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MARKET SET-UP IN ADVANCE OF FEDERAL RESERVE POLICY RATE DECISIONS*

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This article considers the extent to which the federal (fed) funds futures market prepares for Federal Open Market Committee (FOMC) announcements. We demonstrate that there is often less variation in fed funds futures prices during the period immediately preceding an FOMC announcement than in earlier periods, despite greater trading activity, as the market has already incorporated anticipated signals. We find that macro announcements and central bank officials' congressional testimony are of comparable importance, whereas speeches are relatively unimportant. In addition, macro announcements have stronger effects when they are released during the Fed's 'blackout' period, emphasising important interaction effects.

This article considers fluctuations in the federal (fed) funds futures market in advance of Federal Open Market Committee (FOMC) decisions concerning the federal funds target rate. Much of the literature has focused on the post-announcement effects of such decisions.[1] This line of research has demonstrated that asset prices and volatilities only respond to the surprise component in these announcements, that is, when the actual target decision differs from the market's expectation (Bomfim, 2003; Bernanke and Kuttner, 2005; Gürkaynak *et al.*, 2005*a*; Chulia-Soler *et al.*, 2010), mirroring the findings of a substantial body of work considering the effects of macroeconomic announcements on various financial market prices (Ederington and Lee, 1993; Jones *et al.*, 1998; Balduzzi *et al.*, 2001; Andersen *et al.*, 2003, 2007; Faust *et al.*, 2007; Love and Payne, 2008; Beber and Brandt, 2010; Taylor, 2010). While this literature has thoroughly documented the market reaction to the announcement, much less attention has been given to the anticipatory effects or market set-up in advance of the information arrival.

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[1] Throughout this article , we use the terms 'announcement' and 'decision' interchangeably to refer to the announcement surrounding the FOMC decision.

In this article, we consider the anticipation of a news event from a risk management perspective. We define 'market set-up' in the context of a trader adjusting his or her positions prior to a news event in an attempt to be ahead of his or her peers (i.e. the rest of the market). Specifically, traders generally do not wait until the last minute to trade (when the cost of hedging may be very high) but instead try to 'set up' their positions in advance. Because a substantial amount of this market set-up may occur well before the days immediately preceding an announcement of the FOMC decision, we argue it is necessary to look much farther back in time in order to measure these anticipatory effects. Such anticipatory set-up may be caused by, for example, a desire to hedge the added risk/uncertainty surrounding the future path of upcoming announcements (Gürkaynak *et al.*, 2005*a*). Alternatively, it may reflect early warning signals that the market believes provide information about the Fed's intentions. To consider this possibility of early anticipatory set-up, we examine the dynamics of fed funds futures prices for a period of up to six months before a target rate decision is scheduled to be made. Specifically, we examine how fed funds futures prices are affected by various forms of central bank communication, such as speeches and congressional testimony, and how those effects interact with scheduled announcements of macroeconomic variables. Quantifying the respective contributions of macroeconomic announcements and Federal Reserve officials' communications to the evolution of daily changes in fed funds futures prices is the main focus of this article.

We address the following questions:

(*i*) How far in advance does the market prepare for an FOMC announcement and how does the uncertainty surrounding various upcoming events (in the form of scheduled macro announcements or Federal Reserve communications) affect the timing of such preparation?
(*ii*) How do central bank communications and macro announcements affect the federal funds futures prices?
(*iii*) What is the interaction between scheduled macro announcements and central bank communications (i.e. which is more important and does the effect of one differ depending on the presence or absence of the other etc)?

The possibility of such interaction effects is especially important in the context of the Fed's convention of a 'blackout period' (i.e. a period before the meetings whereby FOMC members curtail public-speaking engagements). In particular:

(*i*) relatively more information about the Fed's intentions may be available before this period begins through speeches and testimony by FOMC members; and
(*ii*) macro announcements during this period may have a greater effect than those released at other times since (in the absence of direct communication from the FOMC) these announcements serve as a predominant source of information to the market about the upcoming FOMC decision.

To our knowledge, our article is the first to investigate differential effects of macroeconomic announcements during and outside of the blackout period directly.

We design a comprehensive regression framework to examine anticipatory set-up of financial market participants in the run-up to FOMC decisions concerning the federal funds target rate. Our modelling approach enables us to investigate how this set-up is

shaped by scheduled FOMC and macroeconomic announcements, as well as Federal Reserve communications in the form of speeches and testimony of members of the Board of Governors of the Federal Reserve System. Our results indicate that the market prepares for FOMC announcements much farther in advance than had previously been demonstrated. We find strong evidence of anticipatory set-up going back as far as the six months prior to an FOMC meeting that we consider. Furthermore, these effects decline as the FOMC meeting nears: earlier FOMC decisions and surprises in macroeconomic announcements affect fed funds futures prices more strongly than more recent ones. Failure to look back far enough results in inference that attributes much less significance to both Fed communications and macroeconomic announcements in shaping fed funds futures prices.

Among the different information sources that we examine, we find that previous FOMC announcements are the most important drivers of fed funds futures prices. The relevance of macroeconomic announcements differs substantially across the (24) variables considered, with surprises in non-farm payrolls having the strongest effects, consistent with previous literature. Macroeconomic announcements generally have stronger effects when they are released during the black-out period that precedes an FOMC announcement, when Fed Board members typically curtail their public speaking engagements. Testimony by Fed Board members are of comparable importance to the most influential macroeconomic announcements. In contrast, speeches are relatively unimportant.

The article is organised as follows. Section 1 briefly reviews the large literature that has examined the predictability of FOMC target rate decisions and financial market reaction to news announcements. Section 2 describes the data, including descriptive statistics. Section 3 provides descriptive statistics on our main variable of interest, the average absolute change in federal funds futures prices, and presents the baseline econometric specification. Section 4 considers time-varying effects and the interaction of macroeconomic news and Federal Reserve communication, as well as the inference that results from considering a much shorter anticipatory period of only a single month before the FOMC announcements. The final Section concludes.

1. Related Literature

By focusing on whether market set-up occurs farther in advance of FOMC target rate decisions, this article contributes to a large body of existing literature, including research on FOMC decisions,[2] the information content of fed funds

[2] This includes literature that investigates whether FOMC target rate decisions are predictable via either macroeconomic announcements, fed funds futures, the yield curve (Lange *et al.*, 2003; Hamilton, 2007, 2008; Hamilton and Okimoto, 2011; Hamilton *et al.*, 2011) or a combination of these, and literature on anticipation of Federal Reserve actions (see, e.g. Lucca and Moench (2015) and Cieslak *et al.* (2014), who document strong patterns in financial markets caused by the FOMC meeting announcements and the meeting cycle, respectively, as well as evidence of prior effects in the days immediately leading up to FOMC meetings). A relevant (and closely related) literature concerns modelling and forecasting FOMC target rate decisions from macroeconomic and financial variables (Dueker, 1999; Hamilton and Jordá, 2002; Dueker and Rasche, 2004; Hu and Phillips, 2004; Piazzesi, 2005; Kim *et al.*, 2009; Hayo and Neuenkirch, 2010; Monokroussos, 2011; Kauppi, 2012).

futures prices,[3] and the impact of Federal Reserve communications on financial markets.[4] In each of these strands of the literature, some studies hint at the possibility of advance market set-up but none provides a formal investigation as we conduct here. For example, Kuttner (2001) and Poole *et al.* (2002) note little evidence of anticipatory effects in fed funds futures prices prior to FOMC actions. On the other hand, Carpenter and Demiralp (2006) present evidence that the federal funds rate tends to move in the direction of an anticipated change in policy prior to that change. These studies, however, only consider a couple of days immediately preceding the announcement and do not consider an extended period in which the market may prepare for such announcements. A notable exception is Carlson *et al.* (2006), who document that, for the period 1999–2006, market participants' expectations of FOMC target rate decisions have been fairly accurate over horizons of up to two to three months, especially compared to the period 1989–94. While they hint at the possibility that more transparent FOMC communication may be an important driving force for this improved predictability, this is not backed up by a formal statistical analysis.[5]

Indeed the way in which central bank communications potentially shape market participant's expectations has led the Fed itself to increase its emphasis on communication as an effective monetary policy tool, separate from its decisions to raise or lower the fed funds rate. As a result, market participants pay significant attention to the speeches and testimony of Federal Reserve officials; this was particularly likely recently as the market awaited the first Federal Reserve rate increase in nearly a decade. A similar episode of heightened attention to Fed communications arose in the spring of 2004. After an extended period of benign economic conditions and Fed easing followed by nearly a year of the Fed being 'on hold', market anxiety as to when the Fed would begin an inevitable tightening

[3] For example, Gürkaynak *et al.* (2005*a*, 2007) note that fed funds futures are better at predicting the target rate than are other securities and Piazzesi and Swanson (2008) document that this predictive ability might further be improved by accounting for time-varying risk premia.

[4] The communications typically considered include speeches (Bernanke *et al.*, 2004) and congressional testimony by the seven-member Federal Reserve Board and twelve Federal Reserve Bank Presidents, and the subsequent release of the minutes from FOMC meetings (Blinder *et al.*, 2008 contains a survey). For example, Kohn and Sack (2004) document that congressional testimony by Chairman Greenspan had a considerable influence on short and medium-term interest rates. Similarly, Ehrmann and Fratzscher (2007) show that financial markets respond to statements by FOMC members, especially statements by the Fed Chair. An excellent review of much of the research related to FOMC communication is contained in Middeldorp (2011), where it is noted that, 'Communication reforms that allow market interest rates to anticipate monetary policy earlier than one meeting ahead can't be identified', a conclusion reached by examining the ability of fed funds futures to predict the target rate.

[5] There is also evidence that since the Fed's 1994 communication enhancements, the market has been able to predict Fed actions farther in advance, in addition to being more accurate at three-month horizons about what the action would be, see Lange *et al.* (2003) and Carlson *et al.* (2006). Also Poole and Rasche (2003) document that policy actions taken at scheduled FOMC meetings generate little if any news in the market. Furthermore, they demonstrate (using a case study for the June 2002 FOMC meeting) that the market forms accurate expectations quite long before the actual target rate decision is announced.

cycle was evident.[6] Indeed minutes of the FOMC meetings during that time period indicate that committee members were aware of the market uncertainty and desired transparent communication. Once the tightening began, similar anxiety was observed as to when the tightening cycle would end (it ultimately ended after the June 2006 meeting). The potential importance of these communications has been recognised by the Federal Reserve itself, through a series of decisions since 1994 designed to increase transparency.[7] Additionally, in 2005, the Federal Reserve announced it would shorten the length of time between its meetings and the release of the associated meeting minutes. A further change to the Fed's communication policy, on 24 March 2011, involved the announcement that then-Chairman Bernanke would hold regular press briefings (following four of the eight scheduled FOMC meetings) 'to present the FOMC's current economic projections and to provide additional context for the FOMC's policy decisions'. The press release noted that, 'The introduction of regular press briefings is intended to further enhance the clarity and timeliness of the Federal Reserve's monetary policy communication'. Such enhanced clarity (and, by implication, reduced uncertainty) might be expected to increase the extent of anticipatory set-up (as well as reducing the volatility of associated risk premia).

Within the literature, there is some evidence that anticipatory effects build gradually and that fed funds futures may not entirely capture the complexity associated with the path of financial market participants' expectations.[8] For example, Gürkaynak *et al.* (2005*a*) find that changes in the fed funds target rate are not sufficient to explain the effects of FOMC decisions (at least two factors are required). They define an additional factor, termed the 'future path of policy', which is linked to the policy statements themselves. Similarly, Söderström (2001) notes that many changes to the effective fed funds rate are unrelated to changes in the fed funds target rate itself, implying that market prices also may change due to other information (e.g. macro announcements, speeches, time-varying term or other risk premia). Our focus on anticipatory effects blends the idea of an additional

[6] Reflecting on this period in an April 2013 speech, then-Vice Chair Janet Yellen recalled, 'For the first time, the Committee was using communication – mere words – as its primary monetary policy tool. Until then, it was probably common to think of communication about future policy as something that supplemented the setting of the federal funds rate'. The full text of this speech is available at http://www.federalreserve.gov/newsevents/speech/yellen20130404a.htm (last accessed: 24 October 2014).

[7] A list of the key steps the Fed has taken to improve transparency is available on the Federal Reserve Bank of San Francisco's Ask Dr. Econ blog, available at http://www.frbsf.org/education/publications/doctor- econ/2012/august/transparency-lessons-financial-crisis, published 19 August 2012 (last accessed: 24 June 2013).

[8] The interpretation of federal funds futures rates (or other market prices) as measures of financial markets' expectations of future monetary policy is disputed. For example, the presence of (possibly time-varying) risk premia in these market prices may lead to systematically biased forecasts of the future path of monetary policy, as argued by Piazzesi and Swanson (2008) in particular. Other studies, including Durham (2003) and Sack (2004), however, find only small variation in risk premia in fed funds futures. In addition, as noted by Piazzesi and Swanson (2008), risk premia seem to change primarily at (relatively low) business-cycle frequencies, suggesting that our approach of analysing one-day changes in fed funds futures prices may mitigate the role of such 'unobserved' risk premia, by 'differencing out' their effect.

policy factor from Gürkaynak *et al.* (2005*a*) with the foresight model specified in Leeper *et al.* (2013).[9] Rather than characterising the effects of all outstanding futures contracts with two latent factors as in Gürkaynak *et al.* (2005*a*), we study the futures contracts individually to get a more detailed picture of the anticipatory effects. Our general econometric framework also allows us to examine separately the anticipatory effects of the macroeconomic news releases, speeches and testimonies themselves. We recognise that what we call 'anticipatory effects' may reflect trader foresight, risk premia, or some other manifestations of participants' expectations; we are agnostic regarding these interpretations and emphasise that the main contribution of our article is the documentation of effects that arise much earlier than much of the literature on federal funds futures has presumed. Henceforth, we discuss our findings subject to the caveat that it is hard to isolate changes in risk premia from a variety of other sources that may explain the anticipatory effects we capture.

There is also a large literature that studies the influence of macroeconomic news releases on the whole term structure of interest rates and similarly documents that reactions are more pronounced at longer maturities than at short ones. This pattern has been documented in the term structure of forward rates, with forward rates at longer horizons reacting significantly to the unexpected component of economic news (Gürkaynak *et al.*, 2005*b*). Analogously, Bauer (2015) studies the effect of both monetary policy actions and macroeconomic news on the term structure of bond yields, for maturities up to 10 years, finding that while monetary policy actions appear to have effects across the yield curve, the effects of macroeconomic news appear to be less evident the farther out the yield curve one goes. Fleming and Remolona (1999) analyse the effects on eight Treasury securities, spanning from three-month bills to 30-year bonds showing that the responsiveness of yields to news is hump-shaped, with a small response for short maturities, the strongest response at maturities of one to two years, and a smaller response again for longer maturities.[10] One challenge with considering the effects on long-dated maturities, however, is the increasing role that the presence of risk premia might play in the interpretation of the findings; the benefit of term structure models is that they admit the possibility of decomposing the response into separate expectations and risk premium components. A number of approaches have

[9] Although in a different context (concerning foresight in the context of fiscal policy rather than monetary policy), Leeper *et al.* (2013) document the importance of the news process itself, arguing that the nature of news arrival induces a moving average representation that can make it difficult to disentangle the underlying reasons behind the reaction of economic agents. In particular, their model implies that more recent news is discounted relative to older news, under the assumption that agents have perfect foresight (whereby agents receive signals in advance and there is no uncertainty as to the magnitude of the signal). More generally, Leeper *et al.* (2013) highlight the tension between econometric models that typically discount the effects of shocks farther back in the past *versus* the actions of agents that cumulate information and hence have more information about events that occurred farther back in the past. Simply put, farther back news has more time to translate into economic response than more recent news. We are sympathetic to this possible interpretation of our results and thank the Editor for bringing it to our attention.

[10] An earlier article (Fleming and Remolona, 1997) considers the effects of macro and fed funds rate announcements on the on-the-run five-year US Treasury note using high frequency data for a single year (1994).

been used for such a decomposition in the context of bond yields.[11] Such a decomposition is more challenging in the context of federal funds futures prices due to the nature of the underlying contract. Partly for this reason (that it is difficult to disentangle the effects due to risk premia from those due to changes in expectations and that the effect due to risk premia potentially becomes quite large at higher maturities), as well as the low levels of volume for futures contracts with longer maturities, we study the effect of announcements, speeches and testimonies on futures contracts that are at most six months out. In addition, we are interested in how the processing of a collection of news evolves over time for a single contract, rather than the simultaneous effect of a single news item on current Treasury rates of different maturities. We use federal funds futures contracts rather than bond yields because the former are specifically designed to reflect the FOMC decision.[12]

2. Data and Descriptive Statistics

We combine three sources of information (detailed below):

(*i*) federal funds futures data;
(*ii*) macroeconomic announcement data; and
(*iii*) information on speeches, congressional testimony, and other important statements.

Scheduled FOMC meeting (and hence announcement) dates are known well in advance (e.g. via Bloomberg or the Federal Reserve's website), although at times there have been unscheduled meetings as well (see below).

The data are of a daily frequency, excluding weekends and holidays. It is necessary to use daily data since the timing of speeches is not random. Speeches tend to occur in clusters because FOMC members generally refrain from speaking on monetary policy near the time of an FOMC announcement (the 'blackout period'). Since not every month has an FOMC meeting, using lower frequency (i.e. monthly) data would induce a speech seasonality because months with a blackout period would have fewer speeches than the other months. Due to the blackout period, we also would expect that macro announcements are more important to market set-up in the days immediately preceding FOMC announcements while speeches may be more important earlier. We consider this possibility in Section 4.

[11] For example, Hanson and Stein (2015) use forecasting regressions, while Nakamura and Steinsson (2015) consider market expectations as an additional source of information and use risk-neutral expected short rates from an affine term structure model. Hördahl *et al.* (2015) also study the effect of macroeconomic news announcements on the yield curve, and document a hump-shaped term premium with a peak at maturities beyond four years.

[12] We of course understand that any change to the fed funds rate immediately results in a change in the term structure of all bond yields but find it plausible that any evidence of market set-up in advance of a specific FOMC decision is most likely to be reflected directly in the market price corresponding to the futures contract associated with that specific decision. A deeper exploration of the underlying cause of the responses at different horizons (e.g. whether it is attributable to implications of news for expectations of future yields, as opposed to change in term premia), akin to the work done in the term structure literature, is beyond the scope of this article, although we return to this issue in subsection 3.2.

2.1. *'Market-Based' Federal Funds Target Rates*[13]

The daily effective fed funds futures data come from Bloomberg and span the period 31 July 2001 to 30 September 2008.[14] Fed funds futures contracts are specified for calendar months and settle based on the average effective fed funds rate over the contract month. Each month in the year can be traded and, for each contract, data are available for approximately two years preceding its end-month expiration. We obtain the open, high, low, close, volume and open interest for each contract. Each of the prices can be translated to average effective fed funds rates for the contract month using 100 minus the contract price. We use the daily closing price to calculate the market 'expectation' for the target rate on a particular day.[15]

The FOMC meets eight times a year, according to a pre-announced schedule. In addition, the Committee has occasionally convened at non-scheduled times as conditions have warranted. A complete list of meeting dates, the target rate that was decided at each meeting and the market expectations of the target rate on the day immediately preceding the FOMC meeting is given in online Appendix Table A1 for the period August 2001 until September 2008. The unexpected component of the decision is the difference between the actual and expected levels, with a positive number indicating a higher-than-expected target rate and a negative number indicating a lower-than-expected level.

In general, the market is very capable of predicting the target rate decision at scheduled FOMC meetings (cf. Poole and Rasche, 2003). Most of the time, the unexpected component (expressed in basis points, bps) is very small and below 5bps, in absolute magnitude. This is particularly true during the calmer times between August 2003 and June 2007. Cases where the market was surprised by the target rate

[13] As noted in the introduction and literature sections, earlier literature has often interpreted the market price of futures as the market's 'expectation' of the underlying security; we follow that convention for ease of discussion. We emphasise though that our approach is agnostic regarding this interpretation and allows for a number of reasons why the market prices of fed funds futures may reflect significant departures from such expectations, in particular the presence of time-varying risk premia (Piazzesi and Swanson, 2008). At the same time, we note that Gürkaynak *et al.* (2007) find that:

(*i*) federal funds futures dominate other securities in forecasting monetary policy at horizons out to six months; and
(*ii*) the best measure of shocks to the immediate policy setting would be based on federal funds futures rates, as in the approach described by Kuttner (2001), adopted here.

For much of the discussion below, we use the term 'market-based target rate' to refer to the rate computed from fed funds futures prices to emphasise that the information contained in the prices may represent more than just market expectations.

[14] The starting date of our sample period was selected to minimise the possible effects of unscheduled FOMC meetings at the beginning of the sample (other than the market closure as a result of 9/11, prior to the 2008 financial crisis, the FOMC had not had an unscheduled meeting since January 2001). The end date was selected for two reasons:

(*i*) there was severe market disruption in the fourth quarter of 2008, beginning with concern on 29 September 2008 that Congress would not agree to the proposed Troubled Assets Relief Program; and
(*ii*) by the end of 2008, the Fed had shifted the articulation of the fed funds target rate from a single number (e.g. 5.25%) to the 0–25 basis point range, where it remained until recently.

Because the use of the range would require us to make additional assumptions to evaluate the accuracy of market-based levels, we have opted to truncate the data prior to the move to the range.

[15] Below we describe in detail how this market expectation is obtained.

decision are 6 November 2002, when the target rate was cut by 50bps rather than the expected 25bps; 25 June 2003, when the Fed ended its easing cycle; and the period of the financial crisis (from the unexpected intermeeting decision on 17 August 2007 onwards). Even with these big moves, over our sample, the average unexpected component of the scheduled meetings is 1bp; the average absolute unexpected component is 4bps. These low numbers confirm the market's ability to anticipate the target rate decision quite well immediately prior to an FOMC meeting, as documented in the literature.

For each scheduled FOMC meeting date in the period January 2002–September 2008, we construct an associated market price of the target rate for every day preceding the meeting back to 124 trading days (six months) prior, using the following procedure.[16] First, for each scheduled FOMC meeting we select the relevant fed funds futures contract to use. An important consideration here is that the fed funds contracts represent the average effective fed funds rate over the relevant contract month. Hence, for months with (scheduled) FOMC meetings, the futures price reflects the weighted average of (market expectations of) pre and post-meeting target rates. For that reason, we use the futures contract for the month following the FOMC meeting if there is no (scheduled) FOMC meeting in that next month. We can readily use a rate based on this contract without dealing with possibly different pre and post-announcement target rates.[17] For example, for the 20 January 2002, meeting we use the 2002-February futures contract to obtain the market's expectation of the target rate after the January meeting. If, however, the month following the (scheduled) FOMC meeting contains another FOMC meeting, we use the futures contract corresponding to the actual month of the meeting.[18] For example, for the 6 November 2002, meeting we use the 2002-November contract because on 10 December 2002, there is also an FOMC meeting.

In case the contemporaneous futures contract is used, we follow the procedure of Kuttner (2001) to extract the market price of the post-meeting FOMC target rate. We can write the effective fed funds rate in month l (denoted with FFR_l), during which the

[16] We choose 124 trading days because it balances our desire to look as far back as possible to capture potential set-up effects with the reality of limited trading activity in the farther out contracts. When there is limited trading activity, price accuracy is impaired. Although for some months there is ample trading activity even beyond 124 trading days, our choice of look-back period enables us to have a balanced sample for all FOMC events we consider. As noted above, we acknowledge that the market price in this context might not be a pure expectation but also may reflect a term premium component.

[17] Carlson *et al.* (2006) limit their analysis to such 'clean' contracts, effectively discarding approximately half of the scheduled FOMC meetings.

[18] Kuttner (2001) notes that because the futures contract represents the average effective fed funds rate (FFR) over the month of the contract, an announcement that arrives towards the end of the month will not have much impact in the current contract. This is a second reason to use the next full-month contract when there is no FOMC meeting the next month (typically the case for FOMC meetings near the end of the month). Kuttner (2001) contains an excellent description of some of the technical nuances related to using effective fed funds futures data. These nuances include:

(*i*) the reference point for each contract is the average over the month rather than at a single point in time,
(*ii*) the contract is based on the effective fed funds rate rather than the actual FOMC target rate;
(*iii*) how to deal with multiple signals that arise as a result of the term structure of the futures contracts;
(*iv*) the use of futures information as a proxy for market expectations since the latter are not observable; and
(*v*) how maturity roll affects the embedded time-varying risk premium and how to correct for this.

The reader is directed to the Kuttner (2001) paper for detailed discussion of these issues.

i-th FOMC meeting occurs, as the weighted average of the pre and post-meeting target rates (denoted TR_{i-1} and TR_i), where the respective weights correspond with the proportion of days before and after the FOMC meeting (denoted as P_l and $1 - P_l$). Given the previous target rate, the market price of the post-FOMC meeting i target rate is calculated by solving:

$$P_l TR_{i-1} + (1 - P_l) TR_i = FFR_l,$$

to get

$$TR_i = \frac{1}{1 - P_l} FFR_l - \frac{P_l}{1 - P_l} TR_{i-1}. \quad (1)$$

So in order to calculate the day t market price of the target rate after FOMC meeting i for the case when we use the current month's contract, we subtract the scaled previous target rate from the day t futures-implied target rate. When day t is before the ith FOMC meeting but after the $(i - 1)$th meeting, we use the actual target rate after announcement $(i - 1)$ for TR_{i-1}. When, however, day t is also before the $(i - 1)$th meeting, we use the market price of the $(i - 1)$th target rate and thus follow a recursive procedure. For example, for the 6 November 2002, meeting we use (1) with the actual previous target rate (1.75%) on all days since the date of the previous meeting (that is, from 24 September) until 6 November. To infer the market price associated with the 6 November post-meeting rate on days before 24 September, we use the market price of the 24 September post-meeting target rate computed from (1). This more involved procedure when using the contemporaneous futures contract explains our preference to use next month's contract in the case where no meeting is scheduled for that month. In practice, of the 54 scheduled FOMC meetings in our sample, we are able to use the next 'full-month' contract 27 times (exactly half).[19]

2.2. *Macroeconomic Announcements*

We obtain data on 24 macroeconomic announcements from Econoday. For each of the announcements, the data set records both a consensus expectation among market participants and the actual first-released number. Our selection of macroeconomic variables follows Andersen *et al.* (2003) and includes GDP, employment, price indices and income numbers. A full list of the indicators, the time of their public releases, as well as the average surprise and the average absolute surprise (both expressed in standard deviation units, where 'surprise' is defined as the actual release minus the consensus estimate) is given in online Appendix Table A2. There are three frequencies at which the variables are released: quarterly (the GDP figures), weekly (the initial unemployment claims number on Thursdays) and monthly (all other variables). For most series, there is little evidence of systematic bias, as the average surprise is near zero. There are a few series, however, where the market's expectations systematically differ from the actual release, for example, the GDP advance number, non-farm payrolls, personal consumption expenditures and the NAPM index.

[19] This is to be expected as the FOMC meets eight (more or less evenly spaced) times a year, such that there are four meetings for which no meeting is scheduled during the next month.

We consider the uncertainty associated with these announcements in two ways:

(*i*) as a dummy variable to denote the occurrence of a macro release on a given day; and
(*ii*) as a surprise.[20]

The first characterisation (dummy) can be viewed as an attempt to measure general market nervousness or uncertainty. The second (surprise, i.e. a deviation from the consensus estimate) recognises the likelihood that a larger deviation from consensus generates greater volatility than a smaller one. We follow the convention adopted in the literature (Andersen *et al.*, 2003; Rigobon and Sack, 2008) and (as noted above) standardise the surprises by dividing each of them by their sample standard deviation to account for the variation in measurement units across macro variables. This standardisation facilitates comparison across announcement surprises and does not affect the statistical significance of the response estimates nor the fit of the regressions.

2.3. *Speeches and Testimony*

The speech and testimony data are collected from the Federal Reserve's website[21] for each of the 11 individuals that served on the Federal Reserve Board during the sample period. Speeches and testimony are treated separately in our model, since the latter are often viewed by the markets with particular scrutiny and contain extensive Q&A (as well as a transcript). Note that in two cases (Bernanke, Kohn), a Governor became Chair or Vice-chair; we treat these positions as separate from the earlier roles. The terms of all 11 Governors, Vice-chairs, and Chairmen are shown in the online Appendix Figure A1(*a*) while the distribution of speeches and testimonies for each Board member is given in online Appendix Figure A1(*b*).[22]

[20] Our choice of these two characterisations reflects our desire to place our findings in the context of earlier research (Andersen *et al.*, 2003, 2007) while at the same time recognising the empirical challenges associated with using surprise data constructed from surveys. In particular, Rigobon and Sack (2004, 2008) emphasise a number of factors that may lead to biased estimates when using surprise data, as a result of lack of identification and errors-in-variables. These include the time interval between the consensus estimate and the actual release; the use of multiple announcements, some of which occur on the same day; and the endogeneity between the determination of expectations and asset prices. We note that these criticisms are not unique to our study but apply to all previous literature that has adopted a similar approach. Nonetheless, in recognition of these concerns, we have replicated all results using dummy variables rather than surprises and find the results to be qualitatively unchanged. We further discuss sensitivity of our results to these issues in the online Appendix. We thank Ricardo Rigobon for his extensive discussions on these details as they relate to our article.

[21] http://www.federalreserve.gov. Following the delineation on this website, there are three distinct types of public addresses considered: speeches, testimony, and the semi-annual Monetary Policy Report to the Congress (also known as the 'Humphrey-Hawkins' testimony). Public addresses that on the Federal Reserve's website were designated as either 'opening remarks' or 'dedication remarks' are not included in the sample.

[22] Kelley was also a Governor at the beginning of our sample but left in 2001 and hence is not included in our speech data set. Similarly Duke joined in August 2008 but did not deliver any speeches or testimony during our sample period. We also do not include speeches by the 12 Reserve Bank Presidents due to lack of consistency regarding availability of the data across the different entities. For example, as of the writing of this article, while the Federal Reserve Bank of San Francisco website contained speeches of current-President John Williams and past-President Janet Yellen, it did not contain speeches of past-President Robert Parry, whose term ended in 2004, nor did it reliably note when essentially the same remarks were delivered at an earlier date (we use only the first instance of such remarks in our collection of Board speeches, under the plausible assumption that once made public, the information is reflected in market prices). While the Board of Governors website contains an aggregated collection of many of the speeches of the Reserve Bank Presidents, it is by no means comprehensive, nor does it contain all Reserve Banks.

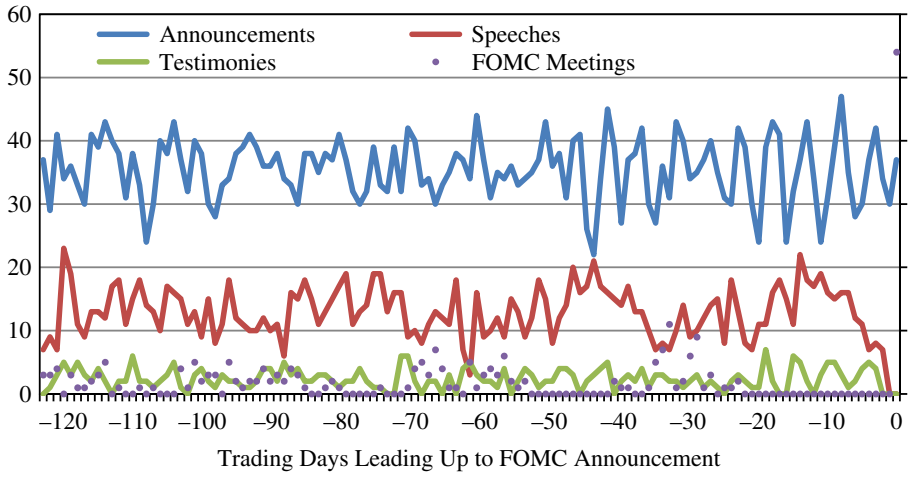

Fig. 1. *Macro Announcements, Speeches, Testimonies, and Prior FOMC Meetings*
Notes. The Figure shows the number of macroeconomic announcements, speeches, testimonies, and prior FOMC meetings in event-time for the 124 trading days prior to an FOMC announcement day (excluding weekends and holidays).

Over our sample period, the average number of speeches by Board members is about 72 per year.

Evidence of a so-called 'blackout period' is shown in Figure 1. This Figure contains the total number of announcements, speeches and testimonies, shown in event-time for the period of 124 trading days prior to an FOMC announcement day. While the numbers fluctuate across days, there is a notable drop-off in the number of speeches and testimonies in the 10–15 days right before an FOMC meeting. The same pattern can be observed 35–45 days before, due to the black-out period before the previous scheduled FOMC meeting. This pattern suggests that in the lead-up to an FOMC meeting, the macro announcements may take on greater significance as the market seeks guidance from economic information in the absence of Federal Reserve communication, something we explore in subsection 4.1.2.

3. An Analysis of Market Set-up

We analyse our research questions concerning the market set-up in advance of an FOMC decision by relating the market-based fed funds target rates to information conveyed by macroeconomic announcements and Fed communication in the form of previous FOMC decisions, and speeches and testimony by Fed Board members. Before introducing our baseline specification, we first motivate the idea of market set-up by examining a particularly important FOMC announcement: 30 June 2004, the previous date that the Federal Reserve began a tightening cycle after being on hold at a (then) historically low federal funds rate. We then provide descriptive evidence of the set-up effect. We next outline our baseline specification in which the effects of these variables on the market-based target rate are assumed to be constant throughout the six-month

period before the FOMC decision that we consider. A more detailed investigation where the effects are allowed to vary over time in a number of different ways is deferred to Section 4.[23]

3.1. *An Example of Market Set-up*

As an example of how market prices change in advance of an FOMC announcement, consider the beginning of the tightening cycle that resulted from the Fed's 30 June 2004 meeting, shown in Figure 2. This Figure shows the market price associated with the 30 June 2004 target rate, as inferred from the 2004-July fed funds futures contract.[24] After nearly a year of being 'on hold', speculation began to arise as to when the Fed would begin tightening. By March 2004, some market participants and the press started worrying that the Fed was 'behind the curve' and would wait too long to hike, potentially giving rise to inflation. The top half of the Figure shows how the market-based target rate evolved in the 124 days leading up to the Fed's announcement that the target rate was increasing from 1% to 1.25%. Despite the eventual convergence to the actual target rate by the time the Fed made its announcement, uncertainty as to the timing of the increase in the months leading up to the announcement created significant volatility in the market-based rate, as illustrated by its daily fluctuations, shown in the bottom half of the Figure.

From this picture, we observe that six months prior to the 30 June 2004 meeting, which corresponds with 5 January, the market's expectation of the target rate was rather close to the eventual level of 1.25%. Although over all days the mean change in the market-based target rate was −0.1bps and the median change was zero, there are a number of days with much larger changes, suggesting increased uncertainty and market nervousness. For example, two large drops occurred on 6 and 9 January, corresponding to a manufacturing release that was below market expectations and much softer non-farm payrolls (1,000 *versus* the market expectation of 130,000), lowering the target rate to around 1.1%. It remained fairly stable at that level until the end of the month when it began to rise but sharply decreased again when the FOMC announced (after its meeting on 28 January) that it would leave the target rate unchanged. Over the following month, the market-based target rate gradually declined again to around 1%, the current level at the time. A large increase (2bps) in the market price of the target rate occurred with 86 days to go, on 2 March. On that day, both the then-Chairman Greenspan and the then-Governor Bernanke made speeches. While neither directly addressed the Fed's intentions regarding the policy rate, Greenspan's speech referenced inflation in import prices as a result of a weaker dollar and

[23] In the discussion of the results in this Section and the next, we occasionally refer to results of additional analyses we conducted. For all such instances, these detailed results are available in the online Appendix.

[24] At first glance, the fluctuations in this Figure may seem to be at odds with the information given in online Appendix Table A1. It is important to recognise that online Appendix Table A1 reflects the fed funds futures price on the day immediately preceding each FOMC meeting date (i.e. corresponding to the '−1' point in each of 54 distinct figures like Figure 2, one for each meeting) while Figure 2 is for a single meeting date (30 June 2004) and shows the market prices of the corresponding fed funds futures on 124 distinct days preceding that specific meeting date.

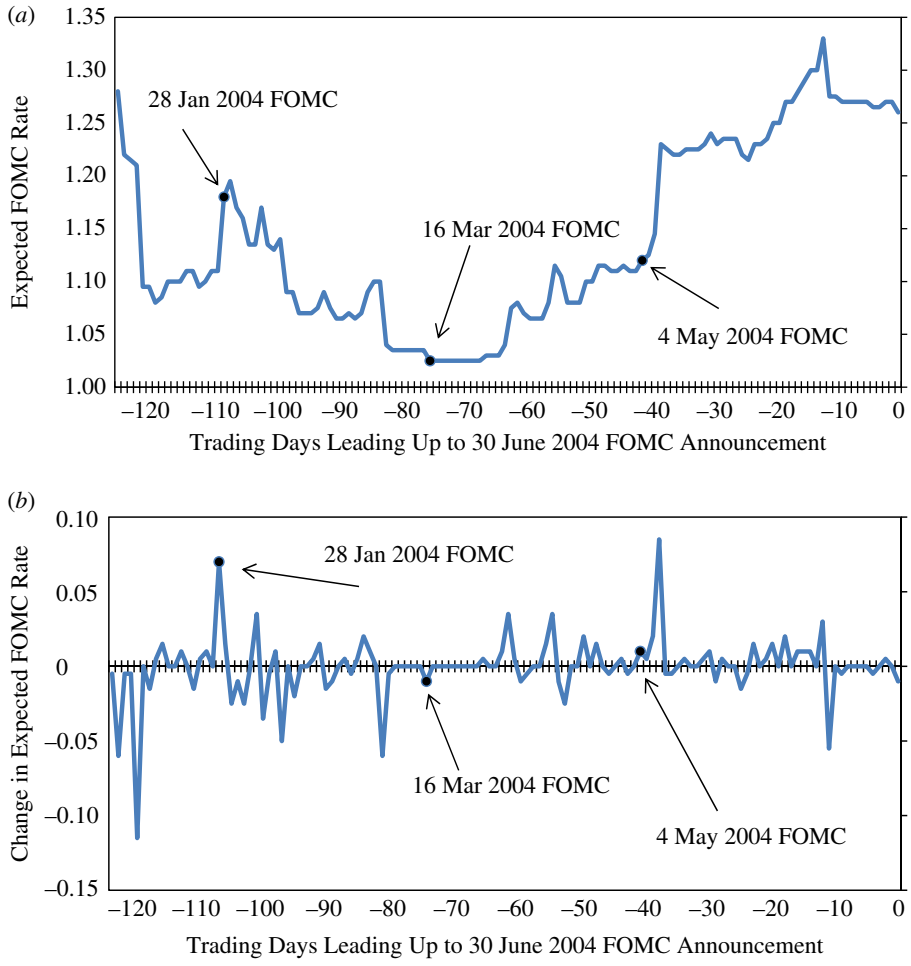

Fig. 2. *Market-based Target Rate for the FOMC Announcement on 30 June 2004. (a) Market-based Target Rate; (b) Change in Market-based Target Rate*

Notes. This Figure shows the market-based fed funds target rate after the FOMC announcement on 30 June 2004 on the 124 trading days (excluding weekends and holidays) before the announcement. At the 30 June 2004 meeting, the FOMC decided to increase the target rate from 1% to 1.25%. The market-based target rate on each day prior is obtained from the closing price of fed funds futures contract for July 2004. Panel (*a*) shows the market-based target rate; panel (*b*) shows the daily change in the market-based target rate.

Bernanke's discussed historic episodes where Fed tightening may have made matters worse.

Three days later, on 5 March, a non-farm payrolls release (an actual increase in the number of jobs of 21,000 *versus* a consensus estimate of 125,000) sent the market-based target rate down by 6bps, as the market wondered whether the Fed might ease further, rather than tighten. From 7 March until 15 March (the day before the March FOMC meeting), there was no change in the market-based target rate; it is spells like this that

lead us to speculate that the market prepares for FOMC meetings well in advance, given the weak employment data. On 16 March, the Fed left the policy rate unchanged at 1%, resulting in a further 1bp decline in the market-based target rate. There were three large changes in April, on the 2nd, 13th, and 14th. On 2 April, non-farm payrolls again resulted in a large surprise, this time to the upside as the release was an increase in the number of jobs of 308,000 *versus* a consensus estimate of 120,000. The market-based target rate rose 3.5bps on speculation that the positive economic news increased the likelihood the Fed would tighten. The large changes on 13 and 14 April were a reflection of the arrival of a large chunk of economic news, with higher-than-expected retail sales, business inventories, and budget deficit on the 13th. In addition, both PPI and CPI came in higher than expected on 14 April, no doubt accelerating the market's anticipation of Fed tightening.

The largest change in the market-based target rate occurred on 6 May, two days after the FOMC's 4 May meeting and 39 days prior to the 30 June meeting. On this day, the minutes from the Fed's 16 March meeting were released.[25] These minutes made reference to the market's perception that the Fed was 'behind the curve' and also acknowledged the market's concerns about inflation despite the Fed's internal models showing few signs. From this point on, the market-based target rate moved closer to the eventual 1.25% level and away from the then-prevailing 1% rate as the market clearly believed the Fed would raise the policy rate at its 30 June meeting. On 1 June, 21 trading days before the next FOMC meeting the market-based target rate reached the eventual rate for the first time and stayed above that level for the remaining days. Concerns that the Fed had waited too long and inflation would rise too quickly led the market to briefly consider the possibility that the Fed would hike by more than 25bps in its first instance of tightening. Two more large moves followed (in opposite directions) on 11 and 14 June (12 and 11 business days prior to the meeting respectively).

This Figure motivates our model and analysis of the interplay between macro-economic announcements and Federal Reserve communications. In particular, it illustrates that much of the market set-up occurs well before the actual FOMC announcement. In the last 10 days prior to the meeting, the market-based target rate barely moved. One might interpret this as evidence that the Fed's communication about its intentions was understood by the market by the time its decision was announced.

3.2. *Market Set-up over the Sample*

Another way to characterise the potential market set-up is by considering the average absolute change in the market-based target rate in the days leading up to an FOMC decision. In Figure 3(*a*) we present this, shown in event-time for the period of 124 trading days prior to an FOMC announcement day.[26] Despite substantial day-to-day

[25] In addition, three Board members gave speeches: Chairman Greenspan, and Governors Bies and Olson.
[26] For example, the value corresponding to −57 is computed by summing the absolute change in the market-based target rate 57 days prior to each of the FOMC meetings in our sample and dividing by the total number of meetings (54).

variation, a clear downward trend is visible from this graph.[27] The large upward spikes between the 70 and 65 days preceding and again between the 40 and 30 days preceding correspond to previous FOMC decision days. It is also clear that the FOMC decisions themselves (i.e. day 0) show substantial changes in the market-based target rate. This is largely driven by the days when an actual rate change occurred; on days when there is no change, the effect is much smaller. Note that this Figure does not take macroeconomic announcements into effect – presumably many of the fluctuations are largely driven by those. Because the FOMC calendar does not correspond to the periodicity of any of the macro events (i.e. weekly, monthly, quarterly), however, the trend is still apparent.

As noted above, on many days, the market-based target rate does not change. Figure 3(*b*) shows the number of preceding days with no changes, for each FOMC decision. The total period of 124 days prior to the FOMC meeting is divided into five bins of equal length. This graph largely corroborates the inference from Figures 2 and 3(*a*). It is apparent from this Figure that there is no change in the market-based target rate in a larger proportion of trading days in the 25 days immediately before an FOMC meeting than in earlier subperiods. In fact, across the 54 FOMC decisions in our sample, the average number of zero-change trading days declines from 15.3, 10.1, 6.1, 4.3 to 2.4 for the subperiods corresponding with 1–25, 26–50, 51–75, 76–100 and 101–124 days prior to the meeting. Again this suggests that the fed funds futures market looks towards upcoming FOMC decisions well before the actual decision is made. As noted above, we are agnostic as to why such set-up occurs and in particular note that the observed pattern is consistent with the possibility of a reduction in risk premia rather than a convergence of expectation. Regardless of what is driving the observed lower average absolute changes and the greater number of days with no change, however, the pattern is, in our view, what is most important, namely that there is greater price activity much farther in advance of an FOMC meeting than in the days immediately preceding it. To the best of our knowledge, we are the first to demonstrate such a large lead time.

In contrast, the data also indicate that trading volume in fed funds futures substantially increases in the days leading up to an FOMC announcement, shown in Figure 4. Average volume on the day of an FOMC decision is markedly more than that of any other day (more than double the next highest average). It is interesting that in

[27] A referee has highlighted the possibility that the downward trend is merely a reflection of the existence of risk premia that underlie an upward-sloping yield curve, so that on average, one should observe a downward trend in the price of a fed funds futures contract as it approaches maturity and risk premia decline. In order to examine this possibility, we consider the average change in the market-based target rate (i.e. without taking absolute values). The average change across all 54 FOMC announcements in our sample period is shown in online Appendix Figure A2 with panel (*a*) showing the average price change for the 124 days prior to the announcement individually and panel (*b*) showing the averages per group of 25 days. Consistent with the downward trend in the fed funds futures price, as suggested by Hamilton and Okimoto (2011), we observe that the price change is negative on average. In addition, the magnitude of the average price change becomes smaller nearer to the FOMC announcement. At the same time, comparing the scales on the vertical axes in the graph below with the one of Figure 3(*a*), we note that these are an order of magnitude smaller. Hence, it seems that risk premia cannot fully explain the downward trend in the absolute price change, although again we emphasise that distinguishing between various drivers of the patterns we document is beyond the scope of this article.

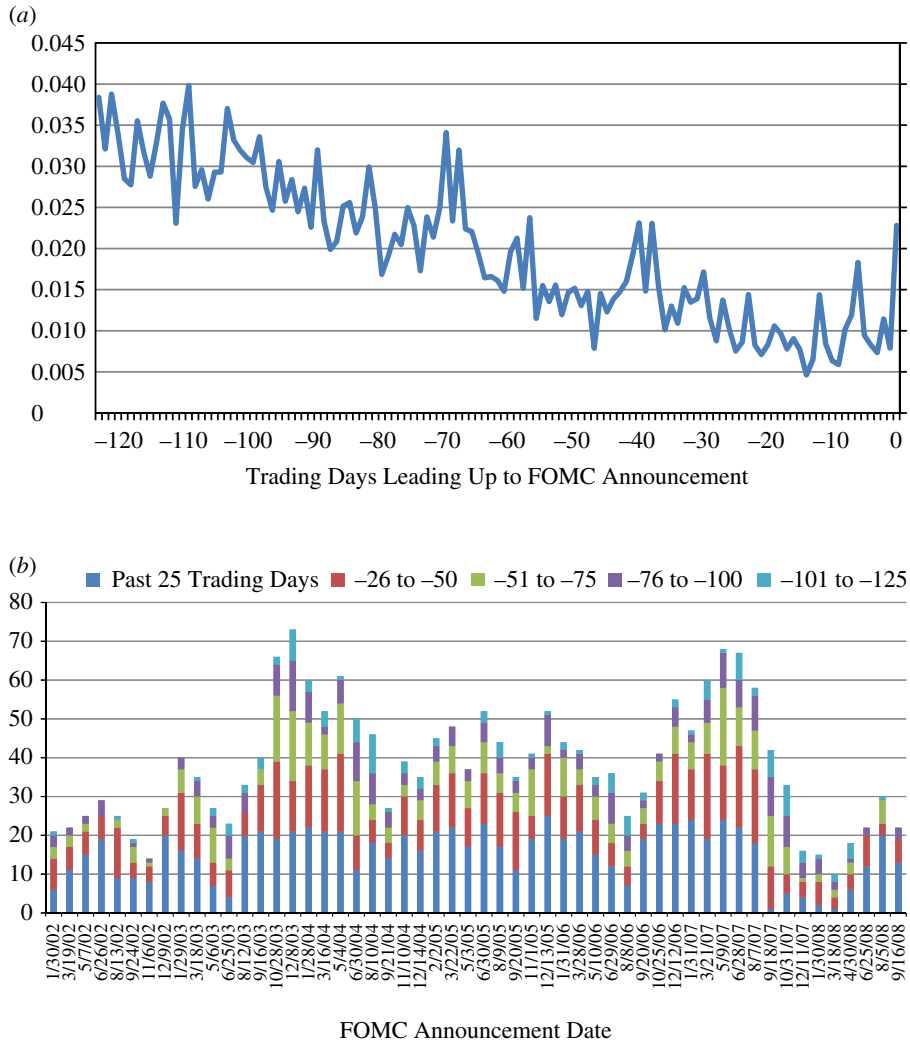

Fig. 3. *Changes in Market-based Target Rate on Pre-announcement Days. (a) Average Absolute Change; (b) Number of Days With No Change*

Notes. Panel (*a*) shows the average absolute change in the market-based target rate in event-time for the period of 124 trading days prior to an FOMC announcement day (excluding weekends and holidays). Panel (*b*) shows the number of days on which the market-based target rate did not change in the period of 124 trading days prior to an FOMC announcement. The number of no-change days is shown separately for each FOMC announcement during the period January 2002–September 2008. The period of 124 trading days prior to an announcement is divided into five sub-periods of 25 days each.

the lead-up to the FOMC decision, average absolute changes in expected target rate decline even as volume increases, suggesting a convergence of market opinion (e.g. a reduction in uncertainty as to the Fed's intention or a reduction in term premium). While one might interpret the large spikes in both average absolute change in

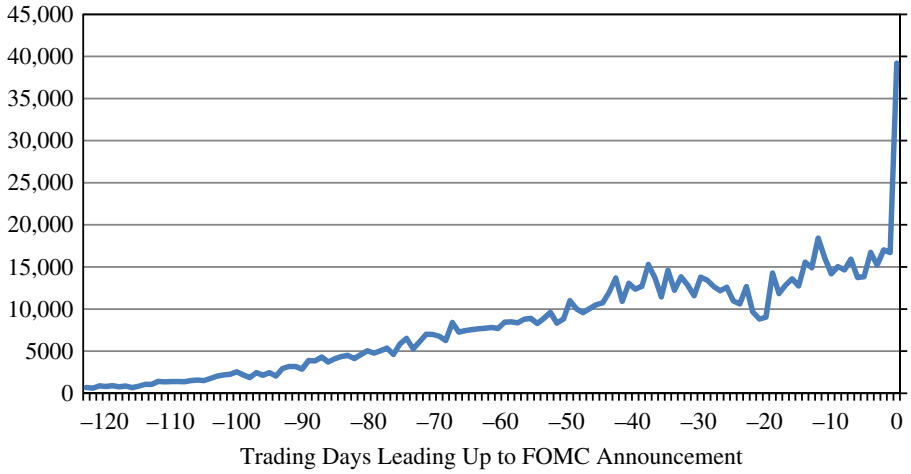

Fig. 4. *Trading Volume in Fed Funds Futures Preceding FOMC Announcements*
Notes. The Figure shows the average trading volume in Fed Funds futures in event-time for the 124 trading days prior to an FOMC announcement day (excluding weekends and holidays).

expected target rate and volume as suggesting the market was caught unawares, an alternative interpretation is that as soon as the FOMC decision is revealed, the market repositions in preparation for subsequent meetings.

3.3. *Baseline Specification*

Using the procedure described in subsection 2.1, we construct the market-based fed funds target rate, denoted f_{ijt}^{MB}, after FOMC decision i at the close of day t, which is j trading days (excluding weekends and holidays) prior to the announcement of interest.[28] Here $i = 1, 2, \ldots, I = 54$ (the total number of scheduled FOMC announcements in the sample) and $j = 1, 2, \ldots, J = 124$ (trading days, corresponding to a calendar period of approximately six months).

We relate the absolute change in the market-based fed funds rate to macroeconomic announcements and measures of Fed communication using a linear regression. We use the absolute value of the change in the market-based target rate since we do not have information on the tone of the speeches and testimony. Therefore we cannot distinguish between a positive and negative change. Our baseline regression model is given by:

$$|\Delta f_{ijt}^{\mathrm{MB}}| = \alpha + \sum_{m=0}^{M} \theta_m D_{mit}^{F} + \theta_u D_t^{U} + \sum_{k=1}^{K} \kappa_k D_{kt}^{S} + \sum_{l=1}^{L} \lambda_l D_{lt}^{T} + \sum_{n=1}^{N} \gamma_n |S_{nt}| + \varepsilon_{ijt}, \qquad (2)$$

[28] Technically only two of these subscripts are necessary: i identifies the announcement number in our sample. The date of the FOMC meeting at which this decision is made together with the index j for the number of days left until this meeting produces the calendar date t. For notational convenience, we also include t as a third subscript to denote the actual date.

where Δ is the first-difference operator between two consecutive trading days. Important information for the market-based target rate after meeting i presumably is gleaned from previous target rate decisions due to the path dependence noted by Gürkaynak *et al.* (2005*a*). For that reason we include dummy variables D^F_{mit}, $m = 0, 1, \ldots, M = 4$, which are equal to 1 if the m-th scheduled FOMC meeting prior to meeting i occurred on day t. We set $M = 4$ because this is the maximum number of prior FOMC meetings during the period of 124 trading days we consider. We include a separate dummy variable D^U_t for unscheduled FOMC meetings, given that their impact presumably is different from scheduled FOMC decisions. The information in speeches and testimony is included in the form of two sets of dummy variables. Specifically, D^S_{kt} is a dummy that is equal to 1 if there was a speech by Fed official k on day t (and zero otherwise), $k = 1, 2, \ldots, K = 13$. Similarly, D^T_{lt}, $l = 1, 2, \ldots, L = 3$, is a dummy that is equal to 1 if there was congressional testimony of type l on day t. We distinguish three types of testimony:

(*i*) the so-called Humphrey-Hawkins testimony by the Fed Chair, also known as the semi-annual Monetary Policy Report to Congress,
(*ii*) other testimony by the Fed Chair, and
(*iii*) testimony by other Board members.

In contrast to the treatment of speeches where we assign a separate dummy variable to the speeches of each Board member, it is necessary to group the testimony into these types due to the lower frequency with which Board members give congressional testimony. Finally, $|S_{nt}|$ is the absolute surprise of macroeconomic announcement n ($n = 1, 2, \ldots, N = 24$) on day t (and 0 if there is no such announcement). The reason for using the absolute value of the macroeconomic surprises is for comparison with the Fed communications variables where we lack information on the tone of the speeches and testimony. This regression is combined with the error specification:

$$\varepsilon_{ijt} = \omega_j + \delta_i + \eta_{ijt}, \tag{3}$$

which includes 'fixed effects' ω_j for each day j prior to the announcements and δ_i for each FOMC meeting $i = 1, 2, \ldots, 54$.

Our model allows for time-varying volatility of the fed funds futures in addition to the effects of macro announcements and Fed communication. This reflects the fact that our sample period is quite varied in terms of economic conditions, starting with the aftermath of the burst of the dot-com bubble and 9/11 and ending with the first part of the financial crisis and Great Recession, with a relatively calm period in between. Also in terms of the target rate itself, our sample period includes prolonged sub-periods with a (close to) stable target rate during the periods while the Fed was on hold, as well as periods of easing and tightening monetary policy with substantial changes in the target rate. Obviously, the volatility of the fed funds futures may be quite different during these sub-periods, and failing to account for this may influence our results.

Note that because we consider up to 124 trading days before an FOMC meeting, the data structure we employ creates overlapping observations. We control for this by

using heteroscedasticity and autocorrelation consistent standard errors throughout the analysis.[29]

Estimation results for the baseline model in (2)–(3) are shown in Table 1. For comparison purposes, we note that the market-based fed funds rate moves an average of 1.6bps on days without events (i.e. no FOMC decisions, speeches, testimony, or macro announcement).[30] Not surprisingly, previous FOMC meetings have a large and significant effect on the market-based target rate. Consistent with the idea that the market looks towards upcoming FOMC meetings well in advance of the actual decision, the effect of the FOMC meetings increases the farther back one goes. On average, the fed funds rate changes by 0.94bps more on the day of the FOMC meeting itself and 1.58, 2.13, 2.44, and 3.81bps more on days corresponding to the first, second, third and fourth preceding FOMC meetings. We also observe a substantially larger effect when the market is caught by surprise via an unscheduled FOMC decision, consistent with the results of Ehrmann and Fratzscher (2009). On average, unscheduled FOMC announcements shift the market-based fed funds futures by more than an additional 20bps.

Several macro announcements have an economically and statistically significant effect on the market-based fed funds rate. The largest effect comes from non-farm payrolls, on average, a 2.70bps change (similar in magnitude to the scheduled FOMC meetings) in response to a one standard deviation surprise. This is in line with previous literature, which generally has concluded that non-farm payroll employment is the 'king' of macroeconomic announcements (Andersen *et al.*, 2007). A one standard deviation surprise in retail sales, durable goods, PPI, and NAPM each increases the change in market-based fed funds by between 0.6 and 0.8bps. The negative sign of the significant coefficient on consumer credit bears mention – on days that these data are released, the fed funds rate changes on average by 0.3bps less than on non-announcement days. One-third of the consumer credit announcements in our sample

[29] Although at first glance, they may appear quite different, it is important to emphasise the relationship between the announcement response literature and our analysis. In the former, changes in fed funds futures contracts of different maturities are regressed on macroeconomic announcement surprises (Taylor, 2010). By looking at the impact of a surprise at different maturities, it is possible to gauge the impact of news at further horizons. Our analysis differs from this earlier literature in a number of key aspects. First, rather than focusing on fed funds futures contracts, we consider explicitly the market-based target rate. The fed funds futures contract's settlement price is based on the average of the month's effective fed funds rate. Thus, if the FOMC meeting is somewhere in the middle of a month, movements in the contract reflect movements for target rates of two separate FOMC meetings. If there is no FOMC meeting in a month, movements in the contract for that month are non-informative as these are already reflected in either the preceding or subsequent contract. Our analysis uses the Kuttner (2001) correction to focus on rates after each FOMC meeting, rather than prices of a derivative contract that represent some (weighted) average of rates across two FOMC meetings. Second, our econometric framework for the target rate using all trading days allows for a direct study of effects from a wide array of macroeconomic and policy indicators. Specifically, one can deal properly with the irregular occurrence of the speeches and announcements, and introduce various fixed effects that represent FOMC meeting specific effects and the market preparation for each FOMC meeting. Finally, important additional issues can easily be considered within our framework, such as time-variation in the effect of macroeconomic announcements and speeches due to interactions and black-out periods, a topic we turn to in Section 4.

[30] For purposes of presentation and interpretation, coefficients and standard errors have been multiplied by 100. Therefore, a coefficient of 0.94 means that on average the change in the market-based fed funds rate is 0.94bps larger than on an average (non-event) day.

Table 1

Baseline Specification

Dummy variables	Coeff.	SE	Continuous variables	Coeff.	SE
FOMC meetings (θ_m)			*Macroeconomic announcements* (γ_n)		
Current	0.940*	0.546	GDP (advance)	0.132	0.190
Previous	1.583***	0.476	GDP (preliminary)	−0.054	0.225
2nd previous	2.129***	0.497	GDP (final)	−0.189	0.135
3rd previous	2.443***	0.580	Non-farm payrolls	2.696***	0.253
4th previous	3.809***	0.803	Retail sales	0.628***	0.169
Unscheduled (θ_u)	20.837***	7.336	Industrial production	−0.084	0.222
			Capacity utilisation	−0.053	0.244
Speeches (κ_k)			Personal income	0.099	0.190
Greenspan	0.130	0.138	Consumer credit	−0.321**	0.149
Bernanke (Governor)	0.166	0.153	Pers. consump. exp.	−0.163	0.173
Bernanke (Chair)	0.064	0.224	New home sales	0.175	0.138
Ferguson	−0.145	0.140	Durable goods	0.645***	0.209
Kohn (Governor)	0.153	0.183	Constr. spending	−0.043	0.161
Kohn (Vice-Chair)	0.871**	0.342	Factory orders	−0.226*	0.127
Meyer	4.673**	1.877	Business inventories	0.190	0.156
Gramlich	−0.061	0.259	Government purchases	0.088	0.129
Olson	−0.111	0.178	Trade balance	0.069	0.170
Bies	−0.034	0.110	Producer price index	0.674***	0.231
Mishkin	0.376	0.490	Consumer price index	0.413	0.278
Kroszner	−0.071	0.296	Consumer confidence	0.396**	0.168
Warsh	−0.493	0.433	ISM manufacturing (NAPM)	0.765***	0.179
			Housing starts	0.123	0.114
Testimony (λ_l)			Leading indicators	0.075	0.142
Humphrey-Hawkins	0.781***	0.287	Initial unemployment claims	0.201**	0.090
Testimony – Chair	0.598***	0.221			
Testimony – others	−0.377**	0.164			

Notes. The Table shows coefficient estimates in the baseline regression model given by:

$$|\Delta f_{ijt}^{\mathrm{MB}}| = \alpha + \sum_{m=0}^{M} \theta_m D_{mit}^{F} + \theta_u D_t^{U} + \sum_{k=1}^{K} \kappa_k D_{kt}^{S} + \sum_{l=1}^{L} \lambda_l D_{lt}^{T} + \sum_{n=1}^{N} \gamma_n |S_{nt}| + \varepsilon_{ijt},$$

where f_{ijt}^{MB} is the market-based fed funds target rate after FOMC decision i at the close of day t, which is j trading days prior to the announcement, and Δ is the first-difference operator. D_{mit}^{F}, $m = 0, 1, \ldots, M = 4$ are equal to 1 if the m-th scheduled FOMC meeting prior to meeting i occurred on day t. D_t^{FU} is a dummy variable for unscheduled FOMC meetings. D_{kt}^{S} is a dummy that is equal to 1 if there was a speech by Fed official k on day t (and zero otherwise), $k = 1, 2, \ldots, K = 13$. D_{lt}^{T}, $l = 1, 2, 3$, is a dummy that is equal to 1 if there was a testimony of type l on day t. Three types of testimony are distinguished: (*i*) the so-called Humphrey-Hawkins testimony to Congress by the Fed chairman related to the semi-annual Monetary Policy Report, (*ii*) other testimony by the Fed chairman, and (*iii*) testimony by other Board members. $|S_{nt}|$ is the absolute surprise of macro announcement n ($n = 1, 2, \ldots, N = 24$) on day t (and 0 if there is no such announcement). The regression is combined with the error specification $\varepsilon_{ijt} = \omega_j + \delta_i + \eta_{ijt}$, which includes 'fixed effects' ω_j for each day j prior to the announcements and δ_i for each FOMC meeting $i = 1, 2, \ldots, 54$. The model is estimated using the 54 FOMC announcements during the period January 2002–September 2008, with $j = 1, 2, \ldots, 124$ indicating the j-th trading day prior to an FOMC announcement day (excluding weekends and holidays). Reported standard errors are heteroscedasticity and autocorrelation consistent. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

occur on the same day as non-farm payrolls, however; hence the negative coefficient may partially reflect the lower importance of a surprise in consumer credit relative to a non-farm payrolls surprise. Surprisingly the effect of a surprise in PPI is larger than that of CPI (0.67 compared to 0.41bps); this may reflect the fact that over the sample period

PPI was announced before CPI 84% of the time.[31] The correlation between changes in these two inflation measures is 0.82 over the time period we examine. Weekly unemployment claims numbers are also significant, although the effect (0.2bps) is not as large as for the other macroeconomic variables.

Congressional testimony of the Chair of the Federal Reserve as part of the semi-annual Monetary Policy Report to Congress (i.e. the Humphrey-Hawkins testimony) increases the change in the fed funds rate by almost 0.8bps, a magnitude similar to that of a one standard deviation surprise in the most important macro variables (except non-farm payrolls) we consider. Other testimony by the Fed Chair has a comparable impact on the market-based target rate. In contrast, the market-based target rate experiences smaller changes on days accompanied by testimony of other Board members.

The estimation results reveal surprisingly little effect of Board members' speeches. Large changes in the fed funds rate accompany only the speeches of Meyer and Kohn when he was Vice-Chair (4.7bps and 0.9bps, respectively). We emphasise that these effects may as much reflect the differences in calendar time as to when the speeches and testimonies occurred; for example, all of Meyer's speeches were in 2001, a particularly volatile time.[32,33]

Figure 5 shows the estimated values of δ_i along with associated 95% confidence bands. The chart clearly shows the increased effect of FOMC meetings post-crisis; the meetings since October 2007 are associated with a significantly larger average magnitude of the change in the fed funds rate. The largest value of δ_i, more than 4.5bps, occurred in response to the March 18, 2008 meeting that occurred immediately after Bear Stearns was sold to JP Morgan Chase. We identify similarly significant effects (albeit smaller in absolute magnitude) prior to December 2003,

[31] This result was surprising to us because CPI is the main inflation index underlying Treasury Inflation Protected Securities (TIPS) yields and the computation of breakeven inflation (that is, the spread between nominal and real yields). Over the past decade (and particularly since the 2004 episode we highlight above where the market viewed the Fed as being 'behind the curve' in part due to escalating breakevens), breakevens (and specifically forward inflation rates) have featured prominently in FOMC briefings and financial market discussions of inflation. The results suggest that despite this prominence, the market does not wait for the CPI release but rather adjusts in reaction to the earlier PPI release.

[32] Measuring volatility by means of the average absolute value of the daily change in the effective fed funds rate, we find that this is equal to 7.79bps during the second half of 2001. This contrasts with values of 3.57, 2.84, 2.14, 3.28 and 2.18 for the years 2002, ..., 2006. Volatility increased again in 2007 and 2008 to values of 4.73 and 8.06, respectively. To study timing concerns and to mimic the set-up for testimonies, we also consider a variant of our baseline model where we include only two dummy variables for speeches, one to capture the speeches of both Chairs (Greenspan and Bernanke while he was Chair) over the sample period, and another equal to one whenever there was a speech of one of the other members and zero otherwise. Only the combined speech variable for others is significant, at the 10% level. This confirms the relatively limited effect of Board members' speeches. These results are available in Table A3 in the online Appendix.

[33] Also, we acknowledge that the timing of both macroeconomic announcements and Fed communications varies throughout the day, so that in some cases there is a possibility that some of these events occurred after the close of the fed funds futures market. To consider the sensitivity of our results to this timing, we re-estimate the baseline specification (2) but:

(*i*) omit the contemporaneous FOMC meeting;
(*ii*) lag the dummy variables for speeches and testimony by one day; or
(*iii*) lag all explanatory variables (including the macro announcement surprises) by one day.

The results in online Appendix Tables A4, A5 and A6 are mostly similar to those for the baseline specification in Table 1.

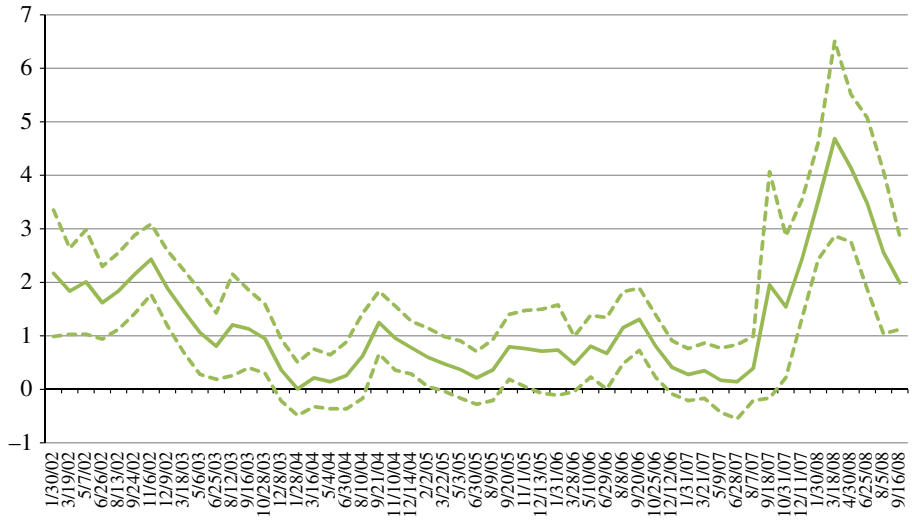

Fig. 5. *FOMC Meeting Effects*

Notes. The Figure shows the estimates of the FOMC meeting effect coefficients δ_i in the baseline specification (2)–(3), estimated using the 54 FOMC announcements during the period January 2002–September 2008. The coefficient estimates (solid line) are shown together with two standard error bands (dashed lines).

when the Fed was nearing the end of its easing cycle. Interestingly, for most FOMC announcements between October 2003 and August 2007, the values of δ_i are not statistically significantly different from zero, suggesting the market had already incorporated/anticipated the results of the meetings. Two interesting exceptions occur. First, for a brief period of about six months following the 30 June 2004 meeting, the values of δ_i are again highly significant, perhaps a reflection of market uncertainty regarding the pace of tightening. Second, significant meeting effects are also found for the second half of 2006, possibly indicating that the market was not completely convinced that the period of tightening had actually ended.

The final set of estimates corresponds to ω_j, for $j = 1, 2, \ldots, 124$, the fixed effects for each of the j days before the FOMC announcement. These capture patterns in the absolute changes of the market-based fed funds rate that are not explained by the macroeconomic announcements or Board communications. They are summarised graphically in Figure 6.[34]

These estimates confirm our hypothesis that the fed funds futures market reflects views about future FOMC meetings well in advance of the actual meeting: on average changes in fed funds futures clearly dampen as the FOMC decision day approaches. The average value of ω_j over the nearest 25 days is −0.60bps, indicating that the volatility of the market-based fed funds rate is below average during this period. The same applies to the preceding 25 days, with an average ω_j of −0.14bps. The averages

[34] The complete set of estimates and associated standard errors are in Table A7 in the online Appendix.

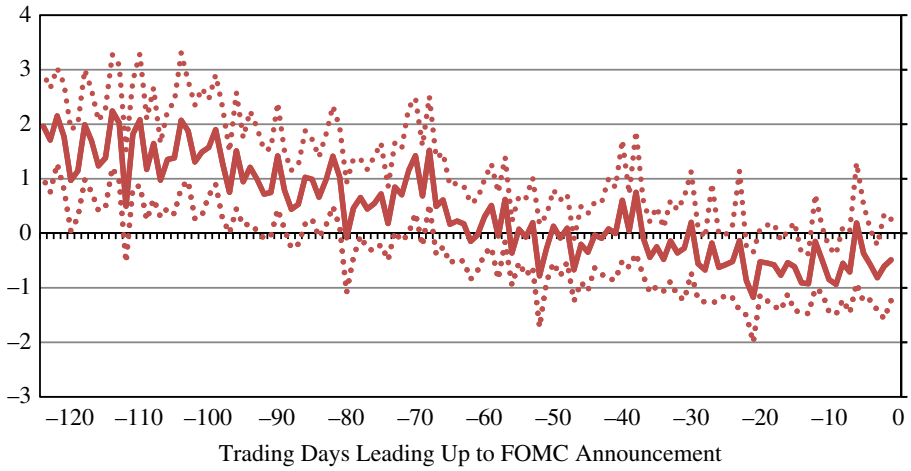

Fig. 6. *Trading Day Effects*

Notes. The Figure shows the estimates of the trading day effect coefficients ω_j in the baseline specification (2)–(3), estimated using the 54 FOMC announcements during the period January 2002–September 2008, with $j = 1, 2, \ldots, 124$ indicating the jth trading day prior to an FOMC announcement day (excluding weekends and holidays). The estimates of ω_j (solid line) are shown together with two standard error bands (dashed lines).

over the next two 25-day intervals (51 to 75 and 76 to 100 days before the FOMC) are 0.36bps and 0.92bps, respectively. During the farthest back interval, we consider (100 to 124 days before the FOMC), the average change in fed funds rate is 1.58bps above the overall average. In addition, in the first 75 days leading up to the FOMC, only three of the dummy variables are significantly different from zero, while in the 49 days prior to that, 38 of them are.[35]

4. Time-varying Effects, the Macro-communication Interaction and the Length of the Anticipatory Period

The results from estimating our baseline model suggest that the effects of macroeconomic surprises are for the most part of similar magnitude to the effects of Federal Reserve communication.[36] We view this result as indirect evidence for the importance

[35] One interpretation of the declining magnitude of the estimates is that information exists, in addition to that considered in our model, that is important to the expectations formation process but becomes less important as the decision day approaches. Under this interpretation, the lack of significance in the fixed effects indicates that the model adequately captures much of the variation in fed funds futures changes in the 75 days leading up to an FOMC announcement.

[36] There is little change to the other variables in the model when the macroeconomic surprises are omitted, i.e. the results for prior FOMC meetings, as well as speech and testimony dummy variables, are qualitatively similar although somewhat smaller in magnitude to the baseline specification. Detailed results are available in Table A8 in the online Appendix. Likewise, we find only minor changes in estimation results when the speech and testimony dummy variables are omitted, see Table A9 in the online Appendix. Together these results suggest that the FOMC communication and macroeconomic announcements bear complementary information for the fed funds futures prices.

of including both macroeconomic surprises and Fed speeches and testimony in the specification.

In this Section, we examine the effects of both types of information in more detail, in particular whether these effects vary over (event) time and whether there are potential interaction effects. We begin this Section by considering whether the macroeconomic effects display a monotonic effect similar to the effect observed for previous FOMC announcements in our baseline specification. We next consider whether macroeconomic announcements have a different effect during the Fed's blackout period *versus* other times and explore whether the presence of Federal Reserve communication on the day of a macroeconomic announcement might mitigate some of the uncertainty surrounding such events. Finally, we explore how inference changes when a shorter anticipatory period is considered.

4.1. *Time Variation of Macroeconomic Effects*

Recall that the effects of a macro surprise are assumed constant in the baseline specification (2). There may in fact be several mechanisms that could lead to time-varying effects of macro announcements. First, consistent with the finding of Taylor (2010) that macroeconomic announcements have stronger effects on longer-maturity than on nearby fed funds futures contracts, if market set-up occurs mostly well in advance of an FOMC meeting it may be that macro surprises have a larger impact the longer before the FOMC decision they occur. On the other hand, macroeconomic announcements may also have a larger impact immediately prior to an FOMC meeting due to the blackout period, where there is little Federal Reserve communication. Also, macroeconomic announcements may be looked upon differently if they occur at the same time as a speech or testimony by an FOMC member. The market may pay less (or more) attention to a macroeconomic surprise if later in the day a Federal Reserve official is speaking or testifying before Congress, believing that the Fed communication may provide helpful interpretative information regarding the surprise. We consider each of these mechanisms in turn, and investigate whether there are time-varying effects of macroeconomic surprises:

(*i*) in conjunction with the number of days before an FOMC announcement;
(*ii*) during the 'blackout' period; and
(*iii*) in conjunction with Fed communication.

The intuition behind these three variations is to allow for the possibility that following a macroeconomic surprise, the market will set up for the FOMC announcement differently depending on what other information might be available. In all three cases, there is little qualitative change to the coefficients on the dummy variables for prior FOMC meetings, speeches, or testimony. We therefore focus our remarks below on the coefficients related to the macroeconomic surprises.

4.1.1. *Market set-up and macro surprises*

To examine the extent and timing of market set-up in response to macro announcements, we divide the complete 124-day period before an FOMC meeting into five sub-periods according to the preceding FOMC meetings. The effects of the macro announcements are allowed to vary (unrestrictedly) across these sub-periods. Thus, we allow for different effects of macroeconomic releases that occurred:

(*i*) since the most recent FOMC meeting;
(*ii*) more than one but less than two FOMC meetings ago;
(*iii*) more than two but less than three meetings ago;
(*iv*) more than three but less than four meetings ago; and
(*v*) more than four (but less than five) meetings ago.[37]

A first impression of the relevance of this type of time-variation in the effects of macro announcements is obtained by pooling all releases of the different variables and only considering their occurrence and not their 'content' or surprise. That is, in the baseline specification (2) we replace the 24 macro surprise variables $|S_{nt}|$ with a single 'macro announcement dummy' that takes the value 1 on days with a macro announcement and zero otherwise. We then estimate a specification in which the coefficient of this dummy is allowed to be different across the five different sub-periods of the 124 trading days prior to the FOMC meeting. Figure 7(*a*) shows the resulting coefficients together with two standard error bands, which provides strong evidence of set-up effects. We find that the effect increases monotonically as we go farther back in time. While the impact of macro announcements that have occurred since the most recent FOMC meeting averages 0.18bps and is not significantly different from zero, macro announcements that occurred more than four meetings ago increase the change in the fed funds rate by an average 1.4bps.

Next we return to the baseline specification in (2)–(3) and again consider the effect of surprises of the individual macro announcements, now with the magnitude of these effects varying across the five sub-periods. For ease of interpretation, we display the estimates of the five coefficients for each of the macro surprises graphically in panels (*b*)–(*x*) of Figure 7; the numerical estimates are reported in online Appendix Table A10.[38] Although not always monotonic, for many macro announcements their effects are larger when one goes farther back in time, particularly for those that have significant effects during all five sub-periods. For example, for non-farm payrolls we find that a one standard deviation surprise (on average) in the release leading up to an FOMC announcement moves the fed funds

[37] An alternative interpretation is that this specification allows a given macroeconomic announcement on day *t* to have different effects on the expected target rates after each of the next four FOMC meetings. Note that the baseline specification in (2) restricts the effects on all future FOMC decisions to be the same.

[38] There are no GDP (preliminary) announcements before the 5-th FOMC meeting prior to the current one, and therefore no coefficient is estimated for this variable. The negative sign of the significant coefficient on final GDP in the two earliest subperiods also bears mention – on days that these data are released, the market-based fed funds rate changes on average by less than on non-announcement days. These releases occur on the same day as other releases, however; hence the negative coefficient likely reflects the lower periodicity of this release.

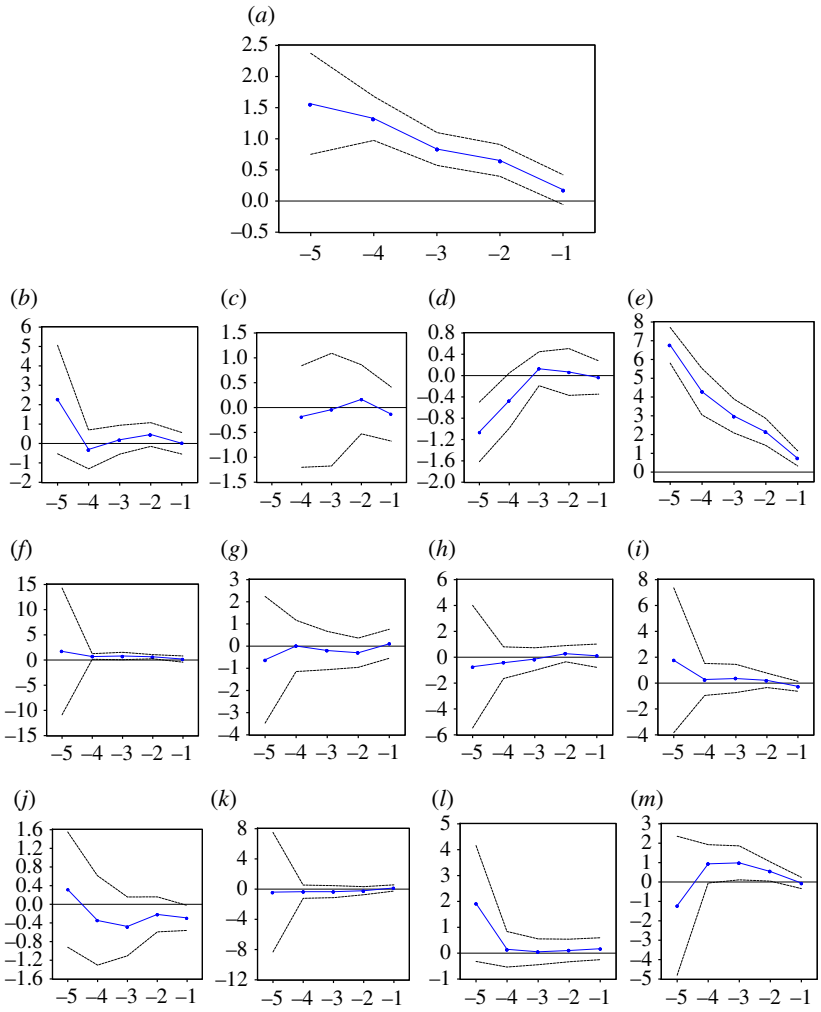

Fig. 7. *Time-varying Effects of Macroeconomic Announcements. (a) Aggregate; (b) GDP (Advance); (c) GDP (Preliminary); (d) GDP (Final); (e) Non-farm Payrolls; (f) Retail Sales; (g) Industrial Production; (h) Capacity Utilisation; (i) Personal Income; (j) Consumer Credit; (k) Personal Consumption Expenditure; (l) New Home Sales; (m) Durable Goods Orders; (n) Construction Spending; (o) Factory Orders; (p) Business Inventories; (q) Government Budget Deficit; (r) Trade Balance; (s) Producer Price index; (t) Consumer Price Index; (u) Consumer Confidence Index; (v) NAPM Index; (w) Housing Starts; (x) Index of Leading Indicators; (y) Initial Unemployment Claims*

Notes. The Figure shows the coefficients on macroeconomic announcements that have occurred: (*i*) since the most recent FOMC meeting; (*ii*) more than one but less than two FOMC meetings ago; (*iii*) more than two but less than three meetings ago; (*iv*) more than three but less than four meetings ago, and (*v*) more than four but less than five meetings ago. These correspond to the labels −1, −2, −3, −4, and −5, respectively, on the horizontal axis. Panel (*a*) shows estimates in the specification where the announcements of all 24 macro variables are pooled and represented by a single dummy variable. Panels (*b*)–(*x*) show the coefficients in the specification where the announcements of the individual macro variables are included separately and represented by the absolute surprise. The coefficient estimates (middle line) are shown together with two standard error bands (outer lines).

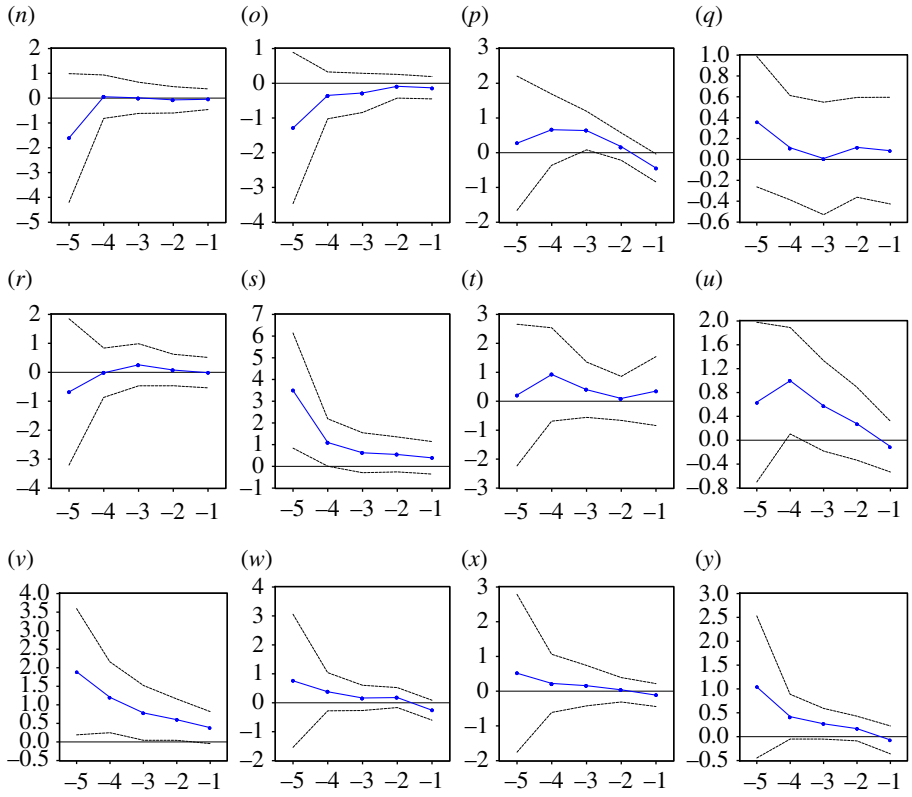

Fig. 7. *(Continued)*

future by just 0.7bps, whereas similar surprises in the release occurring more than four FOMC announcements earlier have an effect of almost 6.8bps (Figure 7(*e*)). A similar pattern is evident with ISM Manufacturing announcements. These results echo the evidence from the baseline specification that the fed funds futures market shows signs of anticipatory movement much earlier than considered in previous literature.[39]

4.1.2. *Macro announcements during blackout periods*

Next, we examine whether the effect of macroeconomic surprises is different when they arrive during the Fed's blackout period *versus* during other parts of the FOMC meeting cycle. Based on the pattern in the number of speeches observed in Figure 1, we assume that the blackout period corresponds with the ten weekdays leading up to

[39] We also consider whether the magnitude of the effects of speeches and testimony varies over the six-month period before an FOMC meeting according to the five sub-periods determined by the preceding FOMC meetings. Results are shown in online Appendix Table A11. We find little evidence of time-varying effects, although where significant, the effects are greater when one goes farther back in time, consistent with our results for the effects of macroeconomic surprises.

an FOMC announcement.[40] Table 2 shows the estimation results for a specification that allows the coefficients on the macro announcements to differ during blackout periods *versus* non-blackout periods.[41] Because there are fewer days associated with blackout periods than with non-blackout periods and hence fewer releases that occur during blackout periods, the standard errors are larger on many of the coefficients in the blackout period. Consistent with the idea that macroeconomic announcements carry more weight in the absence of central bank communications, however, the magnitude of the effect of a one standard deviation surprise is larger during the blackout period than in the non-blackout period for 17 of the 24 variables and, in many cases, significantly so.[42] For example, for retail sales, the effect of a surprise more than doubles, from 0.6bps in the non-blackout period to nearly 1.4bps during the blackout period. The effect of a one standard deviation surprise in non-farm payrolls increases by around 18%, from 2.4 to almost 2.9bps. In addition, a one standard deviation surprise in PPI is only significant during the blackout period and the magnitude of the effect is more than ten times that of a surprise during the non-blackout period. Finally, the type of information that the market focuses on appears to differ in the two periods; surprises in new home sales, PPI, CPI, leading indicators and unemployment claims are only significant during the blackout period while surprises associated with underlying economic conditions (consumer credit, business inventories, ISM manufacturing) have significant effects only during non-blackout periods.

[40] At the time of the initial writing of this article, to our knowledge there was no official definition of the exact convention of timing that the Fed uses, although a referee has subsequently drawn our attention to discussion on pages 34–38 of the 31 January–1 February 1995 transcript of the FOMC meeting, available online at http://www.federalreserve.gov/monetarypolicy/files/FOMC19950201meeting.pdf. Despite the absence of the official policy, the conventional wisdom was that a blackout period existed; additionally we have first-hand evidence of reference to a 'blackout' period in personal communications. It was on this knowledge that our assumption of ten weekdays was based. Our interest in examining the role of this blackout period also was related to earlier research by Ehrmann and Fratzscher (2009) who refer to a similar period as 'Purdah', a reference to the religious practice of female seclusion, and define it to be the ten-day period spanning seven days before and three days following both FOMC announcements and Humphrey-Hawkins testimony. Noting some instances of communication during these Purdah periods, they find greater effects on the financial markets and increased market volatility during these episodes, although they do not specifically examine the effects of macroeconomic announcements. For robustness, we also consider their definition (i.e. from −7 to +3 days) rather than the one we use (from −10 to 0 days) and find the results to be qualitatively similar. Using their definition, however, a few of the macroeconomic announcements have less significant effects, namely durable goods (no longer significant), retail sales and government purchases during the Purdah period and government purchases during the non-Purdah period. See Table A12 in the online Appendix. We have since become aware of an FOMC Policy on External Communications (Board of Governors of the Federal Reserve System, 2013) that defines the blackout period as 'seven days before the beginning of the meeting' until 'midnight Eastern time on the next day after the meeting'. Although this definition was officially adopted after our sample period ends, we note that it falls within the robustness window we consider. We also emphasise that the moratorium discussed in the 1995 transcript refers specifically to monetary policy communication and hence presumably would not apply to speeches related to other topics, e.g. bank supervision. For this reason, some speeches did occur during the seven day window preceding an FOMC meeting; 25 of the 495 speeches in our sample (6.6%) to be precise.

[41] We distinguish between blackout and non-blackout periods throughout the complete 124 day lookback period, and not just for the 10 days before the particular *i*th FOMC announcement. Results for the latter case are qualitatively similar.

[42] Evidence for this also has been documented in Ehrmann and Sondermann (2012) who find that the response of British government bond yields to macroeconomic announcements increases as the time since the latest release of the Bank of England's Inflation Report grows.

Table 2

Macroeconomic Surprises During Blackout Periods

				Blackout		Not Blackout	
Dummy variables	Coeff.	SE	Continuous variables	Coeff.	SE	Coeff.	SE
FOMC meetings			*Macro announcements*				
Current	0.810	0.521	GDP (advance)	0.277	0.206	0.239	0.310
Previous	1.516***	0.444	GDP (preliminary)	−0.230	0.354	−0.064	0.255
2nd previous	2.029***	0.463	GDP (final)	−0.319	0.202	−0.008	0.182
3rd previous	2.346***	0.543	Non-farm payrolls	2.878***	0.430	2.426***	0.326
4th previous	3.577***	0.771	Retail sales	1.369**	0.548	0.585***	0.183
Unscheduled	20.878***	7.355	Industrial production	−0.747	0.470	−0.130	0.249
			Capacity utilisation	1.099*	0.674	−0.147	0.241
Speeches			Personal income	−0.191	0.189	0.298	0.293
Greenspan	0.102	0.140	Consumer credit	−0.001	0.319	−0.578***	0.123
Bernanke (Governor)	0.193	0.155	Pers. consump. exp.	−0.039	0.177	−0.176	0.234
Bernanke (Chair)	0.006	0.205	New home sales	0.622**	0.246	−0.224	0.156
Ferguson	−0.071	0.139	Durable goods	0.950***	0.312	0.450**	0.219
Kohn (Governor)	0.247	0.184	Constr. spending	−0.102	0.225	−0.028	0.211
Kohn (Vice-Chair)	0.976***	0.333	Factory orders	−0.420*	0.240	−0.117	0.143
Meyer	4.460**	1.940	Business inventories	0.108	0.373	0.325**	0.165
Gramlich	−0.228	0.252	Government purchases	0.635***	0.217	−0.158**	0.080
Olson	−0.100	0.173	Trade balance	−0.147	0.383	0.155	0.186
Bies	−0.059	0.114	Producer price index	2.585***	0.617	0.150	0.181
Mishkin	0.383	0.477	Consumer price index	1.676*	0.933	0.039	0.139
Kroszner	0.074	0.306	Consumer confidence	0.661**	0.314	0.396**	0.195
Warsh	−0.457	0.439	ISM manuf. (NAPM)	0.267	0.200	0.967***	0.245
			Housing starts	−0.141	0.257	0.197	0.127
Testimony			Leading indicators	0.573**	0.271	−0.049	0.172
Humphrey-Hawkins	0.937***	0.285	Initial unemp. claims	0.548***	0.183	0.089	0.094
Testimony – Chair	0.582***	0.221					
Testimony – others	−0.294*	0.160					

Notes. The Table shows estimation results from the baseline specification in (2)–(3) but with the coefficients on the absolute macro surprises allowed to differ during blackout periods *versus* non-blackout periods. The blackout period is defined as the period of ten weekdays leading up to an FOMC announcement. The model is estimated using the 54 FOMC announcements during the period January 2002–September 2008, using 124 trading days prior to an FOMC announcement day (excluding weekends and holidays). Reported standard errors are heteroscedasticity and autocorrelation consistent. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

4.1.3. *Interaction between macro announcements and Fed communication*

Using a similar approach as in the previous subsection, we consider whether macroeconomic surprises have more of an effect on days where there is a speech or testimony or on days without. The results are reported in Table 3. For 14 of the 24 macroeconomic surprises, the effect on the fed funds futures is larger in magnitude (although not always statistically significant) on days where a speech or testimony occurred than on days without one. There is also modest evidence that the market receives the macroeconomic news more calmly when it occurs on a day with a Federal Reserve speech or testimony; 11 coefficients have negative signs *versus* eight when there is not a speech or testimony. For example, the effect of a surprise in non-farm payrolls is dampened by nearly 30% when it occurs on a day when Federal Reserve communications occur. In addition to non-farm payrolls, the coefficients on the trade balance and CPI are statistically significant both in the periods that coincide with a

Table 3

Macroeconomic Surprises and Speeches and Testimony

				No S&T		S&T	
Dummy variables	Coeff.	SE	Continuous variables	Coeff.	SE	Coeff.	SE
FOMC meetings			*Macro announcements*				
Current	0.944*	0.540	GDP (advance)	0.178	0.189	−1.146	0.901
Previous	1.583***	0.469	GDP (preliminary)	0.249	0.449	−0.269	0.176
2nd previous	2.151***	0.489	GDP (final)	−0.187	0.140	−0.251	0.670
3rd previous	2.468***	0.574	Non-farm payrolls	2.989***	0.306	2.103***	0.400
4th previous	3.822***	0.789	Retail sales	0.771***	0.144	0.262	0.578
Unscheduled	20.839***	7.351	Industrial production	0.075	0.309	0.301	0.401
			Capacity utilisation	0.419	0.292	−1.404***	0.514
Speeches			Personal income	0.107	0.218	0.407	0.449
Greenspan	0.148	0.129	Consumer credit	−0.351**	0.161	−0.161	0.252
Bernanke (Governor)	0.212	0.172	Pers. consump. exp.	−0.314	0.212	0.141	0.201
Bernanke (Chair)	0.101	0.221	New home sales	0.276	0.201	−0.167	0.177
Ferguson	−0.124	0.152	Durable goods	0.892***	0.244	−0.010	0.209
Kohn (Governor)	0.203	0.199	Constr. spending	0.015	0.171	−0.236	0.490
Kohn (Vice-Chair)	0.961***	0.357	Factory orders	−0.221	0.211	−0.284**	0.127
Meyer	4.454**	1.900	Business inventories	−0.094	0.150	0.783*	0.427
Gramlich	0.053	0.258	Government purchases	0.134	0.139	−0.918**	0.434
Olson	−0.056	0.173	Trade balance	−0.322**	0.158	1.198**	0.496
Bies	0.071	0.124	Producer price index	0.802***	0.258	0.222	0.525
Mishkin	0.491	0.468	Consumer price index	−0.503**	0.212	1.444**	0.621
Kroszner	−0.001	0.296	Consumer confidence	−0.073	0.148	1.494***	0.336
Warsh	−0.503	0.432	ISM manuf. (NAPM)	1.038***	0.181	0.353	0.425
			Housing starts	0.222	0.163	0.242	0.224
Testimony			Leading indicators	0.182	0.176	−0.169	0.189
Humphrey-Hawkins	0.917***	0.317	Initial unemp. claims	0.296**	0.118	0.042	0.120
Testimony – Chair	0.613***	0.221					
Testimony – others	−0.326*	0.179					

Notes. The Table shows estimation results from the baseline specification in (2)–(3) but with the coefficients on the absolute macroeconomic surprises allowed to differ depending on whether or not the macroeconomic announcement coincided with Fed communication. Columns headed S&T (No S&T) show coefficient estimates and standard errors on macroeconomic surprises announced on days with (without) a speech or testimony by a Fed Board member. The model is estimated using the 54 FOMC announcements during the period January 2002–September 2008, using 124 trading day prior to an FOMC announcement day (excluding weekends and holidays). Reported standard errors are heteroscedasticity and autocorrelation consistent. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

speech or testimony and those that do not but with opposite signs. On days when a speech or testimony occurs, both types of announcement add more than a basis point of additional uncertainty to fed funds futures while on days without a Federal Reserve communication, these announcements coincide with lower uncertainty. The coefficients on capacity utilisation, factory orders, business inventories, government purchases and consumer confidence are all statistically significant only when the release coincides with a day in which a Fed speech or testimony occurs and, for four of these (all except consumer confidence), changes in the market-based fed funds target rate on average are lower. In contrast, retail sales, consumer credit, durable goods, PPI, ISM Manufacturing, and initial unemployment claims are only significant on days where no official Federal Reserve communication occurs. For all of these variables, the effect is large and positive (between 0.3 and 1.0bps). These results are consistent with

an interpretation of greater market anxiety in the absence of Federal Reserve communication, underscoring the potential mitigating effect that Fed officials' communication can have.[43]

4.2. *Shorter Anticipatory Period*

The main conclusion that emerges from our analysis is that it is important to consider a larger window than typically is done in the literature when examining the market's anticipation of an FOMC meeting. This is demonstrated by the significant 'trading day' effects we find up to six months prior to such meetings, as well as the stronger reaction to macro announcements the longer before the meeting these occur. As noted in the introduction, because most previous literature has considered much shorter time horizons, it is possible that the effects of both macro announcements and Fed communications have been underestimated. To consider this possibility, we re-estimate our baseline model in (2)–(3) using only the most recent 20 business days' worth of information. Results are shown in Table 4. We find that failure to control for the longer horizon leads to inference that attributes too much weight to the information contained in FOMC meetings. Although there is no qualitative change to inference regarding the effect of the FOMC meeting itself, the magnitude of the effect is estimated to be 50% larger. In addition, the impact of the unscheduled meetings is estimated to be much larger (48bps rather than 21bps). In contrast, the effects of speeches are mitigated for most individuals and none of the testimony variables are significant; in particular both the Humphrey-Hawkins and congressional testimony of the Chair are no longer significant. In contrast, Governor Gramlich's speeches are highly significant and negative. In addition to the speeches and testimony, the macroeconomic surprises also are much less significant; only non-farm payrolls have a significant effect on the change in the fed funds rate. The diminished effect of the macro surprises is in fact not surprising given the results in subsection 4.1.1, which already show that macroeconomic announcements since the most recent FOMC meeting generally have small (and mostly insignificant) effects on the expected target rate.

These results suggest the effects of both macro announcements and Fed communications that have been documented in previous literature have been underestimated. Instead the effect is incorporated much earlier than previously thought; even looking back up to 20 days prior to the FOMC meeting we find little evidence. In contrast, our baseline specification shows strong effects of anticipatory set-up as early as six months in advance (the earliest horizon that we consider).

[43] We also examine whether the effects of testimony and speeches differ according to whether the day they are given coincides with an important macroeconomic release. The results as reported in online Appendix Table A13 show that generally the effects of these types of Federal Reserve communication are not affected by the coincidence of macro announcements, although some subtle differences occur. In particular, we find:

(*i*) a significant effect of both Humphrey-Hawkins testimony and testimony of the other FOMC members only for the days that also had a macroeconomic release; and
(*ii*) a substantially larger effect from the testimony of the Federal Reserve Chair on days without a macroeconomic release than on days with.

Table 4

Using 20-day Anticipatory Period

Dummy variables	Coeff.	SE	Continuous variable	Coeff.	SE
FOMC meetings (θ_m)			*Macro announcements* (γ_n)		
Current	1.505***	0.434	GDP (advance)	0.191	0.264
Previous			GDP (preliminary)	−0.064	0.283
2nd previous			GDP (final)	−0.255	0.160
3rd previous			Non-farm payrolls	0.688***	0.205
4th previous			Retail sales	0.285	0.255
Unscheduled (θ_u)	47.758***	0.761	Industrial production	−0.144	0.389
			Capacity utilisation	0.495	0.651
Speeches (κ_k)			Personal income	0.012	0.226
Greenspan	0.274	0.193	Consumer credit	−0.151	0.190
Bernanke (Governor)	0.096	0.256	Pers. consump. exp.	0.087	0.262
Bernanke (Chair)	0.470	0.451	New home sales	0.344	0.255
Ferguson	−0.093	0.162	Durable goods	−0.316	0.312
Kohn (Governor)	0.059	0.194	Constr. spending	−0.160	0.271
Kohn (Vice-Chair)	0.410	0.470	Factory orders	−0.054	0.142
Meyer	0.531	0.693	Business inventories	−0.308	0.257
Gramlich	−0.453**	0.204	Government purchases	−0.139	0.167
Olson	0.132	0.257	Trade balance	0.249	0.363
Bies	−0.024	0.157	Producer price index	0.457	0.376
Mishkin	1.229	0.962	Consumer price index	0.716	0.740
Kroszner	0.673	0.722	Consumer confidence	0.005	0.224
Warsh	0.518	0.610	ISM manufacturing (NAPM)	0.162	0.229
			Housing starts	−0.055	0.182
Testimony (λ_l)			Leading indicators	0.002	0.308
Humphrey-Hawkins	−0.201	0.412	Initial unemployment claims	0.028	0.111
Testimony – Chair	0.273	0.266			
Testimony – others	−0.217	0.264			

Notes. The Table shows estimation results from the baseline specification in (2)–(3) in the article when the anticipatory period is limited to 20 business days prior to the FOMC meeting. See Table 1 for comparison and notes of further details. Reported standard errors are heteroscedasticity and autocorrelation consistent. ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively.

5. Conclusion

The main contribution of this article is to examine the anticipatory set-up of financial market participants during an extensive period of six months before a particular FOMC target rate decision is made. For the most part previous research only considered the market's expectation immediately prior to these events and the ensuing reaction. As the Federal Reserve considers an eventual 'lift-off' from the range that it has held since December 2008, there is renewed interest in the role that Fed communications and interpretations of other sources of information (such as macroeconomic announcements) play in shaping financial market participants' actions.

We find convincing evidence of financial market set-up well in advance of an FOMC meeting. Prior FOMC announcements, macroeconomic surprises, and the speeches and testimony of Board members generate large moves in fed funds futures. For both macroeconomic announcements and prior FOMC decisions we find that their impact is larger the farther in the past they occur, indicating that the set-up effects decline as the meeting approaches. This is also suggested by the fact that we document a larger proportion of days immediately preceding the FOMC meeting where the daily change

in the futures is zero than in days farther back, suggesting heightened market convergence relative to those earlier periods. Our analysis demonstrates the importance of considering the path of macroeconomic announcements and Federal Reserve communications as drivers for the fluctuations in fed funds futures prices. We find both that inference on the effects of macroeconomic announcements is similar whether or not speeches and testimonies are included and that inference of the effects of the speeches and testimonies remains the same with or without macroeconomic announcements. Taken together these results suggest that in some sense the information sets may be orthogonal and emphasise the benefits of including both types of information in the model.

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Additional Supporting Information may be found in the online version of this article:

Appendix A. Technical Appendix.
Data S1.

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