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The impact of FOMC statements on the volatility of asset prices

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This article examines the impact of Federal Open Market Committee (FOMC) statements on asset prices. Statements are found to have a much more pronounced impact on the volatility of asset prices than interest rate surprises. They influence primarily stock returns, intermediate and long-term yields, whereas short-term rates are driven both by statements and by interest rate surprises. We also find that the regime shift of May 1999 has improved the effectiveness of monetary policy, as reflected in an overall reduction in market volatility during the most recent regime. In addition, markets are equally well-prepared for the upcoming rate decision in both regimes, but the process of adjustment depends on whether a statement was issued in the old regime or not. When a statement is issued, price adjustments are very similar across both periods, whereas if no statement is issued then the rate of adjustment towards the new value is more gradual and occurs throughout the entire intermeeting period.

Keywords: FOMC statements; interest rate surprises; financial market volatility

JEL Classification: E52; E58; E65; G12; G14

I. Introduction

In recent years, the statements issued by the Federal Open Market Committee (FOMC) have become an increasingly important component of US monetary policy. On announcement day, these statements are closely scrutinized by financial markets and at times a slight word change or a shift in the nuance can generate large movements in asset prices.¹ For example, on 28 January 2004 the Federal Reserve Bank (Fed) announced that it would keep the target rate constant but slightly changed the wording of the FOMC statement causing one of the

largest reactions in history in Treasury yields and stock prices.

While surprise target rate decisions do affect the markets, FOMC statements have become an important coordination device in shaping market expectations and improving the overall stability of the financial system. In their current form, they provide information to the public on the rationale for the just-made interest rate decision, the Fed's view on economic conditions, a risk-assessment to the attainment of the dual objectives of price stability and economic growth and signal the likely direction and magnitude of future policy changes.

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¹ Since 2004, *The Wall Street Journal* has dedicated an entire column 'Parsing the Fed' to FOMC statements which analyses each sentence in the current statement and compares it with the previous statement to discern the likely direction of future monetary policy.

FOMC statements were first released in 1994, but the language and information content of statements have evolved considerably over time. Early statements (1994–1999) were issued only if there was a change in the target rate and their primary goal was to inform the market about the most recent interest rate change. They also provided a general assessment on the stance of monetary policy as well as a very brief overview of the prevailing economic conditions. A major change occurred in May 1999 when the Fed adopted a ‘policy-tilt’ language which was later replaced by a ‘balance-of-risk’ assessment to inform the market more directly about the likely path of future monetary policy. Since May 1999, the statements have included the Fed’s assessment of current and future macroeconomic conditions and more recently incorporated a ‘forward-looking’ language aimed at informing the public about the direction, speed and pace of interest rate adjustments. Thus, it is possible that the impact of FOMC statements on financial markets since May 1999 (a new regime) may differ compared to the pre-May 1999 period.

The rising importance of FOMC statements has led to the view that monetary policy announcements should be measured along two dimensions: (1) interest rate decisions and (2) FOMC statements. Many studies analyse the impact of policy announcements strictly along the ‘interest rate’ dimension using a single-factor model to capture unexpected moves in the federal funds rate (interest rate surprises).² More recent studies focus on FOMC statements as an additional and sometimes independent element of monetary policy. For example, Bernanke *et al.* (2004) and Kohn and Sack (2004) report that FOMC statements increase the variance of asset prices relative to policy days when no statements are issued. Gürkaynak *et al.* (2005) find that FOMC statements explain most of the variation in the 5- and 10-year notes. The impact of speeches, testimonies and FOMC statements on the 30-year Treasury bond futures was investigated by Chirinko and Curran (2005) who conclude that FOMC statements are the most effective communicative tool. Asymmetric statements (tilted balance-of-risk-assessments), according to Ehrmann and Fratzscher (2007), generate a much

larger response from short-term rates than symmetric statements, suggesting that what is being communicated does matter to market participants.

The main goal of this article is to determine whether the release of FOMC statements has improved the effectiveness of monetary policy. We evaluate this by estimating the volatility effect of ‘FOMC statements’ and ‘interest rate surprises’ on asset prices across two regimes (February 1994–April 1999 and May 1999–June 2007). If increased transparency (via statements) has led to a more effective monetary policy, then this should increase the predictability of Fed’s actions which in turn should *reduce noise* and *volatility* in financial markets on announcement days. The baseline sample is from February 1994 (when the first FOMC statement was issued) to June 2007 (before the recent financial crisis). It appears as though earlier statements (pre-1999), when issued, provided important information to the market.³ In addition, the regime shift of 1999 offers a natural break in the sample to assess if changes in the content of FOMC statements adopted since May 1999 (more informative, more direct, and more ‘forward-looking’) have increased the effectiveness of monetary policy.

To evaluate the information content of FOMC statements, we conduct a comprehensive search of three major news sources for media stories published within minutes of a policy announcement that cover the just-released policy statement. An indicator variable is constructed that reflects (quantifies) the consensus view regarding the information content of the FOMC statement. The indicator variable assumes a value of one when FOMC statements release important information about economic conditions, future policy actions or changes in the wording of a statement compared to preceding meetings, and zero otherwise. The traditional one-factor model of ‘interest rate surprises’ is then augmented with the ‘FOMC statement’ indicator variable. A high-frequency dataset is used to address the endogeneity (simultaneous reaction between policy rates and asset prices) and omitted variable problems that arise when analysing how policy announcements affect asset prices.

We first document the adjustment process of short-term rates during intermeeting periods. The data

² Results from these studies show that an unexpected tightening in policy rates causes a significant decline in stock prices (e.g. Smirlock and Yawitz, 1985; Jensen *et al.*, 1996; Reinhart and Simin, 1997; Thorbecke, 1997; Fair, 2002; Lobo, 2002; Rigobon and Sack, 2004; Bernanke and Kuttner, 2005; Gürkaynak *et al.*, 2005; Farka, 2009), a flattening of the yield curve (e.g. Cook and Hahn, 1989; Evans and Marshall, 1998; Fleming and Remolona, 1999; Balduzzi *et al.*, 2001; Kuttner, 2001; Wu, 2001; Cochrane and Piazzesi, 2002; Fleming and Piazzesi, 2005; Gürkaynak *et al.*, 2005; Piazzesi, 2005) and an increase in volatility (e.g. Jones *et al.*, 1998; Chen *et al.*, 1999; Bollerslev *et al.*, 2000; Lobo, 2002; Bomfim, 2003; De Goeij and Marquering, 2006; Farka, 2009).

³ To our knowledge, this is the first study that takes into account the information content of FOMC statements before May 1999. Ehrmann and Fratzscher (2007) also include the earlier period, but they look at the overall impact of policy announcement across the two regimes, without separating the impact of ‘interest rate surprises’ from ‘FOMC statements’.

shows that market participants have anticipated interest rate decisions quite well under both regimes and they are equally well-prepared for the upcoming rate decision in both periods. However, the adjustment process differs in the two regimes depending on whether a statement was issued under the old regime or not. If a statement was issued, the results show no differences in price adjustments across periods as interest rates incorporate the information content and adjust quickly towards the target level expected to prevail in the next meeting. In contrast, in the old regime when no statements are issued, the rate adjustment towards the new value is more gradual and stretches over the entire month.

These results are further supported by Generalized Autoregressive Conditional Heteroscedasticity (GARCH) estimates. The impact of FOMC statements on asset price volatility is generally lower under the new regime which indicates that the change in communication content has increased the effectiveness of monetary policy in recent years. Though the impact of 'interest rate surprises' on asset prices is also lower under the new regime, the difference is generally not significant across the two periods. In addition, both 'interest rate surprises' and 'FOMC statements' cause a 'tent-shaped' volatility pattern in asset prices in both regimes. Volatility is abnormally low several hours before announcement ('calm-before-the-storm-effect'), spikes during the announcement period, declines steadily but still remains elevated after the announcement and continues to decrease on the day following the policy release. The adjustment process is considerably more protracted in the old regime where volatility remains high several hours after the announcement.

II. The Information Content of FOMC Statements

The disclosure practices of the FOMC have changed considerably over time (Table 1). A major change occurred in 1994 when the Fed began to explicitly announce its policy decisions right after a meeting at around 2:15 p.m. eastern time.⁴ This was important

because the Fed began to openly state its target rate decisions and the timing of this information was known to all market participants. Prior to 1994, the Fed's decisions were not announced directly and market participants inferred the policy move on the following day from the amount of liquidity provided through the Desk of the New York Fed.

FOMC statements have also undergone significant transformations. From February 1994 to May 1999 a relatively short policy statement was issued right after a policy meeting only if the FOMC changed the target rate. These statements imparted valuable information to market participants, often causing sizable movements in asset prices. For example, the markets responded strongly on 4 February 1994, when the Committee raised the federal funds rate and issued its first policy statements which stated that '...this decision was taken to move towards a less accommodative stance of monetary policy'. Likewise, on 6 July 1995, Treasuries declined by as much as 18 basis points when the Fed lowered the target rate and issued a statement to the effect that '...as a result of monetary tightening initiated in early 1994, inflationary pressures have receded enough to accommodate a modest adjustment in monetary conditions'. Towards the end of the old regime, the statement included a general assessment of current and future economic conditions.

Another significant change came in May 1999, when the FOMC decided to release a statement after *every* meeting regardless of whether the target rate was changed or not. From May 1999 to February 2000, the statements included a 'policy bias' (an assessment of the likelihood of future tightening or easing in monetary policy) which was later replaced by a 'balance of risk' assessment about future growth and inflation. FOMC statements have been further modified to: (i) include the Committee's view on economic conditions, (ii) cover a time horizon that extends beyond the next FOMC meeting and (iii) provide information on the likely pace and speed of future interest rate moves. Statements issued in the recent regime (May 1999–June 2007) appear to have a significant impact on asset prices, equal in magnitude and sometimes even larger than policy *actions* (interest rate changes).⁵ For example, despite the decision

⁴The exact timing of policy announcements can vary by up to several minutes and the response of asset prices depends crucially on the time when agents obtain the information. To identify the time when policy decisions became publicly available, we conduct a search of Bloomberg and Reuters and record the time the public first learned about the FOMC decision.

⁵This can be largely attributed to the fact that as the Fed becomes more transparent about its interest rate policy, market forecasts of target rates are more precise. Swiston (2007) shows that interest rate shocks have declined over the 1994 to 2007 period, suggesting that information about monetary policy is incorporated at an earlier stage through revisions in expectations shaped by previous FOMC statements. Therefore, much of the 'policy surprise' in our sample has come from FOMC statements since they shape market expectations about future interest rate changes. This information may not be fully anticipated because it covers a longer horizon and is subject to changing macroeconomic conditions.

Table 1. Brief history of Fed's disclosure practices

Date	Changes implemented
4 February 1994	An immediate public statement is released after a meeting if the meeting resulted in a change in policy rates. No statements are issued if the target rate is not changed.
1 February 1995	A lightly edited transcript of each meeting will be released with a lag of 5 years.
6 July 1995	Numerical targets for the federal funds rate are included in the policy directive.
18 May 1999	Two main changes in policy disclosures: <ul style="list-style-type: none"> • A statement will be issued after each meeting regardless of whether a change in the target rate occurs. • Each statement will include a 'policy bias' assessment indicating the likelihood of future rate increases or decreases.
2 February 2000	The 'policy bias' assessment is replaced with a statement about the balance of risks with respects to long-run goals of price stability and economic growth. The language includes: <ol style="list-style-type: none"> (a) 'risks are balanced with respect to both goals (b) risks are mainly weighted toward conditions that may generate heightened inflation pressures (c) risks are mainly weighted towards conditions that may generate economic weakness. A statement will accompany every change in the Committee's vies of prospective developments, whether that change is major or not.
7 May 2002	A roll call vote is released at the end of each meeting on the federal funds futures decision and policy preferences for dissenters. The release of this information is accelerated by about 6 weeks.
6 May 2003	'Balance of risk' statement is modified by issuing statements about the upside and downside risks to inflation and growth.
2 February 2005	The release of FOMC minutes is accelerated by 3 weeks and they are now published 3 weeks after each meeting.

Source: The Board of Governors of the Federal Reserve.

to leave the target rate unchanged on 18 May 1999, asset prices reacted strongly to the very first 'policy bias' statement when '...the Committee adopted a directive that is tilted towards the possibility of a firming in the stance of monetary policy.'

There are various approaches used to extract the information content from FOMC statements. Some studies use the 'content' analysis, which is a systematic technique for analysing the content of a message. For example, Balke and Petersen (2002) use expert readers and numerical scores to quantify the predictive power of the Federal Reserve Beige Book on economic activity. Guthrie and Wright (2000) use Reuters news stories to classify the Royal Bank of New Zealand's policy statements. Bernanke *et al.* (2004) classify FOMC statements as 'informative' if they release important information about the state of the economy or the future path of monetary policy. Other studies use alternative scoring methods to measure the content of central banks statements: Boukus and Rosenberg (2006) utilize Latent Semantic Analysis to statistically extract content from the FOMC minutes and Lucca and Trebbi

(2008) use an automated algorithm to capture the stance of the statements.

Our approach follows the media-based content analysis of Gurthrie and Wright (2000) and Bernanke *et al.* (2004). We conduct a comprehensive search of three major news sources, *Bloomberg*, *Reuters* and the *Wall Street Journal*, to determine the importance of the information content of each statement as perceived by the consensus view. Because the reading of the news stories may involve some subjective bias, we proceed conservatively to analyse only those stories that satisfy the following criteria: (a) they are released shortly (within minutes) after a policy announcements, (b) they are forward-looking and (c) they provide (directly or indirectly) some comparisons with the 'before-announcement' expectations. An indicator variable as in Farka (2011) is then constructed, which assumes a value of one if the statement reveals important information about the near-term path of monetary policy, a change in the Fed's assessment of the economic outlook or changes in the wording of key phrases (such as 'policy bias' or 'balance-of-risk') compared to a preceding release, and zero otherwise.⁶ Further details on the

⁶ Farka and Fleissig (2009) further refine the indicator variable to capture the monetary policy stance ('hawkish', 'dovish' and 'neutral') revealed by the policy statements.

construction of the indicator are provided in Appendices A and B. The indicator variable is constructed as follows:

$$I^{Statement} = \begin{cases} 1 & \text{if the statement includes information} \\ & \text{about economic outlook, future policy} \\ & \text{or changes in key phrases} \\ & \text{(e.g. 'policy bias' or 'balance of risk')} \\ 0 & \text{otherwise} \end{cases}$$

Of the 112 policy meetings examined, 30 of them correspond to the pre-May 1999 period and had no statement. Of the remaining 82 meetings, 47 (roughly 57%) had statements that released important information about future monetary policy and/or the economic outlook. Separating along the two regimes, there are a total of 44 FOMC meetings in the old regime (February 1994–May 1999) with 13 ‘surprise’ statements and 68 in the new period (May 1999–June 2007) with 34 ‘surprise’ statements.

III. Data and Methodology

Intraday data

Estimates are obtained from a new data set of intraday changes in asset prices around policy announcements for the period from February 1994 to June 2007. There are a total of 112 policy days with 108 regularly scheduled FOMC meetings and 4 intermeetings.⁷ Intraday S&P 500 data are from Cisco Futures and tick-by-tick data for ‘on-the-run’ issues of 3-, 2-, 5- and 10-year US Treasury securities are from GovPX Inc. S&P 500 returns and Treasury yield changes are computed in a 30-minute interval around each policy announcement. The final data set consists of 30-minute time intervals (46 032 observations for S&P 500 and 52 608 for Treasuries) and includes both policy and nonpolicy days (3288 trading days).

Interest rate surprises are constructed from intraday price changes in spot-month federal funds futures as in Kuttner (2001), Gürkaynak *et al.* (2005), Farka (2009) and D’Amico and Farka (2011). Federal funds futures data are from the Chicago Board of Trade.

Interest rate surprises are computed by unwinding the monthly average as follows: $\Delta FFR_t^S = \frac{m}{m-d} (FFR_t^{fut} - FFR_{t-1}^{fut})$, where m is the number of days in the month, d is the day of the monetary policy announcement and FFR_t^{fut} (FFR_{t-1}^{fut}) are the futures rate at time t and $t-1$.

Summary statistics for high-frequency returns around policy announcements from February 1994 to June 2007 are given in Table 2 (Panel A). As expected, the average intraday return for all securities is very close to zero. However, policy announcements tend to move the markets and often by large amounts. For example, the largest changes in 3-month rates occurred during intermeetings (18 April 1994 and 18 April 2001) when the Fed changed interest rates unexpectedly. For intermediate and long yields, the largest increase was on 28 January 2004 when the Fed removed the phrase that policy accommodation can be maintained for a ‘considerable period’ which signalled to the market that a tightening was likely to occur sooner than expected.

Methodology

The impact of ‘FOMC statements’ and ‘interest rate surprises’ on asset prices is estimated using a GARCH(1,1) model. To evaluate the effect of FOMC statements, we augment the traditional single-factor model of ‘interest rate surprises’ (ΔFFR_t^S) with an interaction variable ($\Delta FFR_t^{Statement}$) which reflects FOMC statements. Specifically, $\Delta FFR_t^{Statement}$ is constructed by interacting ΔFFR_t^S with the new indicator variable I^{FOMC} . The interaction variable ($\Delta FFR_t^{Statement}$) contains interest rate shocks that are associated with important FOMC statements.⁸ The variable $\Delta FFR_t^{Statement}$ may capture potentially important interactions between central bank statements and policy actions. Using high-frequency data, the two-factor model is as follows:

$$R_t = \beta_0 + \lambda R_{t-1} + \beta_1 \Delta FFR_t^S + \beta_2 \Delta FFR_t^{Statement} + u_t \quad (1a)$$

$$E_{t-1}(u_t) = 0 \quad E_{t-1}(u_t^2) = v_t^2 \quad (1b)$$

⁷ Following Bernanke and Kuttner (2005) we omit the observation of 17 September 2001, the first meeting after 11 September 2001, due to the extreme idiosyncratic nature of the policy move.

⁸ The interaction variable $\Delta FFR_t^{Statement}$ is equal to zero if ($I^{Statement}=0$) or if $\Delta FFR_t^S = 0$. It is possible that a zero rate surprise may cause the interaction variable to assume a value of zero even when the FOMC statement is informative ($I^{Statement}=1$). There are two observations in our sample where zero interest rate shocks coincide with informative statements. We re-estimate the models excluding these two observations and found that results are robust and remain virtually unchanged by this modification.

Table 2. Summary statistics: high-frequency data

	3-month rate	2-year note	5-year note	10-year note	S&P500 returns	Rate Surprises
Panel A: Full sample (February 1994–June 2007)						
Average	−0.0143	−0.0067	−0.0034	−0.0008	0.0156	−0.0119
SD	0.0636	0.0641	0.0826	0.0457	0.6421	0.0826
Max.	0.1680	0.1930	0.2051	0.1760	3.9911	0.1633
Min.	−0.3700	−0.2700	−0.1420	−1.0473	−1.0473	−0.4375
Panel B: Regime shifts						
February 1994–May 1999						
Average	−0.0076	−0.0043	−0.0027	0.0028	0.0049	−0.0101
SD	0.0628	0.0682	0.0591	0.0479	0.4895	0.0807
Max.	0.1680	0.1930	0.2051	0.1760	2.3906	0.1633
Min.	−0.2138	−0.2700	−0.1420	−0.1420	−0.8473	−0.2422
May 1999–June 2007						
Average	−0.0168	−0.0063	−0.0041	−0.0031	0.0211	−0.0136
SD	0.0644	0.0617	0.0614	0.0444	0.7275	0.0843
Max.	0.0820	0.1750	0.2051	0.1485	3.9911	0.1350
Min.	−0.3700	−0.1530	−0.1814	−0.1257	−1.0473	−0.4375
<i>p</i> -value (mean difference)	0.919	0.983	0.987	0.928	0.985	0.976

Notes: For the full sample, $N = 46\,032$ for S&P500 and 52 608 for each Treasury security, based on the 30-minute high-frequency interval, including policy and nonpolicy days.

Stock returns, Treasury yield changes and interest rate surprises are reported in percentage points.

The *p*-values are for the test that the estimates are no different from zero across the two regimes.

$$v_t^2 = h_t + \sum_{j=0}^3 \gamma_j FOMC_{t-1+j} |\Delta FFR_{t-1+j}^S| + \sum_{j=0}^3 \delta_j FOMC_{t-1+j} |\Delta FFR_{t-1+j}^{Statement}| \quad (1c)$$

where R_t represents asset returns, ΔFFR_t^S denotes 'interest rate surprises,' v^2 is the conditional variance, $h_t \equiv \varphi_0 + \varphi_1 u_{t-1}^2 + \varphi_2 v_{t-1}^2$, u_{t-1}^2 is the Autoregressive Conditional Heteroscedasticity (ARCH) term and v_{t-1}^2 the GARCH term. The $FOMC_j$ variable consists of four indicators designed to capture the pattern of volatility behaviour around FOMC announcements.⁹ Parameter β_1 captures the response of asset prices to interest rate surprises, β_2 to FOMC statements, λ reflects the degree of autocorrelation, γ_j captures the behaviour of volatility associated with 'interest rate surprises' and δ_j the volatility behaviour related to 'FOMC statements.'¹⁰ The conditional probability density is the generalized error distribution with the normal distribution as a special case. Parameter estimates are from maximum likelihood estimation using the algorithm of Berndt *et al.* (1974). Robust SEs are computed as in Bollerslev and Wooldridge (1992).

To test if communication changes in the new regime (May 1999 to June 2007) have increased the effectiveness of monetary policy compared to the earlier period (February 1994–May 1999), the effects of 'interest rate changes' and 'FOMC statements' are modelled separately for each regime as follows:

$$R_t = \beta_0 + \lambda R_{t-1} + \beta_1 I_t \Delta FFR_t^S + \beta_2 I_t \Delta FFR_t^{Statement} + \alpha_1 (1 - I_t) \Delta FFR_t^S + \alpha_2 (1 - I_t) \Delta FFR_t^{Statement} + u_t \quad (2a)$$

$$v_t^2 = h_t + \sum_{j=0}^3 \omega_{1j} I_t FOMC_{t-1+j} |\Delta FFR_{t-1+j}^S| + \sum_{j=0}^3 \omega_{2j} I_t FOMC_{t-1+j} |\Delta FFR_{t-1+j}^{Statement}| + \sum_{j=0}^3 \theta_{1j} (1 - I_t) FOMC_{t-1+j} |\Delta FFR_{t-1+j}^S| + \sum_{j=0}^3 \theta_{2j} (1 - I_t) FOMC_{t-1+j} |\Delta FFR_{t-1+j}^{Statement}| \quad (2b)$$

⁹ Indicator variables are defined as follows: (a) $FOMC_{t-1}$ which assumes a value of one 3 hours prior to the policy release and zero otherwise, (b) $FOMC_t$ which is set to 1 during the 20-minute time-frame corresponding to the policy announcement and zero otherwise, (c) $FOMC_{t+1}$ which assumes a value of one right after a policy release up until the end of the policy announcement day and zero otherwise and (d) $FOMC_{t+2}$ which assumes a value of one during the first 4 hours of the following day and zero otherwise.

¹⁰ Specifically, $\gamma_0(\delta_0)$ corresponds to pre-announcement volatility, $\gamma_1(\delta_1)$ to announcement time, $\gamma_2(\delta_2)$ to same-day post-announcement volatility and $\gamma_3(\delta_3)$ to next-day volatility.

where I_t is a binary variable that takes on a value of one in the new regime and zero in the old regime. Parameters $\beta_1(\beta_2)$ and $\omega_1(\omega_2)$ measure the reaction to 'interest rate surprises' (FOMC statements) under the new regime, and $\alpha_1(\alpha_2)$ and $\theta_1(\theta_2)$ for the old regime.

Models (1) and (2) are estimated using high-frequency data to address issues such as measurement errors, endogeneity and omitted variable biases.¹¹ Intraday data reduce measurement errors in asset prices (which enhances efficiency) and in interest rate shocks (which reduces bias). While endogeneity can also be addressed by using daily data given that the Fed reacts only once on announcement days, the omitted variable bias is still an issue in daily frequencies since during the course of an entire day a number of factors may influence both policy rates and stock prices. Intraday data significantly reduces the omitted variable bias by closely bracketing the policy announcement, thus decreasing the likelihood that other relevant information is released during this time-frame. In addition, the inclusion of FOMC statements in the two-factor model does in itself help mitigate omitted variable issues since statements may capture investor's time-varying risk premia which is an omitted variable in a single factor model.¹²

IV. Results

Price adjustments across regimes

To investigate whether markets have anticipated interest rate decisions better under the new regime, we examine interest rate surprises from February 1994 to June 2007. As shown in Fig. 1, interest rate shocks are generally smaller under the new regime, although there have been occasional large deviations, especially in the early years of the new period. In fact, the statistics for the two periods (Table 2, Panel B) show that the mean surprise is not statistically different from zero across the two subsamples. This indicates that the markets have anticipated interest rate decisions well under both regimes.¹³

However, the process through which market participants form their expectations about policy decision differs across the two regimes. For this, we examine the adjustment process of the 3-month T-bill

rate during the intermeeting period over the two subsamples. We also differentiate between two cases: when a statement was issued in the preceding meeting during the old regime and when no statement was issued. Figure 2(a) and (b) show the adjustment of the 3-month T-bill between two consecutive FOMC announcements under two regimes. In both cases, the Fed lowered interest rates by 25 basis points in the first meeting (marked as day 0 in horizontal axis) and by an additional 25 basis point in the consecutive meeting. The first date of 31 January 1996 occurred in the old regime after the Fed had said in the previous statement that: '...inflation was more favourable than anticipated and this warrants a modest easing in monetary conditions.' The second date of 31 October 2007 occurred during the later regime after the Fed had signalled an easing bias in the preceding statement. As seen from the graphs, the adjustment process for 3-month rate is similar across both regimes with most of the upcoming 25 bp cut priced in right after the previous meeting when the statement was issued. After the initial jump, interest rates oscillated around the new 'expected' value for the remainder of the month with no big adjustments in the next meeting.

The results differ when no statements were issued in a preceding meeting during the old regime (Fig. 2c and d). For example, comparing 25 March 1997 to 2 February 2000, there was 25 bp increase in the target rate but no change in the previous meeting. As seen in the graphs, under the old regime interest rates did not move in the first meeting, but edged up towards the new equilibrium value slowly and steadily throughout the month. In contrast, under the new regime, interest rates moved up instantaneously right after the first meeting to reflect the tightening bias of the statement and stayed elevated until the eventual policy decision of a higher target rate materialized.

This analysis demonstrates that while market participants are equally well prepared at anticipating policy decisions under the two regimes, the mechanism through which they reach decisions differs across periods. In particular, in the old regime if no statements are issued at a previous meeting, the markets correctly anticipate the upcoming decision but adjust their expectations towards the new equilibrium value with considerable delay. This indicates

¹¹ Other studies also employ high frequency data to address similar issues (e.g. Bollerslev *et al.*, 2000; Balduzzi *et al.*, 2001; Fleming and Piazzesi, 2005; Gürkaynak *et al.*, 2005; Farka, 2009).

¹² Statements tend to issue information that may change investors' risk aversion and are likely to impact both 'interest rate surprises' (derived from federal funds futures) and asset prices. Therefore, risk premia can be a missing variable in single-factor models, reflecting third factor effects rather than the direct impact of interest rate shocks on asset prices.

¹³ This finding is consistent with studies which also report that monetary policy decisions have been well anticipated by markets since 1994 (e.g. Demiralp, 2001; Lange *et al.*, 2003; Poole and Rasche, 2003; Ehrmann and Fratzscher, 2007).

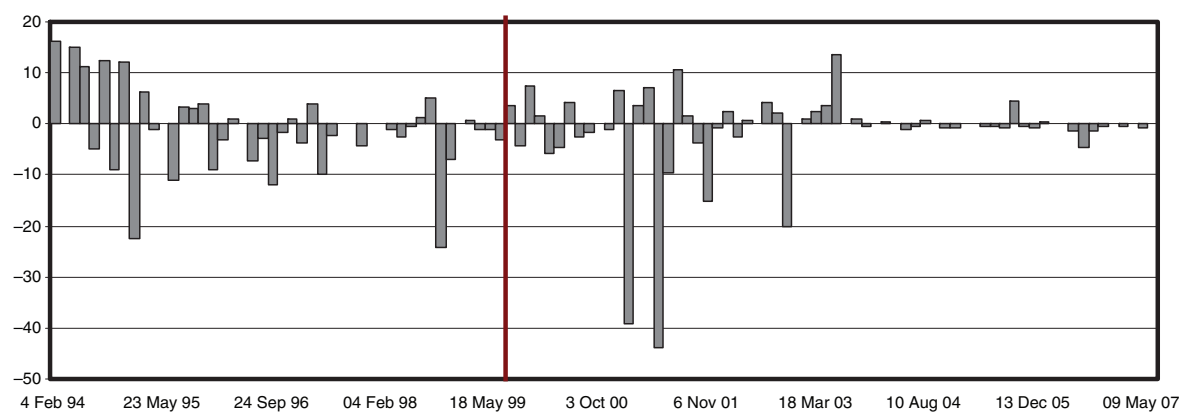


Fig. 1. Interest rate surprises

Notes: The figure shows 'interest rate surprises' as measured by changes in federal funds futures around policy announcements. The sample runs from February 1994 to June 2007 with a total of 112 policy days. Of these, 108 are regularly scheduled meetings and four are intermeetings.

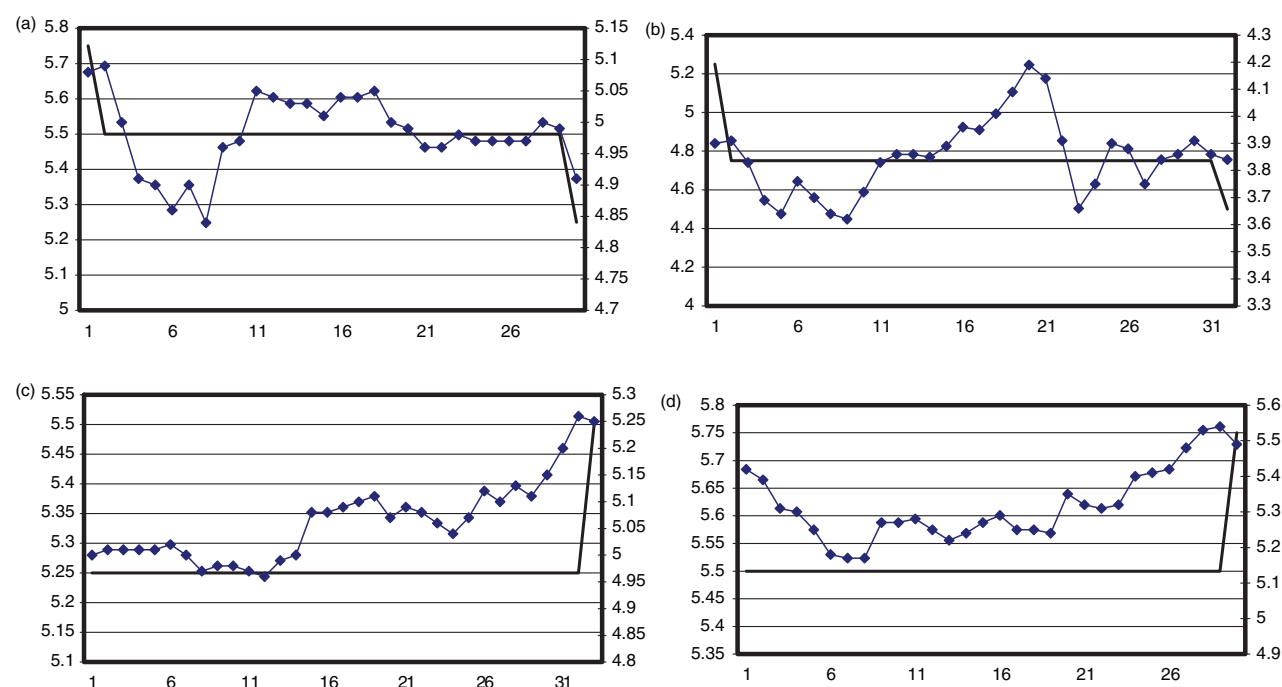


Fig. 2. Adjustment path during intermeeting period across two regimes

Notes: The figure shows the adjustment path of the 3-month rate in between policy meetings. (a) shows adjustment under the old regime when an FOMC statement was issued in the preceding meeting; (c) shows adjustment under the old regime when no statement was issued during a preceding meeting. (b) and (d) show adjustments under the new regime.

that in the old regime, information about the upcoming decision comes indirectly through macroeconomic announcements and other news.¹⁴ In contrast, if a statement is issued, the process of adjustment is very similar across the two periods, suggesting that FOMC statements under both regimes tend to prepare markets about future monetary decisions at an *early stage*.

GARCH estimates

To investigate the response of market participants to FOMC statements, we estimate a GARCH (1,1) model in which the conditional mean and volatility of asset prices are expressed as a function of 'interest rate surprises' and 'FOMC statements.' As a first step, we estimate Model (1) which is defined over the

¹⁴ Ehrmann and Fratzscher (2007) also find the process of adjustment is more gradual under the old regime, but do not distinguish between 'no statement' and 'statement' scenarios during the earlier period.

entire sample (February 1994–June 2007). Subsequently, we test if changes in FOMC statements since 1999 have increased the effectiveness of monetary policy compared to the earlier regime by estimating Model (2).

Estimates from Model (1) are in Table 3 and show that both ‘interest rate surprises’ and ‘FOMC statements’ have a significant impact on 3-month rates, 2Y notes and S&P500. Specifically, a 1% ‘interest rate surprise’ causes a decline of 1.98% in stock returns, an increase of 42.3 basis points (bp) in 3-month rates, and 15.3 bp in 2Y notes. The effect of interest rate shocks on 5Y and 10Y yields is small and not statistically significant. In contrast, FOMC statements tend to have a much larger impact on all securities (with the exception of 3-month rates where the response is almost equal). The 2-year yields rise as much as 39.6 bp in response to FOMC statements, the reaction of the 5Y note and S&P500 is three times as large to statements relative to rate shocks, and the response of the 10Y note seems to be entirely driven by FOMC statements.¹⁵

Results show that FOMC statements do move the markets and for most securities, statements dominates interest rate shocks. This does not imply that policy moves do not matter, but rather that by the time the Fed changes interest rates, this decision is well anticipated by the market because of previously formed (correct) expectations shaped by earlier FOMC statements. Another important result is that FOMC statements have a larger impact on stock returns, intermediate and long yields compared to short rates. This may be due to the fact that target rate changes have a stronger impact in the immediate policy setting and by implication, on the short-end of the curve, whereas FOMC statements are presumed to cover a longer horizon. A statement may signal a shift in the economic outlook or in the policy bias that may occur in the future, but this causes an immediate reaction in longer-maturity yields because this information is priced in when the statement is issued and not when the Fed eventually changes the target rate.

Volatility estimates further confirm the importance of FOMC statements. We find that with the exception of the 3-month rates, ‘FOMC statements’ have a more pronounced impact on asset volatility than ‘interest rate surprises.’ For example, FOMC statements result in an immediate increase 3.41% in the volatility of 5-year yields, whereas interest rate shocks raise volatility only by 1.11%. Similarly, the volatility impact of FOMC statements on 2-year,

Table 3. The impact of ‘FOMC statements and ‘interest rate surprises’ on asset prices

	3-Month rate	2-Year note	5-Year note	10-Year note	S&P500 returns
β_1	0.428*** (0.137)	0.153* (0.090)	0.138 (0.817)	0.094 (0.136)	-1.979*** (0.654)
β_2	0.433** (0.198)	0.395*** (0.125)	0.356** (0.140)	0.284** (0.145)	-5.219*** (0.215)
λ	0.079 (0.090)	0.133 (0.105)	0.092 (0.106)	0.0790 (0.060)	0.099 (0.101)
γ_0	0.131 (0.271)	0.508* (0.280)	-0.138** (0.059)	0.212 (0.380)	0.386* (0.227)
γ_1	1.996*** (0.333)	1.219*** (0.223)	1.587*** (0.484)	1.098* (0.591)	1.587*** (0.550)
γ_2	0.713** (0.285)	0.374** (0.147)	0.454* (0.267)	0.435 (0.764)	0.835*** (0.192)
γ_3	-0.654 (0.550)	0.516 (0.505)	-0.047 (0.255)	0.353 (0.683)	0.148 (0.148)
δ_0	0.786** (0.381)	0.579** (0.290)	0.399*** (0.063)	-0.352 (0.292)	0.842** (0.418)
δ_1	2.356*** (0.662)	3.643*** (1.011)	3.414** (1.399)	2.771*** (0.723)	3.037*** (1.160)
δ_2	1.273* (0.750)	1.609*** (0.566)	1.503** (0.761)	1.004* (0.590)	0.910 (0.894)
δ_3	-0.659*** (0.234)	-1.028* (0.625)	-0.194 (0.330)	0.232** (0.096)	0.465** (0.208)

Notes: Estimates are from model (2) based on 30-minute high-frequency intervals including policy and nonpolicy days.

γ_0 , γ_1 , γ_2 and γ_3 capture the pre-announcement ($FOMC_{t-1}$), announcement ($FOMC_t$), post-announcement ($FOMC_{t+1}$) and the day-after announcement ($FOMC_{t+2}$) volatility effects of interest rate shocks.

δ_0 , δ_1 , δ_2 and δ_3 capture the pre-announcement ($FOMC_{t-1}$), announcement ($FOMC_t$), post-announcement ($FOMC_{t+1}$) and the day-after announcement ($FOMC_{t+2}$) volatility effects of FOMC statements.

Robust SEs computed as in Bollerslev and Woldridge (1992) are given in parentheses.

The sample runs from February 1994 to June 2007; $N=46\,032$ for S&P500 and 52 608 for Treasuries.

*, ** and *** denote significance at the 10, 5 and 1% levels, respectively.

10-year yields and stock returns is around two–three times larger than the volatility impact of interest rate shocks.

The volatility patterns for both ‘interest rate surprises’ and ‘FOMC statements’ is ‘tent-shaped’ but the tent-like behaviour is distinctly more pronounced for FOMC statements. Volatility tends to be lower before the policy announcement, it spikes notably during the announcement time, it generally declines though still remains elevated a few hours after the announcement, and it decreases close to

¹⁵ These results differ from Gürkaynak *et al.* (2005) who report an overall smaller response to statements from the 2-, 5- and 10-year yields and an insignificant reaction from stock returns.

pre-announcement levels on the following day.¹⁶ The spike in volatility during announcement time is considerably higher for FOMC statements likely reflecting an increased trading activity as market participants absorb the statement and rebalance their positions accordingly. Pre-announcement volatility is also generally higher for FOMC statements relative to interest rate surprises which is likely due to the fact that important statements (more informative and more unexpected) are generally issued when macroeconomic risks are on the rise, or when the business cycle or the stance of policy are at a turning point. In the old regime, these were exactly the times when the Fed actually decided to issue a statement. Post-announcement volatility declines both for 'interest rate surprises' and 'FOMC statements' but the speed of decrease is a lot faster for interest rates relative to statements. This likely reflects a different learning process associated with the two components of monetary policy: while interest rate decisions are immediately observable and quickly incorporated in asset prices, the markets take longer to reach a final assessment on the content of the FOMC statements.

The regime shift of 1999 is captured by model (2) and offers a natural break in the series that allows us to more fully explore the importance of FOMC statements and their effect on the markets. The parameters of model (2) are estimated jointly allowing for tests in differences in coefficients across the two regimes (Tables 4 and 5). Results for the mean equation indicate that the reaction of asset prices to 'interest rate surprises' are not significantly different across the two subperiods which means that markets are equally well prepared for the upcoming interest rate decision under both regimes. This is consistent with our earlier findings (Fig. 1 and Table 2, Panel B). Furthermore, although the response to 'FOMC statements' is larger during the earlier regime, this difference is also not statistically significant indicating that the markets are just as 'surprised' by the information content of statements under the new regime as they were in the earlier period.

Volatility estimates reveal a different pattern. Aggregating across the two volatility measures (interest rate-induced and statement-induced),

volatility is generally lower under the new regime compared to the earlier period. This is primarily due to a reduction in volatility associated with FOMC statements and shows that improvements in communication style have increased the effectiveness of monetary policy. Volatility estimates associated with interest rate surprises are higher under the earlier regime, but the difference is generally not statistically significant. This result is consistent with our previous findings which indicate that markets correctly anticipate rate decisions under both regimes, though the expectation-forming mechanism varies across the two periods. Under the new regime the information about future rate decision is received from FOMC statements, whereas in the previous regime it comes from actual macroeconomic news as well as other forms of Fed communications (speeches, testimonies).¹⁷

A different picture emerges when looking at the statement-induced volatility estimates. The estimates are higher under the old regime and this result is statistically significant across subsamples. A potential explanation is that under the old regime, FOMC statements were issued only when the target rate was also changed which usually coincided with increased macroeconomic risks or turning points in the business cycle or monetary policy. It is also possible that the wording of the earlier statements was less well understood by the markets since the communication language was not well developed and each statement did not necessarily follow the same format as another. This may have led to market overreaction on announcement day which is manifested in higher volatility.

We also find that pre-announcement volatility is higher under the old regime (the difference is generally statistically significant) reflecting high uncertainty surrounding those events when the Fed actually changed rates (which were also the times when a statement was issued). Furthermore, post-announcement volatility is also higher in the previous regime which suggests that the process of price formation was more prolonged in the earlier sample. One reason for this is the lack of a formal standardized language which may have led to diverse interpretations of statement content by market participants.

¹⁶ These results are consistent with Jones *et al.* (1999), Lobo (2002), Bomfim (2003), Fleming and Piazzesi (2005), De Goeij and Marquering (2007) and Farka (2009), among others, who find a similar volatility behaviour for stocks and bonds in response to various macroeconomic and policy shocks. Our work further extends these studies by providing intraday estimates which capture more fully the behaviour of volatility around announcement time.

¹⁷ These findings are qualitatively consistent with Ehrmann and Fratzscher (2007) who also find that pre-1999 markets gather information primarily from other sources (macroeconomic releases and other news). Our study provides a more detailed analysis since we distinguish between 'interest rate surprises' and 'FOMC statements' and also account for the information content of statements pre-1999.

Table 4. Regime shift effects: pre- and post-1999

	February 1994–May 1999										May 1999–June 2007									
	Interest rate shocks					FOMC statements					Interest rate shocks					FOMC statements				
	α_1	θ_{10}	θ_{11}	θ_{12}	θ_{13}	α_2	θ_{20}	θ_{21}	θ_{22}	θ_{23}	β_1	ω_{10}	ω_{11}	ω_{12}	ω_{13}	β_2	ω_{20}	ω_{21}	ω_{22}	ω_{23}
3 Month	0.579*** (0.117)	0.186 (0.254)	2.183*** (0.611)	0.796 (0.581)	-0.736* (0.404)	0.459*** (0.215)	1.496*** (0.650)	3.183*** (0.735)	1.680*** (0.654)	-0.372* (0.199)	0.314** (0.138)	0.130 (0.201)	1.787*** (0.348)	1.010*** (0.402)	-0.726* (0.399)	0.411** (0.195)	0.133 (0.251)	1.610*** (0.242)	0.527* (0.231)	-0.762** (0.341)
2 Year	0.228*** (0.082)	0.680*** (0.154)	1.190*** (0.243)	0.698 (0.475)	0.377 (0.646)	0.484*** (0.115)	0.968*** (0.123)	4.508*** (0.673)	1.939*** (0.896)	0.147 (0.741)	0.131 (0.090)	0.307*** (0.138)	0.836** (0.348)	0.355** (0.150)	0.670 (0.697)	0.358*** (0.130)	0.383* (0.224)	2.855*** (0.640)	0.333 (0.258)	-1.769*** (0.380)
5 Year	0.173 (0.818)	-0.708* (0.410)	1.435* (0.817)	1.017* (0.557)	0.113 (0.554)	0.283** (0.127)	0.571* (0.186)	3.928*** (0.538)	1.588*** (0.469)	-0.473 (0.892)	0.140 (0.812)	-0.339 (0.386)	0.731 (0.479)	0.435** (0.174)	-0.201 (0.421)	0.346** (0.148)	-0.267 (0.211)	2.539*** (0.449)	0.435 (0.392)	-0.642** (0.281)
10 Year	0.058 (0.121)	-0.913*** (0.283)	1.272* (0.842)	0.274 (0.819)	0.577 (0.743)	0.332*** (0.129)	-0.269 (0.616)	3.281*** (0.548)	1.161** (0.471)	0.556** (0.243)	0.135 (0.154)	0.178 (0.539)	0.891** (0.405)	0.796 (0.019)	-0.493 (0.573)	0.274** (0.133)	0.216*** (0.057)	2.047*** (0.461)	0.230 (0.211)	-0.356 (0.337)
S&P500	-1.932*** (0.597)	0.504* (0.283)	1.446** (0.567)	1.254* (0.552)	0.529** (0.222)	-5.162*** (1.239)	1.097** (1.539)	4.339*** (0.801)	1.205 (0.912)	-0.111 (0.132)	-1.757*** (0.593)	-0.786 (0.539)	2.048*** (0.364)	0.692** (0.348)	-0.372 (0.258)	-5.503*** (1.248)	0.108 (0.123)	2.544*** (0.636)	0.882** (1.339)	-1.332*** (0.312)

Notes: Estimates are from model (2) based on 30-minute high-frequency intervals including policy and nonpolicy days. θ_{1j} and θ_{2j} capture, respectively, the volatility effects of interest rate shocks and 'FOMC statements' in the period from February 1994 to May 1999. ω_{1j} and ω_{2j} capture, respectively, the volatility effects of interest rate shocks and 'FOMC statements' in the period from May 1999–June 2007. Robust SEs computed as in Bollerslev and Wooldridge (1992) are given in parentheses. *, **, and *** denote significance at the 10, 5 and 1% levels, respectively.

Table 5. Tests for symmetric volatility effects

Hypothesis Tests (p -values)										
	$\beta_1 = \alpha_1$	$\beta_2 = \alpha_2$	$\theta_{10} = \omega_{10}$	$\theta_{11} = \omega_{11}$	$\theta_{12} = \omega_{12}$	$\theta_{13} = \omega_{13}$	$\theta_{20} = \omega_{20}$	$\theta_{21} = \omega_{21}$	$\theta_{22} = \omega_{22}$	$\theta_{23} = \omega_{23}$
3 Month	0.1409	0.8503	0.8618	0.5726	0.7707	0.9813	0.0462	0.0399	0.0913	0.3204
2 Year	0.4191	0.4553	0.0720	0.4044	0.5011	0.7532	0.0185	0.0728	0.0799	0.0188
5 Year	0.9794	0.7314	0.5109	0.5569	0.3279	0.6470	-0.0008	0.0454	0.0539	0.8542
10 Year	0.6776	0.7382	0.0729	0.0729	0.9984	0.2491	0.4294	0.0829	0.0659	0.0256
S&P500	0.8532	0.8335	0.0340	0.3719	0.3982	0.0033	0.0700	0.0773	0.7368	0.0003

Notes: Refer to footnotes of Table 4.

V. Conclusions

This article finds that FOMC statements have improved the effectiveness of monetary policy. The information content of FOMC statements is captured through an indicator variable constructed from information obtained from three major news sources to determine the importance of statements as perceived by the consensus view. The indicator variable assumes a value of one if the statement reveals important information about the near-term path of monetary policy, a change in the Fed's assessment of the economic outlook, or changes in the wording of key phrases from a preceding release. The news stories cover the period from February 1994 to June 2007. We examine the regime shift in May 1999 which brought about significant changes in the content of FOMC statements (more information, more direct, and more 'forward-looking').

Results suggest that, for most securities (especially stocks, intermediate and long-term yields), FOMC statements are found to generate a larger reaction than 'interest rate surprises.' Volatility estimates for both 'FOMC statements' and 'interest rate surprises' show a tent-shape pattern which are distinctly more pronounced for FOMC statements. Volatility tends to be lower before the policy announcement, it spikes notably during the announcement time, it generally declines though still remains elevated a few hours after the announcement, and it decreases close to pre-announcement levels on the following day.

In addition, the new statement language adopted since 1999 has improved the effectiveness of monetary policy as reflected in an overall reduction of market volatility on announcement days under the new regime. The process of price formation tends to be more protracted in the old regime which may be caused by market overreaction due to the lack of a standardized language and common information content across statements. The mechanism of adjustment towards the new (upcoming) target rate is also different across the two regimes. While markets

anticipate the upcoming rate decision equally well under the two subperiods, the adjustment process is instantaneous in the new regime but prolonged in the earlier period if no statements are issued in the previous meeting. This suggests that, during the old regime, markets form correct expectations but they do so by relying on macroeconomic news and other announcements. In contrast, under the new regime they receive this information directly from FOMC statements and adjust immediately to the new target rate.

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Appendix A: Indicator Variable

The indicator variable is constructed by searching three major news sources, *Bloomberg*, *Reuters* and the *Wall Street Journal*, to assess the importance of the information content of each statement as perceived by the consensus view. Newswires explicitly state if an FOMC statement changes market expectations with regards to future outlook and policy (informative statement, $I^{Statement}=1$) and if it does not ($I^{Statement}=0$). For example, on 18 May 1999 (when the indicator assumes a value of one), *Reuters* wrote: 'In a historic tipping of its hand, the FOMC kept borrowing rates on hold Tuesday but said its members would lean toward a monetary tightening bias in coming months.' In another informative statement issued on 21 March 2007, *Bloomberg* reported: 'Stocks and bonds rallied after the Fed's statement appeared to indicate that the central bank was a bit more concerned about slowing growth than it had been in prior months. That could mean the Fed is not likely to raise rates in the near term and might even start cutting them if need be later this year'. On 30 June 2005 – a statement that we classified as uninformative – *Bloomberg* commented: 'In its closely watched statement, the central bank said it would probably keep increasing rates at a 'measured' pace. That word, used in every Fed statement since May 2004, means another quarter-point hike is likely when Chairman Alan Greenspan and other Fed policy makers meet again on August 9'.

A sample showing the construction of the indicator variable is provided in Appendix B. We first discuss

those statements that were issued jointly with a target rate change. For example, on 6 July 1995 the Fed eased rates for the first time after a 17-month tightening stance and issued a statement that '...inflationary pressures had receded enough to accommodate a modest adjustment in monetary conditions'. From the language of the statement, the market inferred that monetary policy had shifted towards a more accommodative stance, which led us to set the indicator variable equal to one in this case. In contrast, on 11 December 2001, the Fed lowered rates by 25 basis points but the issued statement was an (almost) exact replica of the preceding one (released on November 6) and for this day, $I^{Statement}=0$.

FOMC statements have disseminated important information to the market even when they were not followed by a change in the target rate. The statement of 5 October 1999, replaced the previous phrase '...the Committee adopted a symmetrical view with regard to the outlook for policy over the near term' with '...the Committee adopted a directive that was biased toward a possible firming of policy going forward', indicating that policy bias had changed from neutral to restrictive. Similarly, on 16 August 2006 the FOMC stated that risks of slower economic growth were higher than risks to inflation, which differed from its previous statement that risks for both factors were balanced. We set $I^{Statement}$ equal to one in these cases, because statements indicate either a shift in policy bias or a change in the Fed's assessment of economic outlook.

Appendix B**Construction of the indicator variable I^{FOMC}**

Date	Target change	Information content ($I^{FOMC} = 1$)
4 February 1994	Yes	The very first policy statement issued indicating a move towards a less accommodative stance in policy.
6 July 1995	Yes	The first easing after a long tightening bias. The statement indicates that inflationary pressures have abated.
16 November 1999	Yes	Statement announces a change in policy bias from tightening to neutral.
18 May 1999	No	The very first 'policy bias' statement announcing that the FOMC adopted a directive that is tilted towards a possible firming in the stance of monetary policy.
5 October 1999	No	Statement announces a change in policy bias from neutral (or symmetric) to a possible firming of policy.
2 March 2002	No	Statement changes the wording of its economic outlook from its previous assessment of 'risks are weighted towards economic weakness' to 'risks are balanced'.
11 December 2001	Yes	Statement largely reiterates the same information as the preceding one (released on 6 November), including the balance of risk assessment.
10 August 2004	Yes	Statement remains (almost) unchanged from the previous one (30 June 2004), including the assessment that 'the stance of monetary policy remains accommodative' and that policy accommodation can be 'removed at a pace that is measured'.
26 June 2002	No	Statement replicates the previous statement (7 May 2002) indicating that 'economic activity continues to increase', 'the stance of monetary policy is accommodative' and 'risks to economic growth and inflation' are balanced.
20 September 2006	No	Exact wording as in the previous statement issued on 8 August 2006.