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FOMC minutes sentiments and their impact on financial markets☆

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ABSTRACT

I develop a semi-automated method that systematically evaluates the information in FOMC meeting documents. This method highlights economic conditions and calculates document sentiment indices that proxy for the FOMC's interest rate tilt. I compare the sentiment indices of FOMC minutes and their corresponding FOMC statements. Using high-frequency data, I then examine how these sentiment indices are associated with the fed funds futures contracts, broad equity, and real estate investment trust indices, and exchange rate valuation of several major currencies against the U.S. Dollar. I find that minutes sentiments have a statistically significant association with the fed funds futures rate and the U.S. dollar's valuation.

1. Introduction

With the evolution of monetary policy, the Federal Reserve has implemented policy tools that address concerns as well as communicate discussions about the economy. As policy decisions are announced, the Fed releases documents explaining the Federal Open Market Committee's (FOMC) rationale for the policy decision. These documents convey the economic conditions and forecasts relevant to policy decisions. With the amount of attention that the Fed receives, these policy documents can influence the public's overall economic assessment as well as their beliefs about future policy targets.

The most prominent types of meeting documents are the brief statements that are released shortly after the meetings and the meeting minutes released three weeks afterward. Much of the previous research has focused on the effect of statements on financial markets because of the timing of their release and their shorter length. As Rosa (2013) explains, the minutes, however, still receive a significant amount of attention because they are longer and contain more information and nuances about the policy meetings. Examining their importance also offers a more independent analysis compared to the policy statements since minutes releases do not overlap with announcements about monetary policy changes. Connecting to this strand of literature that considers the relevance of policy documents, my current work introduces a semi-automated method that evaluates both the content of FOMC meeting minutes and their corresponding statements. Using my approach, I examine the discussed economic conditions and outlook. In contrast to the discrete sentiment measures used in previous work, I create a continuous sentiment index measure that proxies for the policy rate tilt. This tilt reflects the idea that the FOMC is more likely to raise the policy rates sooner when output is growing faster and/or inflation is

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rising. On the other hand, the policy committee has a higher likelihood of lowering the policy rates when output growth is lower and/or price growth is declining.[1]

Considering the importance placed on the meeting minutes, I evaluate how the sentiments of these policy documents impact the predictability of financial market changes. If the statements clearly and fully convey the state of the economy, then the minutes sentiments will not improve the forecasts about financial markets. However, if the minutes offer more information beyond those included in the statements, then they may increase the predictability of asset price changes. The relevance of new information in the minutes depends on whether the differences are systematic or not. If the statements consistently lessen the hawkishness of the policy tilt relative to the minutes, then the market participants can adjust their expectations and, eventually, the minutes will lose their relevance to markets. Hence, the minutes will have a significant effect on financial market predictability only if they provide a more precise set of information about the policy meetings.

To evaluate the association between the policy documents and the financial markets, I follow the literature on FOMC document sentiment extraction and classify the sentiments as hawkish if they relate to more optimistic economic forecasts and/or larger foreseen inflationary pressures. Hawkish sentiments, therefore, signal a higher rate of interest. On the other hand, I categorize the information that portrays a more negative outlook and/or more subdued inflation indicators and therefore conveys a lower natural rate of interest as dovish. Using these sentiment categories, I derive the continuous sentiment index then evaluate how it affects financial market variables, specifically the fed funds futures, the U.S. and emerging market equity indices, and foreign exchange valuations against the U.S. dollar.

My results indicate that fed funds futures rates tend to rise (fall) following hawkish (dovish) minutes releases.[2] My findings emphasize the idea that the sentiments in the minutes help guide financial market expectations. The dollar's valuation against several currencies also has a higher likelihood of increasing after the market observes hawkish minutes information.

My work not only affirms that FOMC minutes releases have a significant influence on the predictability of financial markets, particularly on the federal funds futures rate, it is also the first to help predict how the markets may change based on the type of information sentiments of the minutes. My findings contribute to the understanding of how FOMC documents, and policy documents in general, may be used to affect the economy in addition to conventional policy releases, such as policy rate announcements. They also give insight into how documents can be better tailored to conduct more effective central bank transparency.[3]

Based on my findings, the degree of document hawkishness can be taken as a signal of future policy. Therefore, to be effective at steering policy expectations, central banks have to be careful about how they present their information and how they structure the tone of their document information so that they are consistent with future policies. Together with the conventional monetary policy tools, information included in FOMC documents can be useful in trying to achieve the Fed mandates of maximum employment and price stability, while keeping interest rates at moderate levels in the medium term.

The rest of my paper is structured as follows. Section 2 discusses the relevant literature. Section 3 describes the method used to calculate sentiments in FOMC documents. Section 4 describes the financial data. It also conducts an event study to show stylized facts regarding the changes in the standard deviation of asset prices following the releases of the minutes. It then demonstrates the cross-correlation between the minutes sentiments and the policy rate. Section 5 examines the effects of the information sentiments in the minutes on various financial market indicators, while Section 6 explores some extensions and evaluates the robustness of the results. Finally, Section 7 presents concluding remarks.

2. Literature

A significant amount of literature has examined the effect of FOMC releases in terms of the reactions of financial markets. This is because monetary policy is intended to try to affect the real economy indirectly through the changes in financial assets. Given the immediate response of financial markets to the surprise changes in policy rates, their reactions have become the measure by which to evaluate the impact of monetary policy.

In the mid-1990's when the FOMC steered towards greater transparency, the FOMC began to announce explicit changes to the fed funds target rate shortly after the meetings. These releases had a significant influence on the expectations formation of financial market participants. Documenting the differences in the target rate and its future rate counterpart, Nosal (2001) and Carlson, Craig, Higgins, and Melick (2006) reiterated that the difference between the two, especially during recessionary periods, were smaller after the implementation of explicit announcements of the federal funds target. They argued that even with this simple amount of guidance, the financial markets improved in forming expectations regarding the target rate.

Ehrmann and Fratzscher (2007) adds to the discussion regarding expectation formation by reiterating that through alterations in overnight interest rates, the FOMC indirectly affects the long-run interest rate. He explains that the long-term interest rate is reflected by a series of short-term interest rates such that any changes in expectations of future short-term interest rates can very well affect long-term interest rates. Not only can FOMC actions have repercussions in the short-term, they may also be able to affect the long-run

[1] Specifying the policy beliefs and biases of individual FOMC members is beyond the scope of the current work since the meeting minutes do not always indicate the individual who raises certain macroeconomic viewpoints.

[2] These results are consistent with the discussions presented by Nakamura and Steinsson (2018) indicating that a positive shock to the beliefs about economic fundamentals increases the natural rate of interest.

[3] See Walsh (2007) for a theoretical discussion of optimal central bank dissemination of information. Also, see Blinder, Ehrmann, Fratzscher, De Haan, and Jansen (2008) for a survey covering the evolution of central bank communication and transparency.

fundamentals. Therefore, when a central bank is able to communicate well and be transparent about its actions, expectations about the future can be anchored by the policy path that it maps out.

The effect of funds rate target movements is not limited to interest rates. Bernanke and Kuttner (2005) extends Kuttner's seminal work using fed funds futures and evaluates the impact of the unexpected component of the target rate changes on equity prices. They find that the unexpected component cause a very large reaction from equity markets.

Given that FOMC releases occur on scheduled dates, anticipation may also play a role in how financial markets react to these releases. Lucca and Moench (2015) document a drift in equity prices beginning a couple of days prior to the announcements of FOMC decisions. Since this drift does not seem to exist for other macroeconomic releases, they argue that this movement in equity prices not only demonstrates the amount of attention that the equity markets place on FOMC policy, but also of how the expectations of policy, itself, may affect equity market movements.

In addition, financial market indicators not only react to scheduled policy announcements, but may also change depending on the discussions that FOMC members hold regarding monetary policy. To emphasize this point, Aizenman, Binici, and Hutchison (2016) examine FOMC member speeches during the 'tapering tantrum' period. They find that during this period, tapering news, particularly those relayed by the chairmen, have large and adverse impact on exchange rates. The observed effect is largest among those countries with a combination of low external debt, current account surpluses, and large amounts of international reserves.

There are also research evaluating the association of FOMC document releases with financial markets.[4] Kiley (2014) analyzes the movements in long-term rates that is resulting from FOMC statements using the first-principal component of short-term interest rates. He then evaluates how they affect equity markets before and during the Zero Lower Bound (ZLB) period of the fed funds rate. He finds that equity prices are much more sensitive to the changes in long-term rates prior to 2009 compared to the period during the ZLB. Additionally, Gürkaynak, Sack, and Swansonc (2005) evaluate the influence of FOMC statements on financial markets. They observe that much of the reactions of the markets are due to the information about the future path of policy as conveyed by the statements.

Rosa (2013), on the other hand, explains that the minutes, which are issued three weeks after the meetings, also have significant effects on financial markets as reflected by large spikes in the volatility of asset prices. This increase in volatility does not last longer than the end of the trading day, thereby demonstrating that the financial market is able to adjust its asset valuations shortly after the minutes are released. Extending on the findings of Rosa (2013), Apergis (2015) also disentangles the impact of FOMC minutes releases on the prices of several assets using GARCH volatility modeling. He finds that the reaction of the mean and volatility of these asset prices are more subdued during the financial crisis.[5]

Indeed, financial market reactions may depend on the type of information the documents contain and a nascent literature has turned to using Content Analysis, a common method used in other academic fields, in order to evaluate the qualitative information of the documents. The methods implemented by this strand of research can be thought of as being two types: heuristic and automated. The heuristic implementation simply occurs when an individual or group of individuals manually analyzes the content of the documents and quantifies the information content. An example of the heuristic implementation is conducted by Rosa (2011). He examines the importance of monetary policy statements – in conjunction with policy changes – to exchange rates. He finds that the statements have large and significant effects on the valuation of the U.S. dollar against other global currencies.

A criticism regarding heuristic Content Analysis is that it is more sensitive to the bias of the evaluator(s). The manner of implementing this method may be ambiguous and, at times, even inconsistent. Lucca and Trebbi (2011) shows a case in point as they conduct both a heuristic and an automated evaluation of the statements. They find that the heuristic evaluation does not provide consistent examination especially when compared to the findings of their method conducted algorithmically. Hence, much of Content Analysis, especially the one used in the current project, is conducted in an automated manner. This type of content analysis allows me to be as consistent and transparent as possible in analyzing the contents of the FOMC documents.[6]

Moreover, the FOMC documents not only include the economic information and rationale for implemented policy but also contain what is known as forward guidance (FG), or indications of potential changes in the policy rule in the near future. Campbell, Evans, Fisher, and Justiniano (2012) indicate that FOMC FG has two components: Odyssean and Delphic. Odyssean FG is the component that specifies what policy will be taken in the future. It binds the monetary policy body to implement it or risk losing credibility. On the other hand, Delphic FG indicates the forecasts of future fundamentals that the FOMC uses in their discussions. They imply the nature of policy the FOMC is more likely to implement.

The sentiment indices I obtain in my current work are analogous measures of the Delphic FG expressed in FOMC documents. The indices are calculated based on discussions regarding forecasts of economic fundamentals as well as inflation levels and therefore highlight the perceived economic risks on the Fed's dual mandate. These sentiments hint at the evolution of policy that the FOMC is considering based on the projections the members observe.

[4] The assessments in these papers are structured around major changes in FOMC documents. For instance, back in May 1999, the FOMC began to release more elaborate and systematically-released statements that describe the rationale for the target as well as the policy tilt. This was augmented just a few months afterwards by incorporating "balance of risks." Another major alteration occurred on the meeting minutes back in December 2004 when the release of the minutes, which was previously set at roughly six weeks after each meeting, was expedited to three weeks. This earlier release schedule assured that the information in the minutes are more timely and would therefore preserve their significance.

[5] Jubinski and Tomljanovich (2013) also finds significant reaction on volatility but not on the mean of the asset prices. However, they only utilized data between 2006–2007 while Apergis (2015) uses data from 2005–2011.

[6] See Antweiler and Frank (2004), Boukus and Rosenberg (2006), Apel and Grimaldi (2014), El-Shagi and Jung (2015), and Stekler and Symington (2016) for additional examples and discussions of the use of Content Analysis.

Campbell, Fisher, Justiniano, and Melosi (2016) add to the discussion by empirically and theoretically analyzing the effect of the two FG components. They use fed funds futures and examine how the release of the FOMC's private information about future economic indicators, as represented by Greenbook Forecasts, may be influencing the expectations for the future fed funds target rate. They find significant responses of the expectations for the policy rate and also observe that most of the reaction can be attributed to Delphic FG.

However, the work that Campbell et al. (2016) present does not directly use the qualitative information incorporated in the FOMC statements. Their empirical analysis simply uses the Greenbook forecasts in lieu of the qualitative information. Although these Greenbook forecasts may be affecting the decisions of the FOMC, they do not fully represent the information used in the meetings since the committee members also incorporate other information, such as their own forecasts, when making monetary policy decisions.[7] The information in the documents, which are reviewed by FOMC members before dissemination, present a more complete discussion of the economic indicators that the FOMC members use. Hence, examining the qualitative information of these documents provide better and more timely understanding of the FG that the FOMC members convey. Analyzing these documents will then lead to a better measure of the type of reaction that financial markets have based on the qualitative information they obtain from the FOMC.

3. Sentiment analysis

The FOMC began to release the meeting minutes three weeks after the scheduled meetings, beginning with the December 14, 2004 meeting. The FOMC members offer the reasoning, within those minutes themselves, why they expedited the release from the previous schedule of releasing the documents after six weeks as follows:

> Participants noted that the minutes contained a more complete and nuanced explanation of the reasons for the Committee's decisions and view of the risks to the outlook than was possible in the post-meeting announcement, and their earlier release would help markets interpret economic developments and predict the course of interest rates.

When they were released after a six-week lag, the minutes were seen by some market participants as offering information that was already 'stale' or not that useful. Hence, the expedition of the minutes release not only highlights the relevance of these documents but also enables the FOMC to more effectively guide market expectations.

The relevance of the minutes depend on the information that they provide. Since the contents of the minutes that I analyze in my work are qualitative – or expressed in words – instead of quantitative, I develop a method that could quantitatively assess their information. To extract a quantitative index for the information in the documents, I conduct a semi-automated Content Analysis. Content analysis has had many uses in various fields, such as in political science, computational linguistics, sociology, and even economics, and is typically used to obtain information in documents, blogs, speeches, and social media posts, especially tweets.[8] There are numerous methods associated with this type of analysis and the choice depends on the structure of the classification.

3.1. Automated content analysis: dictionary method

More specifically, I conduct the Dictionary Method of Content Analysis. Given a chosen set of topics, this approach examines the information that the FOMC documents convey about them. Using this method, I can assess how the details in the meeting documents portray the general outlook regarding unemployment, production, inflation, and other economic indicators that the FOMC uses to evaluate how well it is upholding its dual mandate objectives.

To be consistent with the ongoing literature examining FOMC documents, I utilize two pre–specified categorization for the qualitative information. These categories are what I refer to as sentiments and they describe the general outlook that FOMC members have regarding both economic and inflationary conditions. They are classified as either hawkish or dovish. Hawkish sentiments are those that indicate improving economic outlook and heightened inflationary pressures. Therefore, hawkish sentiments indirectly signal a higher likelihood of monetary policy tightening. On the other hand, dovish sentiments tend to emphasize more details regarding deteriorating economic conditions and subdued price changes, thereby hinting at a higher probability that monetary policy loosening would occur.

The Dictionary Method also requires lists of keywords and related terms, or what are termed as 'dictionaries'. The terms in the 'dictionaries' are relevant to the categories that are examined and symbolize relevant topics – particularly those that relate to output, employment, and inflation – that the FOMC emphasizes in meeting discussions.[9]

Using the Dictionary Method allows me to implement my document information analysis in a more systematic fashion using Python's Natural Language Processing capability. Using this method, I can consistently evaluate the documents while accounting for the context of the discussions in the policy documents. Therefore, even if my approach is not completely objective since I determine the topics to incorporate in the analysis, it benefits from user input and syntax examination of the document information. It also outlines the analysis transparently so it enables future research to easily replicate the same methods that I have taken.

[7] Moreover, the public is also able to consult the information in FOMC documents when making expectations about the funds target rate given that they are available much sooner than the Greenbook forecasts, which are publicly released after a five year lag. Hence, the policy meeting documents are more consistent with the FG that financial market participants observe and account for.

[8] See Gorodnichenko and Shapiro (2007) for an application of the method on inflation targeting.

[9] The chosen keywords and categories are consistent with previous work on FOMC documents. Since the categories are pre-established and are well-documented in the literature, the analysis is not subject to overfitting, which is a problem that needs to be addressed when using other methods.

Table 1
Keywords by type.

Hawkish keywords			
business	*businesses*	*demand*	*economic*
economy	*employment*	*energy*	*equities*
equity	*expansion*	*financial*	*growth*
housing	*income*	*indicators*	*inflation*
inflationary	*investment*	*investments*	*labor*
manufacturing	*outlook*	*output*	*price*
prices	*production*	*recovery*	*resource*
securities	*slack*	*spending*	*target*
toll	*wage*	*wages*	
Dovish keywords			
	accommodation	*devastation*	
	downturn	*recession*	
	unemployment		

Table 2
Polarized terms.

Positive terms				
abating[a]	*accelerated*	*add*	*advance*	*advanced*
augmented	*balanced*	*better*	*bolsters*	*boom*
booming	*boost*	*boosted*	*eased*	*elevated*
elevating	*expand*	*expanding*	*expansionary*	*extend*
extended	*fast*	*faster*	*firmer*	*gains*
growing	*heightened*	*high*	*higher*	*improved*
improvement	*improving*	*increase*	*increased*	*increases*
increasing	*more*	*raise*	*rapid*	*rebounded*
recovering	*rise*	*risen*	*rising*	*robust*
rose	*significant*	*solid*	*sooner*	*spike*
spikes	*spiking*	*stable*	*strength*	*strengthen*
strengthened	*strengthens*	*strong*	*stronger*	*supportive*
up	*upside*	*upswing*	*uptick*	
Negative terms				
adverse	*back*	*below*	*constrained*	*contract*
contracting	*contraction*	*cooling*	*correction*	*dampen*
damping	*decelerated*	*decline*	*declined*	*declines*
declining	*decrease*	*decreases*	*decreasing*	*deepening*
depressed	*deteriorated*	*deterioration*	*diminished*	*disappointing*
dislocation	*disruptions*	*down*	*downbeat*	*downside*
drop	*dropping*	*ebbed*	*erosion*	*fade*
faded	*fading*	*fall*	*fallen*	*falling*
fell	*insufficient*	*less*	*limit*	*low*
lower	*moderated*	*moderating*	*moderation*	*reduce*
reduced	*reduction*	*reluctant*	*removed*	*restrain*
restrained	*restraining*	*restraint*	*resumption*	*reversed*
slack	*slow*	*slowed*	*slower*	*slowing*
slowly	*sluggish*	*sluggishness*	*slumped*	*soft*
softened	*softening*	*stimulate*	*strained*	*strains*
stress	*subdued*	*tragic*	*turmoil*	*underutilization*
volatile	*vulnerable*	*wary*	*weak*	*weakened*
weaker	*weakness*			

[a] The term 'abating' is labeled as positive since it is used to describe the deterioration in labor market conditions.

Table 3
Examples of sentence scoring.

Sentence Example 1
according to survey information expectations of near term inflation (hawk key) picked up (pos) in march

consistent with the increase (pos) in energy prices (hawk key)

- Source: May 24, 2005 Minutes
- Sentence Score: +1 (Hawkish) This adds one to the overall document score.

Sentence Example 2
initial claims for unemployment (dove key) insurance declined (neg) further in recent weeks

- Source: Aug. 20, 2014 Minutes
- Sentence Score: +1 (Hawkish) This adds one to the overall document score.

Sentence Example 3
outstanding residential mortgage debt declined (neg) further in the third quarter of 2010 reflecting

weak (neg) housing (hawk key) activity and tight lending standards

- Source: Feb. 16, 2011 Minutes
- Sentence Score: − 1 (Dovish) This subtracts one from the overall document score.

I use this approach on the meeting documents corresponding to the December 14, 2004 meeting up to the December 15–16, 2015 meeting. While examining the minutes and the statements, I have compiled a set of keywords that pertain to inflation and other indicators of economic outlook. The list of keywords are shown in Table 1.[10] The keywords are very similar to those found in Jegadeesh and Wu (2017), who utilized Latent Dirichlet Allocation (LDA), an Automated Content Analysis method, in order to analyze the topic variations in the minutes.[11]

To evaluate the FOMC minutes (and their corresponding statements in the next subsection), I have also created lists of positive and negative terms that are found in the FOMC documents. The lists are shown in Table 2. Their polarization depends on their use in the English lexicon and are comparable to the terms used by Lucca and Trebbi (2011). I use these sets of terms to calculate the overall sentiments of the documents.

The keywords used are then categorized as hawkish or dovish. Keywords are classified as hawkish if they depict hawkish sentiments when associated with *positive* terms and dovish sentiments when connected to *negative* terms. In contrast, keywords are classified as dovish if they portray dovish sentiments when connected to positive terms and hawkish sentiments when associated with negative terms.

To illustrate my keyword categorization, I classify the keyword ‘prices’ as a hawkish keyword. This is because when the term ‘prices’ is connected to the positive term ‘higher’, I get ‘higher prices’. The sentiment of the resulting phrase is hawkish because with higher observed prices, the perceived risk of inflation increases, thereby causing the Fed to lean towards setting contractionary monetary policies – actions that could fend off inflationary risks. On the other hand, ‘higher unemployment’, in which ‘unemployment’ is classified as a dovish keyword, portrays a relatively more dovish sentiment. This is because with higher unemployment, the FOMC observes risk on its objective of maximizing employment levels and hence will be more likely to implement (or maintain) expansionary monetary policy – policy decisions meant to reduce unemployment.

After creating my sets of keywords and polarized terms, I implement my initial sentiment scoring at the sentence level. I separate out the documents into sentences and take out the punctuations and capitalizations.[12] Eliminating the sentences without any of the keywords follows since these sentences do not portray any significant information regarding the sentiment of the documents. Hence, for each document (d), I am left with a given number of sentences (n_d).

[10] Although there are noticeably more hawkish than dovish keywords, they reflect the word choice that the FOMC documents use to convey information. Moreover, the sentiments are not based solely on these keywords but are determined depending on the context under which these keywords are used.

[11] The difference with the approach used by Jegadeesh and Wu (2017) is that they use LDA to distinguish topics that are emphasized in the minutes. They do not, however, account for the information similar to those in the statements. They also do not determine the cumulative price changes of different financial market indicators to the information sentiments. Finally, they examine the reactions of the S&P 500 from the moment the minutes are released up to 15 min ahead and therefore do not account for the traders who read the entire minutes as well as those who may have withheld their trading shortly before the minutes release.

[12] Some researchers also remove commonly occurring ‘stop words’ and afterwards, stem the words – or strip the words to their roots – before conducting their analysis. I abstain away from doing these changes since these modifications could potentially change the meaning and context of the sentences that I am analyzing.

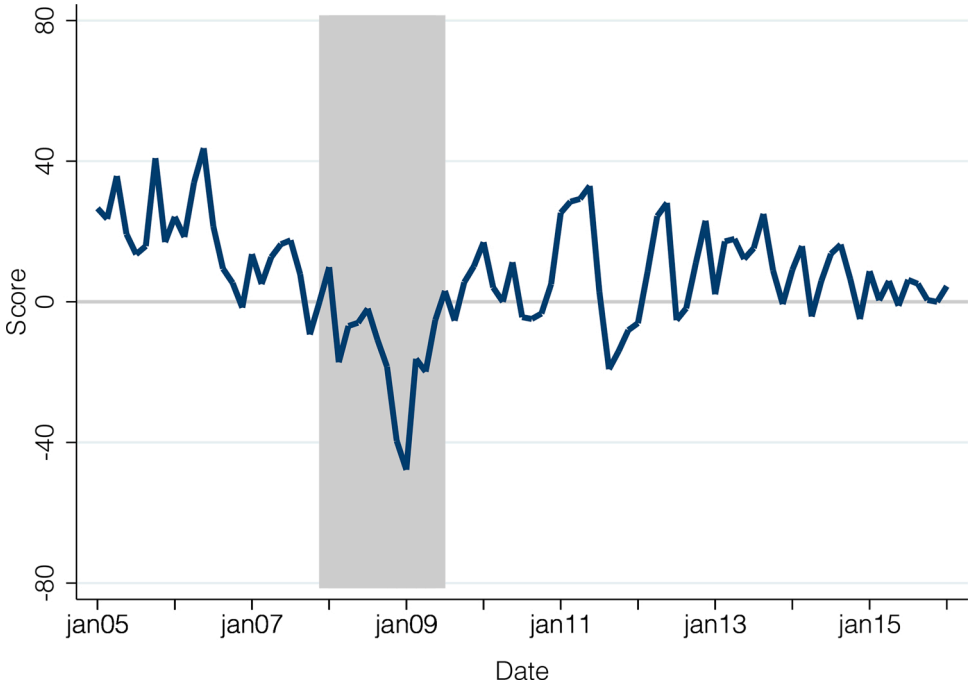

Fig. 1. Sentiment scores of the FOMC minutes.

Each sentence is given a score as follows. Denoting the sentence with keyword type k as $\text{sent}_{d,k}$, the sentiment score of the sentence depends on the number of positive terms (p), relative to the number of negative terms (n). Thus, $\text{score}(\text{sent}_{d,k})$, the sentiment score of sentence ($\text{sent}_{d,k}$), is calculated using the following scoring metric:

$$\text{score}(\text{sent}_{d,k}) = \begin{cases} 1, & \text{if } k = \text{hawk} \& p > n \\ -1, & \text{if } k = \text{hawk} \& p < n \\ -1, & \text{if } k = \text{dove} \& p > n \\ 1, & \text{if } k = \text{dove} \& p < n \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

Sentence scoring examples following this scheme are shown in Table 3. Example Sentence 1 has hawkish keywords and more positive than negative terms. Therefore, it is given a sentence score of '+1', which indicates a hawkish sentiment for that particular sentence. On the other hand, Example Sentence 3 also includes a hawkish keyword but has more negative terms than positive. Based on this evaluation, it is given a sentence score of '-1', which implies that the sentence conveys a dovish sentiment. As illustrated, the sentence sentiment scores are not only determined by the type of keywords they contain, but are also dependent on the relative number of positive and negative terms they have.[13]

Moreover, I also account for the negation terms when scoring these sentences.[14] When a positive term is in the proximity (that is, if they occur after three words or less) of a negation term, then its effect is counted as negative. On the other hand, a negative term is counted as positive if it immediately follows a negation term.

Finally, I calculate the document sentiment score by aggregating the sentence scores and dividing them by the number of sentences with keywords as shown by

$$\text{index}(d) = 100 * \frac{1}{n_d} \sum \text{score}(\text{sent}_{d,k}) \tag{2}$$

This calculation controls for the number of relevant sentences in each document, thereby accounting for potential increases in length of the FOMC documents over time.[15] Accounting for the method used to calculate the sentiment index, a higher index value implies that the document is more hawkish while the index with a lower value implies that the document is more dovish.

[13] Sentences that contain both hawkish and dovish keywords are scored the same as those with only hawkish keywords given that these sentences portray sentiments in a similar manner as sentences with only hawkish keys.

[14] The negation terms used in this analysis are 'fail', 'less', 'never', 'no', 'not', 'opposed', and 'unlikely'.

[15] Changing n_d to be the overall number of sentences per document does not alter the implications of the results.

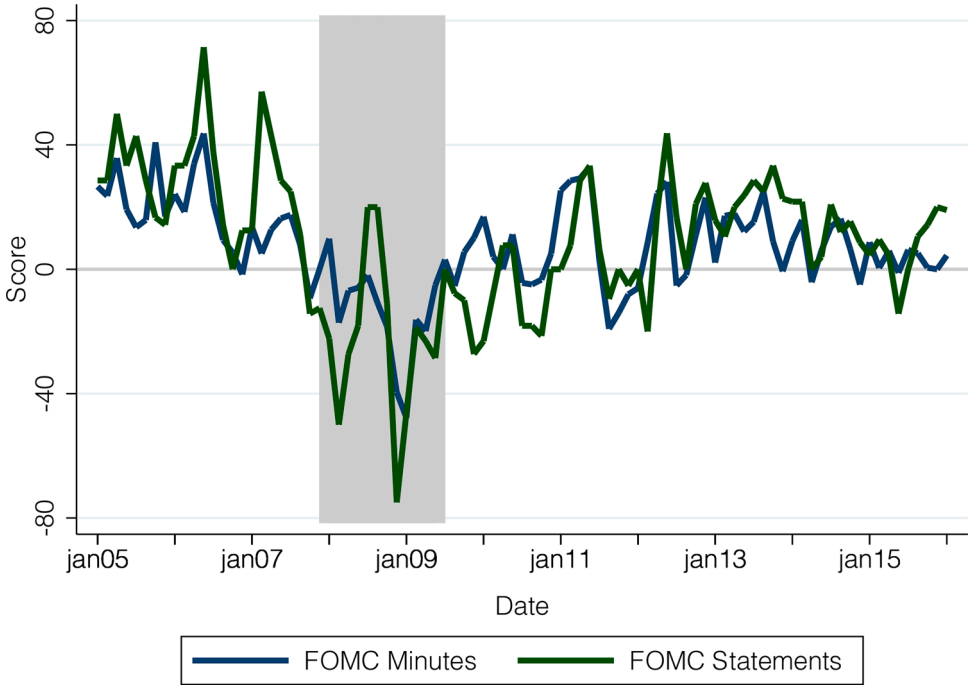

Fig. 2. Sentiment scores of the minutes and statements.

3.2. Executing the automated content analysis on the minutes

As an initial step, I remove the section in the minutes that consists of the whole statement released shortly after the meetings since market participants have already gained access to them three weeks prior. Therefore, any information that this section contains will already have been accounted for by the market. Next, I conduct my content analysis approach to each of the FOMC meeting minutes. The sentiment scores of the minutes are shown in Fig. 1, in which the gray bar depicts the Great Recession.

Prior to the economic downturn, the discussions during the FOMC meetings, as reflected by the minutes, tended to be more hawkish. These sentiments result from the more optimistic FOMC view about the economy and the inflationary concerns prevalent during this period as discussed in detail in the documents. As the recession approached, the minutes sentiment score declined. Since inflation pressures were large around the beginning of the recession, the more dovish sentiments implied signs of impending economic weakness. The perceived weakness continued to worsen until the trough of the sentiment index in December 2008, when the FOMC decided to hold the fed funds rate at a range with zero as its effective lower bound value.[16]

In the meetings following the announced end of the recession in June 2009, more hawkish sentiments emerged, partially because the FOMC also began to monitor equity markets more closely.[17] The meeting discussions also pointed to a slight recovery in the economy. Therefore, the index began to rise a bit to reflect the more hawkish discussions. However, economic turbulence emerged in Europe in 2011. During the height of this European sovereign debt crisis, there was a short dip in the hawkishness of the minutes index. As the U.S. economy was affected minimally by these European economic tensions, the document sentiments rebounded and continued to be slightly hawkish.[18]

3.3. Comparison of the sentiments in the minutes and the statements

The information in the statements is also crucial in assessing how the financial markets respond to the minutes since they are observed a few weeks before the minutes are released. A comparison of the indices will not only demonstrate the similarity in trends between the two sets of documents, but will also determine whether large deviations between them occur. Hence, I conduct the same methodology on the statements and compare them to those calculated for the minutes. The corresponding sentiment indices are shown in Fig. 2.

Comparing the indices of the statements to those of the minutes, I found large deviations at different periods. The statements tended

[16] Stekler and Symington (2016) find that it was not until after the collapse of Lehman Brothers in October 2008 when the FOMC fully realized the severity of the economic downturn.

[17] During this period, the stock market index rose significantly and this change contributed to the hawkishness of the minutes.

[18] Nonparametric structural break test confirms these period breaks.

to be more hawkish than the minutes before the recession hit. As the Great Recession occurred, the sentiments of the statements fluctuated much more than the sentiment in the minutes. For instance, following the collapse of Lehman Brothers in the latter part of 2018, the sentiments in the statements dropped significantly (even lower than the minutes sentiments). When the recession ended, the sentiments in the statements began to inch closer to the sentiments in the minutes. After 2012, the two sentiment indices have began to move together more closely.[19]

In general, the information sentiments in the statements are more volatile than those of the minutes. This is because the discussions in the statements are concentrated on rationalizing the policy decisions as well as the implied monetary policy path. The details on the minutes, on the other hand, include conflicting views of the FOMC members. This inclusion of mixed perspectives about prices and the overall state of the economy results to more subdued sentiments from the minutes.

4. Data description and stylized facts

4.1. Data

The data I am using consists of daily fed funds futures data as well as the NYSE trade quotes of Exchange-Traded Funds (ETFs). The use of high frequency data is common in the literature examining the effects of macroeconomic announcements and news on financial markets. This is because it helps isolate the influence of the examined release from the effects of other macroeconomic information. Therefore, the use of the intraday data in my current work attribute any reactions of the markets to releases of the minutes. The fed funds futures span the period between December 1, 2004 to April 30, 2015 while the ETF data ranges from December 1, 2004 to April 30, 2014. The fed funds data covers the 3-month, 6-month, 12-month, and 24-month contract horizon and are denoted as FF3, FF6, FF12, and FF24 respectively.

The ETFs are equities that closely follow a scaled value of various financial market indices. The ETFs used in this analysis are the SPY, VNQ, EEM, and EWJ. The SPY, the ETF for the U.S. equity market, closely tracks the S&P 500 stock index as it is priced based on the same basket of stocks that the S&P 500 is calculated with. Bond, Edmans, and Goldstein (2012) highlight the "… potential real effects of financial markets that stem from the informational role of market prices." Bernanke and Kuttner (2005) add that evaluating the general effect on equities is crucial given that equity pricing reflects some of the changes in both the cost of capital and the private portfolio valuation. Therefore, equity valuation is a way to examine the effect of new information from FOMC discussions on financial markets, and also serve as an indirect measure of the potential association of monetary policy documents with the real economy.

The VNQ, on the other hand, is the ETF for the Dow Jones Real Estate Investment Trust (REIT) Index. It closely follows that MSCI US REIT Index, which represents about 99% of the US equity REITs.[20] Therefore, it proxies for the valuation of real estate stocks. It also acts as a measure of commercial and residential development activities since the MSCI US REIT Index represents large companies that develop and manage apartment complexes and business offices. Given that surprise changes in monetary policy affects real estate valuation, it is plausible that discussions about these policies also trigger REIT pricing changes.[21] It is thus insightful to examine how document information affect the REITs.

EEM is the ETF that tracks the exposure of MSCI large and mid-sized emerging market companies.[22] The higher the value of EEM is, the larger the weighted investment measure on the companies from emerging markets are. In addition, EWJ tracks the large and mid-sized companies that are from Japan. It represents roughly 85% of the Japanese stock market.[23] . These two ETF's measure a portion of the international effects of FOMC document sentiments. Given that policy rate decisions and discussions about U.S. economic outlook have confounding effects on global capital and trade flows, the financial markets in other countries may also be responding to the FOMC document releases.[24] Hence, incorporating these ETF's are relevant in order to determine how influential the sentiments from the document information are to foreign equity markets.

I also complement my ETF and fed fund futures data with high frequency foreign exchange (forex) data acquired from Tick Data.[25] I utilize the level 1 Best Bid and Offer (BBO) pricing of four of the largest world currencies against the dollar, namely U.S. Dollar to Japanese Yen, U.S. Dollar to Swiss Franc, Great Britain Pound to U.S. Dollar, and Euro to U.S. Dollar. This set of data ranges from May 7, 2008 to Jan. 12, 2016.[26]

For my analysis, I aggregate the data so that I have high frequency data for equally spaced time intervals. More specifically, I take the last trade price of each 5 minute interval of the ETF data. As for the forex data, I utilize the midpoint of the last tick of each 5 minute

[19] There are two possible explanations for this. The first is that the FOMC have begun to more closely match the information in the minutes and the statements. The second, and perhaps more likely explanation, is that the increasing length of the statements enabled it to procure additional information that would have only been available in the minutes.

[20] It does not, however, include mortgage REIT.

[21] See Iacoviello and Minetti (2008) and Bredin, O'Reilly, and Stevenson (2007) for discussions about the effect of monetary policy on REITs and on the housing market.

[22] There are 23 emerging markets involved. 42% of the companies followed by the index are from countries that constitute BRICS, i.e. Brazil, Russia, India, China, and South Africa.

[23] The ETF for Japan's equity market is included since it is among the most traded for a singular country.

[24] See Bruno and Shin (2015) for discussions about the effect of monetary policy on cross-border bank capital flows.

[25] Rosa (2011) finds significant reactions of exchange rates against the U.S. Dollar following monetary policy and meeting statement surprises.

[26] To avoid discrepancies with exchange rate data collection, I have adopted the formatting used by Tick Data. This results to two pairs of forex data converted from U.S. Dollar to another currency while another pair is converted from a foreign currency to the U.S. Dollar.

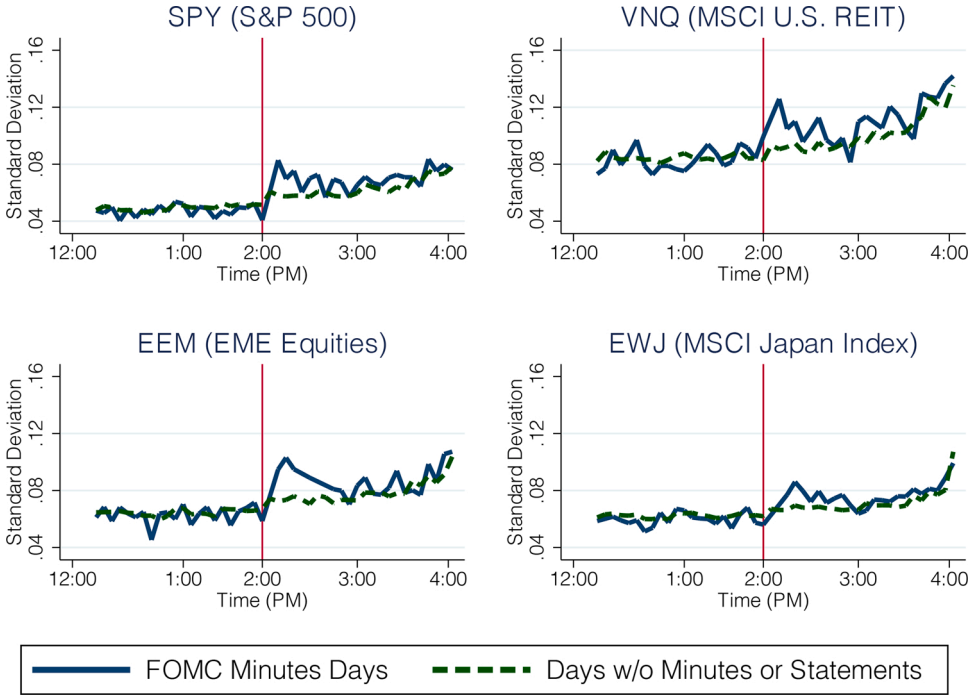

Fig. 3. Standard deviations of ETFs.

interval to proxy for the forex value.[27]

4.2. Preliminary empirical methodology using 5-minute log returns

I begin the empirical analysis by following the literature and examining whether financial market indicators react to the releases of the minutes. To do this examination, I conduct an event study using intraday data. I examine whether or not volatility spikes occur following the release of the minutes.[28] To conduct this examination, I calculate the log returns of each financial market variable using the equation

$$r_{T,\tau} = 100 * \log\left(\frac{P_{T,\tau}}{P_{T-1,\tau}}\right)$$

where $P_{T,\tau}$ is the effective asset price level at time period T on day τ. Hence, for the ETF data, $P_{T,\tau}$ is the last trade price of time interval T. As for the forex data, $P_{T,\tau}$ is the midpoint of the last tick in time interval T.

Financial data that is examined at tick-by-tick frequency is highly influenced by outliers. These values do not represent the activities occurring in the financial markets since they are typically caused by erroneous placements of bid and ask prices.[29] To address potential outliers in the data, I remove the returns with values that are greater than the 95th percentile or lower than the 5th percentile of the corresponding time period. The remaining data, therefore, more accurately represents ongoing market activity.

Afterwards, I separate the returns on the release days of the minutes from the set of days in which minutes nor statements are released. The type of day is denoted by DS. Therefore, $r_{T,\tau,\mathrm{DS}}$ is the 5-minute change in the asset price at the given time period T on day τ of day set DS. The statement days are excluded from this analysis since many papers have already cited significant price movements of various financial market variables on these days. This follows from the fact that monetary policy changes, together with a brief rationalization for such a change – the statements – are announced on this set of days.[30]

4.3. Volatility comparisons

Calculating the standard deviation of $r_{T,\tau,\mathrm{DS}}$ for each 5 minute interval T determines whether large reactions in financial markets

[27] Using the median quote of each time interval does not qualitatively affect the results.

[28] I exclude the federal funds futures in this portion of the empirical methodology since it is in daily frequency and the influence of the minutes is harder to isolate from the impact of other economic information.

[29] See Brownlees and Gallo (2006) for more discussions about outliers.

[30] The omission of the days with statement releases does not qualitatively affect the results.

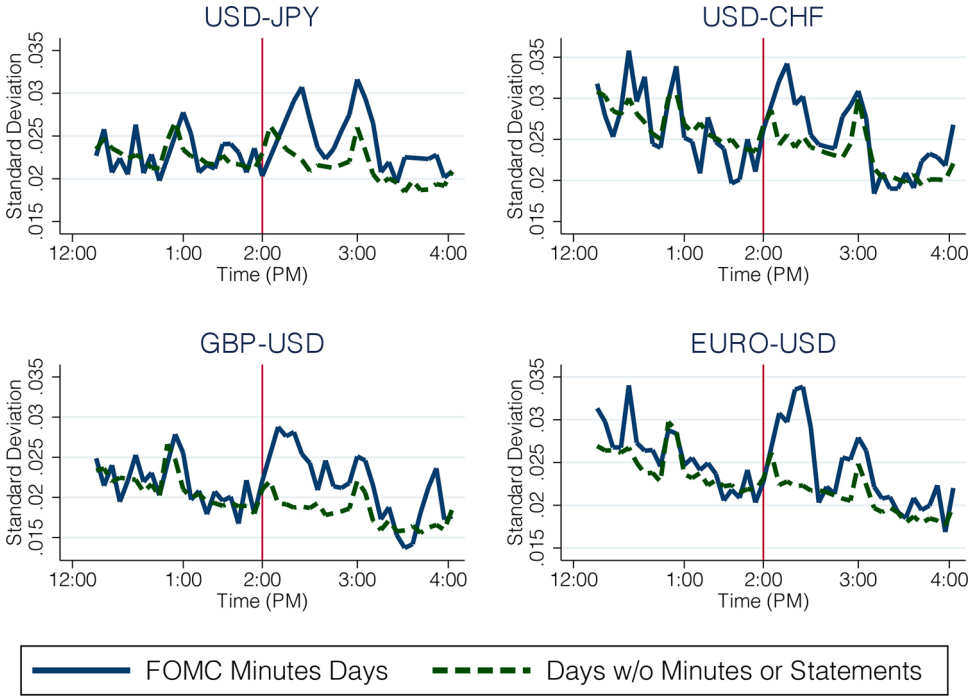

Fig. 4. Standard deviations of ForEx pairs.

occur shortly after the release of the minutes. The calculation of the standard deviations for each set of days is conducted using the formula

$$\sigma_{T,\mathrm{DS}} = \sqrt{\frac{\sum_{\tau=1}^{\Xi_{\mathrm{DS}}} \left(r_{T,\tau,\mathrm{DS}} - \bar{r}_{T,\mathrm{DS}}\right)^2}{\Xi_{\mathrm{DS}}}}$$

where $\bar{r}_{T,\mathrm{DS}}$ is the mean of $r_{T,\tau,\mathrm{DS}}$ for time interval T of all Ξ_{DS} days in day set DS.

Following Rosa (2013), I compare the standard deviations of days with releases of the minutes to those with no FOMC statement or minutes releases. The comparisons are shown in Figs. 3 and 4. I find that prior to the release of the minutes at 2PM Eastern Time, the standard deviation of the 5-minute returns of the ETFs tended to move about the same during the release days of the minutes and the non-release days.

Interestingly, as the minutes are released (depicted by the red vertical line), the volatility of the 5 minute returns spikes for all of the financial market variables. This large spike in the standard deviations is not observed on days with no FOMC document releases. The volatility on release days fluctuates then slowly converges to the corresponding standard deviation of nonrelease days.[31]

The financial market reactions to the releases of the minutes imply that the document information may also matter to market participants. There are several concerns with these observations, however. Findings involving volatility do not account for any reversals in market activity. Moreover, significant and lasting financial market reactions may depend on the type of 'new' information in the minutes. To address these issues, I derive a measure for the new information in this set of documents. I then assess the direction of asset price reactions by the end of the trading days that had releases of the minutes. In this way, I am able to quantify the new information in the documents and examine their persistent effect on asset prices.

4.4. Association between minutes sentiments and the policy rate

The increase in market volatility following FOMC minutes releases indicates that they have value to market participants. One possible source of the rise in value is that they provide information that may help forecast the policy rate. To evaluate the validity of this possibility, I examined the cross-correlation between the minutes sentiments and the monthly average of the policy rate.

Fig. 5 demonstrates the cross-correlation. The red horizontal line points out the 0.35 correlation line for the range between -1 and 1. I find that the minutes sentiments have strong and positive correlations with the policy rates, especially from the six-months-ahead

[31] To examine the robustness of these stylized facts, sets of days are randomly selected to determine whether such movements on minutes release days can be observed in various sets of non-release days. This is not an issue, however, given that no such reactions are observed in the placebo sets examined.

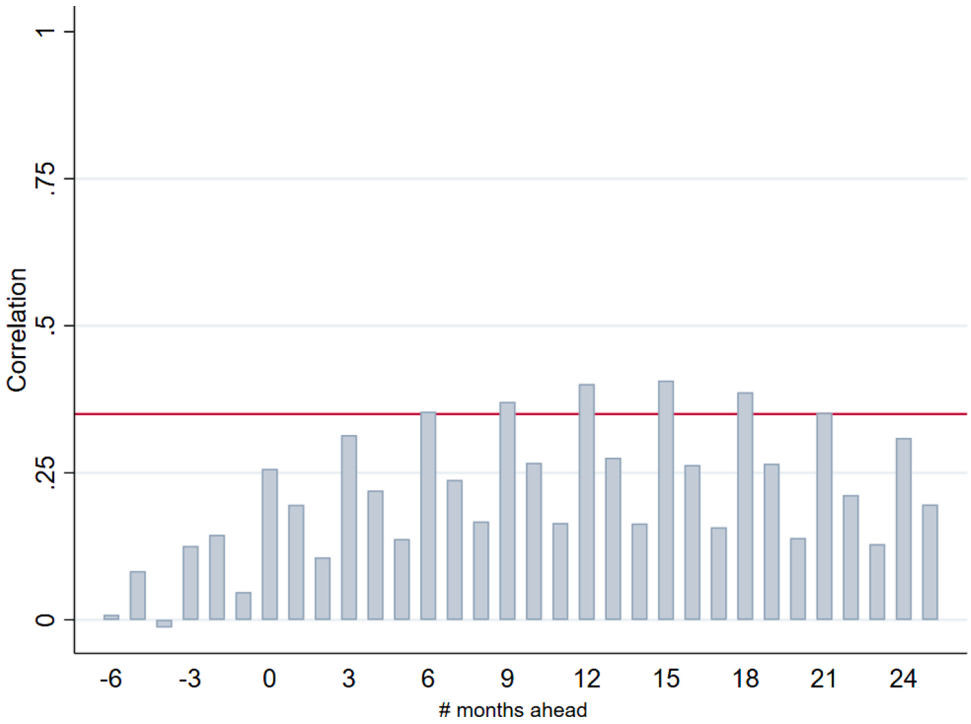

Fig. 5. Cross-correlation between the minutes sentiments and the policy rates.

average onward.

The positive correlation peaks around 12 to 15 months ahead of the minutes releases. This observation implies that more hawkish sentiments precede higher policy rates set about a year afterward. With this type of information, market participants are better able to forecast future policy rates and may be generating heightened interest.

5. Empirical methodology and results

5.1. Standardizing the document sentiments

The rise in the volatility of the financial market variables following minutes releases suggests that there is some significant informational value in the minutes beyond those already presented in the statements. The content of the minutes must be differentiated from the statements to isolate the information that causes market participants to reevaluate their positions.

When examining the difference between statement and minutes sentiments, there is a concern that they may not be comparable even though they were calculated using the same approach. Hence, to have more comparable measures of the statement and minutes sentiment scores, I calculate the standardized sentiment scores by subtracting the mean and dividing by the standard deviation for each document type. I then take Z_t^M and Z_t^S, the standardized values of the sentiment scores of the minutes and statements.

In addition, Rosa (2011) points out that macroeconomic fundamentals change gradually and that due to this consistency, the discussions between meetings may resemble one another. The content of the minutes may convey new information or may affirm the economic discussions in the preceding policy documents. Therefore, I consider the previous minutes since they also contain publicly-available information.

5.2. Regression specification and results: fed funds futures

In assessing how the monetary policy meeting minutes affect policy expectations, I use federal funds rate futures of varying horizons as the measure for market policy expectations for different periods. To conduct the statistical analysis, I use the regression specification

Table 4
Regression results for fed funds futures.

Variables	[1] FF3	[2] FF6	[3] FF12	[4] FF24
p^f_{t-1}	0.973***	0.972***	0.972***	0.968***
	(0.0213)	(0.0208)	(0.0182)	(0.0194)
Z^M_t	− 0.0713***	− 0.0707***	− 0.0602**	− 0.0875*
	(0.0236)	(0.0241)	(0.0272)	(0.0460)
Z^M_{t-1}	0.0506	0.0519	0.0248	0.0458
	(0.0356)	(0.0319)	(0.0210)	(0.0469)
Z^S_t	− 0.145**	− 0.133**	− 0.0963***	− 0.0767**
	(0.0615)	(0.0541)	(0.0343)	(0.0308)
VIX	0.00222	0.00337	0.00490	0.00624
	(0.00321)	(0.00309)	(0.00356)	(0.00406)
Constant	2.624	2.779	2.766	3.071
	(2.102)	(2.052)	(1.804)	(1.908)
Month of year	YES	YES	YES	YES
Observations	82	82	82	81

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10%level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

Table 5
Main regression results for ETFs.

Variables	[1] SPY	[2] VNQ	[3] EEM	[4] EWJ
p^f_{t-1}	1.000***	0.999***	1.005***	1.001***
	(0.00314)	(0.00382)	(0.00417)	(0.00243)
Z^M_t	0.210**	0.0929	0.153**	0.0195***
	(0.0923)	(0.0582)	(0.0598)	(0.00545)
Z^M_{t-1}	− 0.0326	− 0.153*	− 0.106	− 0.00590
	(0.0938)	(0.0772)	(0.0684)	(0.00756)
Z^S_t	− 0.0602	0.00399	0.0369	0.000835
	(0.0690)	(0.0795)	(0.0863)	(0.00578)
VIX	− 0.101***	− 0.0670**	− 0.0762***	− 0.00567***
	(0.0239)	(0.0256)	(0.0265)	(0.00127)
Constant	0.0266	0.105	− 0.490	− 0.00586
	(0.470)	(0.174)	(0.299)	(0.0355)
Month of year	YES	YES	YES	YES
Observations	73	60	73	74

Note: The numbers in parentheses are Newey-West standard errors.
* Signifies significance at the 1% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

$$p^f_t = \lambda p^f_{t-1} + \alpha + \beta_{Z^M_t} Z^M_t + \beta_{Z^M_{t-1}} Z^M_{t-1} + \beta_{Z^S_t} Z^S_t + \beta_{\text{VIX}} \text{VIX}_t + \beta_Y Y + \phi_t \tag{3}$$

where p^f_t is the asset price in period t of the daily futures contract f. VIX_t is the log percentage change of the adjusted closing price of VIX on day t.[32,33] It serves as a measure of the perceived financial market riskiness and therefore has been found to have significant influence on the changes in asset prices. Furthermore, Y is a vector of month-of-year indicator variables used to implement month of year fixed effects while ϕ_t is the error term of the specification.

When conducting the analysis, I consider the possibility that some of the regressors may be correlated. To account for this possibility, I use Newey-West standard errors. Following the Bayesian Information Criteria in choosing the optimal number of lags, I use 12 lags when conducting the analysis.[34]

[32] VIX is the implied riskiness of the financial market and is measured using the annualized value of the expected standard deviation change in the S&P 500 stock index in the next 30 days.
[33] Data for the adjusted closing price of VIX is obtained from Yahoo Finance.
[34] I utilized the instrumental variable analysis and consulted the BIC to determine the optimal number of lags.

Table 6
Main regression results for ForEx.

Variables	[1] USDJPY	[2] USDCHF	[3] GBPUSD	[4] EuroUSD
p_t^f	0.996***	0.997***	0.998***	0.998***
	(0.00164)	(0.00362)	(0.00249)	(0.00315)
Z_t^M	9.23e−06***	7.53e−08**	− 4.73e−08	− 8.08e−08
	(2.45e−06)	(3.55e−08)	(5.81e−08)	(5.35e−08)
Z_{t-1}^M	− 6.44e−06	− 7.98e−08*	− 4.31e−08	3.94e−08
	(5.19e−06)	(4.05e−08)	(5.85e−08)	(5.23e−08)
Z_t^S	5.18e−06	3.25e−08	− 3.49e−08	− 2.85e−09
	(4.67e−06)	(3.25e−08)	(5.32e−08)	(5.33e−08)
VIX	− 7.31e−07	1.13e−09	− 1.46e−08**	− 8.86e−09
	(5.69e−07)	(5.50e−09)	(5.97e−09)	(8.40e−09)
Constant	3.36e−05*	2.95e−07	3.02e−07	2.78e−07
	(1.77e−05)	(3.85e−07)	(4.10e−07)	(3.70e−07)
Month of year	YES	YES	YES	YES
Observations	62	62	62	62

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

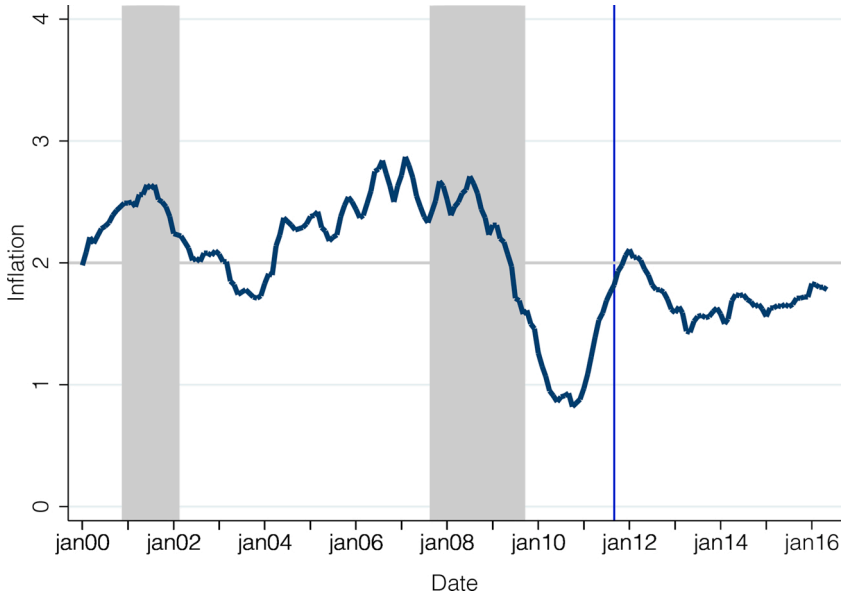

Fig. 6. Trimmed mean PCE inflation.

The results are found in Table 4. The coefficient estimates of Z_t^M in these regression specifications are negative. They are also statistically significant at the 1% level for the three-month and six-month horizon, at the 5% level for the twelve-month horizon, and at the 10% significance level for the 24-month horizon. These results indicate that more hawkish-leaning minutes sentiments were negatively related to the fed futures contract prices across different time horizons. These results imply that after the release of the meeting minutes with hawkish-leaning sentiments, there is also a higher likelihood of observing an increase in the fed funds futures rates.

Interestingly, the coefficient estimates for the statement sentiments are also negative. They are statistically significant at the 5% level. The magnitudes of these estimates are also larger relative to the coefficient estimates of the minutes sentiments. In contrast, the coefficient estimates of the lag of the minutes sentiments and the change in VIX do not have statistically significant association with the Fed Funds Futures.

Table 7
Regression results for fed funds: separate periods based on FG.

Panel A: Federal funds futures (3 and 6 month contracts)

Variables	[1] FF3_full	[2] FF3_per1	[3] FF3_per2	[4] FF6_full	[5] FF6_per1	[6] FF6_per2
p^f_{t-1}	0.973***	0.944***	0.883***	0.972***	0.945***	0.850***
	(0.0213)	(0.0250)	(0.0687)	(0.0208)	(0.0271)	(0.130)
Z^M_t	− 0.0713***	− 0.0738***	− 0.0147***	− 0.0707***	− 0.0727**	− 0.0150**
	(0.0236)	(0.0262)	(0.00454)	(0.0241)	(0.0345)	(0.00644)
Z^M_{t-1}	0.0506	0.0659*	− 0.00441*	0.0519	0.0629*	0.00713
	(0.0356)	(0.0349)	(0.00243)	(0.0319)	(0.0340)	(0.00785)
Z^S_t	− 0.145**	− 0.217***	0.0214***	− 0.133**	− 0.198***	0.00564
	(0.0615)	(0.0586)	(0.00553)	(0.0541)	(0.0607)	(0.0193)
VIX	0.00222	0.000195	0.000217	0.00337	0.00166	0.00152
	(0.00321)	(0.00468)	(0.000474)	(0.00309)	(0.00520)	(0.00125)
Constant	2.624	5.430**	11.65	2.779	5.385**	14.92
	(2.102)	(2.411)	(6.854)	(2.052)	(2.605)	(12.96)
Month of year	YES	YES	YES	YES	YES	YES
Observations	82	52	30	82	52	30

Panel B: Federal funds futures (12 and 24 month contracts)

Variables	[1] FF12_full	[2] FF12_per1	[3] FF12_per2	[4] FF24_full	[5] FF24_per1	[6] FF24_per2
p^f_{t-1}	0.972***	0.955***	0.983***	0.968***	0.936***	0.906***
	(0.0182)	(0.0293)	(0.0865)	(0.0194)	(0.0513)	(0.0906)
Z^M_t	− 0.0602**	− 0.0527	− 0.0476***	− 0.0875*	− 0.0744	− 0.116**
	(0.0272)	(0.0508)	(0.00690)	(0.0460)	(0.0741)	(0.0421)
Z^M_{t-1}	0.0248	0.0108	0.0200	0.0458	0.0282	0.0580
	(0.0210)	(0.0382)	(0.0223)	(0.0469)	(0.0703)	(0.0772)
Z^S_t	− 0.0963***	− 0.127**	0.0260	− 0.0767**	− 0.110**	0.00589
	(0.0343)	(0.0501)	(0.0380)	(0.0308)	(0.0496)	(0.0813)
VIX	0.00490	0.00264	0.00321	0.00624	0.00194	0.00831
	(0.00356)	(0.00571)	(0.00365)	(0.00406)	(0.00664)	(0.0122)
Constant	2.766	4.418	1.641	3.071	6.147	9.179
	(1.804)	(2.853)	(8.633)	(1.908)	(5.001)	(9.062)
Month of year	YES	YES	YES	YES	YES	YES
Observations	82	52	30	81	51	30

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

5.3. *Regression specification and results: equity and exchange rate markets*

The estimated association of the minutes sentiments with the futures market conveys that the expected policy rate rises with hawkish-leaning sentiments. This same set of information can then affect the rest of the financial market in two opposing ways. The first is that since more hawkish minutes increase the perceived likelihood of future contractionary policy, they could have adverse effects on the prices of other financial assets. On the other hand, the same set of information that has a strong association with expected policy rates may also reshape the public's macroeconomic outlook. Any positive macroeconomic surprises could then raise the expected asset prices.

To examine how the ETFs react to the information sentiments of the minutes, I utilize the same regression specification given by Eq. (3). Table 5 reports the results for the ETFs. I find that hawkish minutes sentiments have a positive estimated connection with these assets. Furthermore, aside from the estimates for the VNQ, the coefficient estimates of the minutes sentiments are statistically significant at the 5% level.

In contrast to the results for the fed funds futures, I find that the equity indices do not respond significantly to the statement sentiments. The coefficient estimates of the change in the VIX, however, are negative for these sets of assets. They are also statistically significant at the 1% level.

I also evaluated the reactions of the foreign exchange rate. Table 6 shows the results for various foreign currencies against the U.S.

Table 8
Regression results for ETFs: separate periods based on FG.

Panel A: SPY and VNQ						
Variables	[1] SPY_full	[2] SPY_per1	[3] SPY_per2	[4] VNQ_full	[5] VNQ_per1	[6] VNQ_per2
p^f_{t-1}	1.000***	1.003***	1.001***	0.999***	0.998***	0.972***
	(0.00314)	(0.00410)	(0.00540)	(0.00382)	(0.00652)	(0.00637)
Z^M_t	0.210**	0.153	0.134	0.0929	0.00312	0.0798
	(0.0923)	(0.134)	(0.0907)	(0.0582)	(0.0593)	(0.0696)
Z^M_{t-1}	− 0.0326	− 0.0834	− 0.0180	− 0.153*	− 0.140**	0.0293
	(0.0938)	(0.127)	(0.171)	(0.0772)	(0.0576)	(0.0967)
Z^S_t	− 0.0602	0.0688	− 0.138	0.00399	0.155	− 0.136
	(0.0690)	(0.0811)	(0.410)	(0.0795)	(0.127)	(0.116)
VIX	− 0.101***	− 0.102***	− 0.110***	− 0.0670**	− 0.0806**	− 0.0444**
	(0.0239)	(0.0254)	(0.0295)	(0.0256)	(0.0320)	(0.0153)
Constant	0.0266	− 0.161	− 0.533	0.105	0.416	1.745***
	(0.470)	(0.600)	(0.651)	(0.174)	(0.293)	(0.396)
Month of year	YES	YES	YES	YES	YES	YES
Observations	73	51	22	60	38	22
Panel B: EEM and EWJ						
Variables	[1] EEM_full	[2] EEM_per1	[3] EEM_per2	[4] EWJ_full	[5] EWJ_per1	[6] EWJ_per2
p^f_{t-1}	1.005***	1.005***	0.988***	1.001***	0.998***	0.987***
	(0.00417)	(0.00489)	(0.0187)	(0.00243)	(0.00348)	(0.00694)
Z^M_t	0.153**	0.125	0.00756	0.0195***	0.0173**	− 0.00510
	(0.0598)	(0.131)	(0.0673)	(0.00545)	(0.00822)	(0.0118)
Z^M_{t-1}	− 0.106	− 0.108	0.0101	− 0.00590	− 0.00901	− 0.00383
	(0.0684)	(0.109)	(0.0912)	(0.00756)	(0.00937)	(0.0161)
Z^S_t	0.0369	0.0542	− 0.0337	0.000835	0.0131	0.0488
	(0.0863)	(0.131)	(0.138)	(0.00578)	(0.00846)	(0.0342)
VIX	− 0.0762***	− 0.0960***	− 0.0317	− 0.00567***	− 0.00499***	− 0.00994***
	(0.0265)	(0.0261)	(0.0224)	(0.00127)	(0.00131)	(0.00294)
Constant	− 0.490	− 0.551	0.348	− 0.00586	0.0500	0.0929*
	(0.299)	(0.547)	(0.830)	(0.0355)	(0.0506)	(0.0498)
Month of year	YES	YES	YES	YES	YES	YES
Observations	73	51	22	74	52	22

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

dollar. I find that the U.S. dollar experienced a statistically significant appreciation against the Japanese Yen and the Swiss Franc after more hawkish minutes are released. The coefficient estimates for the exchange rate of the U.S. dollar against the British Pound and the Euro indicate that the dollar may have also appreciated following the release of hawkish minutes, although the estimated relationship is not statistically significant.

5.4. Discussions about the results

Considering the negative association between the sentiments of the minutes and the Fed funds futures contract prices, I find that hawkish-leaning minutes raise the perceived likelihood of futures rate increases. Given that the futures market reflects the projections about upcoming policy, the sentiments of the minutes help guide expectations about the future policy rate.

I also observe that the sentiments of the meeting statements have a statistically significant relationship with the fed funds futures rates. This suggests that using the statement sentiments further improves the predictability of fed funds futures market changes on days with minutes releases. This result is interesting given that the statements are distributed three weeks before the minutes releases.

The predictability of the futures markets may be affected by how consistent the statement information is to the contents of the minutes. If the minutes reflect the information in the statements, then the economic outlook that these policy documents discuss may

Table 9
Regression results for ForEx: separate periods based on FG.

Panel A: 1 U.S. Dollar to #JPY and 1 U.S. Dollar to #CHF						
Variables	[1] USDJPYfull	[2] USDJPYper1	[3] USDJPYper2	[4] USDCHFfull	[5] USDCHFper1	[6] USDCHFper2
p^f_{t-1}	0.996***	0.986***	0.997***	0.997***	1.001***	0.985***
	(0.00164)	(0.00212)	(0.00148)	(0.00362)	(0.00585)	(0.00897)
Z^M_t	9.23e−06***	6.15e−09	1.72e−05***	7.53e−08**	1.05e−07**	1.22e−07**
	(2.45e−06)	(1.73e−06)	(4.42e−06)	(3.55e−08)	(4.24e−08)	(4.87e−08)
Z^M_{t-1}	− 6.44e−06	− 1.01e−05***	7.59e−06	− 7.98e−08*	− 9.81e−08***	− 1.37e−08
	(5.19e−06)	(2.81e−06)	(8.01e−06)	(4.05e−08)	(1.97e−08)	(9.10e−08)
Z^S_t	5.18e−06	1.76e−05***	− 1.82e−05**	3.25e−08	− 6.34e−09	8.36e−10
	(4.67e−06)	(2.12e−06)	(6.65e−06)	(3.25e−08)	(6.53e−08)	(7.52e−08)
VIX	− 7.31e−07	− 2.06e−06***	2.35e−07	1.13e−09	− 7.84e−09	3.23e−09
	(5.69e−07)	(5.00e−07)	(3.95e−07)	(5.50e−09)	(5.85e−09)	(7.35e−09)
Constant	3.36e−05*	0.000134***	3.95e−05**	2.95e−07	− 2.66e−07	1.46e−06
	(1.77e−05)	(2.16e−05)	(1.76e−05)	(3.85e−07)	(6.70e−07)	(9.39e−07)
Month of year	YES	YES	YES	YES	YES	YES
Observations	62	26	36	62	26	36
Panel B: 1 GBP to #U.S. Dollars and 1 Euro to #U.S. Dollars						
Variables	[1] GBPUSDfull	[2] GBPUSDper1	[3] GBPUSDper2	[4] EuroUSDfull	[5] EuroUSDper1	[6] EuroUSDper2
p^f_{t-1}	0.998***	0.997***	1.003***	0.998***	1.008***	0.993***
	(0.00249)	(0.00266)	(0.00980)	(0.00315)	(0.00548)	(0.00455)
Z^M_t	− 4.73e−08	− 1.39e−07	1.39e−08	− 8.08e−08	− 1.01e−07***	− 1.45e−07*
	(5.81e−08)	(1.04e−07)	(6.66e−08)	(5.35e−08)	(2.85e−08)	(7.62e−08)
Z^M_{t-1}	− 4.31e−08	− 2.15e−08	1.81e−08	3.94e−08	3.67e−08	− 6.83e−10
	(5.85e−08)	(4.18e−08)	(1.48e−07)	(5.23e−08)	(3.24e−08)	(1.40e−07)
Z^S_t	− 3.49e−08	6.90e−08	− 1.66e−07	− 2.85e−09	7.52e−08	4.65e−08
	(5.32e−08)	(7.82e−08)	(1.30e−07)	(5.33e−08)	(7.04e−08)	(9.66e−08)
VIX	− 1.46e−08**	− 1.10e−08	− 1.52e−08**	− 8.86e−09	5.19e−09	− 1.68e−08*
	(5.97e−09)	(1.07e−08)	(6.79e−09)	(8.40e−09)	(1.22e−08)	(8.63e−09)
Constant	3.02e−07	8.89e−07**	− 6.02e−07	2.78e−07	− 8.57e−07	7.33e−07
	(4.10e−07)	(3.87e−07)	(1.47e−06)	(3.70e−07)	(6.75e−07)	(4.87e−07)
Month of year	YES	YES	YES	YES	YES	YES
Observations	62	26	36	62	26	36

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

have more clarity and credibility.[35] This could then be raising the predictability of the fed funds futures markets.[36] However, if the sentiments of the corresponding documents are different from one another, then their information content has very minimal influence on the predictability of the futures market changes.

Notably, hawkish-leaning sentiments emerge from positive views about the economy and higher inflation risks. However, much of the period examined covers a time of low observed and projected inflation rates. As shown in Fig. 6, low perceived inflation risk coincides with the timing of much of the analysis. As we see in Fig. 6, the inflation rate hovered a little above the 2% target rate before the Global Financial Crisis. It stayed mostly below the 2% target as the Great Recession occurred. As a result, the hawkish (dovish) sentiments of the minutes during this period more closely projected improvements (deterioration) in economic fundamentals and therefore led to increased optimism (pessimism) in financial markets, both domestic and abroad.

[35] Determining whether the minutes provide a more precise set of economic information or if it also increases statement credibility is beyond the scope of this paper.
[36] The minutes contain a copy of the statements. When evaluating the minutes, I omitted these copies before calculating the document sentiments.

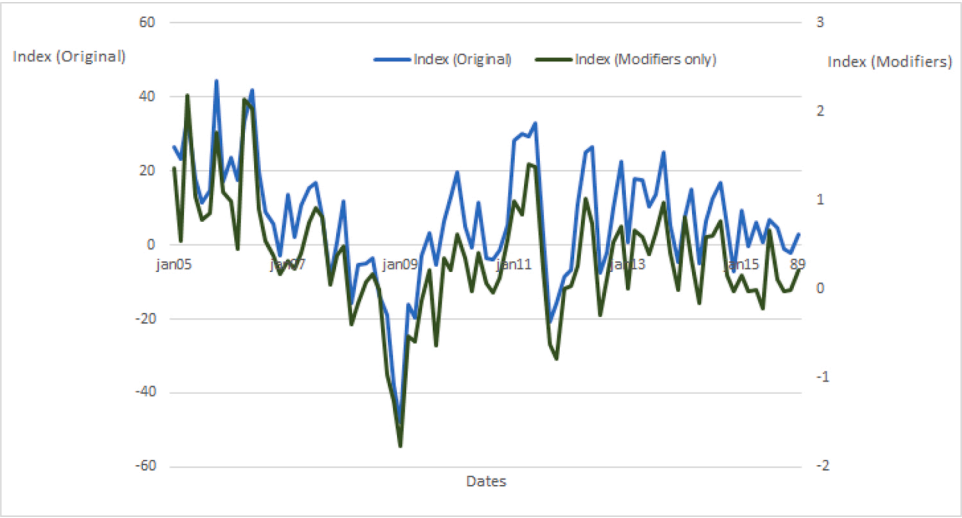

Fig. 7. Minutes sentiment index: dictionary method vs. modifiers only.

Table 10
Regression results for fed funds futures (modifiers only).

Panel A: Federal funds futures (3 and 6 month contracts)						
Variables	[1] FF3_full	[2] FF3_per1	[3] FF3_per2	[4] FF6_full	[5] FF6_per1	[6] FF6_per2
p^f_{t-1}	0.974***	0.954***	0.939***	0.973***	0.955***	0.849***
	(0.0179)	(0.0203)	(0.0329)	(0.0178)	(0.0210)	(0.112)
Z^M_t	− 0.0470*	− 0.0425	− 0.0187***	− 0.0537*	− 0.0491	− 0.00710
	(0.0250)	(0.0430)	(0.00509)	(0.0313)	(0.0550)	(0.0103)
Z^M_{t-1}	0.0429	0.0578	− 0.000442	0.0516	0.0645	0.0160*
	(0.0380)	(0.0430)	(0.00594)	(0.0351)	(0.0412)	(0.00866)
Z^S_t	− 0.162***	− 0.224***	0.0211**	− 0.145***	− 0.202***	− 0.0101
	(0.0568)	(0.0513)	(0.00994)	(0.0496)	(0.0548)	(0.0197)
VIX	− 0.000198	− 0.00105	0.000949***	0.00127	0.000607	0.00101
	(0.00373)	(0.00622)	(0.000292)	(0.00377)	(0.00664)	(0.000750)
Constant	2.620	4.507**	6.109*	2.710	4.401**	15.03
	(1.758)	(1.949)	(3.289)	(1.755)	(2.010)	(11.17)
Month of year	YES	YES	YES	YES	YES	YES
Observations	82	52	30	82	52	30
Panel B: Federal funds futures (12 and 24 month contracts)						
Variables	[1] FF12_full	[2] FF12_per1	[3] FF12_per2	[4] FF24_full	[5] FF24_per1	[6] FF24_per2
p^f_{t-1}	0.971***	0.961***	0.976***	0.966***	0.946***	0.930***
	(0.0158)	(0.0222)	(0.0733)	(0.0165)	(0.0373)	(0.0757)
Z^M_t	− 0.0545	− 0.0483	− 0.0191	− 0.108***	− 0.0999	− 0.106**
	(0.0349)	(0.0628)	(0.0132)	(0.0391)	(0.0739)	(0.0370)
Z^M_{t-1}	0.0309	0.0244	0.0445***	0.0724	0.0565	0.114
	(0.0280)	(0.0386)	(0.00939)	(0.0503)	(0.0646)	(0.0667)
Z^S_t	− 0.104***	− 0.130**	− 0.0430	− 0.0863**	− 0.102*	− 0.0876
	(0.0331)	(0.0519)	(0.0253)	(0.0428)	(0.0606)	(0.0899)
VIX	0.00338	0.00155	0.00232	0.00476	0.000504	0.00430
	(0.00380)	(0.00681)	(0.00217)	(0.00394)	(0.00699)	(0.00868)
Constant	2.840*	3.807*	2.316	3.196*	5.115	6.838
	(1.565)	(2.167)	(7.313)	(1.626)	(3.680)	(7.574)
Month of year	YES	YES	YES	YES	YES	YES
Observations	82	52	30	81	51	30

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

Table 11
Regression results for ETFs (modifiers only).

Panel A: SPY and VNQ						
Variables	[1] SPY_full	[2] SPY_per1	[3] SPY_per2	[4] VNQ_full	[5] VNQ_per1	[6] VNQ_per2
p^f_{t-1}	0.999***	1.003***	1.002***	0.996***	0.999***	0.984***
	(0.00294)	(0.00371)	(0.00489)	(0.00270)	(0.00741)	(0.0150)
Z^M_t	0.278**	0.217	0.256**	0.0861	0.0103	0.169
	(0.106)	(0.141)	(0.0961)	(0.0621)	(0.0961)	(0.109)
Z^M_{t-1}	− 0.0812	− 0.175*	0.00405	− 0.133*	− 0.172	0.0555
	(0.0857)	(0.0995)	(0.155)	(0.0715)	(0.101)	(0.0907)
Z^S_t	− 0.0582	0.103	− 0.316	0.0434	0.188	− 0.372
	(0.0865)	(0.0969)	(0.378)	(0.108)	(0.136)	(0.391)
VIX	− 0.0981***	− 0.0995***	− 0.107**	− 0.0650***	− 0.0806**	− 0.0355
	(0.0224)	(0.0235)	(0.0334)	(0.0241)	(0.0311)	(0.0248)
Constant	0.0748	− 0.179	− 0.656	0.293***	0.375	0.989
	(0.421)	(0.490)	(0.729)	(0.108)	(0.318)	(0.878)
Month of year	YES	YES	YES	YES	YES	YES
Observations	73	51	22	60	38	22
Panel B: EEM and EWJ						
Variables	[1] EEM_full	[2] EEM_per1	[3] EEM_per2	[4] EWJ_full	[5] EWJ_per1	[6] EWJ_per2
p^f_{t-1}	1.004***	1.005***	0.997***	1.000***	0.998***	0.988***
	(0.00409)	(0.00481)	(0.0117)	(0.00258)	(0.00342)	(0.00833)
Z^M_t	0.310**	0.311	0.0600	0.0257***	0.0235***	0.0122
	(0.147)	(0.208)	(0.0571)	(0.00618)	(0.00531)	(0.0147)
Z^M_{t-1}	− 0.218	− 0.289*	− 0.0328	− 0.0116	− 0.0187**	0.00724
	(0.135)	(0.159)	(0.0561)	(0.00723)	(0.00729)	(0.00951)
Z^S_t	− 0.0137	0.0337	− 0.00533	0.00298	0.0174**	0.0216
	(0.0783)	(0.104)	(0.163)	(0.00765)	(0.00843)	(0.0304)
VIX	− 0.0750***	− 0.0932***	− 0.0407*	− 0.00541***	− 0.00466***	− 0.0102***
	(0.0254)	(0.0253)	(0.0188)	(0.00115)	(0.000948)	(0.00219)
Constant	− 0.466	− 0.556	− 0.0399	0.00744	0.0538	0.0939
	(0.296)	(0.487)	(0.469)	(0.0355)	(0.0452)	(0.0727)
Month of year	YES	YES	YES	YES	YES	YES
Observations	73	51	22	74	52	22

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

6. Robustness and extensions

6.1. Separate periods based on forward guidance

Much of my analysis covers the period when the policy rate is set around its zero lower bound. Because of this fed-imposed zero lower bound constraint, the fed considered different options to further boost the weak economy. One of the tools it decided to use was a commitment to keep its near-zero policy rate levels up to a specified date. This is what has been referred to as calendar-based forward guidance.[37]

To describe calendar-based FG in more detail, Swanson and Williams (2014) explain that August 9, 2011 corresponds to the time when the FOMC first used calendar-based FG. On this date, the FOMC replaced the announcement of keeping the policy rate at their near-zero levels "… for an extended period" with "… at least through mid-2013." This change in FG effectively removed some of the uncertainty regarding the implied path of monetary policy, at least for a specified amount of time, by indicating that the FOMC will be holding the prevailing expansionary policy until the middle of 2013.[38]

The calendar-based forward guidance, along with other forward guidance tools that the Fed used, serves as a Fed commitment to

[37] See Campbell et al. (2016) for further discussions.
[38] The "… at least through mid-2013" phrase was later modified to "… at least through 2014" and "… at least through mid-2015" in the January 2012 and September 2012 meetings, respectively. The phrase was then revised to "… a considerable time after the asset purchase program ends…" in the December 2012 meeting. None of these changes qualitatively affected the results.

Table 12
Regression results for foreign exchange rate (modifiers only).

Panel A: 1 U.S. Dollar to #JPY and 1 U.S. Dollar to #CHF						
Variables	[1] USDJPYfull	[2] USDJPYper1	[3] USDJPYper2	[4] USDCHFfull	[5] USDCHFper1	[6] USDCHFper2
p^f_{t-1}	0.996***	0.985***	0.998***	0.996***	1.002***	0.994***
	(0.00209)	(0.00253)	(0.00123)	(0.00377)	(0.00764)	(0.00871)
Z^M_t	8.90e−06***	2.87e−07	1.97e−05***	7.09e−08*	1.05e−07**	1.61e−07**
	(2.93e−06)	(2.83e−06)	(4.98e−06)	(3.79e−08)	(3.68e−08)	(7.29e−08)
Z^M_{t-1}	− 4.81e−06	− 1.32e−05***	1.11e−05	− 6.60e−08	− 9.78e−08**	5.16e−08
	(5.82e−06)	(2.45e−06)	(8.29e−06)	(3.95e−08)	(4.01e−08)	(7.83e−08)
Z^S_t	4.22e−06	1.81e−05***	− 2.47e−05**	6.01e−09	1.50e−08	− 1.66e−07*
	(6.26e−06)	(2.99e−06)	(8.91e−06)	(4.08e−08)	(3.66e−08)	(9.33e−08)
VIX	− 7.07e−07	− 1.78e−06***	1.25e−07	7.45e−10	− 9.27e−09*	3.30e−09
	(5.10e−07)	(4.60e−07)	(2.87e−07)	(6.16e−09)	(4.55e−09)	(8.25e−09)
Constant	3.41e−05	0.000137***	3.02e−05**	3.93e−07	− 3.52e−07	7.21e−07
	(2.11e−05)	(2.77e−05)	(1.21e−05)	(4.08e−07)	(8.14e−07)	(8.93e−07)
Month of year	YES	YES	YES	YES	YES	YES
Observations	62	26	36	62	26	36
Panel B: 1 GBP to #U.S. Dollars and 1 Euro to #U.S. Dollars						
Variables	[1] GBPUSDfull	[2] GBPUSDper1	[3] GBPUSDper2	[4] EuroUSDfull	[5] EuroUSDper1	[6] EuroUSDper2
p^f_{t-1}	0.999***	0.995***	1.006***	0.999***	1.010***	0.995***
	(0.00254)	(0.00251)	(0.00919)	(0.00287)	(0.00577)	(0.00413)
Z^M_t	− 1.37e−07	− 3.47e−07*	− 4.50e−08	− 8.02e−08	− 1.14e−07**	− 1.60e−07*
	(8.27e−08)	(1.76e−07)	(1.14e−07)	(5.76e−08)	(4.31e−08)	(9.23e−08)
Z^M_{t-1}	− 2.22e−08	9.45e−08	− 1.06e−07	1.35e−08	5.32e−08	− 5.77e−08
	(6.57e−08)	(5.66e−08)	(1.18e−07)	(4.39e−08)	(5.17e−08)	(9.45e−08)
Z^S_t	4.27e−08	1.75e−07	6.70e−08	2.83e−08	4.78e−08	1.72e−07
	(5.90e−08)	(1.07e−07)	(1.11e−07)	(5.95e−08)	(3.87e−08)	(1.24e−07)
VIX	− 1.18e−08*	− 8.01e−09	− 1.48e−08	− 8.11e−09	7.99e−09	− 1.67e−08
	(6.53e−09)	(1.14e−08)	(9.10e−09)	(9.07e−09)	(1.09e−08)	(1.05e−08)
Constant	2.20e−07	1.11e−06***	− 1.13e−06	1.81e−07	− 1.16e−06	5.03e−07
	(4.41e−07)	(3.53e−07)	(1.44e−06)	(3.29e−07)	(6.90e−07)	(4.25e−07)
Month of year	YES	YES	YES	YES	YES	YES
Observations	62	26	36	62	26	36

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

maintaining the near-zero policy rates. Still, economic discussions in the minutes may send opposing information. On one hand, the policy documents relay economic information that the policymakers consider and that could affect the public's economic outlook. On the other hand, this same information could lead the financial markets to reassess the likelihood of policy changes despite the fed committing to a particular policy rate.

Since the association with the minutes sentiments may be significantly different after the calendar-based forward guidance is implemented, I examine the results of Eq. (3) for the period before and the period after the calendar-based forward guidance was set in motion. Referring to Table 7, I find that the coefficient estimates of Z^M_t are negative across all four horizons, even if the data is split between the two periods. I also find that the coefficient estimates are statistically significant at the 5% level for both periods for the three-month and six-month horizons and for the more recent period (after the calendar-based FG is implemented) for the twelve-month and 24-month horizons.

These results confirm that hawkish minutes increase the expected policy rate. However, the magnitude and statistical significance differ by the period and fed funds futures horizon. I find that before the calendar-based FG, hawkish minutes and statements exhibit similar full-period coefficient estimates for the 3-month and 6-month horizons. As the calendar-based FG (period 2) occurs, the estimates for the 3-month and 6-month horizons decrease in magnitude. In contrast, the minutes sentiments do not have a statistically significant relationship with the 12-month and 24-month fed funds futures contracts before the calendar-based FG. With the

Table 13
Regression results for fed funds futures: pre vs. post 2008.

Variables	FF3		FF6		FF12		FF13	
	w/ 2008 [1]	w/o 2008 [2]	w/ 2008 [3]	w/o 2008 [4]	w/ 2008 [5]	w/o 2008 [6]	w/ 2008 [7]	w/o 2008 [8]
P^f_{t-1}	0.953***	0.566***	0.930***	0.535***	0.894***	0.569***	0.880***	0.816***
	(0.0295)	(0.209)	(0.0404)	(0.199)	(0.0443)	(0.134)	(0.0370)	(0.0352)
Z^M_t	− 0.207***	− 0.00267	− 0.196***	− 0.0427	− 0.177***	− 0.118**	− 0.160***	− 0.172**
	(0.0405)	(0.0753)	(0.0526)	(0.0400)	(0.0607)	(0.0491)	(0.0565)	(0.0695)
Z^M_{t-1}	0.0309	0.130*	0.0331	0.105**	0.00852	0.0684**	0.0374	0.0939*
	(0.0269)	(0.0669)	(0.0238)	(0.0524)	(0.0209)	(0.0307)	(0.0444)	(0.0536)
Z^S_t	− 0.110**	− 0.0956*	− 0.107**	− 0.0937*	− 0.0773*	− 0.0477	− 0.0523	− 0.0230
	(0.0547)	(0.0552)	(0.0518)	(0.0558)	(0.0418)	(0.0559)	(0.0474)	(0.0416)
$Z^M_t \times ZLB$	0.222***	− 0.186	0.201***	− 0.109	0.177***	− 0.0182	0.0912**	− 0.0375
	(0.0348)	(0.113)	(0.0469)	(0.0874)	(0.0514)	(0.0728)	(0.0421)	(0.0566)
ZLB	0.0560	1.999**	0.143	2.103**	0.283*	1.808***	0.321**	0.643***
	(0.0864)	(0.975)	(0.126)	(0.899)	(0.145)	(0.540)	(0.130)	(0.158)
VIX	− 0.00155	0.00335	− 8.03e−06	0.00491	0.00229	0.00829***	0.00607	0.0129***
	(0.00264)	(0.00418)	(0.00302)	(0.00367)	(0.00339)	(0.00303)	(0.00425)	(0.00326)
Constant	4.689	41.51**	6.861*	44.42**	10.27**	41.25***	11.48***	17.60***
	(2.874)	(19.92)	(3.922)	(18.96)	(4.284)	(12.80)	(3.539)	(3.366)
Month of year	YES	YES	YES	YES	YES	YES	YES	YES
Observations	82	74	82	74	82	74	81	73

Note: The numbers in parentheses are Newey-West standard errors.
* Indicates significance at the 10% level.
** Signifies significance at the 5% level.
*** Indicates significance at the 1% level.

implementation of this type of FG onward, the coefficient estimates for the minutes sentiments for the 12-month and 24-month horizon become statistically significant at the 5% level.

When examining the influence on the equity market, I find that the coefficient estimates for the minutes sentiments are mostly positive. The only difference is for the EWJ in which the coefficient estimate is positive and statistically significant at the 5% level before the calendar-based FG. It is negative but not statistically significant for the period beginning with the calendar-based FG. However, the statistical significance of the coefficient estimate disappears. This is perhaps due to the larger standard errors from the smaller sample sizes of separate periods (Tables 8 and 9).

6.2. *Changing the calculation of sentiments*

To calculate the sentiments in the meeting documents, I used the Dictionary method. To do this, I made a list of relevant key terms that portray discussions about economic conditions and eliminated sentences without any of those keywords. I then scored each sentence with keywords based on the number and type of key terms and modifiers they contain.

A particular concern that arises with the empirical analysis is that the results may be sensitive to the way that the sentiments are measured. Therefore, I recalculated the sentiment index using a different measure.[39] For each document, I calculated the number of positive modifiers and subtracted the number of negative ones. I also incorporated the use of negation by reversing the semantic meaning of the modifier that follows a negation term. I apply this negation effect for up to three terms that follow a negation term. I then divided the resulting difference by the number of words in the document to account for the length of the FOMC press releases. The resulting value is multiplied by a 100 to obtain a continuous sentiment index between − 100 to 100. Considering the construction of the index, those texts with more positive than negative modifiers have positive index measures while those with more negative than positive modifiers are given a negative sentiment index.

Fig. 7 shows the comparison between the original index and the one calculated using modifiers only. Although the two indices have different scales, they reflected each other's movements over time. They resemble very similar sentiment changes of the minutes.

I then evaluated how minutes sentiments from the altered index affect the predictability of the financial assets. I examined how these influence financial assets following the specification given by Eq. (3). Table 10 shows the results for the Fed Funds Futures. Consistent with earlier findings, the results indicate that hawkish-leaning minutes generated higher expected values of the policy rate. However, the statistical significance of the estimated association decreased with these adjusted sentiment scores. Compared to my previous observations, these results imply that although the modifiers determine the tonality of economic discussions, the keywords

[39] I want to thank the anonymous referee for pointing out this issue and for suggesting this method.

focus the attention on the key economic indicators and are also critical in determining how the policy documents affect the financial markets.

I also examined if the associations with equities and foreign exchange rate changed. The results are shown in Tables 11 and 12. I find that the coefficient estimates for the adjusted sentiment scores are qualitatively similar for both types of financial assets.

These results verify earlier findings. They indicate that the construction of the minutes sentiment index was not driving the results. Using the key term selection focuses on the discussions related to economic information and is crucial in evaluating the association between the financial markets and the sentiments of the policy documents.

6.3. Accounting for the zero lower bound period

The Zero Lower Bound constraint that became binding at the end of 2008 may have affected how well the policy documents help predict the movements of the financial markets. To account for this possibility, I modify Eq. (3). I include the binary variable ZLB, which takes a value of 1 for the period after 2008, and 0 otherwise, and the interaction term between ZLB and the minutes sentiment index Z_t^M in the analysis. With these additions, I have the following regression specification:

$$p_t^f = \lambda p_{t-1}^f + \alpha + \beta_{Z_t^M} Z_t^M + \beta_{Z_{t-1}^M} Z_{t-1}^M + \beta_{Z_t^S} Z_t^S + \beta_{Z_t^M \times \mathrm{ZLB}} Z_t^M \times \mathrm{ZLB} + \beta_{\mathrm{ZLB}} \mathrm{ZLB} + \beta_{\mathrm{VIX}} \mathrm{VIX}_t + \beta_Y Y + \xi_t$$

To more clearly compare the period before and after 2008, I also evaluate the results when I omit the minutes release days in 2008.

Table 13 shows the results for the fed funds futures contracts. The odd-numbered columns give the results for the whole time period while the even-numbered columns coincide with findings that omit the minutes release days from 2008. I find that before the Zero Lower Bound period, the sentiments of the minutes have a statistically significant association with the fed funds futures contracts. Even with the omission of the policy document releases in 2008, the results indicate that the document sentiments help predict the changes in the fed funds future rates, particularly for the longer-term horizon.

Interestingly, the coefficient estimates for the interaction term are positive and statistically significant when the 2008 releases are included in the analysis. In contrast, these estimates are negative but not statistically significant when the 2008 releases are omitted. These observations further support the idea that the policy sentiments help predict the changes in longer-term fed funds future rates.

I also examined the results for the equity and exchange rate markets.[40] Similar to earlier findings, I do not find a consistent and statistically significant association between the minutes sentiments and the equity markets. Considering the foreign exchange rate market, I find some support for the idea that the U.S. dollar has a slightly higher likelihood of appreciation after the release of more hawkish minutes.

7. Concluding remarks

Central bank meeting documents have increased their relevance in recent policymaking. These documents assist in communicating the policy decision-making process and in conveying the economic outlook to the public. As my work empirically demonstrates, the documents can also be used for significantly affecting expectations about future policy and the predictions about financial market changes.

In addition, the amount of information in the minutes relative to the statements may play a role in the relevance of more detailed policy documents. The minutes provide additional discussions about projected economic conditions and therefore gives more specificity about the type of information that has influenced monetary policy. These extra details have a potentially mixed effect on the understanding of macroeconomic conditions. On one hand, the information in the minutes may provide more clarification and credibility to the economic discussions in the statements. Even after seeing the statements three weeks earlier, the market participants may not completely understand or believe the economic information conveyed. The minutes may then offer more discussions that clarify and support the information in statements. This possibility is supported by my findings that the statement sentiments have a statistically significant association with futures markets even on days with minutes releases.

On the other hand, additional details may also create more noise about macroeconomic outlook. These noisy signals could distort the clarity and credibility of communication and eventually weaken the association that policy documents have with financial market changes. Future work can examine the accuracy of the information in the minutes and statements and how it impacts the effectiveness of policy communication in guiding market expectations.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jeconbus.2021.106021.

[40] Results are available upon request.

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