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JEL Classification: E52, E58, C55

Keywords: Central banks, monetary policy, communications, Uncertainty

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Central Bank Communication of Uncertainty

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December 5, 2022

Abstract

In this paper, we examine how the monetary policy setting committees of the Federal Reserve, the Bank of England and the European Central Bank communicate their reaction to incoming data in their policy deliberation process by expressing confidence and surprise or uncertainty with respect to existing narratives. We use text analysis techniques to calculate forward and backward looking measures of relative surprise from the published Minutes of these decision-making bodies. We find many common patterns in this communication. Interestingly, policymakers tend to express more surprise and uncertainty with regard to developments in the real economy, whereas they are more likely to confirm their expectations with regard to inflation and monetary policy. When considering the monetary policy stance, we observe a tendency for policymakers to highlight surprise and uncertainty several meetings in advance of changes, particularly when easing monetary policy. Importantly, we document that a higher proportion of expressions of surprise and uncertainty increases the likelihood of an easier policy stance. By contrast, a higher proportion of expressions of confirmation tends to increase the likelihood of a tighter policy stance.

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1 Introduction

In setting monetary policy, central bankers make forward-looking decisions subject to uncertainty. In deciding whether to act and, if so, by how much, central bankers have to assess the likely future difference between their objective variables and their targets under different paths of their policy instruments. Given the possibility of future shocks, these forecasts are inherently highly uncertain. But central bankers can also be uncertain about the current conjuncture because data are inherently noisy, subject to revision, and may give conflicting signals. The assessment of the current conjuncture and near-term outlook will also depend on judgments about the uncertain impact of past policy decisions (including other policy domains).

These assessments evolve over time. More data help resolve or clarify past puzzles but inevitably throw up new ones in their place. This dynamic process is reflected in the way central banks communicate about their decisions. These tend to be structured around a discussion of the current conjuncture and then a discussion about the outlook. Each part contains elements of continuity and surprise. Some data will have evolved in line with past expectations and some will not. Indeed, surprise in this context is essentially with respect to previous expectations.

This balance between confirmation and surprise is unlikely to be constant through time. Economies are subject to shocks of greater and less magnitude that perturb this evolving assessment. In an optimal control setting, one would expect decisions to change policy to be associated with significant changes in the current assessment and future outlook. This may or may not be contemporaneous. Central banks are sometimes, but not always, reluctant to act rapidly in response to changing circumstances. Policy under optimal control may require quickly reversing course which central banks are generally reluctant to do. For this reason, central banks sometimes see value in waiting for more information in uncertain times.

Finally, it is important to realise that central banks make decisions about how much of this uncertainty they wish to communicate to the public. Differences in institutional culture, political context, accountability mechanisms or target audience could cause central banks to be more of less transparent about the degree of uncertainty they face in making their decisions.

The purpose of this paper is to examine how central bankers communicate their confidence and uncertainty about their assessment of the state of the economy in their policy deliberation process. We contribute by quantifying this type of communication and by documenting how it relates to decisions to change the stance of the monetary policy. To this end, we analyze similarities and difference in the Minutes of the Federal Reserve (Fed), the Bank of England (BoE) and the European Central

Bank (ECB). Central bank minutes are interesting for several reasons. They provide detailed summaries of the policy discussions and deliberations in the meeting and are, therefore, richer in information than policy statements. Even though they are published with a delay with respect to the policy decision, minutes are closely watched by market participants who scrutinise them for nuances in the descriptions of the meetings to better gauge the policy debate, the consensus of the members and to get clues about future policy moves. Moreover, the minutes serve comparable purposes across our central banks and are publicly available. Our analysis covers the period 1993-2020 for the Federal Reserve, 1998-2020 for the BoE and since 2015 for the ECB.

We first contribute with *text-based* measures of central bankers' confirmation and surprise or uncertainty, as communicated through their Minutes. To obtain these measures we construct bespoke dictionaries of terms that policymakers use to express confirmation of their previous expectations but also to express surprise and uncertainty. These dictionaries are based on our reading of several Minutes from the three central banks, further enriched with machine learning techniques. We find a similar pattern across central banks, with committee members sometime confirming their previous expectation (i.e "as expected"), but very often acknowledging that the situation remains similar or trends continue. With respect to surprise, members seem to express either that the situation did not go as expected or comment on new risks, shocks and uncertainty in general. Our Confirmation dictionary contains keywords like: "As expected", "In line with", "Unchanged", "Consistent with", "Remain" and "Continue". By contrast, our Surprise dictionary contains keywords like: "Than expected", "Less likely", "Surprise", "Uncertain" and "Risk". For instance, typical Confirmation and Surprise quotes from the Accounts of the ECB meeting 23/01/2020 are (respectively):

> *In discussing recent inflation developments, members were encouraged by the fact that headline and underlying inflation had recently evolved in line with the December staff projections.*

> *Against the background of the pandemic, it was emphasized that the outlook for the euro area was subject to an exceptionally high level of uncertainty and that the March ECB staff projections already appeared rather outdated.*

With these dictionaries in hand we use computational methods to build measures of Surprise versus Confirmation. These are based on the count of the occurrences of

our keywords in Minutes, for each central bank, at meeting frequency. Our first set of results shows that:

(i) policymakers tend to express more confirmation than surprise in the Minutes.

(ii) more space is dedicated to ongoing trends and less to past expectations (either when they are confirmed or not).

(iii) the proportion of surprise to confirmation tends to increase during recessions and around specific events with uncertain outcomes, like the Brexit referendum and the US elections in 2016, and the Covid-19 pandemic more recently.

(iv) the Fed has been more likely to confirm than to be surprised relative to the BoE and the ECB.

(v) policymakers are more likely to express surprise in relation to real activity than to inflation and to confirm their views about monetary policy.

Overall, our results suggest that this communication is forward-looking, confirming the consensus that policy deliberation is based on forward-looking elements and and that there is a preference for highlighting continuity in monetary policy. The tendency for the Fed to be more likely to confirm than to be surprised compared to the other central banks could relate to various factors, such as heterogeneity in the severity of economic shocks they have faced or different forecasting abilities, but nothing in our data helps us clarify this. It could also simply be due to a strategic communication from central banks, i.e, to downplay or overplay the uncertainty component (see Herbert, 2022).

Finally, we show how the Fed, the ECB and the BoE's communication of surprise and confirmation relate to monetary policy decisions. For instance, do policy makers "wait and see" when confronted by surprising outcomes so that policy changes comes with some delay or do they act rapidly in response to shocks so that policy changes coincide with the highest uncertainty? Market participants look carefully for such clues, as the quote below (referring to the ECB accounts of September 2020) suggests:

> "Uncertainty was the key word ... it was mentioned 23 times," Nordea economist Jan von Gerich said. "Such language has been used in the past to signal the central bank is planning further stimulus measures. We expect this to be the case this time as well." Reuters, 8/10/2020

Overall, we find that meetings with policy changes (through interest rates or asset purchases) are preceded by a higher incidence of expressions of Surprise in the meetings ahead of the decision. In addition, we find this is predominantly the case when policy moves towards an easier stance. When estimating policy reaction functions using ordered-probit techniques, we find that the sentiment of the committee whether the economy is evolving as expected or not is informative about the policy stance, above and beyond what the macroeconomic data suggest. We find that a higher communication of Surprise increases the likelihood that the policy will ease in the coming meetings (controlling for the inflation and GDP growth projections). In contrast, a higher incidence of phrases confirming existing trends increases the likelihood of a tighter policy stance. These findings correspond well with the sources of surprise (economic activity) and confirmation (inflation) that we identify in Minutes.

Our study relates to several strands of the literature. First, it contributes to understanding the role and informational content of central bank communication (see Blinder et al. (2008) for a review). This literature is rapidly evolving towards studying such communication on policy meeting days (Gürkaynak et al. (2005); Nakamura and Steinsson (2018) for the Fed and Altavilla et al. (2019); Andrade and Ferroni (2021) for the ECB, among others) and outside of regular meeting days, i.e., in the form of speeches or Congress/Parliament hearings (Kohn and Sack (2004); Kliesen et al. (2019); Neuhierl and Weber (2019); Ehrmann et al. (2022); Istrefi et al. (2020) for the Fed, Ehrmann and Fratzscher (2007) and Born et al. (2014) for several central banks, and Ehrmann et al. (2014); Gertler and Horvath (2018); Tillmann and Walter (2019); Leombroni et al. (2021); Istrefi et al. (2022) for the ECB, among others).

We contribute by showing that communication of continuity and surprise in central bank Minutes can signal changes in monetary policy. This result confirms the informational content of Minutes for the central banks in our study but seen from a new angle relative to the existing literature. For instance, among others, Rosa (2013) shows a correlation between the publication of FOMC minutes and asset prices in the US and Jung (2016) shows that FOMC meeting minutes have provided assurance to markets about the most likely path of future interest rates.

Our focus on policymakers' communication of surprise relative to confirmation also relates us closely to the literature on policy uncertainty, as discussed in Baker et al. (2016) (BBD) with regard to uncertainty about several types of economic policy and more specifically about monetary policy in Husted et al. (2020). These measures are based on newspaper articles and are supposed to capture uncertainty

about economic policy as perceived by the public. By contrast, our measures capture uncertainty as expressed by the decision makers themselves. They are based on the deliberation by policymakers as expressed in Minutes and reflect policymakers' uncertainty about the state of the economy and how to respond to it. We show that the BBD measures of perceived (monetary) policy uncertainty seem to identify similar periods of high uncertainty as our measures of relative surprise as communicated by central bankers. Finally, our paper is complementary to the work of Cieslak et al. (2022) who study the Fed's uncertainty as expressed in the economy round of FOMC meetings, based on FOMC transcripts.[1] By contrast, our interest is in the expression of both confidence and uncertainty during the policy rounds of these meetings for the BoE, the ECB and the Fed, when the policy decision is discussed and taken. Even though we use different approaches and sources, we confirm that uncertainty is indeed a pervasive feature of monetary policy deliberation and that heightened communication of surprise and uncertainty by policymakers contains information for policy decisions.[2]

More generally, our paper also relates to the literature that investigates text in economics (Tetlock, 2007; Tetlock et al., 2008; Loughran and McDonald, 2011; Baker et al., 2016; Caldara and Iacoviello, 2022). An overview of methods for analyzing text and a survey of applications in economics is provided in Gentzkow et al. (2019). Work related to central bank communication, among others, includes Lucca and Trebbi (2011); Schonhardt-Bailey (2013); Hansen and McMahon (2016); Hansen et al. (2018); Acosta and Meade (2015); Hubert and Labondance (2021); Ehrmann et al. (2022); Gorodnichenko et al. (2021). Specific to text in Minutes, there are several contributions constructing positive or negative sentiments based on pre-defined dictionaries (Hansen and McMahon (2016); Josselyn and Meade (2017); Hubert and Labondance (2021); Jegadeesh and Wu (2017) on FOMC statements and minutes, among others) or hawkish or dovish sentiments (Apel and Blix-Grimaldi (2012) on Riksbank minutes, and Villanova et al. (2020) for the ECB, among others). We contribute by constructing expert-curated dictionaries containing terms that central bankers use to express their confident about their assessment (Confirmation) and when they are not (Surprise). We build these dictionaries for the Fed, the BoE and the ECB, allowing us to compare this type of communication across different central banks.

The paper is structured as follows. In Section 2 we introduce the dataset based

[1] Cieslak et al. (2022) policymakers' uncertainty index is a count of phrases related to risk and uncertainty relative to the overall count of words in the economy round of a given FOMC meeting.

[2] Kozicki and Vardy (2017) discuss various ways in which the Bank of Canada communicates about uncertainty when explaining its economic outlook and monetary policy decisions.

on central bank minutes and some stylised facts. In Section 3 we build our sentiment measures and compare them across time and with respect to other uncertainty measures. In Section 4 we discuss how central banks communicate about uncertainty around meetings with policy changes. We conclude in Section 5.

2 Communication through Minutes

To foster transparency and accountability in monetary policy, most advanced country central banks nowadays publish a policy statement immediately after the policy meeting and, with a delay of several weeks, a document that provides a more detailed summary of the policy discussions and deliberations in the meeting. This document is called the Minutes for the Fed and the BoE and the Monetary Policy Accounts for the ECB (hereafter collectively referred to as Minutes). Minutes contain far more detailed information about the arguments underlying the Committees or Board members' assessment of the state of the economy and the reasoning behind their monetary policy decisions, including the range of views of expressed by members. The Minutes contain considerably more information than the policy announcement.

Minutes are closely watched by market participants even though they come with a delay of some weeks after the policy decision. Market participants look for the details of the meetings and the nuanced discussion to better gauge the policy debate, the consensus of the members and look for clues for future policy moves. Several studies have shown that markets tend to respond to this information. For instance, among others, Rosa (2013) shows a correlation between the publication of FOMC minutes and asset prices in the US and Jung (2016) shows that FOMC meeting minutes have provided assurance to markets about the most likely path of future interest rates. Moreover, for our purposes the minutes are comparable across central banks in our analysis and they are publicly available.

While similar in concept, there are differences in the exact content of these Minutes across our central banks. For instance, the ECB Accounts are intended to present a "fair and balanced reflection of the policy deliberation" and they do not contain a formal voting record, although the degree of consensus is commonly provided. By contrast, both the Fed and the BoE Minutes provide information on votes, dissents and the main reasons why those members dissented from the majority or the consensus view.

The structure of these Minutes has been pretty stable over time. Following the structure of policy meetings themselves, Minutes are generally divided into two main

parts - an overview of economic and financial conditions (Presentations) and then the policymakers views on economic developments and the rationale for their policy decisions (Deliberation). The first part is presented by the staff at the Fed and by Executive Board members at the ECB and in the second part all committee members participate in the debate. The Minutes of the BoE have a different structure as they contain only the MPC members' views on the state of the economy and their deliberations on policy.

Table 1 shows some statistics on the frequency of policy meetings per year for each central bank, the publication lag and the sample period that we use for our analysis. The Fed has been releasing information related to the FOMC meetings since 1936. However, Minutes in the current format have only been released since 1993 (Meade et al., 2015). Over this time, there has been a reduction in the publication lag (currently 3 weeks after the meeting), providing the public with more timely information about policy deliberations and the rationale for policy decisions. The FOMC decision to accelerate the release by 3 weeks was taken in the meeting of December 2004 (which began with the Minutes of February 2005).

The BoE has published Minutes since late 1997. Following a procedural change in 2015, the Minutes of each meeting (including the policy preferences of each member) are published on the BoE's website at the same time as any decision is announced. Finally, the ECB started publishing its Accounts in 2015, with a delay of around four weeks after the ECB Governing Council's monetary policy meeting.

Table 1: Summary statistics about Minutes

Central bank	Meetings (per year)	Publication lag (in weeks)	Published votes	Number observations	Period
ECB	8	4	no	44	2015-2020
Fed	8	3	yes	219	1993-2020
BoE	12	0	yes	253	1998-2020

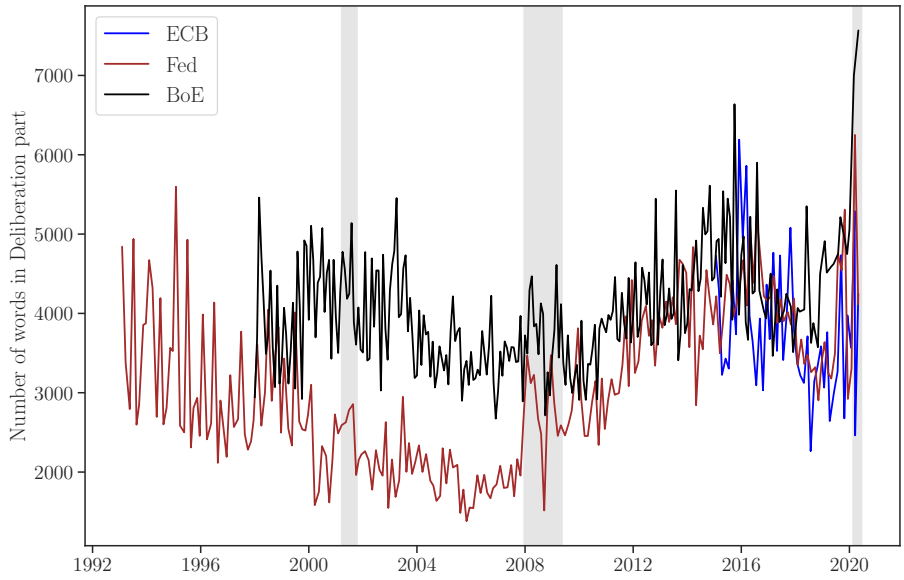
Note: The source are respective websites of the three central banks, ECB, Fed, BoE.

Our dataset contains every meeting date and its associated text of Minutes. However, we are only interested in the *Deliberation* part of the meeting where committee members present their views on the economy and deliberate on policy. Since the structure of these Minutes is relatively stable overtime, we are easily able to identify where the *Deliberation* starts, in order to split the Minutes and use only the relevant part of them. We have read several of these Minutes over time to identify the border split for the deliberation part. For instance, for the Fed the deliberation usually starts after the section "Staff Review of..." or the paragraph "In its forecast prepared

for this meeting..." and for the ECB after the line "Governing Council's discussion and monetary policy decisions" (see related details in Table A.1 in Appendix).

On average, we notice that the deliberation part captures a prominent space in the Minutes, at last half of it for the Fed and more than half for the ECB. In Figure 1 we show the evolution over time of this part (in number of words) for each central bank. We can observe already some interesting common trends. The lengths of the Minutes have varied through time and tended to move together across the three central banks. The Minutes for the Fed and BoE were comparatively short during the Great Moderation of the mid-2000s but have risen in tandem after the Great Financial crisis. Looking at more specific episodes we can observe that major global events lead to an increase in the number of words in the deliberation part of the Minutes, i.e., around recessions and events with uncertain outcomes, such as Brexit, the US elections, the USA and China trade war, the Covid-19 pandemic and so on. The general increase in the number of words after the financial crisis could also be related to the introduction of unconventional monetary policy measures and it might also reflect a greater diversity of viewpoints or more transparent reporting of the diversity of views.[3]

Figure 1: Deliberating monetary policy, Fed, BoE and the ECB



Note: Number of words in the Deliberation part over time across central banks, moving average of four meetings.

Furthermore, Figures A.1 and A.2 in the Appendix provide suggestive evidence

[3]Meade et al. (2015) have shown that the FOMC meeting minutes capture a wide diversity of viewpoints and that this diversity appears to have increased over time, particularly since the financial crisis.

that the length of the Deliberation component is influenced by the chair of the committee. For example, there was a trend decline in the length of the Deliberation section for the FOMC under Chairman Greenspan, which reversed under Chairman Bernanke. Similarly, the average length of the MPC's minutes were shorter under Mervyn King than Eddie George. These suggest that communication styles can differ within the same institutional framework.

3 Surprise versus Confirmation in Minutes

In the following, we analyse the relative frequency of statements of continuity or confirmation versus statements of surprise or uncertainty, as expressed in the Deliberation part of the Minutes. To achieve this we build measures that express: i) policymakers' confirmation of their views about the state of the economy and ii) policymakers' surprise and uncertainty about the state of the economy. Working with the text of the Minutes, we proceed in several steps, combining expert knowledge with textual analysis approaches.

The first step is to build a dictionary of keywords that help the machine algorithm to identify automatically those parts of the text that can be categorised as either expressing Confirmation or Surprise on the part of the policymaker.[4] We build this dictionary based on our readings of several Minutes (evenly distributed over time and central banks). We read several of these texts and identified quotes that a human reader (an expert) would categorise as either Confirmation or Surprise. After evaluating this selection of quotes, we identified a list of keywords that are present in these quotes and help distinguish confirmation versus surprise sentiment. Table 2 shows some examples of quotes and selected keywords.

During these readings, we noticed that there are nuances around how committee members express Confirmation and Surprise. Sometimes they explicitly confirm previous expectations ("as expected"), but on other occasions confirmation is more indirect through the absence of surprise (for example "the situation remains" or "trends continue". With respect to Surprise, members either seem to express that the situation did not go as expected or comment on new risks, shocks and uncertainty in general. To capture these nuances, we divided the keywords into two subcategories of Confirmation and Surprise, as presented in Table 3.

In a second step, we use textual analysis algorithms to extend the scope of our dictionaries (to add relevant synonyms) and to take into account negations. Our final

[4]In the dictionary approach, the researcher relies on "expert-curated" (Davis et al., 2020) terms to characterize and quantify the information content in relevant text documents.

Table 2: Human reading and keyword identification

Date	Confirmation quote	Surprise quote	Keywords
ECB, 23/01/2020	In discussing recent inflation developments, members were encouraged by the fact that headline and underlying inflation had recently evolved *in line with* the December staff projections.	Against the background of the pandemic, it was emphasised that the outlook for the euro area was subject to an exceptionally high level of *uncertainty* and that the March ECB staff projections already appeared rather outdated.	"in line with"; "uncertainty"
Fed, 29/01/2020	Participants acknowledged the staff report suggesting that overall financial vulnerabilities *remained* moderate and that the financial system remained resilient.	All saw U.S. economic activity as likely to decline in the coming quarter and viewed downside *risks* to the economic outlook as having increased significantly.	"remain"; "risk"
BoE, 29/01/2020	Indicators of uncertainty covering the post-election period had fallen *broadly in line with* the Committee's expectation in the November Report.	... in which prices had tended to increase more slowly *than had been expected* given developments in unit wage costs and import prices.	"broadly in line"; "than...expected"

Note: This table shows examples of quotes and selected keywords from the first step of human reading several Minutes for the Fed, the BoE and the ECB.

Table 3: Keyword dictionary from the human reading phase

Confirmation

Confirmation about past expectations	*Confirmation of an on-going trend*
"As [...] expected"; "In line with"; "Unchanged"; "Little changed"; "Changed little"; "Consistent with"	"Remain";"Continue"

Surprise

Surprise about past expectations	*Surprise: other*
"Than [...] expected"; "Than [...] envisaged"; "Than [...] anticipated"; "Than [...] thought"; "Than at the previous meeting";"Less likely"; "In contrast to expected";"Surprise"; "Forecast/outlook/growth/inflation [...] revised"	"Shock"; "Uncertain";"Risk"

Note: Selected keywords based on readings of Minutes from the Fed, BoE and the ECB Accounts.

keyword dictionaries, and their extended versions with control rules, are presented in Table A.2 in Appendix A. Concretely, the algorithm performs the following steps:

1. Pattern analysis. Some keywords are not attached words and exhibit patterns such as "than [...] expected". We used a Regular Expression framework to capture quotes that contain such patterns.

2. Lemmatisation. We work with the grammatical root of our keyword (the lemma) to be able to capture every grammatical form of them, i.e to capture both "surprising" and "surprise".

3. Negations. We employ RegEx framework to discard any sentence that contains

a control or negation word that changes the meaning of a particular keyword, found in the same sentence. We present the list of control and negation words in Table A.3 in Appendix A.

3.1 Surprise to Confirmation Sentiments

To build our sentiment indicators we begin by counting the occurrences of dictionary words in each subcategory in the *Deliberation* part of the Minutes of each central bank. We take into account that the number of words in the *Deliberation* part changes across central banks and time by defining "sentiment" as the ratio between the frequency of all keywords and the total number of words in each of the Minutes. Concretely:

$$Sentiment_{i,t} = \frac{\sum x_{i,t}}{N_t}$$

with $x_{i,t}$ being the count of keywords in dictionary $i = [confirmation, surprise]$ in Minutes of meeting t and N_t being the total of words in the Deliberation part.

Figure 2 presents the evolution of these sentiments for our three central banks. We observe several common features. Both central banks tend to make more confirmatory statements (blue) than surprise statements (yellow). Within each main category, we notice a higher proportion of forward-looking statements, with more space dedicated to ongoing trends and less to past expectations (whether they are confirmed or not). The low share of the "past" and the high share of continuing trends and expectations highlights the fact that policy discussions in the Deliberation part are based on forward-looking elements. Although it might be coincidental, in both central banks the overall proportion of sentiment words increased over the first 5-10 years, suggesting that both committees found these words useful to explain their decisions.

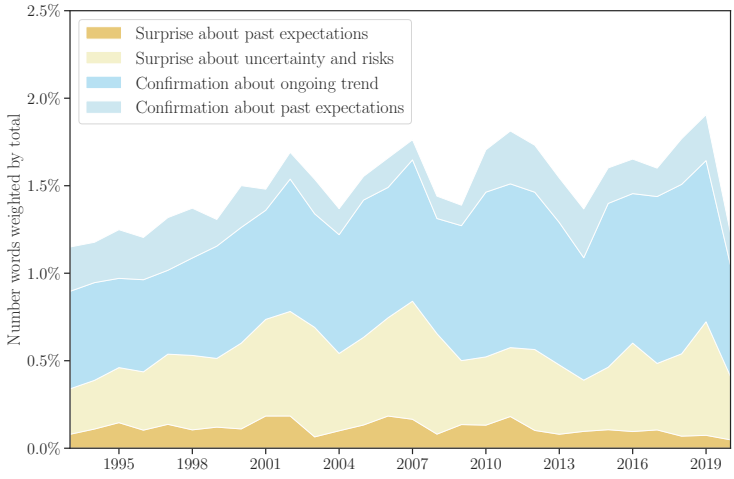
Finally, we compare the evolution of Surprise over Confirmation sentiments, for each central bank. We calculate three ratios, one referring to Surprise total versus Confirmation total and the other two with respect to the past and actual/future (trend) subcategory, at each meeting:

$$Ratio_{total,t} = \frac{\sum x_{Surprise,t}}{\sum x_{Confirmation,t}}$$

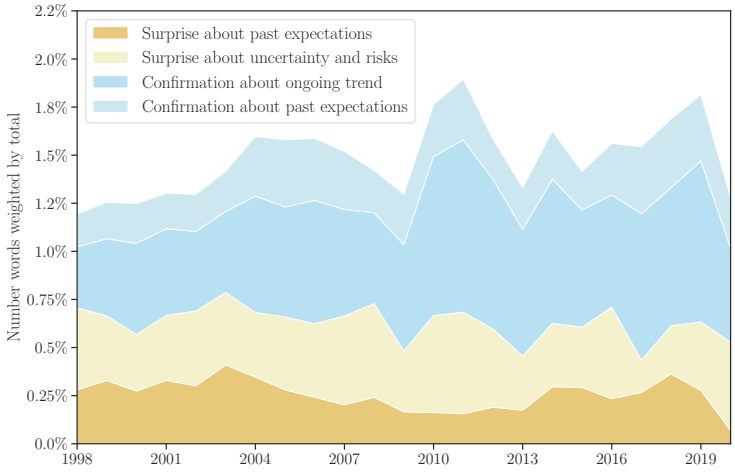
$$Ratio_{past,t} = \frac{\sum x_{SurprisePast,t}}{\sum x_{ConfirmationPast,t}}$$

$$Ratio_{trend,t} = \frac{\sum x_{SurpriseTrend,t}}{\sum x_{ConfirmationTrend,t}}$$

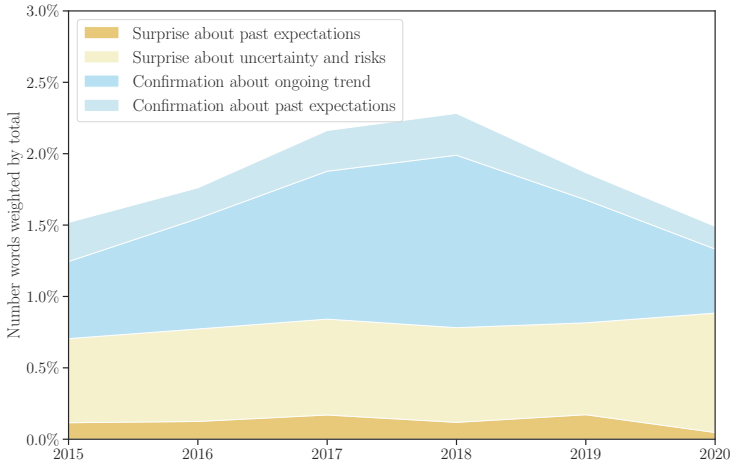
Figure 2: Evolution of Surprise and Confirmation sentiments



(a) Fed



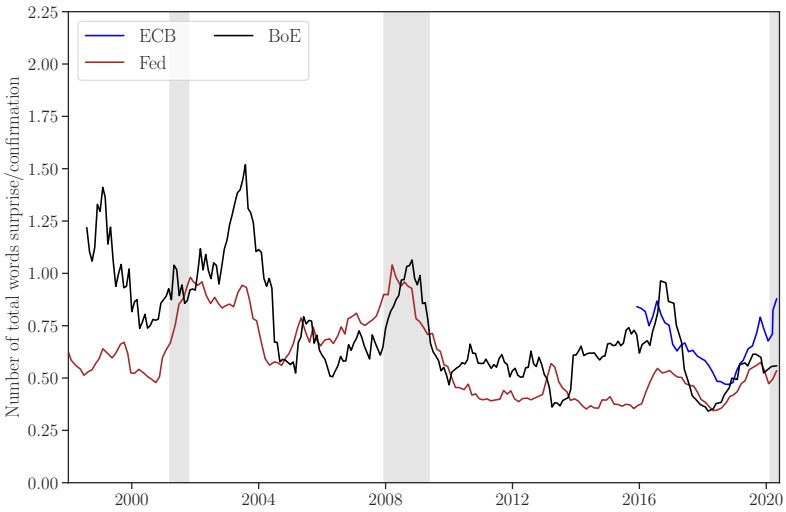
(b) BoE



(c) ECB

Note: These shares represent the count of keywords weighted for total words in text. The figure shows the annual averages of each sentiment measure.

Figure 3: Surprise to Confirmation ratio - total

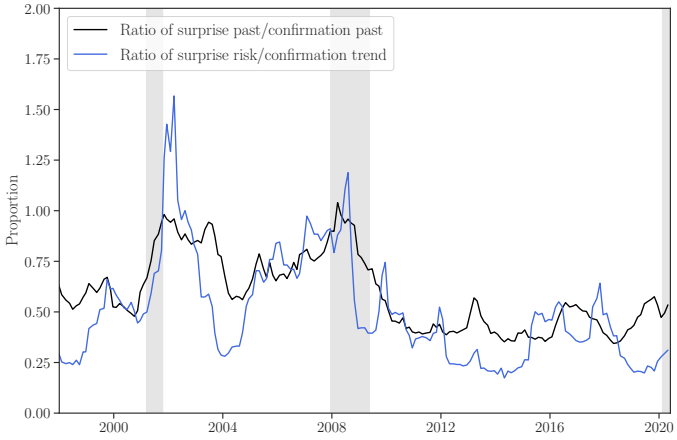


Note: The figure shows the ratio of all Surprise versus all Confirmation measure (annual averages).

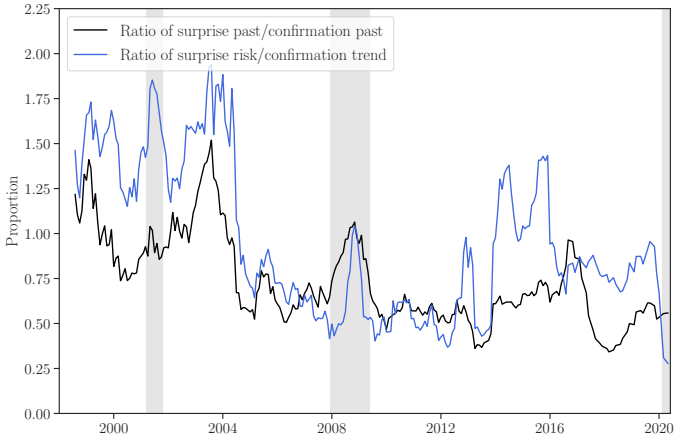
Figure 3 shows a striking similarity in the relative ratio of surprise through time between the Fed and the BoE. We have much more limited observations for the ECB but over the common time period, they follow a broadly similar trend to the other two. There are identifiable patterns behind these similarities. Relative surprise tends to increase during recessions and specific events with uncertain outcomes, like the Brexit referendum and the US elections in 2016, and the Covid-19 pandemic more recently. It is particularly interesting to observe the decline in surprise during 2017-2018, a period with comparatively positive economic developments for the US, and the UK but also for the euro area. The spike in this ratio for the Fed in 2013, reflects internal discussions, uncertainties and risks surrounding the potential tapering of asset purchases, which was subsequently followed by the so-called "taper tantrum" episode. Moreover, in general, it seems that the Fed has been more likely to confirm than to be surprised compared to the BoE (and also to the ECB in the last part of the sample). This could relate to various factors, either different economic conditions, different forecasting abilities or to strategic communication from central banks either to downplay or overplay the uncertainty component.

In Figure 4 we split the total ratios into forward-looking (“trend") and backward-looking “past") statements. We observe that “past" and “trend" uncertainty tend to move together, consistent with the idea that surprises with respect to past expectations increase uncertainty about future outcomes. Overall, both types of relative surprise are roughly equally present, although the forward-looking relative surprise measure is more volatile for all three central banks. In particular, these sentiments tend to increase during recessions.

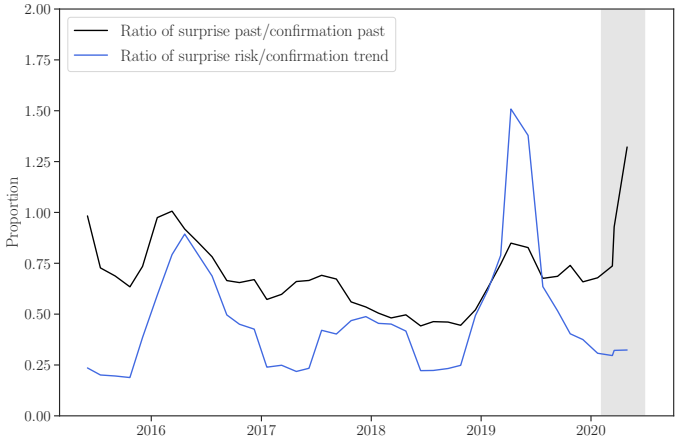
Figure 4: Surprise to Confirmation ratios - detailed



(a) Fed



(b) BoE



(c) ECB

Note: The figure shows the ratio of Surprise versus Confirmation measures (annual averages).

3.1.1 What are central bankers more confident or surprised about?

In the following we investigate which topics are more likely to be found in confirmation quotes and in surprise quotes. Are central banks more surprised about inflation or other economic variables? Importantly, the Federal Reserve has a dual objective: maximum employment and stable prices while the ECB and the BoE have a price stability objective. Thus, we expect that topics communicated in each category will vary across these central banks.

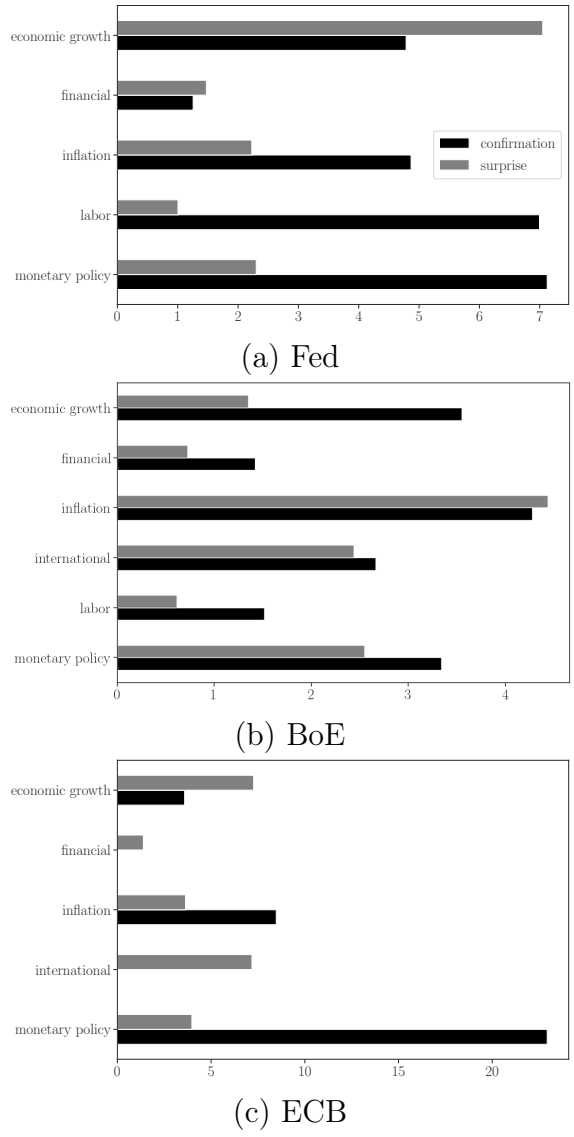
To answer to these questions we look at the top 30 words that appear in quotes that we have labeled as "Surprise" and "Confirmation". In this list we observe our main keywords like "remain", "continue", "risk" and "uncertainty" among the top words used in these quotes and this is similar across central banks. Second, words like, "committee", "members", "participants", "governing council" and word "monetary policy" and words about policy instruments like, "interest rate", "bank rate", "fed funds rate" also show up, a confirmation that we are looking at policymakers' assessments about the state of the economy and their deliberation on policy. Third, in terms of economic variables, we observe we have different words that relate to the same concept, like, "inflation" and "prices" or "economic activity" and "economic outlook". For ease of analysis, we have grouped similar words under one topic. For instance, under "monetary policy" topic we grouped all the words that relate with policy instruments and under "financial", those words that relate with financial market conditions.

We present these results in Figure 5. This figure shows the average count of words pertaining to each topic, in either Confirmation or Surprise quotes, per each central bank Minutes, respectively. Overall, we find similar topics in these quotes, like "monetary policy", "inflation" and "economic growth" but there are also differences. The topic "labor" appears prominently for the Fed, especially in Confirmation quotes. We see the labor topic in the the BoE discussions as well but not for the ECB. In addition, the BoE and the ECB quotes contain references to the external environment but not those of the Fed. Interestingly, for the ECB, the external environment appears strongly in Surprise quotes, as a source of uncertainty and risks.

The topic "Inflation" is among the top ones in Confirmation and Surprise quotes for the three central banks. For the Fed and the ECB this topic appears more in Confirmation quotes, while for the BoE it takes same weight on both types of quotes. We observe the reverse when considering the "economic growth" topic, suggesting that the Fed and the ECB have spoken more confidently about the evolution of inflation and have considered economic outlook and growth as more uncertain. Fi-

nally, all three central banks "confirm" monetary policy rather than express surprise, suggesting a preference for highlighting continuity in monetary policy.

Figure 5: Top words from Confirmation and Surprise quotes



Note: This figure shows main topics in the top 30 words in Confirmation and Surprise quotes and the respective average count of these words per Minutes.

3.1.2 Comparison with benchmark policy uncertainty measures

In the following we compare our sentiment of Surprise as expressed in policy communication with the well known measure of economic policy uncertainty of Baker et al. (2016) (BBD). This measure is calculated based on the frequency of newspaper coverage of uncertainty in relation to economic policy in general (EPU) or specific

to monetary policy (MPU). The latter measure is available only for the US.

Conceptually, the BBD measures are supposed to capture uncertainty about economic policy as perceived by the public, such as uncertainty about what measures will be taken or uncertainty over the effect of policies. In contrast, our measure reflects policymakers' uncertainty about the state of the economy as communicated while deliberating monetary policy. However, since Minutes are public information, it is likely that policymakers' uncertainty will feed into public uncertainty and, thus be reflected in the EPU and the MPU measures of BBD. It might also work the other way, with heightened public uncertainty about policy feeding back onto the discussions of policymakers.

When comparing these indices with our measure of policymaker's uncertainty we see that they generally move together (see Figure 6). We observe a correlation of up to 0.5 in the case of the Fed between our measure and the MPU of BBD. Correlations with the EPU are positive but smaller (0.3 the highest for the ECB). Overall, even though the EPU measures are based on different dictionaries and applied on different communication outlets, they seem to capture high uncertainty periods similarly as communicated by central bankers.

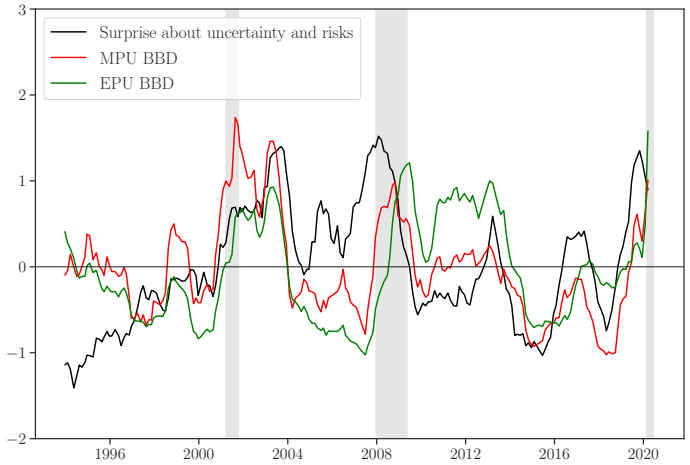
4 Communication of surprise and policy changes

In the following we analyze how the Fed, the ECB and the BoE's communication about risk and uncertainty relates to changes in monetary policy. For instance, do policy makers "wait and see" in face of high uncertainty, and the policy change comes only after some periods with high uncertainty or is policy adjusted promptly in response to new information reflected in greater surprise?

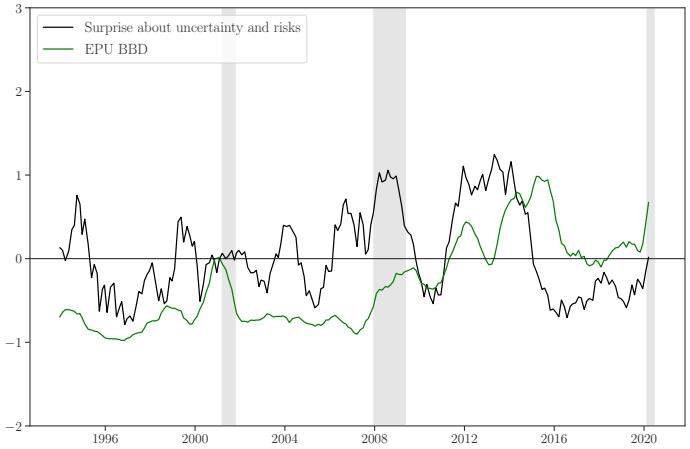
To investigate this, we first examine how central banks communicate around meetings with policy changes. We start by classifying policy meetings into those with a policy change and those that don't, considering conventional and unconventional policies, i.e., interest rate and balance sheet policies, although we leave out changes in forward guidance because they were often renewed because they were about to expire. Then, for each meeting with changes, we look at the sentiment of "Surprise" in that meeting and the two meetings before and after. Finally, we average across all these meetings and look at the distribution of this sentiment (median and two standard deviations), at each of these lag, lead dates.

In a second exercise, we divide meetings with policy changes into meetings with tightening or easing of policy. To this end, we construct a "policy stance" indicator, differentiating between monetary policy decisions with no change and with decisions

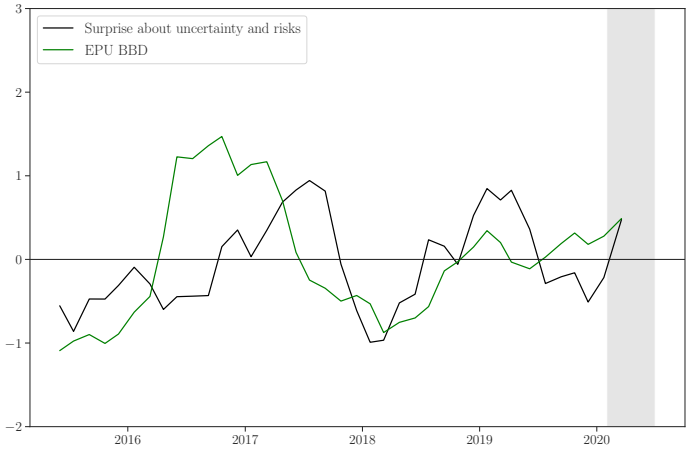
Figure 6: Comparison with BBD uncertainty measures



(a) Fed



(b) BoE



(c) ECB

Note: To compare these with our measure, we averaged them all between meeting dates. For comparability, all measures are standardized and we calculated the moving average over four meetings. BBD's monetary policy uncertainty (MPU) is available only for the US.

that indicate policy easing or tightening. We define monetary policy changes as easing (tightening) if one of the following three criteria is met: (i) a decrease (increase) in policy rate was announced, (ii) new unconventional measures were announced that aimed at providing more (less) monetary stimulus, or (iii) the parameters of unconventional measures were adjusted to provide more (less) stimulus. Working with a "policy stance" indicator rather than the policy tool itself is important when examining sample periods where conventional tools where constrained (interest rates at the zero lower bound) and monetary policy has been conducted with new tools, like balance sheet policies. Overall, our definition of policy stance leads to 40 (30) tightening (easing) events for the Fed for the period 1993-2019, 17 (33) tightening (easing) events for the BoE for the period 1998-2019, and only 9 easing events for the ECB for the period 2015-2019.[5]

We can observe relatively similar communication styles, focusing first on the top panel of Figure 7. The peak expression of surprise for our central banks occurs in meetings ahead of policy changes. This suggests that policymakers are cautious when facing uncertainty and wait for more information before changing policy. The lower panel of Figure 7 indicates that this is predominantly true ahead of easing decisions. There is a stark difference between loosening episodes (where surprise is highest in advance of decision meetings) and tightening episodes (when it is the reverse). These differences in behavior are statistically different.

In the following, we look at this issue more formally, and test whether Surprise and Confirmation sentiment in Minutes give clues on forthcoming monetary policy decisions, beyond what the state of the economy suggests. To do this we estimate policy reaction functions controlling for the forecasts available to the policymakers at the time of the decision.

As discussed above, since a large part of our sample corresponds with a period when policy rates were stuck at the zero lower bound and other (unconventional) tools were being used to conduct monetary policy, we work with the measure of policy stance, to account for monetary decisions with different tools. At each meeting, policymakers face three mutually exclusive choices: tighten the monetary policy stance, loosen it or keep it unchanged. We consider these options, controlling on the one hand for the expected levels of inflation and economic growth, typically used

[5]We do not take into account forward guidance on rates and asset purchases because measuring policy stance from changes in forward guidance is challenging. We find it difficult to assess whether a change in the forward guidance communication reflects a change in the policy stance or a change in the clarity of the FG communication, considering that, this communication has changed often from open ended, to calendar-based and then to state-dependent forward guidance. In addition, we abstract from changes in unconventional tools that are not undertaken for monetary policy reasons.

Figure 7: Surprise (total) around meetings with policy change

Note: These figures show sentiment of Surprise past and about risk/uncertainty as expressed in the Deliberation part of respective central bank minutes. The sample correspond to the period 1993-2020 for the Fed, 1998-2020 for the BoE and since 2015 for the ECB.

in forward-looking Taylor-type rules (Taylor, 1993) and, on the other hand, for its current and previous communications on Surprise or Confirmations, as measured in Minutes.

Given the latent nature of our dependent variable, we specify an Ordered Probit model in the spirit of (Gerlach-Kristen, 2004; Gerlach, 2007)[6], as below:

$$MPstance_t = \phi_\pi E_t\pi_{t+h} + \phi_{dy} E_t dY_{t+h} + \phi_{Minutes} CommunicationMinutes_t^i + u_t \quad (1)$$

where $MPstance_t$ is the ordinal variable capturing the change of the policy stance taking three values: 1 for policy tightening, -1 for policy accommodation and 0 for no policy change, constructed as explained above. $E_t\pi_{t+h}$ and $E_t dY_{t+h}$ represent central bank forecasts of inflation and GDP growth (at time t, for a specific horizon h), respectively. Finally, $CommunicationMinutes_t^i$ is our standardised communication measure for $i = \{Surprise, Confirmation\}$. Equation (1) constitutes an ordered-response model that says that the committee members will adopt one of the policy stance options depending on their forecasts about the economy but also on their assessment, captured by our sentiment measures, whether the economy is evolving

[6]Gerlach-Kristen (2004) has studied the information content of MPC votes for the BoE's future interest rate decisions. Gerlach (2007) and Cour-Thimann and Jung (2020) estimate reaction functions for the ECB where the dependent variable is ordinal, representing interest rate changes at different magnitudes, ranging from +0.5% to -0.75%. Cour-Thimann and Jung (2020) have augmented the ECB's reaction function with communication indicators on risks to price stability as reflected in the ECB's Introductory Statements.

as expected (Confirmation) or not (Surprise).

For each central bank we use forecasts available to the respective committees when deciding policy. For the Federal Reserve, we use Greenbook forecasts on inflation (PCE) and real GDP growth, four quarters ahead. These forecasts are prepared by the Research staff at the Board of Governors some days before each FOMC meeting and are made available to all FOMC members. Since these forecasts are published with a five year delay, our sample will be constrained to the period 1993 to 2015. For the ECB, we employ one-year ahead ECB/Eurosystem staff macroeconomic projections on real GDP growth and HICP inflation for the euro area. These forecast are prepared four times a year (ECB staff forecasts in March and September and Eurosystem staff in June and December) and provide important input into the ECB Governing Council's monetary policy decisions.[7] For the other four meetings without a forecast round, we assign them the most recently available forecast that corresponds to an horizon of four quarters ahead from the quarter of the current meeting.

The BoE publishes the MPC's macroeconomic forecasts, which are a key input to the setting of monetary policy. These forecasts are communicated each quarter in the *Inflation Report*.

We present our findings for the BoE and the Fed in Table 4. For the ECB we discuss the results in the text as the sample (about 40 observations and with no tightening episodes) is too small for meaningful conclusions. First, we present a baseline specification for each central bank with forecasts only. We observe that a higher forecast for inflation and output growth increases the probability of a policy tightening, in line with the predictions of a typical forward-looking Taylor rule.

A key finding of this section is that a higher Surprise sentiment (both about the past and the new risks and uncertainty) lowers the likelihood of a tighter monetary policy stance. For both central banks, previous communication is significant, that of one meeting before for the BoE and two meetings before for the Fed. In addition, for the BoE these estimates are significant for both the contemporaneous and the previous meeting measures when considering the sub-measure of Surprise about risks and uncertainty (results not shown here for brevity). We find similar qualitative effects for the ECB but the corresponding estimates are not statistically significant.

By contrast, a higher proportion of confirming statements (about the past and trend) by BoE policymakers increases the likelihood of a tighter policy stance. We observe a similar significant result for both the BoE and the ECB when taking into

[7] A full database of past projections is available for download from the ECB's Statistical Data Warehouse.

Table 4: Ordered Probit policy reaction functions

	Bank of England			Federal Reserve		
Variables	Baseline	Surprise	Confirmation	Baseline	Surprise	Confirmation
CPI forecast	**0.574**	**0.739**	**0.528**	**0.665**	**0.580**	**0.725**
	[0.185]	[0.173]	[0.215]	[0.151]	[0.160]	[0.166]
GDP forecast	**0.598**	**0.662**	**0.490**	**0.464**	**0.491**	**0.484**
	[0.132]	[0.144]	[0.123]	[0.116]	[0.114]	[0.113]
Communication		0.015	**0.210**		-0.064	0.041
		[0.117]	[0.097]		[0.062]	[0.076]
Communication (-1)		**-0.287**	**0.200**		-0.065	0.008
		[0.121]	[0.108]		[0.071]	[0.083]
Communication (-2)		0.006	-0.064		**-0.151**	0.046
		[0.127]	[0.103]		[0.072]	[0.073]
Pseudo-R^2	0.20	0.24	0.27	0.06	0.10	0.07
LR	23.90	29.58	32.71	20.05	32.99	21.59

Note: Results from the estimation of the ordered probit regression for the BoE and the Fed. The dependent variable captures the change of the policy stance taking three values: 1 for policy tightening, -1 for policy accommodation and 0 for no policy change. The sample period for the BoE is 2007:08-2019:12 (138 obs) and for the Fed is 1993:02-2015:12 (184 obs). Figures in bold show significance level of at least 10%. Huber-White standard errors are presented in brackets. Communication refers to the Surprise total (sentiments of "Surprise about past expectations" plus "Surprise new risks/uncertainty") or Confirmation total (sentiments of "Confirmation about past expectations" plus "Confirmation of an on-going trend") from respective central bank Minutes. The CPI and GDP forecast are one year ahead forecasts for each central bank, as explained in text.

account the sub-measure of Confirmation about trends, particularly. For the Fed we observe similar qualitative results but the estimates are not statistically significant.[8]

We discussed before that the top words in Surprise quotes for the Fed and the ECB are rather for the economic growth and top words in Confirmation quotes are about inflation. These results combined suggest that a higher communication of risk about growth correlates with a lower probability of tightening of policy and a higher confirmation of trends for inflation correlates with a higher probability for tighter policy. Differently from the Fed and the ECB, inflation is the top word in both Surprise and Confirmation quotes of the BoE, thus the message is less clear. Overall, our results suggest that the committee members will adopt one of the policy stance options depending not only on their forecasts about the economy but also on their assessment whether the economy is evolving as expected (Confirmation) or not (Surprise).

[8]We observe the same conclusion for the BoE and the Fed when we include the Confirmation and Surprise sentiments in one regression. These results are available upon request.

5 Conclusion

Central banks make decisions against a backdrop of evolving uncertainty. Assessments about the recent past, current conjuncture and near-term outlook are in constant flux as new data arrives and economic shocks are observed. In this paper we have constructed measures of expressions of surprise and continuity from the published Minutes of the monetary policy setting committees of the US Federal Reserve, the Bank of England and the European Central Bank. We show that these measures fluctuate over time, consistent with episodes of relative economic tranquility and volatility and in line with other measures of policy uncertainty such as Baker et al. (2016).

However, there are important differences in the way these central banks communicate about uncertainty even though all three have similar mandates and policy instruments. These differences could partly be a question of style and there is indicative evidence that the identity of the the chair of the committee can influence the style of the Minutes. But it seems also to reflect differences in decision-making style. In general, we observe that policymakers signal policy easing in advance by communicating higher uncertainty and surprise in meetings prior to its actual decision to change policy. This communication is starkly different between decisions to loosen and tighten. In contrast, a higher communication of confirming trends is more likely to signal a tighter policy.

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A Data and Methodology

Table A.1: Splitting choices

Central bank	Total words (period average)	Deliberation words (share of total)	Deliberation border
Fed	6458	3064 (1/2)	"Staff Review of..." or "In its forecast prepared for this meeting..."
ECB	6594	3806 (2/3)	"Governing Council's discussion and monetary policy decisions"
BoE	4028	4028 (1)	Entire text

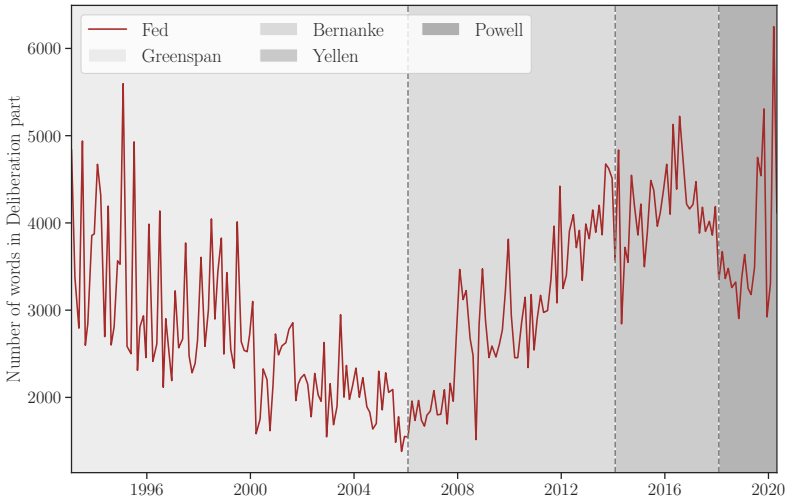


Figure A.1: Deliberating monetary policy, FED

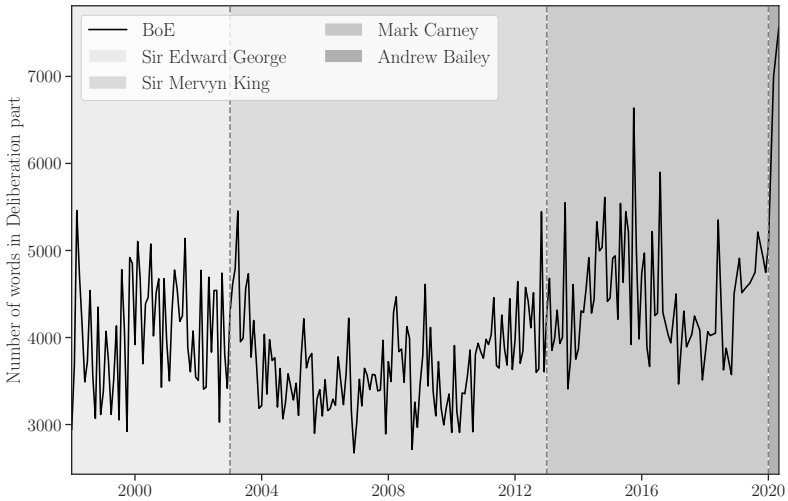


Figure A.2: Deliberating monetary policy, BOE

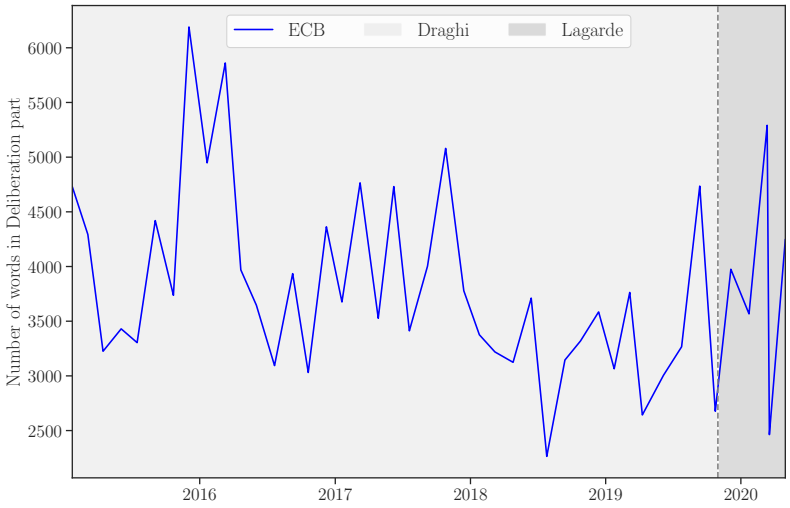


Figure A.3: Deliberating monetary policy, ECB

Table A.2: Extended keyword dictionary

Main category	**Confirmation**	
Sub categories	*Confirmation about past expectations*	*Confirmation of an on-going trend*
Keywords	No conditional word +: "As [...] expected"; "In line with"; Negation+"changed"; Negation +"altered"; "Consistent with"; Negation +"surprise"	No conditional word +: "Remain";"Continue"; "Stay"
Main category	**Surprise**	
Sub categories	*Surprise about past expectations*	*Surprise about risk*
Keywords	No conditional word +: "Than [...] expected/envisaged/ anticipated/thought/at the previous meeting"; Negation+"likely"; "In contrast to expected"; "Forecast/outlook/growth/inflation [...] revised"; Negation +"expected/anticipated/envisaged /thought"; "Surprise"; Negation+"in line with"; Negation+"consistent with";	No conditional word +: "Shock"; Negation+"certain"; "Risk";"Danger";"Doubt";

Table A.3: Control words list

Type	**Control words**
Diminisher/negation	no, not, never, none, nothing, neither, nor, nowhere, cannot, without hardly, less, little, rarely, scarcely, seldom Prefixes: un-, in- ; Suffix: -less
Conditional	if, could, provided that, given that

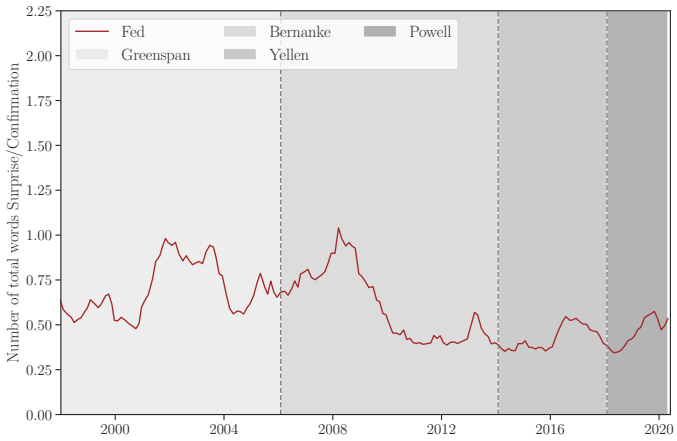
B Further Results

Table B.1: Distribution of quotes per category

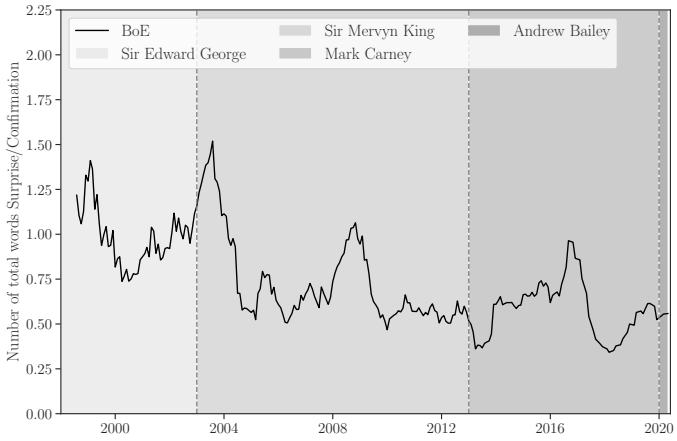
Main category	**Confirmation**	
Sub categories	*Confirmation about past expectations*	*Confirmation of an on-going trend*
Number of quotes	4954 (27,3%)	13257 (72,7%)
Total	18211 (61%)	

Main category	**Surprise**	
Sub categories	*Surprise about past expectations*	*Surprise about risks*
Number of quotes	3055 (27,2%)	8197 (72,8%)
Total	11252 (39%)	

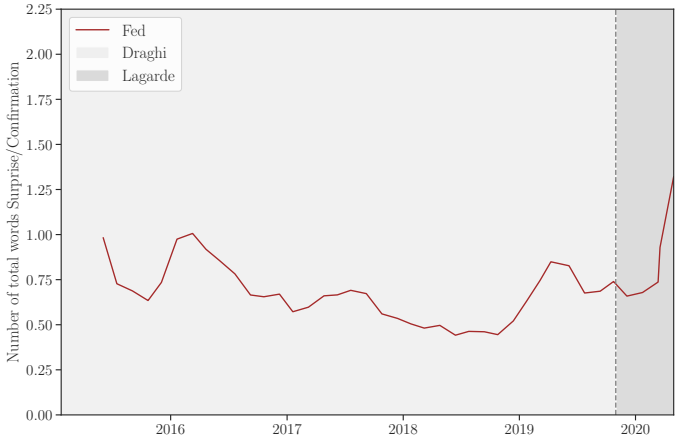
Figure B.1: Surprise all to Confirmation all ratio



(a) Fed

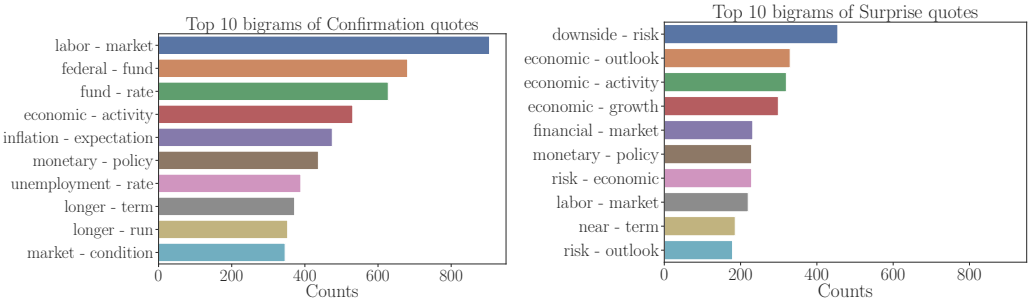


(b) BoE

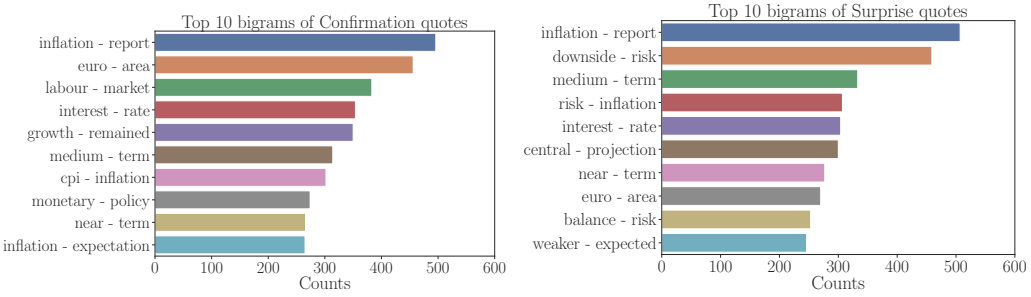


(c) ECB

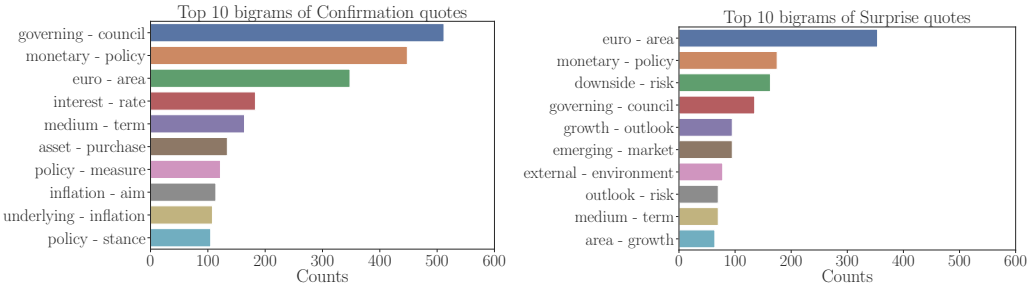
Figure B.2: Top 10 bi-grams from Confirmation and Surprise quotes



(a) Fed



(b) BoE



(c) ECB

Figure B.3: VIX and our index compared for the FED

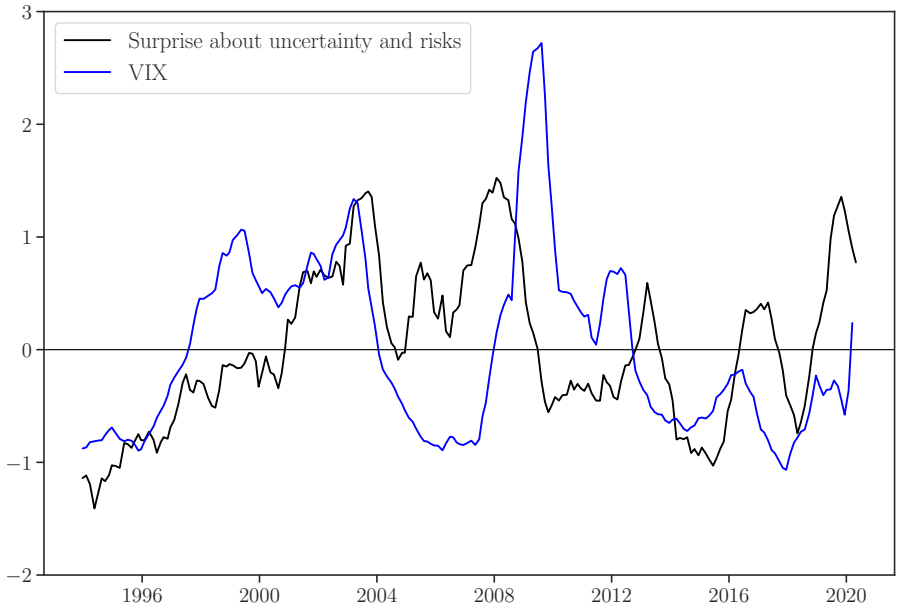
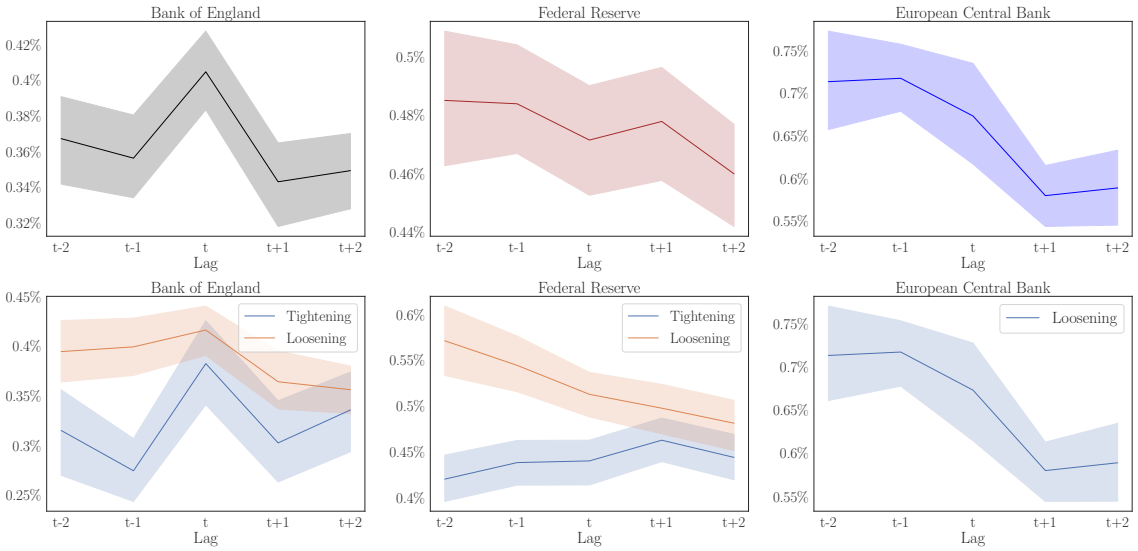


Figure B.4: Surprise abour risk/uncertanty around meetings with policy change



Note: These figures show sentiment of Surprise abour risk/uncertainty as expressed in the Deliberation part of respective central bank minutes. The sample correspond to the period 1993-2020 for the Fed, 1998-2020 for the BoE and since 2015 for the ECB.