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Have FOMC minutes helped markets to predict FED funds rate changes?

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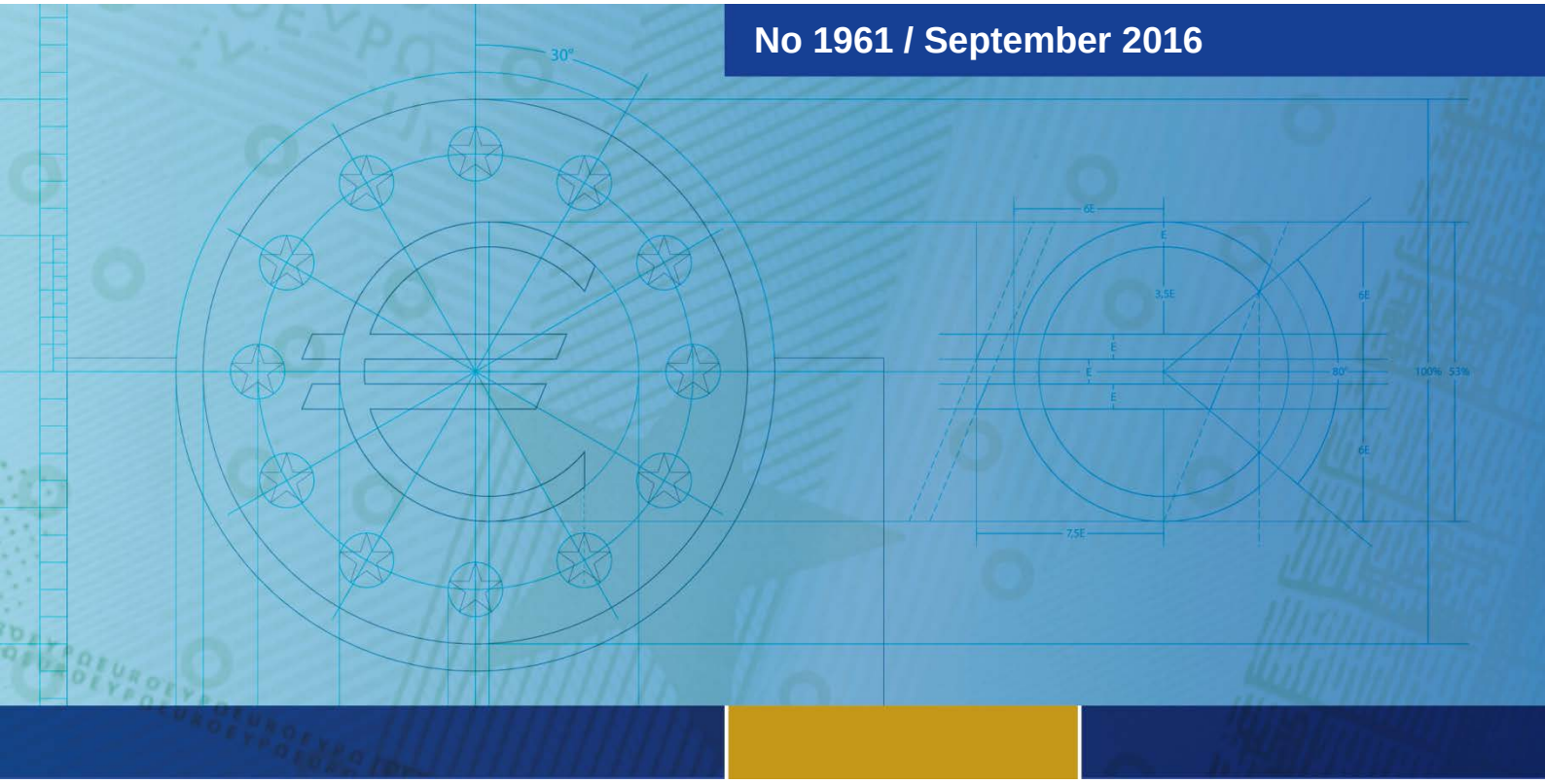

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Abstract

This paper examines whether the release of minutes of the Federal Open Market Committee (FOMC) has provided markets with systematic clues about its future policy rates. We explain the future fed funds rate changes using Ordered Probit models (sample 1996 to 2008). We find that timely FOMC meeting minutes have provided assurance to markets about the most likely path of future interest rates. Though, their release did not cause markets to fundamentally revise their expectations on future policy decisions. The paper also discusses lessons from the Fed experience for the ECB and other central banks.

JEL codes: C34, E52, E58

Keywords: Monetary policy, communication, FOMC minutes, predictability, ordered Probit.

Non-technical summary

Over recent decades, the Fed has undertaken sustained efforts to improve the public's understanding of its monetary policy. Over time, it has substantially increased its level of transparency thereby aiming at making monetary policy more effective. The communication strategy of the US Federal Reserve (Fed) is of particular interest, since it has evolved over time and uses a wide range of communications. The Fed is a highly predictable central bank and its communications have helped markets to anticipate future policy rate changes. The policy decision and communications by which the Fed or its officials explain monetary policy may have an impact on the market assessment of the future monetary policy course.

In policy discussions on enhancing central bank transparency, central bank minutes have received particular attention in academic debates. The FOMC meeting minutes provide a detailed summary of the FOMC discussion and inform the public and Congress about the full range of policy-makers´ views and debate about monetary policy issues, including the diversity of views. They have a clear, recurring structure and convey the content of the meeting through commonly used language. Compared to the post-meeting statement, which is released immediately after the FOMC meeting, minutes are published with a lag but provide far more detailed information on the arguments underlying the committee's assessment of the economic situation, the reasoning for the monetary policy decision and the diverse views of the FOMC members.

The present analysis addresses a knowledge gap as to whether the publication of the FOMC minutes has helped markets in real time to improve their predictions of forthcoming fed funds rate changes. It focuses on the sample 1996 to 2008, which excludes the more recent financial crisis episode. The approach of this paper is an empirical one explaining future interest rate changes based on an Ordered Probit model and applying the Vuong test to identify changes in the market assessment coinciding with the release of the FOMC minutes.

We find that timely FOMC meeting minutes have provided assurance to markets about the most likely path of future interest rates. Though, their release did not cause markets to fundamentally revise their expectations on future policy decisions. This finding can be explained by the presence of other FOMC communications, which provided markets with relevant information about forthcoming interest

rate changes. It implies that information contained in the published meeting minutes did not produce great surprises to them.

In terms of policy implications, the present analysis is consistent with the view that the practice of publishing timely minutes is a useful tool for central banks to enhance their transparency. Transparency about the internal deliberations tends to provide markets with additional assurance about the future policy course, thereby stabilising expectations. At the same time, the present study suggests that markets normally obtained enough clues about forthcoming fed funds rate changes from the Fed's other communications.

1. INTRODUCTION

On a global scale, central banks have been very active in overhauling their monetary policy frameworks so as to enhance transparency and monetary policy effectiveness (Poole, 2005a; Geraats, 2006; Dincer and Eichengreen, 2014; Horváth and Vaško, 2016). More openness about individual views of policy-makers may enhance monetary policy transparency, but increasing the degree of openness may not always be desirable from the perspectives of accountability and clarity (Issing, 2005). In addition, as shown by Meade and Stasavage (2008), greater openness about central bank policymaking may prevent the full and frank (internal) discussion among policy-makers that is needed to make the best decisions.

In policy discussions on enhancing central bank transparency, central bank minutes have received particular attention in academic debates. By now, most major central banks subscribe to the practice of publishing timely minutes of their internal deliberations together with or without voting records (see Table 1 and Hammond, 2012). Central banks provide the public with very detailed information about the confidential deliberations of a monetary policy committee for several reasons. First, they may have to comply with a legal requirement (e.g., the Bank of Japan, the Bank of England, and the Federal Reserve). Second, by explaining in more depth the considerations that lie behind the decisions of the monetary policy committee, they aim to enhance transparency about monetary policy decision-making. In some instances, notably in frameworks with individual accountability of policy-makers, publishing individual votes is part of the accountability process. Third, by revealing the main factor(s) contributing to a decision, a central bank signals openness. Fourth, information about policy options and about disagreement in a monetary policy committee can help to increase predictability of policy decisions. Fifth, publication of minutes gives a clear structure to the decision-making process and may enhance effectiveness of internal discussion.

The communication strategy of the US Federal Reserve (Fed) is of particular interest, since it has evolved over time and the Fed has a long tradition in publishing minutes and voting records. Over recent decades, the Fed has undertaken sustained efforts to improve the public's understanding of its monetary policy (Woodford, 2005; Spencer, Huston and Hsie, 2013).[2] Over time it has substantially

[2] Chairman Bernanke introduced a number of additional communication measures. In November 2007 the FOMC added numerical forecasts to the meeting minutes four times per year, with a three-year horizon. On 23 February

increased its level of transparency thereby aiming at making monetary policy more effective (Yellen 2012). The Fed, which is today ranked among the most transparent central banks in the world (Dincer and Eichengreen, 2014; Horváth and Vaško, 2016), provides markets with a wide range of communications which contain information about the future monetary policy stance (e.g., statements, speeches, minutes, press conferences, transcripts). Most empirical studies find that the Fed is a very predictable central bank and that its communications have helped markets to anticipate future policy rate changes (e.g., Wilhelmsen and Zaghini, 2011; Ehrmann and Fratzscher, 2007a). Though, a knowledge gap exists as to whether the publication of the FOMC minutes has helped markets in real time to improve their predictions of forthcoming fed funds rate changes.

The aim of this paper is to examine whether the release of FOMC minutes has provided markets with systematic clues about the future course of the Fed´s monetary policy. The present analysis focuses on the sample 1996 to 2008 and deliberately excludes the more recent episode of the zero lower bound from it. Unlike for the MPC members of the Bank of England, FOMC members' votes do not solely apply to the monetary policy decision itself, but they may also include members' views on extraordinary measures. In such an environment, the quality of the interest rate skew as a predictor for forthcoming policy rate changes can deteriorate. For example, between March 2010 and September 2013, the voting record signalled disagreement in the FOMC about whether to embark on further quantitative easing measures and on whether to exit from the extraordinary accommodative stance. Some members were requesting the termination of the QE programme with their dissent, which implied a positive skew, although, given the Fed's forward guidance it was clear to markets that it would maintain its fed funds target rate unchanged at the level of 0 to 0.25 per cent.

The paper is organized as follows. Section 2 provides a brief overview on the FOMC communication tools. Section 3 describes the data used for this analysis. Section 4 presents the approach and empirical results for the Fed. Section 5 concludes.

2009, the Federal Reserve (Fed) launched a new website and provided detailed information about the Fed's policy actions during the financial crisis. On 27 April 2011, it added a quarterly press conference to the release of a summary of economic projections. On 25 January 2012, it provided a statement on the committee´s longer-run goals and monetary policy strategy including a 2% inflation target and Fed policy-makers started reporting their short-term interest rate projections over the next few years ("dot plot chart").

2. FOMC COMMUNICATION TOOLS: A BRIEF OVERVIEW

The policy decision and communications by which the Fed or its officials explain monetary policy may have an impact on the market assessment of the future monetary policy course. In this section, we briefly survey the literature and review those FOMC communication tools, which have a bearing on market expectations, and explain how they have evolved (for a detailed exposition see e.g., Ehrmann and Fratzscher, 2007b; Yellen, 2012; Woodford, 2005; Wynne 2013).

Brief survey of the literature

The literature has shown that central bank communication is an important determinant of the market's ability to anticipate monetary policy decisions. While central banks differ in their communication strategies, different strategies can be equally effective (Blinder, Ehrmann, Fratzscher and de Haan, 2008). In this context, available studies for the Bank of England (Reeves and Sawicki, 2007) suggest that the Bank of England's minutes affect short-term interest rate expectations Bank of England's and that published minutes of the MPC's deliberations have helped markets in forming their expectations on future monetary policy decisions (El-Shagi and Jung, 2015b). While several studies for the US (see Kohn and Sack, 2003; Bernanke, Reinhart and Sack, 2004) have shown that the publication of FOMC minutes affects interest rate expectations along the entire yield curve, there is to our knowledge no study which examines whether FOMC minutes have contributed to inform the market assessment in real time with a view to forthcoming interest rate changes. This question is relevant, given that the FOMC has more actively used other communication tools (e.g., forward guidance).

Over the past decades the Fed has made important changes in its disclosure policy, such as the timelier release of the minutes, the release of the voting record immediately after the meeting and the occasional adoption of forward guidance. Moreover, a host of factors contributed to more consensual voting in the FOMC such as the Great Moderation, the Taylor rule as a framework to guide policy decisions, Chairman Greenspan's outstanding leadership (El-Shagi and Jung, 2015a), the FOMC bias statement (Chappell et al., 2007), and informal rules limiting the dissent, such as the "musical chairs" (Meyer, 2004). So far many studies have examined the Federal Open Market Committee´s (FOMC) voting record showing that members´ dissent can help forecast future policy decisions (e.g., Chappell,

McGregor and Vermilyea, 2005; Meade, 2005; Jung, 2013; Riboni and Ruge-Murcia, 2014). For several central banks, the interest rate skew as a measure of disagreement in a monetary policy committee has been found to contain information that helps markets to predict future policy moves (Gerlach-Kristen, 2004; Horváth, Smidková and Zápal, 2012a).

For the Fed a study by Horváth, Smidková and Zápal (2012b) has shown that, for the early Greenspan years, the interest rate skew from the voting members could have helped markets to predict the fed funds rate. Moreover, a study by Riboni and Ruge-Murcia (2014) confirms this result for the sample 1987 to 2009 using an ordinal skew variable. The regression used in both these studies does not allow to test whether the release of FOMC minutes has actually changed the market assessment. They analyse the question whether the skew is a potentially useful variable, which could contain information on future fed funds rate changes.

Agreement in a monetary policy committee often takes time and building a consensus on a decision may involve a series of meetings. The notion that some members in the committee are quicker than others in recognising changes in the economic dynamics ("early birds") is important to understanding the inertia of the monetary policy process (Blinder, 2004; Horváth and Jonásová, 2015). Because voting is largely consensual and communication is dispersed across policy-makers, it appears to be crucial for markets to figure out whose statements to watch closely (Ehrmann and Fratzscher, 2007a). In order to empirically show that the skew is a good predictor of future interest rate changes, it may therefore matter one measures disagreement in the committee. Horváth, Smidková and Zápal (2012b) also calculate the skew for the "alternate" members (i.e., the non-voting FOMC members) based on information from the transcript, but do not find that it could have helped markets to predict the fed funds rate. Riboni and Ruge-Murcia (2014) find that the skew from the preferences of the Reserve Bank Presidents leads to better results compared to a skew using all FOMC members or a skew including only the Board members. Though, in the period until the end of 2001 the voting record was released only after the subsequent meeting. Hence, markets could only use the skew for interest rate predictions in real time as of 2002. Nevertheless, in real time markets may have obtained information on the skew from other sources, such as the speeches of the Reserve Bank Presidents (Hayo and Neuenkirch, 2013), regional unemployment rates (Meade and Sheets, 2005; Jung and Latsos, 2015) and from the discount rate recommendation from the twelve districts (Tootell, 2000).

FOMC Minutes and the post-meeting statement

Post-meeting communication tools, which have been subject to some refinements over time, provide the public with timely information on the Fed's policy decisions. Since February 1994, as is now standard practice in central banking, the FOMC has announced the outcome of its meeting with a post-meeting statement including a short rationale for the policy action.[3] Before, the Fed did not announce its policy decisions and actions in real time but only after the subsequent meeting and markets needed to guess what the intended federal funds rate was (Ehrmann and Fratzscher, 2007b). In January 2000, the FOMC changed its disclosure policy. First, it clarified that it would issue a statement immediately after each regularly scheduled meeting, regardless of whether there had been a change in monetary policy. Second, a statement on the "balance of risks" in the economy was added, which replaced the FOMC bias statement, i.e., the statement the Fed was issuing between 1983 and 1999 (Chappell et al., 2007). These steps have enhanced the market´s understanding of the fed funds rate setting and appear to have helped markets to predict future monetary policy actions (Rasche and Thornton, 2002; Fawley and Neely, 2014). They were also accompanied by a substantial decrease in market uncertainty and an increase in monetary policy effectiveness (Swanson, 2006). As of 2002 votes of individual (voting) FOMC members have been included in the post-meeting statement. With the regular release of attributed voting records, markets have received systematic information about the distribution of individual votes of the voting members of the policy committee immediately after the meeting.

FOMC minutes are an important complement to the post-meeting statement (Danker and Luecke, 2005). Compared to that very timely statement, minutes are published with a lag but provide far more detailed information on the arguments underlying the committee's assessment of financial market developments, the current and future state of the macroeconomy, and the balance of risks to price stability and economic growth. The FOMC meeting minutes provide a detailed summary of the FOMC discussion and inform the public and Congress about the full range of policy-makers´ views and debate about monetary policy issues, including the diversity of views (Meade, Burk, Josselyn, 2015). They

[3] The post-meeting statement is released at about 2:15 p.m. (ET) on the day of each FOMC meeting. It is brief, and today includes four key components: the federal funds target interest rate decision, the rationale for that decision, the risks to monetary policy and the economy associated with the decision, and how each member voted on the policy decision.

have a clear, recurring structure and convey the content of the meeting through commonly used language (Danker and Luecke, 2005). Minutes provide markets with an update of the staff assessment of the economic outlook and the views of meeting participants on the policy options, based on information that was available at the meeting. In addition, the Fed publishes transcripts with a five-year lag, which are more detailed and contain information about the statements by members at the meeting.

Minutes, which have been published in some form since 1936, have evolved over time both in terms of content and timing. Detailed minutes have been provided since 1993 together with voting records. Initially, the publication lag was six to eight weeks after a meeting, depending on the timing of the subsequent meeting. In December 2004, the Committee decided to bring forward publication of each meeting's minutes to exactly three weeks after the meeting (and three weeks prior to the subsequent meeting). This change has helped to provide markets with greater context in intermeeting periods, allowing them to more precisely formulate expectations for what the FOMC's next policy decision might be. In addition, since end-2004 minutes reflect views of both voting and non-voting committee members (Meade, Burk and Josselyn, 2015).

Figure 1 illustrates the timing of the Fed's principal communications of its monetary policy assessment relative to the announcement of the policy decision. We distinguish between three main phases. Until January 2002, the minutes and voting records were released after the next FOMC meeting. Markets could only incorporate information from it for the subsequent meeting but not for the forthcoming meeting. Between March 2002 and December 2004, the voting record was published together with the FOMC statement on the day of the FOMC meeting, but the minutes were released after the subsequent meeting. While the late release limited their usefulness in conveying the thinking behind the policy decision made at the meeting (Wynne, 2013), markets obtained timelier information on the voting record. Since December 2004, FOMC minutes have been released timelier, i.e., three weeks after the meeting statement and three weeks before the next FOMC meeting. In addition, starting in 2011 (quarterly) press conferences, which are providing detailed explanations by the Fed chair, have been held on the same day on which the meeting statement is released.

Forward Guidance

The Fed has a long history with using forward guidance, which goes back to the late 1990s. A recent study by Hansen and MacMahon (2016) highlights the importance of the Fed's forward guidance, which over the last two decades had stronger effects on the real economy than the Fed's communications on the economic outlook. Forward guidance is an additional element in its communication strategy aiming to improve the markets' understanding of its thinking on future monetary policy decisions. However, forward guidance it is not a promise, but only a conditional commitment by the Fed. In a regime of (credible) forward guidance, other communication tools such as the minutes may have a smaller influence on market expectations about forthcoming policy changes. The Fed´s forward guidance could therefore have led markets to economise on their resources in assessing the economic outlook by following suit the Fed's assessment, thus broadly ignoring any news contained in the minutes.

There have been several episodes when the FOMC gave concrete forward guidance for the next meeting (for details see Gavin, Keen, Richter and Throckmorton, 2013). Starting in 1999, the FOMC experimented for a short time with forward guidance in the post-meeting statement by introducing references to symmetric or asymmetric directives with regard to the outlook for policy over the near term (Wynne, 2013). Later, between May 2004 and January 2006, the FOMC introduced forward guidance using the "measured pace" language (Thornton, 2006). It made a renewed effort in December 2008, when the FOMC stated that it expected to keep the funds rate low "for some time" coinciding with a federal funds rate that was essentially zero and during the financial crisis it switched between Delphic and Odyssian forward guidance (Eggertson and Woodford, 2003; Gavin, Keen, Richter and Throckmorton, 2013).

3. DATA

The present empirical analysis examines the sample from the beginning of 1996 to end-2008 (see Table A.1 of the Appendix for a summary of the data and sources). While the present analysis could be applied also to the more recent financial crisis episode, an important point in case of FOMC dissents is that they apply to both conventional monetary policy and non-standard monetary policy measures (QE). Unlike for the Bank of England, it is not possible to disentangle the two factors completely. It would

require to make assumptions and to apply a judgemental coding on the dissents during the financial crisis. However, in this study we are mainly using the skew as a control variable in assessing alternative forecasting models on the day before and the day after the release of FOMC minutes.

For the econometric analysis, we use the meeting frequency, i.e., eight meetings each year. Section 3.1 presents the interest rate skew from the voting record, Section 3.2 provides other skew measures with changing composition of the FOMC members, Section 3.3 presents the skew from discount rate recommendations of the regional board of directors and Section 3.4 provides information on financial market indicators, which are used to measure the market response.

3.1. The interest rate skew

Data on the interest rate skew of the FOMC were computed from information contained in the committee's voting record which is available for each meeting. The FOMC is made up of up to twelve voting members: up to seven Board members and five Reserve Bank Presidents. The President of the New York district has a permanent voting right, whereas the other four Presidents are from the twelve districts and rotate on an annual basis. The diversity of views of these members is reflected in the voting record.

We define a measure of disagreement in the FOMC in line with the literature (Gerlach-Kristen, 2004; Horváth, Smidková and Zápal, 2012b). The interest rate skew is given by:

$$skew_t = (\sum_{j=1}^{n} i_{j,t} / n) - i_t \qquad (1)$$

where i_t denotes the fed funds rate and $i_{j,t}$ is the interest rate voted for by FOMC member j at the FOMC meeting at time t, and n is the number of members voting at the meeting. The skew takes a positive (negative) value whenever the average of the interest rate preferences lies above (below) the policy interest rate. As a predictor for forthcoming interest rate changes, a positive (negative) skew would be indicative of a possible tightening (easing) at the forthcoming meeting(s), while a zero skew would signal unchanged interest rates. The variable skew has been computed to include the preferences from all voting FOMC participants and refers to information reported in the voting record. In the FOMC dissenting members normally state the direction of their dissent, but not the exact federal funds rate they would have preferred. We follow Riboni and Ruge-Murcia (2014) and code each dissent as a 25

bps deviation from the FOMC decision, when computing the skew. Like previous studies, we ignore the possibility that new appointments to the FOMC would structurally change the interest rate skew in that this would systematically change the distribution of preferences in the committee. We also consider alternative measures of the interest rate skew (see next sections).

Figure 2 shows that the (lagged) skew from the voting record may contain information about forthcoming decisions on the fed funds rate at the next meeting, but not for each meeting. It does in particular a good job in predicting decisions that the fed funds rate remains unchanged. In line with international evidence (Horváth and Jonásová, 2015), we find that the skew can give noisy signals about future policy decisions. More precisely, until end-2004 the skew correctly signalled the interest rate decision (including that the fed funds rate remained unchanged) in more than 50 per cent of the meetings. During the sample from the beginning of 2005 to end-2008, however, the ratio was smaller and amounted to about 35%.

We follow Horváth and Jonásová (2015) and calculate the conditional probability of a fed funds rate change at the forthcoming meeting depending on the number of dissents (Table 2). Since 1995, Reserve Bank Presidents have been the main source of dissent and they usually dissented for tighter policy than the committee average, whereas before Governors were also active dissenters (Thornton and Wheelock, 2014). The absence of dissent or the presence of only one dissenter usually gave a good indication that the Fed would not change its fed funds rate at the forthcoming meeting, given a conditional probability of 0.54 and 0.63 respectively. Changes in the fed funds rate have occurred with practically any number and direction of dissents from the (voting) Reserve Bank Presidents. In this context, the Board always had a structural majority in the FOMC and its proposal is traditionally supported by the President of the New York Fed, which means that the regional representative(s) can be easily outvoted, if necessary. With two dissenters, the chances stood 50% as to whether there would be an interest rate decrease or an unchanged fed funds rate at the next meeting. In addition, the observation that the interest rate skew may occasionally be a noisy indicator is linked to the Fed's forward guidance. For example, a discrepancy arose during the 2004 to 2006 "measured pace" episode, because FOMC members had agreed that the fed funds would be increased in incremental steps of 25 basis points at a series of consecutive meetings, and therefore the skew was zero.

3.2. Other skew measures

We consider alternative "internal" skew measures with varying composition of the FOMC members. Skew2 refers to the internal skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents; skew4 refers to the internal skew from the voiced interest rate preferences (FOMC transcript) of the non-voting Reserve Bank Presidents. The data on interest rate preferences refer to the dataset by Meade (2005) and subsequent extensions (El-Shagi and Jung, 2015a; Jung and Latsos, 2015).[4] The internal skews based on these data were computed until end-2008, taking into account that the transcript is only published with a five year lag. By contrast to the skew from the voting record, skews containing information from the FOMC transcript are not observable by market participants in real-time. Nevertheless, Fed observers following FOMC members' individual communications may have been aware of information that is similar to the internal skew (e.g., from speeches or from requests made at the discount rate meetings).

3.3. Skew derived from discount rate minutes

A further source of information, which normally receives less attention in public debates, is the discount rate recommendation from the twelve districts (Tootell, 2000).[5] Every two weeks, discount rates are established by each Reserve Bank's board of directors, subject to the review and determination of the Board of Governors of the Federal Reserve System. The regional banks' requests for discount rate changes may have helped markets to anticipate future funds rate changes, but those requests have not figured prominently in the Fed's communication strategy. Between May 1994 and December 2008, some information on the discount rate requests by the districts was included in the FOMC post-meeting statement. However, for the purpose of this study the information provided is incomplete, since until 2001 no information on the preferences of the dissenting banks was given therein or in separate press releases on the approval of discount rate actions.

[4] FOMC transcripts include information about individual preferences of all FOMC members (voting or non-voting members), as revealed in the internal policy debates. Information about individual preferences is available in the form of agreement and dissent, or disagreement concerning the decision. In order to provide a quantitative measure, information from the transcript has to be coded. In line with Meade (2005), it is assumed that dissents or disagreements by members are made in multiples of ±25 basis points. Then, the measure is added to the final Fed funds rate to calculate the individual interest rate preference in the form of an interest rate level.

[5] The discount rate is the interest rate charged to commercial banks and other depository institutions on loans they receive from their regional Federal Reserve Bank's lending facility, the discount window. For details see Madigan and Nelson (2002).

We collect preference data from the discount rate minutes in the form of discount rate levels and compute a skew for all twelve Reserve Banks (skew12) relative to the discount rate using (1). Discount rates are the same across all Reserve Banks except on days around a change in the rate. Nevertheless, a regional board of directors may reveal disagreement in their discount rate requests, whenever they deviate from the approved discount rate, and this information is evident from the discount rate minutes. While discount rate requests refer to interest rate preferences of a board of directors and not necessarily that of the regional Reserve Bank President, both regional representatives are normally in synch. Therefore, the recommendations may provide clues as to where each Federal Reserve Bank president may be heading in the FOMC meeting and hence about diversity in the FOMC. Starting in May 2001, the Fed has released discount rate minutes one week after the minutes (i.e., four weeks after the preceding FOMC meeting). The disclosure evolved and information provided has become timelier. Since January 2005, discount rate minutes have included information on discount rate meetings referring to the time period around the previous FOMC meeting.

3.4. Financial market indicators

In order to measure the market response we include alternative measures of asset prices. We are interested in indicators that capture changes in the market assessment of upcoming policy changes. The database comprises of several measures of interest rate expectations, the Dow Jones equity index, and the bilateral US dollar exchange rate vis-à-vis the euro (daily data). When assessing the market response to the FOMC's communications, for the purpose of empirical research, short-term interest rate futures are by far the best proxies of the market reaction. Moreover, a study by El-Shagi and Jung (2015b) for the Bank of England shows that information contained in minutes can be best detected by looking into (daily) one-month-ahead money market futures. The empirical analysis focuses on two proxies when detecting changes in interest rate expectations linked to the release of minutes: (a) the (one-month) market spread between the current policy rate and the interest rate implied by short term (one month) money market futures (source: Bloomberg); (b) the corresponding (one-month) future spread of these money market futures between the publication of the minutes and one day after the

announcement of the policy decision (source: Bloomberg).[6]

We consider using intraday data in addition to daily data (Andersson, 2010). This would allow us to measure more closely the response of interest rate futures during the day when new information is released. It turned out that obtaining longer runs of intraday data is very expensive. Hence, we do not measure the impact of FOMC minutes during the day of its release. When measuring the impact of the release of minutes on expectations, an important issue is identification. Depending on the sample, the use of daily data allows distinguishing between the effects from the release of the FOMC minutes after each meeting and those from other communication tools, namely skew related to meeting statements and press conferences.

4. AN ECONOMETRIC ANALYSIS

In this section, we present the method and results of our econometric analysis. We look into the question whether any information contained in the FOMC minutes has systematically helped markets to learn about the next fed funds rate change The main objective of our empirical analysis, which uses ordered Probit models to forecast interest rates on the day before and on the day after the publication of FOMC minutes, is to examine whether the publication of the FOMC minutes has helped markets in real time to improve their predictions of forthcoming fed funds rate changes. This hypothesis would require that in a model predicting monetary policy using market expectations that reflect market perceptions (immediately) after the publication of the FOMC minutes should significantly outperform a model predicting monetary policy using expectations formed before the publication of the minutes. In the following, Section 4.1 explains the econometric approach and Section 4.2 presents the empirical results.

4.1. The econometric approach

At a meeting the FOMC faces three mutually exclusive choices: it can tighten the monetary policy stance, loosen it or keep it unchanged. Because the FOMC changes the fed funds rate in multiples of 25 basis points, and changes of more than 25 basis points are rare (Poole, 2005b), it is

[6] This measure allows us to account for a persistent and possibly time-varying risk premium contained in the interest rate futures.

preferable to transform these choices into a discrete variable. Figure 3 shows that the majority of decisions led to unchanged fed funds rates, and that changes by 25 basis points were frequent, whereas larger changes were infrequent. It also shows that in our sample the distributions were slightly skewed towards lowering interest rates, but overall they resemble a normal distribution. Unlike the observed federal funds rate (i), which is continuous in time, the dependent variable (Δr^*) in our model is discretionary and has been coded applying three categories: -1: interest rate decrease (≤ -25 basis points), 0: no policy change, 1: interest rate hike (≥ 25 basis points).

We therefore use an Ordered Probit model to predict the FOMC's policy actions. In this respect, we follow the recent literature on voting in monetary policy committees (Gerlach-Kristen, 2004; Horváth, et al., 2012a, b; Riboni and Ruge-Murcia, 2014). These studies have used the skew as explanatory variable for future interest rate changes:

$$\Delta r^*_{t+n} = \beta_1 \Delta i_t + \beta_2 skew_t + \nu_{t+n} \quad (2)$$

where Δr is the ordinal variable capturing the change of the policy rate from one meeting to the next, Δr^* is the corresponding latent variable, Δi refers to the (lagged) change of the interest rate in basis points, *skew* is the skewness indicator, n refers to the future meeting, the β_i are regression coefficients, υ is a Gaussian error term. Evidence provided in Horváth and Jonásová (2015) for five central banks suggests that for certain central banks the skew from the voting record can still be informative for interest rate decisions at future meetings (t+2, t+3). According to Horváth et al. (2015), the above specification allows capturing possible "early bird" effects, which are related to the observation that policy rate changes are discussed in the FOMC at time t, but the committee may need some additional meetings to agree that the economic conditions have changed. Therefore, early birds could make the point for an interest rate change at meeting t and this would be reflected in the skew of meeting t, while the decision is only taken at meeting t+2 or t+3.

In order to measure the impact from the FOMC minutes, we specify the following baseline Ordered Probit (Gerlach-Kristen, 2004; Horváth et al., 2012a, b; El-Shagi and Jung, 2015b):

$$\Delta r^*_{t+n} = \beta_1 \Delta i_t + \beta_2 skew_t + \beta_3 market_{X(t)\pm\tau} + \omega_{t+n} \quad (3)$$

$$\text{with} \quad \Delta r^*_{t+n} = \begin{cases} -1 \; if \; \Delta r^*_{t+n} < \mu^- \\ 0 \; if \; \mu^- < \Delta r^*_{t+n} < \mu^+ \\ 1 \; if \; \Delta r^*_{t+n} > \mu^+ \end{cases},$$

with the notations as above, where *market* is the financial market indicator used in the respective regressions, t is a time index which corresponds to each meeting of the FOMC. In this specification we specify the date of the last interest rate decision as t, X(t) denotes the publication date of the minutes for the meeting in t, i.e., t <X(t)< t+2 (until December 2004) and t <X(t)< t+1 (thereafter; see Figure 1), whereas t+1 is the date of the next policy decision, τ is one (trading) day, i.e., ±τ indicates that our financial market data is obtained one day before the minutes release or one day after it. The β_i are regression coefficients, ω is a Gaussian error term, and μ^- and μ^+ denote the thresholds for a change of the ordinal dependent variable. These regressions are estimated separately with $market_{X(t)-\tau}$ and with $market_{X(t)+\tau}$.

Our hypothesis that FOMC minutes are informative about forthcoming interest rate changes would imply that the above forecasting model (3) improves from the day before the minutes release to the day after it even when controlling for other variables (i.e., the interest rate skew). By means of the Vuong (1989) test we check whether a forecasting model (3), which incorporates information after the release of the minutes, is better than a forecasting model before the release. The Vuong (1989) test compares predicted probabilities of two non-nested models.[7] In this context, the Vuong test does not allow any inference about which of the two models is the "true" model, but this is not needed for the present exercise. For the benchmark specification, the Vuong test compares model 1 (which uses the market variable on the day before the publication of the minutes) with model 2 (which uses the market variable on the day after the publication). Other than using market variables from different days, model 1 and model 2 are identical. Therefore, the Vuong test would only reject the null hypothesis that both models explain the data equally well in favour of model 2, if the post-meeting market variable contains additional information that contributes to improved predictions of the FOMC's future interest rate changes. In order to detect a significant improvement in the formation of market expectations to the

[7] In this paper, we report the results with the one-step Vuong test. Given that the distribution of that test could be skewed, if the two models are partially non-nested, we also performed the two-step Vuong test, and found that these tests fully confirmed the results reported. In addition, we made a second robustness check in which we excluded the lagged interest rate change and the skew from equation (3) so as to make the two models strictly non-nested. Again this check confirmed the results.

publication of minutes, the test therefore has to indicate that the model 2 incorporating information from the release of the minutes is significantly superior to the pre-release model 1.

It is conceivable that the timing in the disclosure of voting records and minutes as well as the introduction of forward guidance - which market participants could have understood as an unconditional "promise" by the Fed to hike by 25 basis points at each meeting - may have distorted the stability of the above relationship. We make further checks for the robustness of the results. First, we estimate the above specifications with alternative proxies of the skew capturing the fact that disagreement raised by Reserve Bank Presidents or regional Board of Directors may be more informative for future rate changes than those by the Board members who tend to vote similar to the FOMC chairman. Thornton and Wheelock (2014) show that during 1994 to 2013 the governors voted along with the Chair, while Reserve Bank Presidents accounted for almost all dissents. Moreover, disagreement on the fed funds rate by the Presidents was most of the times towards the hawkish direction, whereas disagreement by Board members was more often towards the dovish direction.

Second, we distinguish between the full sample (1996 to 2008), which covers a period when the federal funds rate was not hitting the zero lower bound, and different subsamples. This allows capturing the influence coming from changes in the timing and content of the minutes release as well as forward guidance. First, the subsample (1996 to 2004) corresponds to the period when minutes were released after the next meeting and the FOMC was chaired by Alan Greenspan. For the longest part of this subsample the voting record was published with the minutes. Nevertheless, the information provided could still have influenced the market assessment for the next but one meeting. Second, the subsample (2002 to 2008) corresponds to the period when information on the voting record was published on the day of the FOMC meeting. Since March 2002, the publication of new information on the voting record has typically preceded the FOMC's decision to change interest rates and has contained information that is useful for a forward-looking assessment of its monetary policy stance in real time. However, the publication of minutes has only preceded the next FOMC meeting since December 2004. While the first subsample reports results referring to one chairman (Alan Greenspan), the second subsample covers two chairmen (Alan Greenspan and Ben Bernanke).

4.2. Empirical results

Overall, the regressions (see Table 3) show that the skew variable may add significantly to explaining forthcoming changes of the fed funds rate. We find that it matters crucially whether a skew derived from the official voting records or an internal skew is included in the regressions. First, the skew derived from the final votes of all voting members is not informative about forthcoming fed funds rate changes. Second, the internal skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents is informative about forthcoming fed funds rate changes. In this context, markets may not have been able to fully capture information contained in internal skews when forming interest rate expectations for the next meeting, since minutes contain some information on disagreement in the FOMC, but detailed information on the internal skew only became available after five years, i.e., when the FOMC transcript was published. Nevertheless, they may have obtained information on diversity from the recommendations of the Board of Directors at the discount rate meetings. In this context, the skew derived from the discount rate recommendations turns out to be insignificant and hence not informative. Third, regardless of which skew measure is included, the lagged interest rate change is always significant, thus indicating a high degree of persistence in the policy rate.

Often, the committee does not agree on a measure immediately when important early warning indicators change but needs more time to agree on it in order to gain more confidence in its assessment. For the more distant FOMC meetings at time t+2 and t+3, Table 4 provides the results of Probit regressions of equation (2) using those skews that were good predictors at t+1. In line with the findings by Horváth and Jonásová (2015) for five European central banks, our results for the Fed suggest that the internal skews would have also helped private market participants to forecast more distant fed funds rate decisions for the meeting in t+2 but not for the meeting in t+3. This finding applies to both, the internal skew from all Reserve Bank Presidents and the internal skew from the non-voting Reserve Bank Presidents. It supports the notion that the predictive power of the skew decreases the further away the FOMC meeting is, given that serial dissent does not improve predictability (Riboni and Ruge-Murcia, 2014) and incoming information may change the committee's assessment in the meantime (Blinder, 2004). As indicated by the pseudo R^2 statistics, its fit is reasonable for this type of analysis, and, as expected, its magnitude declines for the forecasting models with more distant fed funds rate

changes. Moreover, we find that both internal skews are insignificant during 2002 to 2008. This appears to be an indication of a structural change in the relationship coinciding with a change in the disclosure policy, i.e., that the voting record was published immediately after the meeting.

Table 5 shows the results of the Probit regressions of equation (3) including a market variable before and after the release days of the minutes. All regressions display satisfactory statistical properties.[8] Except for the subsample 1996 to 2004, the lagged interest rate is significant reflecting the persistence of the interest rate setting behaviour. The internal skew from all Reserve Bank Presidents is a relevant control variable in these prediction models. Nevertheless, when the market variable is added to the regression, it is in most cases not significant any more. We make a robustness check, include the internal skew of the non-voting members (skew4) and obtain similar results.[9] While this may be related to the market variable, work by Horváth and Jonásová (2015), which uses the term structure instead, finds similar evidence for Hungary, but not for four other European countries.[10] In the case of the Fed, it appears that the market variable, which is significant in all regressions, picks a large part of the forward-looking information. Moreover, as indicated by the pseudo R^2 statistics, the regressions display a fit that is reasonable for this type of analysis. A comparison of the results in Table 3 and 4 with Table 5 shows that the set of Probit regressions (equation 3) have substantially improved, since they have a better fit than the above regressions (equation 2), as indicated by the higher pseudo R^2 statistics.

When comparing the fit of the regressions using market expectations before and after the FOMC minutes release, it turns out that the fit is somewhat better implying that the forecast model improved following the release of the minutes. This result suggests that the FOMC meeting minutes contained information, which drove the market assessment of future policy changes of the Fed. However, during the subsample 1996 to 2004 the fit is similar before and after the release, i.e., when the model is updated to include information from the minutes. This suggests that in this sample markets did not obtain any additional information from the minutes, which would have helped them to predict

[8] In order to capture the timing of the release of minutes and voting records, we set n=1 in equation (3) for the sample 2002 to 2008, whereas for the samples starting in 1996 we set n=2 and use the skew from meeting before the minutes release.

[9] For brevity of the analysis this result is not reported here but available from the author upon request.

[10] The error terms in the regressions could be correlated, as we explain the effect of skew on the monetary policy rate change in t+1, t+2 and t+3. Following Horváth and Jonásová (2015), we make a check for robustness and extract the bivariate regressions for the dependent variables from the ordered Probit by estimating the seemingly unrelated regressions for an ordered Probit model. If the error terms are correlated, this additional piece of information may decrease the estimated standard errors and eventually influence our conclusions as to the significance of the skew at more distant policy horizons. The robustness check confirms our baseline results.

forthcoming fed funds rate changes. These findings are in line with the notion that the earlier release of FOMC minutes, which from December 2004 were provided before the next meeting, provided markets with some relevant information that was new.

In order to examine whether information contained in the meeting minutes was just giving assurance to markets or caused markets to revise their prediction model, we run the Vuong (1989) test. Table 5 reports the results from the comparison of the Probit models one day before the release of FOMC minutes and with those from the day after it. When using the difference between the current policy rate and the interest rate implied by short term (one-month) money market rate futures as market variable, the Vuong test rejects the hypothesis that the Probit model after the release of minutes could be superior for all samples. This would indicate that markets were typically not able to improve their prediction model of the future bank rate exploiting information on the day of the publication of minutes. For the sample 2002 to 2008, the meeting minutes only provided assurance to markets, as visible from the improved fit, but did not cause them to change their assessment (result of the Vuong test). However, for the sample 1996 to 2004, this analysis suggests that the meeting minutes did not inform the market assessment, neither for the forthcoming meeting nor for the subsequent meeting.

In order to be sure that the Vuong test does indeed detect a signal from the minutes release correctly, and does not generally capture learning by markets when getting closer to the next meeting, we use other proxies for the market response as controls. For example the corresponding (one-month) future spread of these money market futures between the day before (after) the publication of the minutes and one day after the announcement of the corresponding policy decision. These checks for robustness suggest that the test procedure is valid (for further control examples, which confirm the validity of the approach, see El-Shagi and Jung, 2015b).

An important issue is whether the stability of the relationship may have been affected by changes in the Fed's disclosure regime, such as the adoption of forward guidance. We examine this point by conducting Chow breakpoint tests. These tests show that the relationship was neither affected by the earlier publication of the voting record as of January 2002 nor by the earlier publication of meeting minutes as of December 2004. But, one episode linked to the Fed´s other communication tools, namely the adoption of the "measured pace" language in May 2004, seems to have impacted on the stability of the relationship in the prediction model.

5. CONCLUSIONS

This paper examines whether the release of minutes has helped markets in real time to predict the federal funds rate. In fact, the Fed is a highly predictable central bank, which has a long tradition in publishing meeting minutes (and voting records). The approach of this paper is an empirical one explaining future interest rate changes based on an Ordered Probit model and applying the Vuong test to identify changes in the market assessment coinciding with the release of the FOMC minutes.

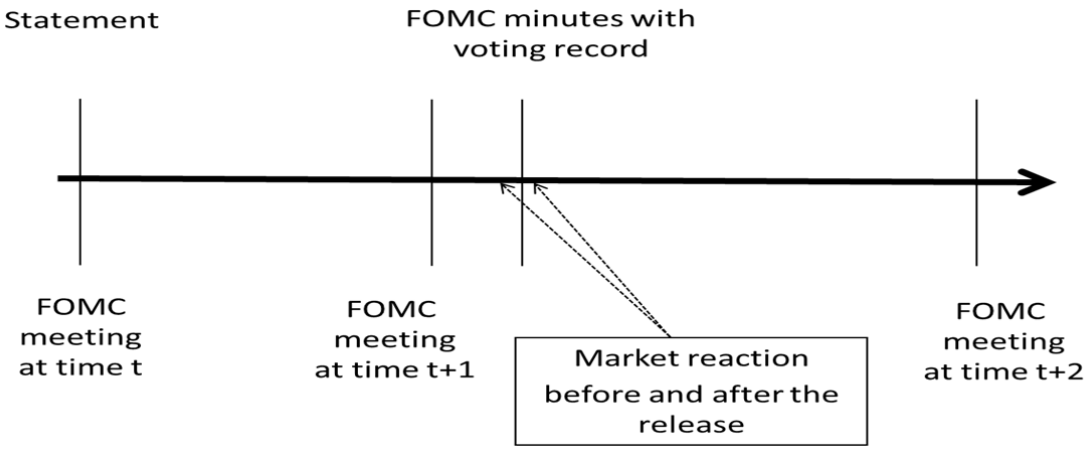
We find that timely FOMC meeting minutes have provided assurance to markets about the most likely path of future interest rates. Though, their release did not cause markets to fundamentally revise their expectations on future policy decisions. This finding can be explained by the presence of other FOMC communications, which provided markets with relevant information about forthcoming interest rate changes. It implies that information contained in the published meeting minutes did not produce great surprises to them.

Different from the Fed, the Bank of England's MPC minutes have systematically helped markets to improve their short-term interest rate expectations of the next interest rate move. In view of the high level of predictability by both central banks, an explanation of the different behaviour appears to be owing to two main differences in the communication strategy and the disclosure regime. First, the Fed has used other communications very actively, for example its forward guidance, whereas the Bank of England has used it only in recent years in response to the financial crisis. Second, the Bank of England provided information on the voting record in its minutes, which were published some weeks after the policy decision. In this context, the Bank of England has recently revised its disclosure policy and since August 2015 the MPC has published its meeting minutes as timely as possible, i.e., together with the policy rate decision.

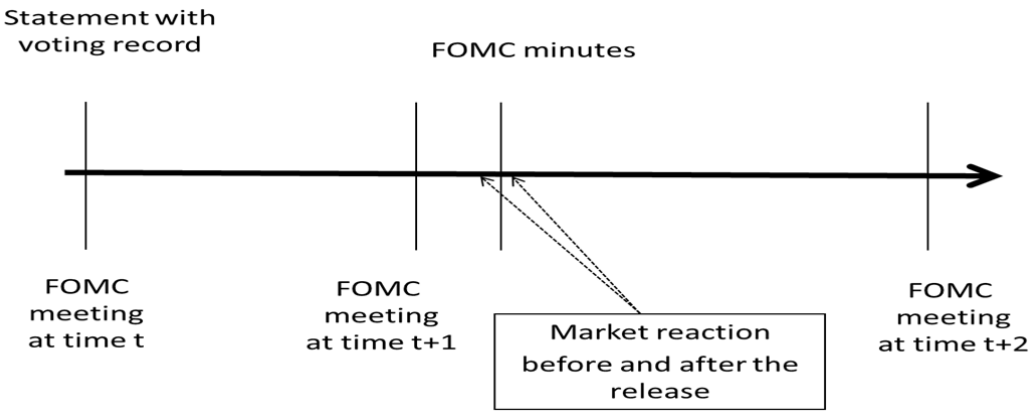
In terms of policy implications, the present analysis is consistent with the view that the practice of publishing timely minutes is a useful tool for central banks to enhance their transparency but the disclosure of confidential information by means of meeting minutes does not always help to improve central bank predictability. While transparency about the internal deliberations tends to provide markets with additional assurance about the future policy course, thereby stabilising expectations, the present study suggests that markets normally obtained enough clues about forthcoming fed funds rate changes from the Fed's other communications.

FIGURE 1: Evolution of the timing of FOMC minutes

a) Until January 2002



b) Until December 2004



c) Since December 2004 (press conference since 2011)

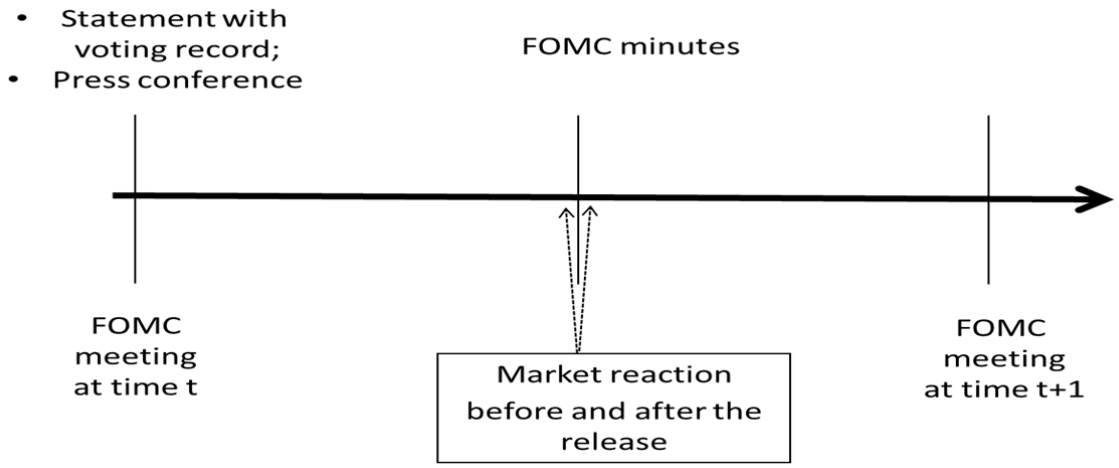
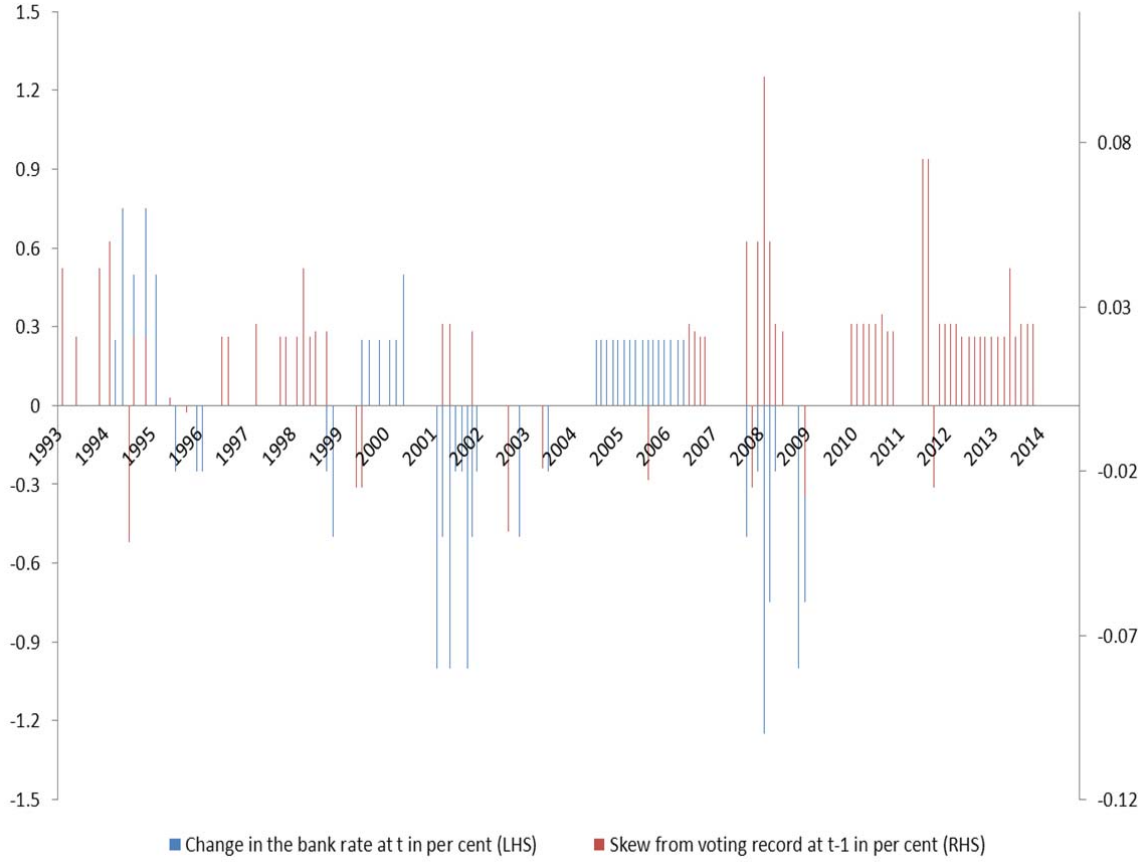


FIGURE 2: Fed funds rate changes and the skew from the voting record

(in per cent)

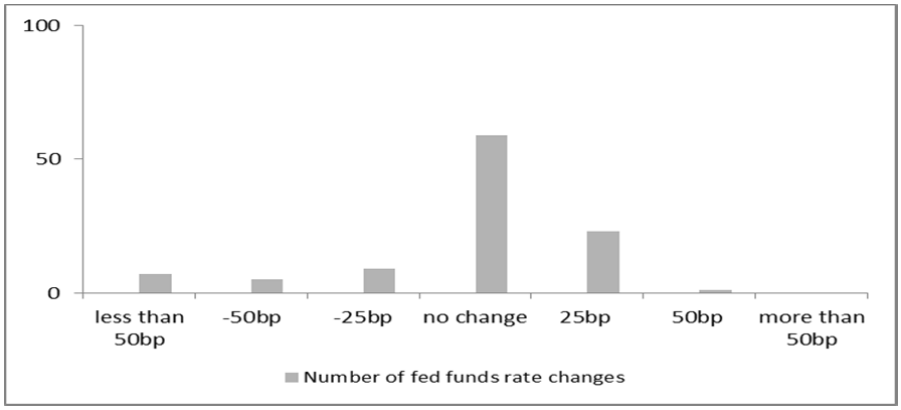


Source: Federal Reserve.

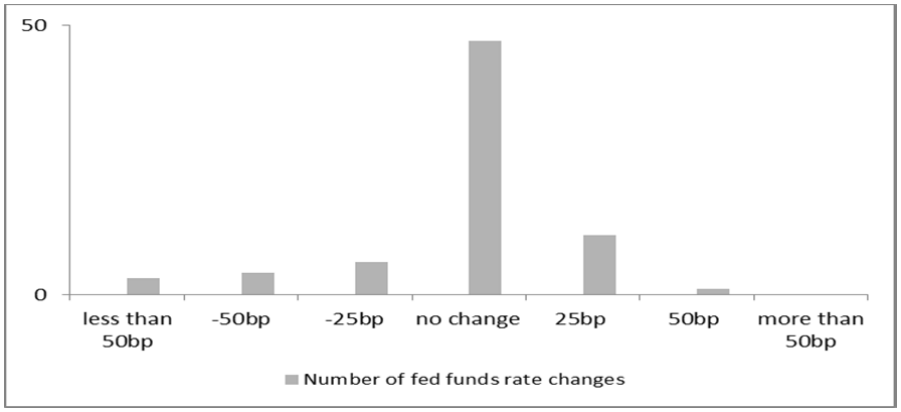
FIGURE 3: Distribution of the fed funds rate changes

(number of observations)

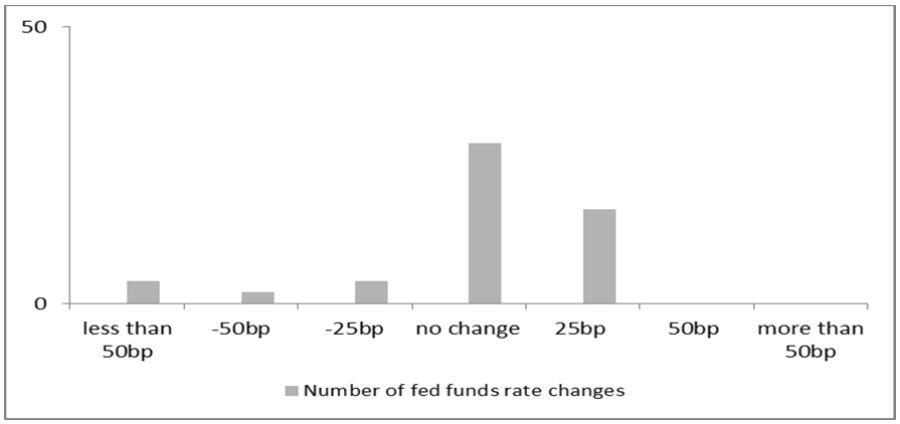
a) 1996 to end-2008



b) 1996 to end-2004



c) 2002 to end-2008



Source: Federal Reserve.

Notes: based on decisions from the regularly scheduled FOMC meetings.

Table 1: Publication of minutes by main central banks

Central bank	Meetings (per year)	Published minutes	Publication lag (in weeks)	Published voting record
Bank of Canada	8	no	na	no
Bank of England[1]	12	yes	2	yes
Bank of Japan [2]	8	yes	7 to 8	yes
European Central Bank [3]	8	yes	4	no
US Federal Reserve	8	yes	3	yes
Norges Bank	6	no	after 12 years	yes
Reserve Bank of Australia	12	yes	2	no
Swedish Riksbank	6	yes	2	yes
Swiss National Bank	4	no	na	no

Notes: **"**na" means not applicable. (1) The Warsh Review recommended in December 2014 that the MPC should in future meet on eight occasions through the year. The Government has announced its intention to implement these changes. (2) Prior to 2016 the Bank of Japan had 14-194 meetings per year. (3) Since 2015, the ECB publishes accounts of the Governing Council meetings. In addition, as of January it changed from a monthly to a six-week meeting cycle.

Table 2: The number of dissenting members and the conditional probability of a fed funds rate change in t+1

Dissent[1]	Large decrease	Decrease	No change	Hike
0	0.15	0.04	0.54	0.27
1	0.15	0.19	0.63	0.03
2	0.25	0.25	0.5	na

Notes: Sample 1996 to end-2008. "na" means not applicable. (1) Includes also conference calls in 2001 and 2008.

Table 3: Results of Ordered Probit models – equation 2

Sample	Variable Δr(t+1)	Δi(t)	skew(t)	skew2(t)	skew4(t)	skew12(t)	Pseudo R squared	Obser-vations
1996-2008		5.46** (0.66)	2.86 (9.00)				0.36	104
		6.61** (0.82)		9.00** (1.53)			0.45	104
		6.46** (0.80)			8.35** (1.34)		0.46	104
1996-2004		4.17** (0.84)	2.74 (10.95)				0.26	72
		5.69** (1.13)		13.17** (3.31)			0.42	72
		5.31** (1.10)			11.13** (2.48)		0.43	72
2002-2008		7.02** (0.92)	11.20 (11.39)				0.44	56
		7.24** (1.01)		6.84* (2.73)			0.47	56
		7.06** (0.94)			6.40* (2.61)		0.47	56
		6.73** (0.97)				-16.09 (28.03)	0.45	56

Notes: standard errors are reported in parentheses; ** refers to the 1% significance level, * refers to the 5% significance level. Skew refers to the skew from the voting record derived from all voting FOMC participants; skew2 refers to the internal skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents; skew4 refers to the internal skew from the non-voting Reserve Bank Presidents; skew12 refers to the skew derived from the discount rate recommendations (discount rate meeting minutes) by all (regional) Board of Directors.

Table 4: Results of Ordered Probit models – equation 2

Sample	Variable	Δi(t)	skew2(t)	skew4(t)	Pseudo R squared	Obser-vations
1996-2008	Δr(t+2)	2.97** (0.42)	4.71** (1.64)		0.22	104
	Δr(t+3)	1.77** (0.36)	3.78 (2.40)		0.11	104
	Δr(t+2)	2.83** (0.43)		4.38** (1.51)	0.22	104
	Δr(t+3)	1.67** (0.36)		4.08 (2.19)	0.13	104
1996-2004	Δr(t+2)	3.38** (1.05)	7.19* (3.27)		0.24	72
	Δr(t+3)	2.00** (0.59)	3.72 (2.81)		0.12	72
	Δr(t+2)	3.17** (0.97)		6.13** (2.42)	0.25	72
	Δr(t+3)	1.90** (0.57)		4.33 (2.48)	0.14	72
2002-2008	Δr(t+2)	2.79** (0.49)	3.12 (2.56)		0.19	56
	Δr(t+3)	1.83** (0.46)	4.34 (4.70)		0.11	56
	Δr(t+2)	2.70** (0.49)		3.28 (2.54)	0.19	56
	Δr(t+3)	1.72** (0.45)		4.63 (4.78)	0.12	56

Notes: standard errors are reported in parentheses; ** refers to the 1% significance level, * refers to the 5% significance level. Skew2 refers to the internal skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents; skew4 refers to the internal skew from the non-voting Reserve Bank Presidents.

Table 5: Results of Ordered Probit models – equation 3

Sample	Variable	Δi(t)	skew2(t)	one month market spread		one month future spread		Pseudo	Vuong
				day -1	day +1	day -1	day +1	R squared	test
1996-2008	Δr(t+1)	6.36**	2.93	16.00**				0.76	-1.689 [0.094]
		(1.30)	(2.42)	(3.47)					
		6.49**	5.68		17.98**			0.80	
		(1.51)	(3.90)		(4.07)				
		4.29**	4.80*			9.77**		0.67	-0.913 [0.363]
		(1.10)	(2.46)			(1.78)			
		4.66**	7.06*				10.85**	0.70	
		(1.12)	(3.09)				(1.92)		
1996-2004	Δr(t+2)	1.55	-0.69	4.48**				0.34	-0.063 [0.950]
		(1.00)	(3.66)	(1.52)					
		1.52	-0.79		4.60**			0.34	
		(1.01)	(3.68)		(1.56)				
		1.39	2.39			3.51**		0.31	-0.812 [0.420]
		(1.05)	(3.20)			(1.34)			
		1.29	2.26				3.84**	0.32	
		(1.06)	(3.20)				(1.42)		
2002-2008	Δr(t+1)	5.76**	5.19	44.94*				0.78	-1.667 [0.101]
		(1.79)	(3.72)	(20.08)					
		7.18**	16.41		32.88*			0.81	
		(1.97)	(9.26)		(13.85)				
		5.63**	3.04			12.56**		0.69	-1.222 [0.227]
		(1.53)	(2.94)			(3.76)			
		5.61**	6.56				14.49**	0.73	
		(1.48)	(4.67)				(3.96)		

Notes: standard errors are reported in parentheses; ** refers to the 1% significance level, * refers to the 5% significance level; skew2 refers to the internal skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents; m^n_t is the interest rate implied by *n* month ahead money market futures at time *t*. Hence, one month market spread refers to: $m^1_{S(t)} - i_t$; one month future spread refers to: $m^1_{S(t)} - m^1_t$. The row "*Vuong test*" reports likelihood ratio statistics of the Vuong test and the *p* values are reported in square brackets. The null hypothesis is that both models under consideration are equally close to the true model.

Appendix A

A.1. Data and sources

Indicators	**Sources**
Fed funds target rate	Federal Reserve website, Board of Governors, at meeting frequency.
Skew	Federal Reserve website, Board of Governors, at meeting frequency. Based on interest preferences by all voting FOMC participants, as reported in the voting record
FOMC policy-makers' interest rate preferences	FOMC transcripts, at meeting frequency. Dataset by Meade (2005) and updates based on FOMC transcripts, Board of Governors as in El-Shagi and Jung (2015a) and Jung and Latsos (2015).
Internal skews: - Skew2 - Skew4	Federal Reserve website, Board of Governors, at meeting frequency. Based on interest preference by all voting FOMC participants, as reported in the transcript or voting record Skew derived from the voiced interest rate preferences (FOMC transcript) by all Reserve Bank Presidents; Skew derived from the voiced interest rate preferences (FOMC transcript) of the non-voting Reserve Bank Presidents.
Skew from the discount rate recommendations - Skew12	Federal Reserve website, Board of Governors, at meeting frequency. Skew derived from the interest rate recommendations by the regional Board of Directors, as reported in the discount rate minutes
Financial market indicators: - Market spread (one month) - Future spread (one month) - Stock prices - Exchange rate	Bloomberg, daily data. Spread between the current policy rate and the interest rate implied by short term (one month) money market futures (source: Bloomberg); (One month) money market futures spread (source: Bloomberg) between publication of the minutes and one day after the announcement of the policy decision Dow Jones Industrial Average equity index (source: Bloomberg) Bilateral US dollar exchange rate vis-à-vis the euro (source: Bloomberg)

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