers, BBD scaling) with correlations of .39 (.72). These last two cases are more difficult to assess. For the most part they suggest that if all BBD were to do was use only our smaller set of newspapers, there would be a decent correlation with our MPU-HRS index and in the full sample period a poor correlation with what they compute from using the large set of newspapers. This indicates that newspaper choice matters. Baker, Bloom, and Davis (2016) use the Access World News database of over 2,000 newspapers, while we use the three major U.S. newspapers that are more tailored to national financial news.

We conclude that in order of importance, the factors explaining the weak correlation between MPU-HRS and MPU-BBD are ranked: (1) Newspapers, (2) Keywords, and (3)
Scaling. The BBD index captures a relatively larger global factor while ours is more U.S. centric.

D Proximate Determinants of MPU

D.1 Dissenting votes

The Federal Open Market Committee consists of the seven Federal Reserve governors and five Federal Reserve Bank presidents on a rotating basis. The FOMC ordinarily meets eight times per year and at each meeting votes on a directive that governs monetary policy during the period between meetings. The policy directives are usually supported by a strong majority but voting often involves dissent (Figure D.2). Dissent could reflect fundamental disagreement about how to achieve the Committee’s objectives and could potentially represent shocks to the preferences of the monetary authority. The FOMC dissenting votes have been revealed in the postmeeting statements only since March 2002. However, they have been included in the minutes since the mid 1990s. Recalling that we lag dissenting votes by one period, it is not ill-designed to examine the relationship with MPU before March 2002.

In the first row of Table 1, we show that there is a positive correlation between the percentage of FOMC dissenting votes at one meeting and the level of MPU during the following inter-meeting period. A “united front” of the FOMC participants conveys to the public that a sudden deviation from the central bank’s reaction function due to preferences shocks is unlikely. The effect is not particularly significant, however.

D.2 Statement persistence

Using techniques developed in computational linguistics, Meade and Acosta (2015) construct a measure of how persistent the content of the statements has been, by calculating the correlation (similarity) of words used in two consecutive postmeeting statements. If identical words are used in consecutive FOMC statements, ignoring changes in word order, the similarity will equal unity. The addition or subtraction of words or the use of the same words in different proportions will reduce similarity between consecutive meetings.

The Meade-Acosta measure of statement persistence is displayed in Figure D.3, along with MPU. Meeting-to-meeting similarity rose between May 1999 through mid-2007. It then fell to an historic low (below 0.20) between the October 2008 and December 2008 meetings when the FOMC reduced the Fed Funds target rate to a range of 0 to 1/4 percent amid a widening crisis. Average persistence declined during the financial crisis and then rose to a very high level through 2014.

As shown in Table 2, we find a negative correlation between persistence in FOMC statements (from the previous meeting to the current) and monetary policy uncertainty perceived by the public (regarding the period up to the next meeting). When the semantic content of
FOMC statements from one meeting to the next is similar, the public seems to perceive little change in the central bank’s policy stance and projects limited uncertainty going forward.

D.3 Uncertainty perceived and conveyed by the central bank

“Part of the game is confidence, and looking clueless and uncertain doesn’t help.”

— Ben Bernanke (2015)

We conjecture that the public’s uncertainty regarding monetary policy is influenced by the degree of uncertainty the Federal Reserve itself perceives and conveys. To examine this, we construct indicators of uncertainty conveyed in publicly archived FOMC documents including statements, minutes, testimony, speeches, and the Chair’s postmeeting press conferences. We use automated text-search to calculate the frequency of words that suggest uncertainty, including synonyms that are taken from a thesaurus. Consistent with our conjecture, Table 1 shows that the degree of uncertainty conveyed in FOMC statements and minutes, displayed in Figure D.1, is positively correlated with contemporaneous monetary policy uncertainty that the public perceives, but only weakly so. Uncertainty conveyed in FOMC speeches and testimonies is also only weakly correlated with MPU.

D.4 FOMC member turnover

A significant turnover of FOMC members may lead to unanticipated changes in the central bank’s policy stance and introduce disparate and unknown voices at the Fed, making it difficult to convince the public with a coherent monetary policy message. Our measure of member turnover is the number of FOMC participants leaving or joining the FOMC for the first time at the current meeting. When we added FOMC member turnover to the regressions of Table 2, the coefficients were positive as expected, yet only occasionally significant. One main challenge of identifying the effects of personnel turnover is that such changes are typically anticipated ahead of time, and it is difficult to pinpoint when turnover becomes public knowledge.

D.5 Endogeneity

Although we are careful about temporal considerations in correlating our measures with MPU in Table 2, and despite the intuitive appeal of the resulting correlations, inference is

31Uncertain, ambiguous, ambivalent, dubious, erratic, hazy, hesitant, insecure, precarious, questionable, risky (this does not include the noun risk), unclear, undecided, undetermined, unpredictable, unreliable, unresolved, unsettled, unsure, and vague (and their derivatives). We sum instances of these words on a document-by-document basis and divide this raw count by the number of total words in the release. In the case of minutes and statements, the resulting observation is just an addition of these two measures on a meeting-date basis. In the case of the speeches and testimony, this is the summed linear combination of all of the speeches and testimony observations in the inter-meeting period.
complicated by concerns of simultaneity and omitted factors. There likely exists hard-to-measure forces, each with varying degrees of quiescence, which simultaneously create, e.g., less monetary policy uncertainty and greater ability by FOMC members to word Statements consistently. We attempt to make progress by controlling for (reasonable proxies of) such hard-to-measure forces. To this end, we employ measures of U.S. macroeconomic uncertainty and financial uncertainty, geopolitical risk, U.S. defense spending shocks, and U.S. natural disasters. The potential importance of macro or financial uncertainty speaks for itself: uncertainty about FOMC policy actions could be high when the basis on which policy is made, the current and expected future state of the U.S. economy, is perceived as highly uncertain. The appealing feature of the latter three controls is that they are arguably orthogonal to the error terms in the MPU regressions that contain only the FOMC institutional/procedural variables. We briefly describe these controls in the following sub-sections.

D.5.1 Macroeconomic uncertainty and financial uncertainty

Imperfect information about the current and expected future state of the economy is another source of uncertainty regarding central bank policy. There is measurement error in the preliminary data available to the FOMC at the time it makes decisions. The actual position of the economy at any time is only partially known, as key information on spending, production, and prices becomes available only with a lag (and is furthermore continuously revised). Therefore, policy makers must rely on estimates of these economic variables when assessing the appropriate course of policy, aware that they could act on the basis of incomplete or misleading information. Uncertainty about policy actions could be high when the basis on which policy is made is perceived as highly uncertain by the public. This in turn could be correlated with, e.g., FOMC-revealed uncertainty. To control for this, we use the macroeconomic uncertainty measure of Jurado, Ludvigson, and Ng (2015), an econometric estimate of whether the economy has become less or more predictable, and the financial uncertainty measure of Ludvigson, Ma, and Ng (2016), which is also estimated – from an iterative projection instrumental variables method.\textsuperscript{32}

Contemporaneous uncertainty about the financial state of the economy is positively, and often significantly, correlated with MPU. On the other hand, macroeconomic uncertainty contributes to uncertainty the public perceives about monetary policy in a way that is unstable over time. Prior to 2008, the estimated relationship (not displayed) is positive irrespective of other controls in the regression, while in the regressions that go through 2015 the estimate is negative and sometimes significantly so.

\textsuperscript{32}We use their 12-month ahead measures as this is a better conceptual match with our MPU than the 1-month or 3-month horizons. Results are quite similar irrespective of which of their horizon-measures we use. We also find robustness to using Scotti's (2016) alternative measure of macroeconomic uncertainty.
D.5.2 Geopolitical risk, Defense spending, and natural disasters

The geopolitical risk index (Caldara and Iacoviello 2017) is calculated using a methodology similar to that used in constructing our MPU index. They search over 11 major U.S. and British newspapers for mentions of the words: geopolitical risk(s), concern(s), tension(s), uncertainty(ies), war risk(s) (or risk(s) of war) and military threat(s), as well as mentions of terrorist threat(s). Our expectation that geopolitical risk will be positively correlated with MPU is confirmed, and indeed we see that it is quite significant statistically as well.

Ramey (2011) constructs a measure of “news about future government spending, by reading news sources to gather quantitative information about expectations. Her defense news variable measures the expected discounted value of government spending changes due to foreign political events. The series was constructed by reading periodicals in order to gauge the public’s expectations. According to Ramey, the constructed series should be viewed as an approximation to the changes in expectations at the time. In calculating present discounted values, she used the 3-year Treasury bond rate prevailing at the time. We estimated all of our regressions with Ramey’s measure included. These specifications never produced estimates of her variable with a t-statistic greater than 0.50, and never had any material effect on the other estimated coefficients, so we do not report these results.

As a final control, we construct a measure of fatalities resulting from notable natural disasters that occurred in the United States. These include cyclones (Rita, Katrina), tornadoes, hurricanes, floods, blizzards, snow storms, earthquakes, and heat waves. We expect this also to be positively correlated with monetary policy uncertainty. In this case too, the estimated coefficients are not significant.

D.5.3 Instrumental variables

All of the OLS estimates displayed in Table 2 convey a consistent message: there is an important association between FOMC communications and monetary policy uncertainty, even when controlling for reasonable proxies of omitted factors that might account for some of this relationship. Of course, these additional controls are not playing the role of instruments. Hence, we also estimated regressions for MPU using both two-stage least squares (2SLS) and limited-information maximum likelihood (LIML). We tried a variety of instruments, alone and in combination with each other, including first lags of each of the $X$ variables and each of our control variables $Z_t$ (as well as the first lag of macro uncertainty). We found that these instruments are “weak”, however, leaving us without reliable IV estimates.

Angrist and Krueger (2001) note that finding good instruments is difficult in practice. They do discuss the popularity of using instruments derived from “natural experiments”.

34For example, in the 2SLS estimates we typically found F-statistics from first stage regressions in the neighborhood of 1.0 to 3.5 or lower, well below the recommended cutoff of 10 (Stock and Yogo (2005)). The most valid instrument, unsurprisingly, was lagged macro uncertainty instrumenting for itself.
Analogous randomized experiments are not likely in our application, however. Just as it is not feasible to coerce a randomly chosen group of people, e.g., to quit smoking, randomization in something like the semantic content of FOMC statements is unthinkable.

### D.6 Proximate determinants: plots of the series

The following three figures depict some of the variables described above, namely: “FOMC-revealed uncertainty” (against MPU), (ii) dissenting votes, and (iii) FOMC statement persistence (against MPU).

![Figure D.1: MPU and FOMC-Revealed Uncertainty](image)

Baseline MPU index against the our measure of uncertainty revealed in FOMC Statements and Minutes.
Baseline MPU index against the percentage of FOMC members voting against the Committee decision.

Baseline MPU index against similarity of FOMC statements from meeting to meeting (Meade and Acosta (2015)).
E  Power of Forward Guidance under Uncertainty

We extend McKay, Nakamura, and Steinsson (2016) (hereafter, MNS) to allow for uncertainty in forward guidance. These authors use a model with uninsurable idiosyncratic shocks to household productivity, borrowing constraints, and nominal rigidities, to analyze the economic effects of forward guidance. We incorporate into their framework uncertainty about whether the Fed will change the rate as promised.

Standard monetary models imply that far future forward guidance has large effects on current outcomes, and that these effects grow with the horizon of forward guidance. MNS show that in a model with incomplete markets, however, forward guidance has substantially less power to stimulate the economy, because a precautionary savings effect tempers household responses to changes in future interest rates. In the model, there is some probability that one will face a borrowing constraint before the promised interest rate reduction, effectively shortening planning horizons. Also, households that are subject to uninsurable idiosyncratic income risk and borrowing constraints will be reluctant to run down wealth since this will reduce their ability to smooth consumption in the face of future income shocks.

The MNS economy is populated by a unit continuum of ex ante identical households with preferences given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_{ht}^{1-\gamma}}{1-\gamma} - \frac{l_{ht}^{1+\psi}}{1+\psi} \right],$$

where $C_{ht}$ is consumption of household $h$ at time $t$ and $l_{ht}$ is labor supply of household $h$ at time $t$. Households are endowed with stochastic idiosyncratic productivity $z_{ht}$ that generates pretax labor income $W_t z_{ht} l_{ht}$, where $W_t$ is the aggregate real wage. Each household’s productivity $z_{h,t}$ follows a Markov chain with transition probabilities $Pr(z_{h,t+1}|z_{h,t})$. The initial cross-sectional distribution of idiosyncratic productivities is equal to the ergodic distribution of this Markov chain, denoted by $\tau(Z_{it})$.

A final good is produced from intermediate inputs according to $Y_t = \left( \int_0^1 y_t(j)^{1/\mu} dj \right)^\mu$, where $Y_t$ denotes the quantity of the final good produced at time $t$ and $y_{j,t}$ denotes the quantity of the intermediate good produced by firm $j$ in period $t$. The intermediate goods are produced using labor as an input according to the production function $y_t(j) = n_t(j)$, where $n_{j,t}$ denotes the amount of labor hired by firm $j$ in period $t$.

While the final good is produced by a representative competitive firm, intermediate goods are produced by monopolistically competitive firms. The intermediate goods firms face frictions in adjusting their prices and can only update prices with probability $\theta$ per period. These firms are controlled by a risk-neutral manager who discounts future profits at rate $\beta$. Whatever profits are produced are paid out immediately to households with each household receiving an equal share $D_t$. Households cannot trade stakes in the firms.

Households trade a risk-free real bond with real interest rate $r_t$ between periods $t$ and
$t + 1$. Borrowing constraints prevent these households from taking negative bond positions. There is a stock of government debt outstanding with real face value $B$. The government raises tax revenue to finance interest payments on this debt. These are collected by taxing households according to their labor productivity $z_{h,t}$. The tax paid by a household $h$ in period $t$ is $\tau_{t}(z_{it})$. The government runs a balanced budget.

MNS analyze an experiment in which the monetary authority announces that the real interest rate will be lowered by 1 percent for a single quarter five years in the future. The real rate is maintained in all other quarters. Using the MNS calibration, we run a thought experiment to analyze the effects of uncertainty households may perceive about forward guidance: we assume that households believe that there is a 50% chance that the central bank will follow through on the rate decrease five years in the future and a 50% chance that there is no rate change in five years.

Figure E.1 plots the response of output to this shock in our extended MNS model, as well as in the complete and incomplete markets versions of the MNS model. The response of output under complete markets is a step function: Output immediately jumps up and remains at that elevated level for 20 quarters before returning to steady state. Consistent with MNS, output has a smaller initial response and is substantially smaller in the incomplete markets model than under complete markets, even in the period right before the interest rate decrease. This is because households trade off the cost of a lower buffer stock (more exposure to future income shocks) with the gains from intertemporal substitution, since they are no longer fully insured against all shocks as they would be with complete markets. In our experiment, when there is uncertainty about whether the rate decline promised under forward guidance will actually materialize, households discount the promise. This results in a muted effect of forward guidance, both at the outset and for the response in the period before quarter 20. In addition, households’ risk aversion implies that, by Jensen’s inequality, uncertainty about future interest rates further depresses the stimulating effects of the announcement.\(^{35}\)

Thus, consistent with our empirical findings, a theoretical argument can be made that forward guidance has less power to stimulate the economy when households perceive some uncertainty about whether the promised rate cut will materialize.

\(^{35}\)This effect is quantitatively small under the MNS calibration. This second-order Jensen’s inequality effect (that further reduces output) is counteracted by a smaller redistribution effect: the interest rate shock leads to a redistribution of wealth away from households with high marginal propensities to consume and toward households with low marginal propensities to consume, which lowers aggregate demand and output; this effect is significantly smaller with our assumption in our experiment.
Figure E.1: Response of Output to 50bps Rate Cut in Quarter 20
F VAR Robustness: alternative measures of monetary policy uncertainty

Figure F.1: Monetary Policy Shock, GK External Instruments Identification, MPU-BBD

See notes to Figure 8.
Figure F.2: MPU Shock, External Instruments, MPU-BBD

See notes to Figure 10.
Figure F.3: Monetary Policy Shock, External Instruments, market-based MPU

See notes to Figure 8.
Figure F.4: MPU Shock, External Instruments, market-based MPU

See notes to Figure 10.
Figure F.5: MPU Shock, External Instruments, Baseline MPU 1994-2015

See notes to Figure 10.
Figure F.6: MPU-SR Shock, Cholesky

- **IP**
- **CPI**
- **MPU-SR**
- **1 Year Rate**
- **EBP**
References


