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**Working Paper**

## Greenspan Shrugs: Central Bank Communication, Formal Pronouncements and Bond Market Volatility

CESifo Working Paper, No. 4236

**Provided in Cooperation with:**

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

*Suggested Citation:* Chirinko, Robert S.; Curran, Christopher (2013) : Greenspan Shrugs: Central Bank Communication, Formal Pronouncements and Bond Market Volatility, CESifo Working Paper, No. 4236, Center for Economic Studies and ifo Institute (CESifo), Munich

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## Greenspan Shrugs: Central Bank Communication, Formal Pronouncements and Bond Market Volatility

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CESIFO WORKING PAPER NO. 4236  
CATEGORY 7: MONETARY POLICY AND INTERNATIONAL FINANCE  
MAY 2013

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# Greenspan Shrugs: Central Bank Communication, Formal Pronouncements and Bond Market Volatility

## Abstract

This paper presents empirical evidence on one aspect of central bank communication policy – formal pronouncements by central bankers – to better understand whether this channel matters and, if so, the nature of the information being transmitted. We examine the relationship between three types of pronouncements from Chairman Alan Greenspan -- speeches, testimonies, and FOMC meetings (STF's) -- and volatility in the 30-year U.S. Treasury bond futures market. Using high-frequency, intraday data proves important in uncovering the impacts of pronouncements on the bond market. Three questions relevant to central bank communication policy are addressed (see Figure 1 for a summary). We find that STF's matter for bond market volatility, that this impact depends on the transmission of information (rather than just noise), and that this information reflects both substantive content and a coordinating signal. We further find that speeches only deliver content, that testimonies are largely a coordinating device, and that FOMC meetings play both roles. These findings of an important coordination channel document the relevance of the “global games” model of Morris and Shin and the “herding” model of Banerjee and the associated policy implication that pronouncements by the central bank may reduce welfare by overwhelming important private information.

JEL-Code: E580, G140.

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We are grateful for the comments and suggestions offered by seminar participants at the American Economic Association (in particular our discussant, Ken Kuttner), Bank of England, CESifo Venice Summer Institute (in particular our discussant, Greg Hess, and the conference organizers, Pierre Siklos and Jan-Egbert Sturm), Deutsche Bundesbank, Emory University, Ente Einaudi, Illinois Economic Association, Midwest Finance Association (in particular, our discussant Stephen Figlewski), Sveriges Riksbank, and the University of Illinois at Chicago, and by Torben Andersen, John Curran, Hashem Dezhbakhsh, Amir Kia, Kai Konrad, Jeff Moore, Rose Pianalto, Peter Postl, Andrea Prat, Arkalgud Ramaprasad, Huntley Schaller, Jukka Sihvonen, Alfons Weichenrieder, and especially by Helge Berger and Hugo Mialon. We thank Kelli Lanier for her timely research support. This paper grew out of Ben Carter's undergraduate honors thesis; we regret that Ben's private-sector job commitments precluded his continuing on this project. A substantial amount of the work on this project was completed while Chirinko was a Visiting Scholar at the Center for Economic Studies, whose research support and hospitality are gratefully acknowledged. Additional critical financial support has been provided by the Bank of England's Houlton-Norman/George Senior Fellows Program, Emory University's Institute for Comparative and International Studies, and two centers at the University of Illinois at Chicago: The International Center for Futures and Derivatives and The Center for Quantitative Finance and Risk Management. All errors and omissions remain the sole responsibility of the authors, and the conclusions do not necessarily reflect the views of the organizations with which they are associated.

## **Greenspan Shrugs: Central Bank Communication, Formal Pronouncements and Bond Market Volatility**

*...the verdict among most, if not all, our 'watchers' seems to be that -- broadly speaking -- the ECB has done a good job but has not been very effective in presenting and explaining itself.*

-- Otmar Issing, Chief Economist, ECB (2001)

*I used to think if there was reincarnation, I wanted to come back as the president or the pope or a .400 baseball hitter. But now I want to come back as the bond market. You can intimidate everybody.*

-- James Carville, Advisor to President Clinton (1993)

*In such circumstances, certain types of central bank talk might actually impinge on welfare-enhancing market pricing by being misunderstood and receiving too much weight relative to private judgments.*

-- Donald Kohn, Vice Chair, Board of Governors (2005)

### **I. Introduction**

There is a broad consensus among central bankers and monetary policy scholars that transparency enhances economic performance. Expectations about the future course of the economy have a substantial impact on economic decisions, and monetary policy has a substantial role in influencing these expectations.<sup>1</sup> The lifting of the veil on central banking operations lowers the level of uncertainty confronting firms, households, and investors, and thus enhances incentives for risk-averse agents to undertake long-term commitments. A more transparent monetary policy informs and anchors expectations. With fewer monetary surprises, economic activity becomes less volatile. Moreover, transparency is consistent with the democratic principles of accountability of public institutions to their citizens.<sup>2</sup>

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<sup>1</sup> The connection between monetary policy transparency and expectations has been analyzed by Blinder, Ehrmann, Fratzscher, de Haan, and Jansen (2008, especially sections 1 and 2), Rudebusch and Williams (2008), and Woodford (2005). Mishkin (2010) lists this channel as one of the nine basic scientific principles that guide thinking by monetary economists and policymakers.

<sup>2</sup> See the lively discussion of transparency, communications, and related issues and references to the literature in Blinder, Goodhart, Hildebrand, Lipton, and Wyplosz (2001) and the comprehensive survey by Geraats (2002).

While transparency is a widely held goal, how do central banks communicate?<sup>3</sup> As indicated by the above quotation from Otmar Issing, communications is an essential element in the conduct of monetary policy.<sup>4</sup> Blinder, Goodhart, Hildebrand, Lipton, and Wyplosz (2001) suggest that, in principle, the central bank should talk about its objectives, its methods for attaining these objectives, and its process of deliberations. There is an extensive literature on the specifics of how central banks should and do communicate -- explicit announcement of targets, immediate notification of policy decisions, prompt publication of the transcripts of central bank meetings, and detailed documentation of economic forecasts and the underlying models (see the survey by Blinder, Ehrmann, Fratzscher, de Haan, and Jansen, 2008). One communications channel that has received much less attention is the formal pronouncements made by central bankers. This paper examines this aspect of communication policy and assesses the impact and nature of the formal pronouncements made by Alan Greenspan.

Focusing on “Greenspan’s shrugs” affords several advantages.<sup>5</sup> The Chair of the Board of Governors of the Federal Reserve System is one of the most important economic policymakers in the world. For the period we study, Greenspan’s influence had been substantially enhanced by the exceptional performance of the U.S. economy during his long tenure and the perception that the Federal Reserve played a prominent role in generating this “Long Boom.” Greenspan communicated frequently in three different ways – in speeches to industry groups, academic audiences, and professional associations; in testimony before Congressional committees; and in Federal Open Market Committee (FOMC) decisions. Given the institutional structure and norms of the Board of Governors and his chairing of the FOMC, Greenspan exerted substantial control over monetary policy. Thus, financial markets were particularly interested in his speeches (S) and testimonies (T) and the outcomes of the FOMC

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<sup>3</sup> The case for transparency in the face of supply shocks has been questioned recently. See Geraats (2010) for citations and a model in which full transparency remains beneficial even when supply shocks proliferate.

<sup>4</sup> Bulíř, Čihák, and Šmídková (2010) evaluate the clarity of the ECB’s monetary policy communications and find that the ECB’s communications are on a par with or better than most other central banks. These results suggest that Issing may have been a bit too hard on himself and the ECB.

<sup>5</sup> The title of the paper is not only an informal description of monetary policy pronouncements by Chairman Greenspan, but also a reference to the Ayn Rand novel *Atlas Shrugged* and Greenspan’s embrace of her free market philosophy.

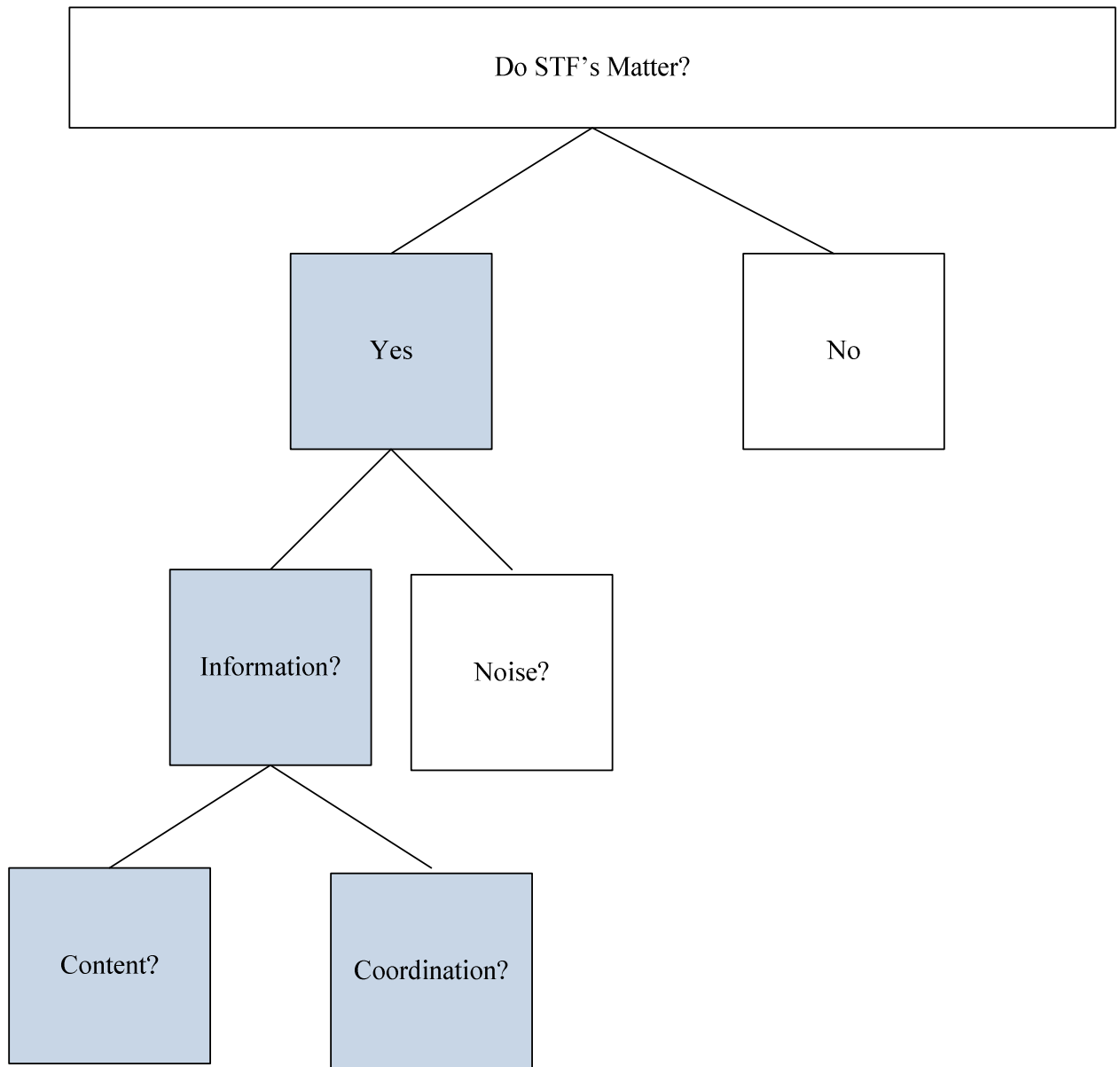
meetings (F). We refer to these formal pronouncements collectively as STF's. Studying the reaction of financial markets to STF's allows us to assess several interesting aspects of the nature of central bank communication policy.

We begin in Section II with a description of the data. We focus on the 30-year Treasury bond futures market because of its important role in connecting real and financial activity (per the above quotation from Carville) and for a variety of additional reasons discussed in that section. Our data are based on a proprietary algorithm that determines the cheapest-to-deliver issue and its price for a given futures contract. The reaction of the bond market to STF's is evaluated in terms of two measures of information flows -- price volatility (measured by the absolute value of the excess return) and quantity volatility (measured by trading volume). The dataset consists of the 56,937 five-minute trading intervals from the beginning of January 1997 through the end of December 1999, and it includes 49 speeches, 40 testimonies, and 24 FOMC meetings.

The next three sections explore the three questions concerning communication policy summarized in Figure 1. We begin by asking what impact, if any, do the STF's have on the bond market? If this aspect of communications policy is redundant or if the bond market is strong form efficient, we would expect the effects to be nil. In contrast to these predictions, Section III reports that bond market volatility is positively affected by STF's and, somewhat surprisingly, that the effects are stronger before the release. We then evaluate the separate effect of each STF and find that testimonies and FOMC meetings have the most impact.

There are two competing explanations of why STF's impact the bond market -- they transmit substantive information relevant for economic decisions or they just create noise agitating markets. Section IV distinguishes between these two explanations by examining how much volatility increases since the last STF. We define a waiting-time (or duration) variable that captures unresolved uncertainty and is measured by the distance (measured in terms of the number of trading periods) between the current period and the release date for the most recent prior STF. If Greenspan's pronouncements merely introduce noise, we would not expect to find any systematic impact of the waiting-time variable. However, if the STF's transmit information and resolve uncertainty about monetary policy, we would expect that the waiting-time variable will be positively associated with volatility in the bond market. The latter implication is confirmed in our empirical work.

**Figure 1: Summary of Empirical Results**  
(Shaded Boxes Indicate Our Empirical Findings)



Section V examines the nature of the information documented in the prior section and tests whether it contains substantive content or just provides a widely-observed costless signal that coordinates activity. In the latter case, STF's are coordinating devices for private agents operating with imperfect common knowledge.<sup>6</sup> Understanding the relevance of the coordination role is important because, in "global games" or "herding" models, rational agents may underweight private information, thus reducing welfare and suggesting that the STF's may be counterproductive. If the information is substantive in providing information about the stance of policy or the state of the economy, then the response of bond prices should occur immediately after the pronouncement. Any response before the announcement suggests a role for coordination. We examine the impact of STF's at five-minute intervals one hour before and one hour after the release of the pronouncement and find evidence in favor of both roles that differ across STF's.

Section VI discusses our results in light of some of the literature on central bank transparency and communication, and Section VII concludes.

## **II. Data And The Estimating Equation**

The impacts of "Greenspan's shrugs" on financial markets are assessed by examining the relation between Greenspan's formal pronouncements and volatility in the 30-year Treasury bond futures market. Formal pronouncements include all original speeches and testimonies made by Alan Greenspan during the period January 1, 1997 through December 31, 1999, as well as the statements (or non-statements) that follow FOMC meetings. Our dataset contains 49 speeches (S) to business, economic, social, and educational groups, 40 testimonies (T) to Congress, and 24 FOMC meetings (F). We refer to these formal pronouncements collectively as STF's. The source of the STF data and the time at which they were released to the public (not necessarily when Greenspan begins to speak) is the website of the Board of Governors (see the web appendix for a detailed listing).<sup>7</sup> The dates for the STF's are set far in advance, and thus they can be viewed as exogenous and widely known. This three-year period is selected for several reasons. First, in choosing the period length, we face a tradeoff between the number of STF's

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<sup>6</sup> Relevant theoretical models will be discussed in Section V.

<sup>7</sup> The Appendix is available from the authors or at <http://www.cesifo-group.de/portal/page/portal/ifoHome/b-publ/b3publwp>.



and a reasonably stable environment.<sup>8</sup> We believe that a three-year period is long enough to provide sufficient STF's for our econometric analysis and short enough to attenuate the incidence of major shocks or structural shifts. (One important shift involved a change in the release of the FOMC policy directives about the balance-of-risks in May 1999; the impact of this shift is explored in Section V and Table 5.) Second, during this particular period, the macroeconomy and domestic financial markets were relatively stable. Third, at the beginning of our sample period, Greenspan had been chair of the FOMC and the 30-year U.S. Treasury bond had been the benchmark long-run security for many years, and thus instabilities due to learning effects were absent from financial markets. Lastly, near the end of our sample period, auctions of new 30-year Treasury bonds were suspended (in 2001), and the inflation measure formally discussed by the FOMC in its semi-annual Humphrey-Hawkins report to Congress changed (in February 2000) from the consumer price index to the personal consumption expenditure deflator.

We focus on the 30-year Treasury bond futures market for several reasons: its sensitivity to monetary policy pronouncements, its substantial effects on real spending, its long-standing role (at that time) as the benchmark long-term Treasury security, its depth, and the availability of market prices at five-minute intervals. The dataset consists of the 56,937 five-minute trading intervals from the beginning of January 1997 through the end of December 1999. Futures prices are anchored to bond prices that are specified for delivery. In order to insure the liquidity of the 30-year Treasury bond futures market, several Treasury bonds with different maturities and coupons can be used to settle a futures contract. Given the bond conversion factors (provided by the exchange) and a possibly sloping yield curve, one of these securities will dominate as the least expensive way to satisfy the futures contract. The price of this bond is the cheapest-to-deliver price. Our price data are based on a proprietary algorithm that determines the cheapest-to-deliver bond price for a given futures contract. There is an important difference between converted futures prices and the cheapest-to-deliver price. The analysis by Sihvonen (2008, section II.1) of 10-year German government bonds shows that, between May 2001 and December 2006, the difference between the cheapest-to-delivery bond and the next cheapest bond ranged from about 15 to 125 basis points (comparable figures for the 30-year Treasury market were not available).

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<sup>8</sup> See the studies discussed in Section VI suggesting that communication channels depend on the current and past macroeconomic and policy environments.

The reaction of the bond market to STF's is evaluated in terms of information flow measured in terms of prices (IFP<sub>t</sub>, price volatility measured as the absolute value of excess returns) and quantities (IFQ<sub>t</sub>, trading volume).<sup>9</sup> These two measures are related to information flows in several asset pricing models, but they may have differential sensitivities to information (Ross, 1989; Campbell, Grossman, Wang, 1993; Beber, Brandt, and Kavajecz, 2011),

$$\text{Information Flow, Price Measure} \equiv \text{IFP}_t \equiv \text{ABS}[\text{XR}_t] \quad (1)$$

$$\text{Excess Return} \equiv \text{XR}_t \equiv [(P_t - P_{t-1}) / P_{t-1}] - [(1 + \text{RF}_t)^{(1/360)} - 1.0] \quad (2)$$

$$\text{Information Flow, Quantity Measure} \equiv \text{IFQ}_t \equiv \text{Volume}_t, \quad (3)$$

where  $P_t$  is the cheapest-to-deliver price for the closing contract over a five-minute interval for the period January 1, 1997 to December 31, 1999, and  $\text{RF}_t$  is the risk-free rate (90-day Treasury bills) for that day. The use of five minute intervals is a compromise between understating the impact of the STF by using lower frequency data and microstructure noise by using higher frequency data (see Aït-Sahalia, Mykland, and Zhang (2005) and Andersen, Bollerslev, Diebold, and Vega (2003) for further discussion). An advantage of focusing on volatility -- either price volatility or quantity volatility qua trading volume -- is that we do not have to undertake the very challenging and historic path-dependent task of deciding whether a certain pronouncement is expected to raise or lower bond prices.<sup>10</sup> Since price volatility is computed with excess returns, we are controlling for the impact of an STF on the short-term risk-free rate, and thus our estimates capture medium-term and long-term policy effects for this measure of volatility.

These series have three interesting characteristics. First, price volatility is more variable in our sample than trading volume, where variability is measured by the coefficients of variation (CV):  $\text{CV}_{\text{Volatility}} = 3.8922 / 3.8643 = 1.01$  and  $\text{CV}_{\text{Volume}} = 14.4648 / 20.7767 = 0.70$ . Second,

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<sup>9</sup> An alternative measurement of price volatility, squared returns, is adversely affected by measurement error relative to absolute returns (Forsberg and Ghysels, 2004).

<sup>10</sup> Several of the conference papers (Bligh and Hess, 2010; Jansen and de Haan, 2010; Lamla and Sturm, 2010) highlight the challenges with transforming central bank communications into objective numerical variables.

the excess return series is unrelated to any day-of-week or time-of-day effects. A regression of  $XR_t$  on indicator variables for days of the week and the time periods within a day yields an  $R^2$  of 0.00009. Third, by contrast, price volatility and trading volume vary systematically over the week. For example, volume peaks during the opening half hour on Friday (128% higher than average weekly volume). Monday during the 12:00 to 1:00 hour is the most tranquil period with volume that is 47% lower than average weekly volume.

These patterns may present a problem for our analysis if certain STF's tend to be released during the same time period and if this period has abnormal volatility.<sup>11</sup> In this case, the STF would be reflecting the effects of release time independent of any additional impact of the pronouncement. To avoid this ambiguity, we compute the means for each day of the week and, within that day, for each of the time-of-day periods (7:30 to 8:00, 8:00 to 9:00, ..., 1:00 to 2:00). We subtract these means from the  $IFP_t$  and  $IFQ_t$  series. These adjusted series are mean zero, and they are used in our subsequent analysis.

We measure the effect of the STF's on bond market volatility with three measures of increasing refinement. Note that increasing refinement of the STF indicator variables does not necessarily lead to better estimates, as the finer measures may be more sensitive to measurement error. The first measure is defined broadly for the day of a STF,

$$\begin{aligned} \text{DAY}_t &= 1 \text{ if a STF occurs on that day ,} \\ &0 \text{ otherwise .} \end{aligned} \tag{4}$$

A more refined measure assesses the effects one hour before and after the STF,

$$\begin{aligned} \text{BEFORE}_t &= 1 \text{ if } t^*-60 \leq t < t^* , \\ &0 \text{ otherwise,} \end{aligned} \tag{5a}$$

$$\begin{aligned} \text{AFTER}_t &= 1 \text{ if } t^* \leq t < t^*+60 , \\ &0 \text{ otherwise,} \end{aligned} \tag{5b}$$

where  $t^*$  is the 5 minute interval during which the STF is released. Given our large dataset, we

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<sup>11</sup> We thank Torben Andersen for making us aware of this possible problem.

can use a third and even more refined set of indicator variables defined for each 5-minute interval 60 minutes before and after the STF,<sup>12</sup>

$$\text{BEFORE60}_t = 1 \text{ if } t^*-60 \leq t < t^*-55; 0 \text{ otherwise,} \quad (6a)$$

$$\text{BEFORE55}_t = 1 \text{ if } t^*-55 \leq t < t^*-50; 0 \text{ otherwise,} \quad (6b)$$

$$\dots\dots\dots \quad \dots\dots\dots \quad (\dots)$$

$$\text{BEFORE5}_t = 1 \text{ if } t^*-5 \leq t < t^*; 0 \text{ otherwise,} \quad (6l)$$

$$\text{AFTER5}_t = 1 \text{ if } t^* \leq t < t^*+5; 0 \text{ otherwise,} \quad (6m)$$

$$\dots\dots\dots \quad \dots\dots\dots \quad (\dots)$$

$$\text{AFTER60}_t = 1 \text{ if } t^*+55 \leq t < t^*+60; 0 \text{ otherwise.} \quad (6x)$$

These 24 indicator variables are referred to collectively as  $Z_t$ , defined in equation (7),

$$Z_t \equiv \{\text{BEFORE60}_t, \text{BEFORE55}_t, \dots, \text{AFTER60}_t\}. \quad (7)$$

Note that the interval during which the STF is released ( $t^*$ ) is included in the  $\text{AFTER5}_t$  indicator variable, which might more accurately be referred to as  $\text{ON-or-AFTER5}_t$ .

The waiting-time (or duration) variable will be discussed in Section V.

### III. Do STF's Matter?

This section assesses the first of our three questions (cf. Figure 1), asking what impact, if any, the STF's have on the bond market. The null hypothesis of no impact is consistent with this aspect of communications policy being redundant relative to the other ways that the Federal

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<sup>12</sup> The models based on the one hour BEFORE/AFTER indicator variables and the 24 5-minute intervals defining the indicator variables in  $Z$  can be thought of as nested models. The latter model is the most general. The BEFORE/AFTER model is a restricted version where the first 12 BEFORE coefficients and the latter 12 AFTER coefficients are constrained to be the same. The DAY variable is not nested because it contains time periods for the entire day, as opposed to just the one hour before and after the release of the STF. In the latter case where the DAY indicator variable is defined over a two hour interval, it would be a restricted version of the BEFORE/AFTER model.

Reserve communicates. Moreover, if the bond market is strong form efficient, then the STF's will not represent any new information, and we would again expect the effects to be nil.

We begin by estimating the following three regressions to determine if there is an effect on the day an STF is released,

$$IFP_t = G[DAY_t], \quad (8a)$$

$$IFQ_t = G[DAY_t], \quad (8b)$$

$$IFQ_t = G[DAY_t, IFQ_{t-1}], \quad (8c)$$

where  $G[\cdot]$  represents a linear operator. Equations (8) are estimated by OLS because it is the efficient estimator under the plausible assumption that the STF's, whose release dates are determined well in advance, are exogenous.<sup>13</sup> Moreover, the regression framework permits the convenient computation of standard errors. As we shall see, there is a great deal of positive autocorrelation in the residuals from equation (8b), and we include a lagged dependent variable in equation (8c) to address this problem and its impact on standard errors.

The null hypothesis is evaluated by the coefficient on  $DAY_t$ , and the results are reported in Table 1, where columns 1, 2, and 3 correspond to equations (8a), (8b), and (8c), respectively. For all three equations, the coefficient on  $DAY_t$  in the first row is positive and statistically significant at conventional levels. Autocorrelation in the residuals is assessed by  $\rho$ , the first-order autocorrelation coefficient for the residuals, and the Durbin  $m$ -statistic.<sup>14</sup> As shown in column 2, the residuals in the trading volume equation are highly autocorrelated. The inclusion of the lagged dependent variable in column 3 leads to a substantial reduction in  $\rho$  and the  $m$ -statistic. In all three models, the formal test for the absence of autocorrelation is rejected, though this result is influenced by the very large sample size. The evidence in Table 1 clearly indicates that STF's are statistically significant.

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<sup>13</sup> Endogeneity might arise because of a relation between current conditions and the content of an STF. This possible channel does not affect our results that are based only on the occurrence of an STF, not its content.

<sup>14</sup> The Durbin  $m$ -statistic is the  $t$ -statistic on the  $\rho$  coefficient from the following auxiliary regression:  $u_t = \rho * u_{t-1} + W_t' \Gamma + v_t$ , where  $W_t$  represents the regressors appearing in a given equation,  $\Gamma$  is an incidental parameter vector, and  $v_t$  is an error term. The Monte Carlo evidence in Dezhbakhsh (1990) favors the Durbin  $m$ -statistic over several other tests for autocorrelation.

**Table 1: OLS estimates of the day of an STF and one hour before/after an STF**

	(1)	(2)	(3)	(4)	(5)	(6)
	DAY			BEFORE/AFTER		
	IFP	IFQ	IFQ	IFP	IFQ	IFQ
DAY	0.1382 (0.0496)	0.7104 (0.1442)	0.2957 (0.1111)	—	—	—
BEFORE	—	—	—	1.4453 (0.1785)	6.4337 (0.4576)	3.3153 (0.3325)
AFTER	—	—	—	0.2244 (0.1216)	2.0315 (0.4031)	0.2258 (0.3243)
LDV	—	—	0.5984 (0.0051)	—	—	0.5958 (0.0051)
R <sup>2</sup>	0.0002	0.0005	0.3585	0.0037	0.0071	0.3601
SER	3.8141	12.6599	10.1420	3.8076	12.6182	10.1292
$\rho$	0.1668	0.5984	-0.0605	0.1636	0.5950	-0.0607
Durbin m	17.5579	117.3333	-9.4531	17.4043	116.6667	-9.4844

*Notes:* Estimates are based on equations (8a), (8b), and (8c) for columns 1 to 3, respectively, and equation (9) for columns 4 to 6. The dependent variables -- IFP<sub>t</sub> and IFQ<sub>t</sub>, -- are defined in equations (1,2) and (3), respectively. The indicator variables -- DAY<sub>t</sub>, BEFORE<sub>t</sub>, and AFTER<sub>t</sub>, -- are defined in equations (4), (5a), and (5b), respectively. LDV is a lagged dependent variable. Standard errors are heteroskedasticity-consistent using the White correction and are displayed in parentheses. R<sup>2</sup> is the customary goodness of fit measure. SER is the standard error of the regression. The  $\rho$  parameter and the Durbin m statistic measure first-order autocorrelation in the residuals; see footnote 14 for details. The sample period extends from January 1997 to December 1999 and contains 56,936 observations.

To evaluate economic significance, we compare the coefficient on DAY<sub>t</sub> to the sample standard deviation of the dependent variable. (In the case of column 3 with a lagged dependent variable, the appropriate comparison is the coefficient on DAY<sub>t</sub> divided by one minus the coefficient on the lagged dependent variable.) The ratios of the estimated DAY<sub>t</sub> coefficients to the sample standard deviation are 3.55%, 4.91%, and 5.09% for columns 1 to 3, respectively.<sup>15</sup> Relative to the average variation in volatility, the STF's appear to have a modest impact on the bond market.

<sup>15</sup> The sample standard deviations are 3.8922 and 14.4648 for IFP<sub>t</sub> and IFQ<sub>t</sub>, respectively.

Columns 4 to 6 in Table 1 extend the analysis by examining bond market activity one hour before and after the release of an STF. Rather than writing-out each equation, we use the following concise notation to describe the estimating equations,

$$Y_t = G[\text{BEFORE}_t, \text{AFTER}_t : \text{IFQ}_{t-1}] \quad Y_t = \{\text{IFP}_t, \text{IFQ}_t\}, \quad (9)$$

where the lagged dependent variable only enters the equation containing  $\text{IFQ}_t$  as the dependent variable. (Our subsequent discussions of  $\text{IFQ}_t$  will emphasize the results based on the model with the lagged dependent variable, though we will also present results for  $\text{IFQ}_t$  without this additional variable.) A surprising result is that the effects of the STF are much larger before than after the release. For example, for the  $\text{IFP}_t$  results in column 4, the ratio of the estimated  $\text{BEFORE}_t$  and  $\text{AFTER}_t$  coefficients is 6.44; comparable statistics for the  $\text{IFQ}_t$  results in columns 5 and 6 are 3.17 and 14.68, respectively. These results generally support the importance of STF's for bond markets, and they further suggest that care must be taken to differentiate between the impacts before and after the release. Thus, the  $\text{DAY}_t$  regressor is omitted in subsequent models.

Table 2 provides an even finer breakdown by examining the separate impacts of speeches, testimonies, and FOMC meetings one hour before and after the release,

$$Y_t = G[S_t^* \text{BEFORE}_t, S_t^* \text{AFTER}_t, T_t^* \text{BEFORE}_t, T_t^* \text{AFTER}_t, F_t^* \text{BEFORE}_t, F_t^* \text{AFTER}_t : \text{IFQ}_{t-1}] \quad Y_t = \{\text{IFP}_t, \text{IFQ}_t\}. \quad (10)$$

Two interesting results emerge from this decomposition of the STF's. First, speeches have a statistically significant impact on information flow only for the  $\text{IFQ}_t$  regression for the before period. By contrast, testimonies and FOMC meetings generate statistically and economically significant effects before the release for all three regressions. Price volatility (column 1) before the release of testimony or FOMC meetings is higher by 54% and 84%, respectively, relative to the average price volatility. Comparable statistics for trading volume (column 3) are 69% and 133%. Second, no effects are found after the release of STF's, though, as we will see in Section V, this result reflects the coarseness of the  $\text{AFTER}_t$  measure of STF influence used in this section. Table 2 suggests two general results concerning impact hierarchies: (i) F (FOMC meetings) > T (testimonies) > S (speeches) and (ii) BEFORE > AFTER.

**Table 2: OLS estimates one hour before/after an S, T, or F**

	(1)	(2)	(3)
	IFP	IFQ	IFQ
S *	0.2053	0.7115	1.0270
BEFORE	(0.1598)	(0.5217)	(0.4079)
S *	0.2426	1.1556	-0.0081
AFTER	(0.2093)	(0.6533)	(0.5244)
T *	2.1062	9.6534	4.0227
BEFORE	(0.3652)	(0.7996)	(0.6028)
T *	0.1275	2.1779	0.6315
AFTER	(0.1432)	(0.5177)	(0.4090)
F *	3.2573	14.6555	7.7900
BEFORE	(0.5014)	(1.2059)	(0.8762)
F *	0.3936	3.9922	0.0987
AFTER	(0.2996)	(1.0575)	(0.8832)
LDV	—	—	0.5939 (0.0051)
R <sup>2</sup>	0.0062	0.0122	0.3611
SER	3.8028	12.5860	10.1216
ρ.	0.1614	0.5927	-0.0601
Durbin m	17.3548	116.2157	-9.3906

*Notes:* Estimates are based on equation (10). The dependent variables -- IFP<sub>t</sub> and IFQ<sub>t</sub>, -- are defined in equations (1,2) and (3), respectively. The indicator variables -- BEFORE<sub>t</sub> and AFTER<sub>t</sub> -- are defined in equations (5a), and (5b), respectively. The indicator variables – S, T, and F – equal 1 for the occurrence of a speech, testimony, or FOMC meeting, respectively. LDV is a lagged dependent variable. Standard errors are heteroskedasticity-consistent using the White correction and are displayed in parentheses. R<sup>2</sup> is the customary goodness of fit measure. SER is the standard error of the regression. The ρ parameter and the Durbin m statistic measure first-order autocorrelation in the residuals; see footnote 14 for details. The sample period extends from January 1997 to December 1999 and contains 56,936 observations.



#### IV. Information Or Noise?

There are two plausible explanations as to why STF's matter: 1) they communicate information relevant to bond prices or 2) they merely create noise that agitates markets. If STF's provide information to the markets either directly or indirectly, then we would expect our  $IFP_t$  and  $IFQ_t$  variables, which reflect information flows, to respond positively. Regarding case 2), Mendel and Shleifer (2012, pp. 303-304) analyze noise in a model where there are three types of investors: "a small number of investors, called insiders, who possess valuable information and trade completely rationally, a small number of noise traders who are vulnerable to sentiment shocks and trade on those, and the vast majority of outside investors, who possess no information but learn from prices and trade rationally." Their simulations document that outside investors can get confused and chase noise. Thus, a small amount of noise can have a substantial effect on volatility. The information and noise channels are observationally equivalent.

To isolate the effects of information from noise, we examine whether the volatility associated with STF's increases since the time of the last STF. With the passage of time, questions arise and accumulate about the state of the economy and the stance of policy and, from the perspective of bond market participants, uncertainty rises. This uncertainty will be resolved if STF's provide information relevant to the bond market either directly or indirectly. The longer the length of time since the last STF, the greater will be the information flow from the release of a STF and hence the greater the impact on volatility. We define a waiting-time (or duration) variable,  $WAIT_t$ , as the distance between the current period and the most recent STF measured in terms of the number of trading periods, and then apply this value (defined at  $t^*$ ) to the one hour intervals before and after the STF,

$$WAIT = \text{Number of five-minute trading periods since the last STF} \quad (11)$$

(or since the beginning of 1997 for the first STF). This value  
is applied to the one hour intervals before and after the STF.

If Greenspan's pronouncements merely introduce noise or have very little impact on volatility, we would expect the coefficients on  $WAIT_t$  to be close to zero. However, the alternative hypothesis that STF's are informative and resolve uncertainty about monetary policy or the economy suggests a positive effect of the waiting-time variable on bond market volatility.

We introduce  $WAIT_t$  into the following OLS regression equation,

$$Y_t = G[WAIT_t * BEFORE_t, WAIT_t * AFTER_t, BEFORE_t, AFTER_t : IFQ_{t-1}] \quad (12)$$

$$Y_t = \{IFP_t, IFQ_t\}.$$

The results presented in Table 3 differ before and after the release of the STF. The coefficients

**Table 3: OLS estimates one hour before/after an STF interacted with the WAIT variable**

	(1) IFP	(2) IFQ	(3) IFQ
WAIT *			
BEFORE	0.0019 (0.0006)	0.0070 (0.0011)	0.0033 (0.0008)
WAIT *			
AFTER	-0.0917 (0.0383)	-0.7008 (0.1267)	-0.1340 (0.1083)
BEFORE	0.5414 (0.3060)	3.0690 (0.6711)	1.7252 (0.4994)
AFTER	0.7296 (0.2912)	5.8788 (0.9543)	0.9680 (0.8135)
LDV	—	—	0.5950 (0.0051)
$R^2$	0.0049	0.0094	0.3604
SER	3.8052	12.6039	10.1267
$\rho$	0.1624	0.5945	-0.0602
Durbin m	17.6522	116.5686	-9.4063

*Notes:* Estimates are based on equation (12). The dependent variables --  $IFP_t$  and  $IFQ_t$ , -- are defined in equations (1,2) and (3), respectively. The indicator variables --  $BEFORE_t$  and  $AFTER_t$  -- are defined in equations (5a), and (5b), respectively. The indicator variable --  $WAIT_t$  -- is the number of trading periods since the last STF and is defined in equation (11). LDV is a lagged dependent variable. Standard errors are heteroskedasticity-consistent using the White correction and are displayed in parentheses.  $R^2$  is the customary goodness of fit measure. SER is the standard error of the regression. The  $\rho$  parameter and the Durbin m statistic measure first-order autocorrelation in the residuals; see footnote 14 for details. The sample period extends from January 1997 to December 1999 and contains 56,936 observations.

for the interaction between the  $W_t$  and  $BEFORE_t$  in the first row are positive and statistically significant at conventional levels in all three regressions. These results reject the null hypothesis of noise in favor of the information alternative. A different conclusion is obtained from the interaction between  $W_t$  and  $AFTER_t$  in the second row. These coefficients are negative, and here the noise hypothesis is sustained against the information alternative.

We further investigate whether STF's transmit information or noise by decomposing each STF into one of its three components (per Table 2) and interacting each component with  $WAIT_t$ ,

$$Y_t = G[WAIT_t * S_t * BEFORE_t, WAIT_t * T_t * BEFORE_t, WAIT_t * F_t * BEFORE_t, \\ WAIT_t * S_t * AFTER_t, WAIT_t * T_t * AFTER_t, WAIT_t * F_t * AFTER_t : IFQ_{t-1}] \quad (13)$$

$$Y_t = \{IFP_t, IFQ_t\}.$$

The results are presented in Table 4 and are broadly consistent with the prior results. For the  $BEFORE_t$  variable, the interaction coefficients are significant for speeches and testimonies, but negative for FOMC meetings. The interaction coefficients for the  $AFTER_t$  variable are either negative or very close to zero.

The weight of the evidence presented in Tables 3 and 4 suggests that formal pronouncements by Chairman Greenspan generally contain information.

## V. Content Or Coordination?

While the evidence suggests that STF's are an effective part of the Federal Reserve's communications policy, the nature of the information being transmitted remains unclear. A communication that has content -- information that relates to insights about future policy decisions or the state of the economy -- is different from information that serves to coordinate the actions of private agents operating with imperfect public common knowledge. This coordination channel can arise in at least two types of theoretical models. In recent work, Allen, Morris, and Shin (2006), Amato, Morris, and Shin (2002), and Morris and Shin (2002, 2003) develop "global games" models in which rational investors coordinate their activities on a common public signal. Investors are imperfectly informed, and each observes public and private signals (the latter unobservable to all other investors) that are used to infer the true but unobservable state. In a

**Table 4: OLS estimates one hour before/after an S, T, or F interacted  
With a WAIT variable**

	(1)	(2)	(3)
	IFP	IFQ	IFQ
WAIT*	0.0015	0.0070	0.0032
S*BEFORE	(0.0006)	(0.0016)	(0.0013)
WAIT *	-0.0521	-0.3247	0.0659
S * AFTER	(0.0678)	(0.2111)	(0.1797)
WAIT *	0.0039	0.0133	0.0062
T*BEFORE	(0.0019)	(0.0018)	(0.0017)
WAIT *	-0.0871	-0.7829	-0.3772
T*AFTER	(0.0439)	(0.1505)	(0.1246)
WAIT *	-0.0010	-0.0059	-0.0032
F*BEFORE	(0.0010)	(0.0021)	(0.0016)
WAIT *	-0.1812	-1.3393	-0.1540
F*AFTER	(0.0862)	(0.3120)	(0.2876)
S*BEFORE	-0.4442	-2.2360	-0.3124
	(0.2452)	(0.7755)	(0.6318)
S*AFTER	0.5360	2.9747	-0.3572
	(0.5159)	(1.5773)	(1.3461)
T*BEFORE	0.4746	4.1355	1.4782
	(0.7337)	(1.0975)	(0.9011)
T*AFTER	0.6085	6.5024	2.7180
	0.3199)	(1.1037)	(0.9030)
F*BEFORE	4.0722	19.2721	10.3025
	(0.9216)	(2.1382)	(1.6147)
F*AFTER	1.3451	11.0233	0.9144
	(0.6852)	(2.4435)	(2.2152)
LDV	—	—	0.5927
			(0.0051)
R <sup>2</sup>	0.0080	0.0154	0.3617
SER	3.7996	12.5663	10.1177
ρ.	0.1597	0.5922	-0.0596
Durbin m	17.5495	116.1176	-9.3125

**Table 4: OLS estimates one hour before/after an S, T, or F interacted  
With a WAIT variable  
(continued)**

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*Notes:* Estimates are based on equation (13). The dependent variables --  $IFP_t$  and  $IFQ_t$ , -- are defined in equations (1,2) and (3), respectively. The indicator variables --  $BEFORE_t$  and  $AFTER_t$  -- are defined in equations (5a), and (5b), respectively. The indicator variable --  $WAIT_t$  -- is the number of trading periods since the last STF and is defined in equation (11). LDV is a lagged dependent variable. The indicator variables -- S, T, and F -- equal 1 for the occurrence of a speech, testimony, or FOMC meeting, respectively. Standard errors are heteroskedasticity-consistent using the White correction and are displayed in parentheses.  $R^2$  is the customary goodness of fit measure. SER is the standard error of the regression. The  $\rho$  parameter and the Durbin  $m$  statistic measure first-order autocorrelation in the residuals; see footnote 14 for details. The sample period extends from January 1997 to December 1999 and contains 56,936 observations.

straightforward adaptation of Morris and Shin (2002), we can assume that investor's utility depends on a weighted-average of two terms: the difference between the trading price and the true value and the difference between the trading price and the trading prices of all other investors. These two differences reflect long-run and short-run considerations, respectively. The STF's serve as a public signal that transmits substantive information about the unobserved true state of the economy and serves as a focal point. In some cases, the public signal will overwhelm private information, and the resulting equilibrium will be socially inefficient.

Herding models are also based on imperfectly informed investors and provide a second theoretical framework highlighting the potentially deleterious effects of public information. In the herding model of Banerjee (1992), trades are observed by other investors, who base their inferences on prior trades. An impending STF's (with a release date known well in advance) is the event that initiates the sequential decision problem facing investors. The resulting equilibrium is inefficient because investors will rely too little on their own information. This "herd externality" can lead to an equilibrium in which "society may actually be better off by constraining some of the people to use only their own information" (p. 798). Avery and Zemsky (1998) introduce several dimensions of uncertainty into a herding model and show that at least

three dimensions of uncertainty are required to lead to substantial mispricing and volatility in the short-run.

The important policy implication from either the global games or herding models is that private information may be underweighted relative to the optimum. Welfare is thus reduced, and STF's, which may coordinate this inefficient activity, can be counterproductive.

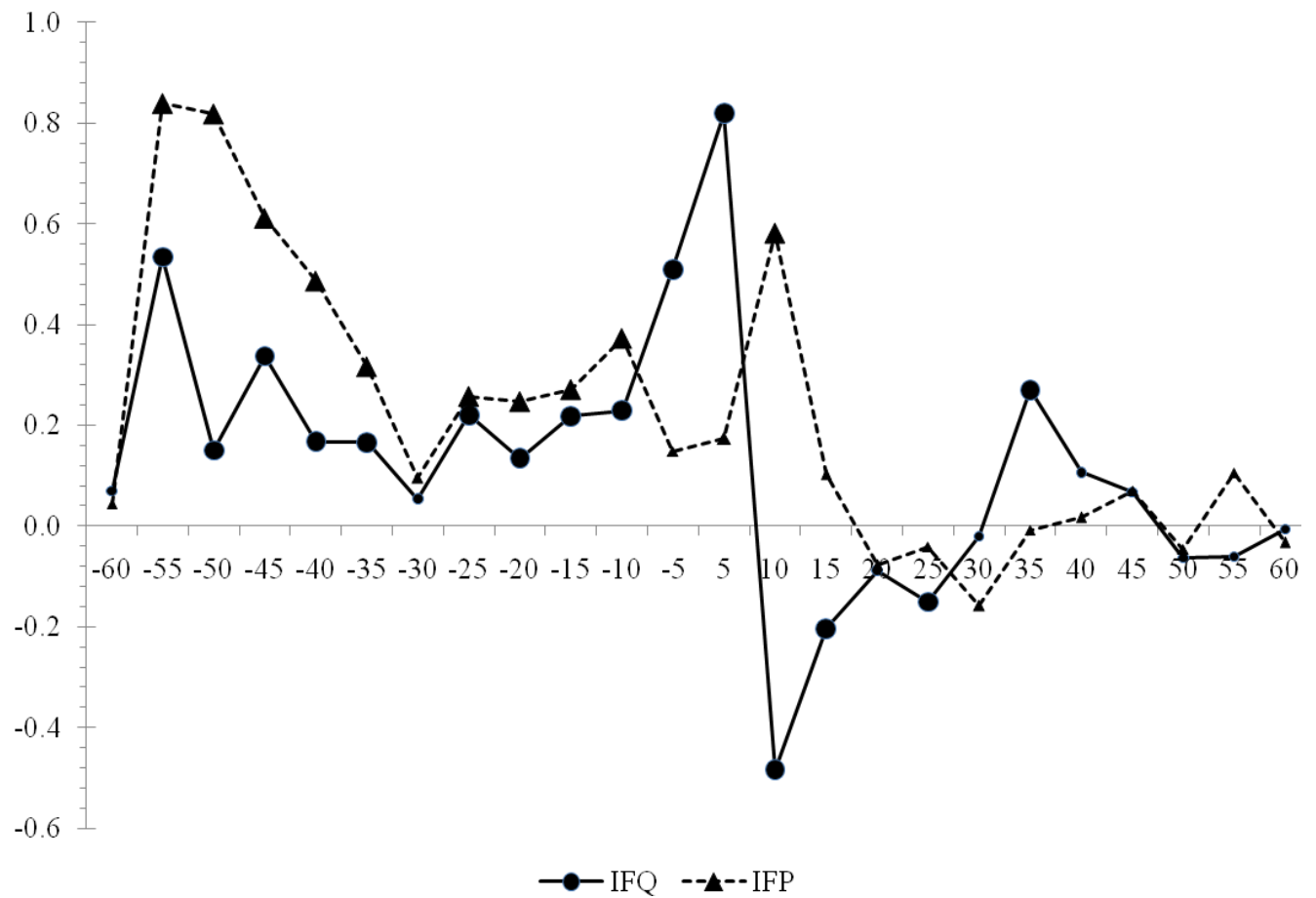
To differentiate between content and coordination, we observe that, if the communication has substantive content, the response of bond prices should occur immediately after the pronouncement. Any response before the announcement suggests that the STF is serving as a coordination device. We thus examine the impact of STF's at five-minute intervals one hour before and one hour after the pronouncement based on estimates of the following OLS model,

$$Y_t = G[Z_t : IFQ_{t-1}] \quad Y_t = \{IFP_t, IFQ_t\}. \quad (14)$$

where  $Z_t$  is defined in equation (7). Results are reported in Figure 2 for  $IFP_t$  and  $IFQ_t$ . The horizontal axis represents "event time," the time (stated in five-minute periods) one hour before and one hour after the release of the STF. In order to ensure comparability, the two series are divided by the standard deviation over the sample of price volatility and trading volume, respectively. Thus, an entry in Figure 2 of 0.50 implies that price volatility ( $IFP_t$ ) or trading volume ( $IFQ_t$ ) is 50% higher than the average variability for these series.

Figure 2 provides evidence in favor of both information and coordination roles. There is a large jump 5 to 10 minutes after the announcement, a result consistent with new information being incorporated into asset prices. The response of  $IFP_t$  is for one period and disappears quickly. For  $IFQ_t$ , the response at the release time is larger and lingers below the average trading volume for several periods after the release. Both measures of information flow also show a substantial response before the release of the STF. Beginning 55 minutes before the release, most of the coefficients are statistically different from zero and many are economically important.

**Figure 2: IFP and IFQ Point Estimates Before and After an STF**  
(●'s and ▲'s Denote Significance at the 5% Level)



We extend this analysis by differentiating by the type of STF and run the following OLS regression,

$$Y_t = G[S_t^*Z_t, T_t^*Z_t, F_t^*Z_t : IFQ_{t-1}] \quad Y_t = \{IFP_t, IFQ_t\}. \quad (15)$$

These results are reported in Figures 3, 4, and 5 for speeches, testimonies, and FOMC meetings, respectively. Each figure contains estimates based on  $IFP_t$  and  $IFQ_t$  normalized by their standard deviations over the sample.

The impacts of the STF's are heterogenous across types. Speeches (Figure 3) have an impact upon release that quickly disappears. For  $IFQ_t$ , there are substantial effects 5 and 10 minutes prior to the release. These significant results may indicate some imprecision in recording the release time of the speech or a systematic pre-release leakage of the impending speech. The largest impact is in the five minute interval immediately after the release time. This result strongly suggests that speeches impact the bond market by providing content and that the prior conclusion about the weaknesses of the speech communication channel is traceable to using too coarse a measure. The response of  $IFP_t$  is relatively muted, though there is a notable (but statistically insignificant) uptick 10 minutes after the release time.

Testimonies (Figure 4), by contrast, have a substantial impact before release on both  $IFP_t$  and  $IFQ_t$ . This statistically and economically significant pattern of coefficients suggests that testimonies largely impact the bond market through coordination.

FOMC meetings (Figure 5) reflect both content and coordination. During the five minutes before and after a release, trading volume is about 1.40 times larger than on a typical day. Price volatility is also elevated during this period, being over twice as large as on a typical day. These are the largest effects reported for any of the three STF's, and they clearly indicate that the FOMC meetings deliver valuable news to the bond market. FOMC meetings also serve as a coordination device, as most of the coefficients prior to the release are statistically significant and large relative to a typical day.<sup>16</sup>

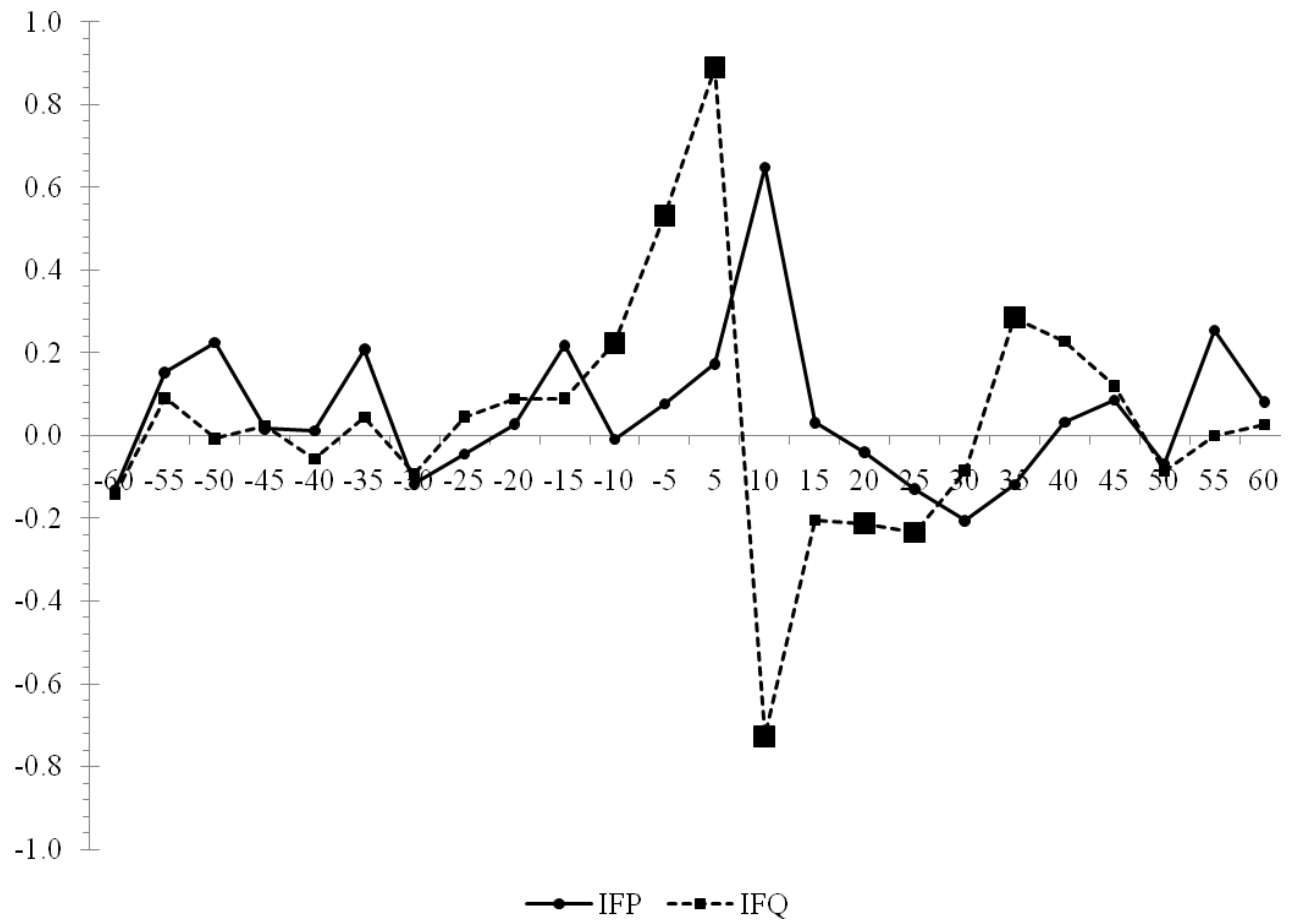
Two additional tests are performed. The FOMC meeting dates represent a mixture of pronouncement effects and, on some occasions, actual changes in interest rates. We disentangle

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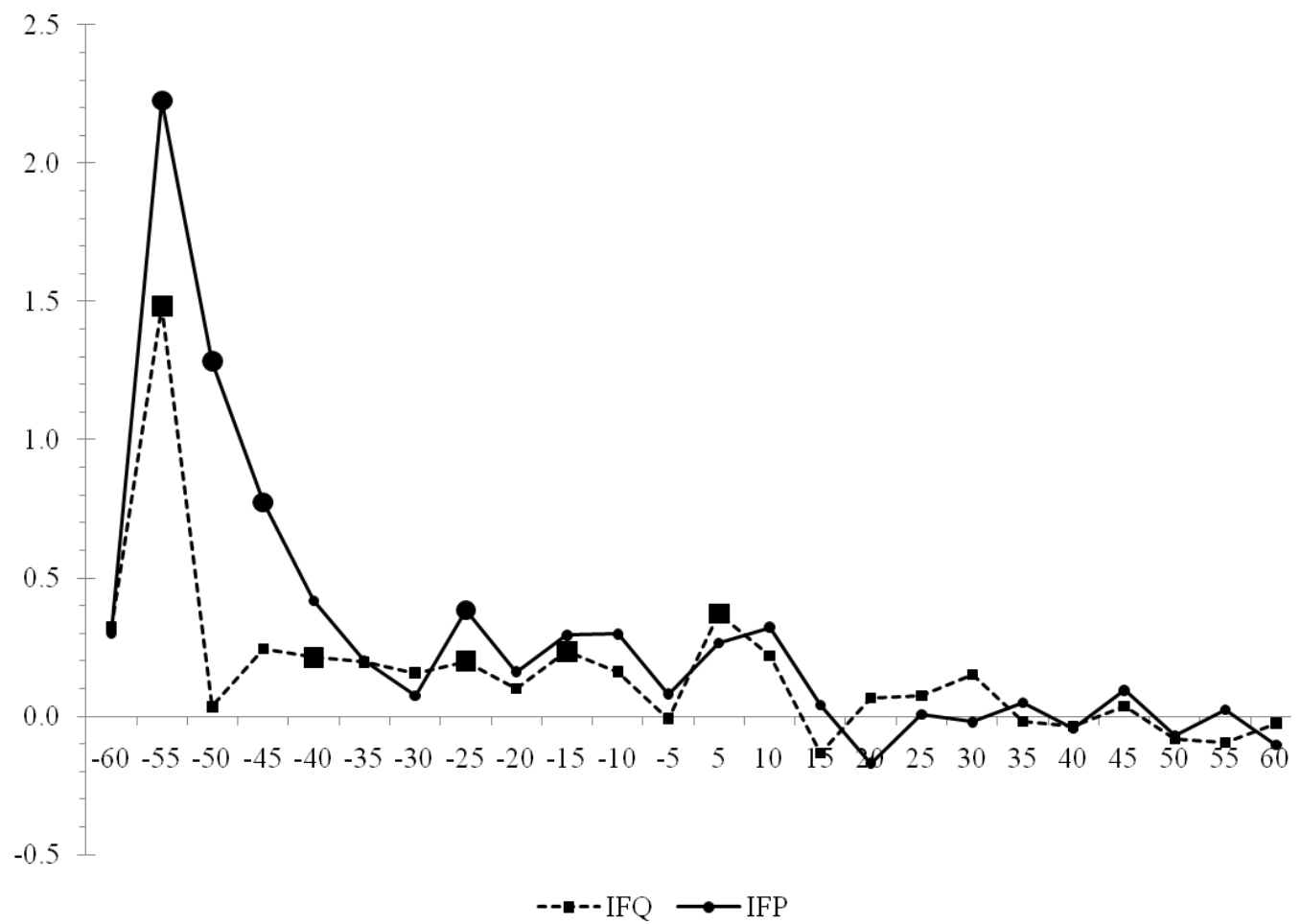
<sup>16</sup> The result for the one-hour period before the release is somewhat in contrast to that of Bomfirm (2003), who finds that the day before the release, the stock market is relatively less volatile.



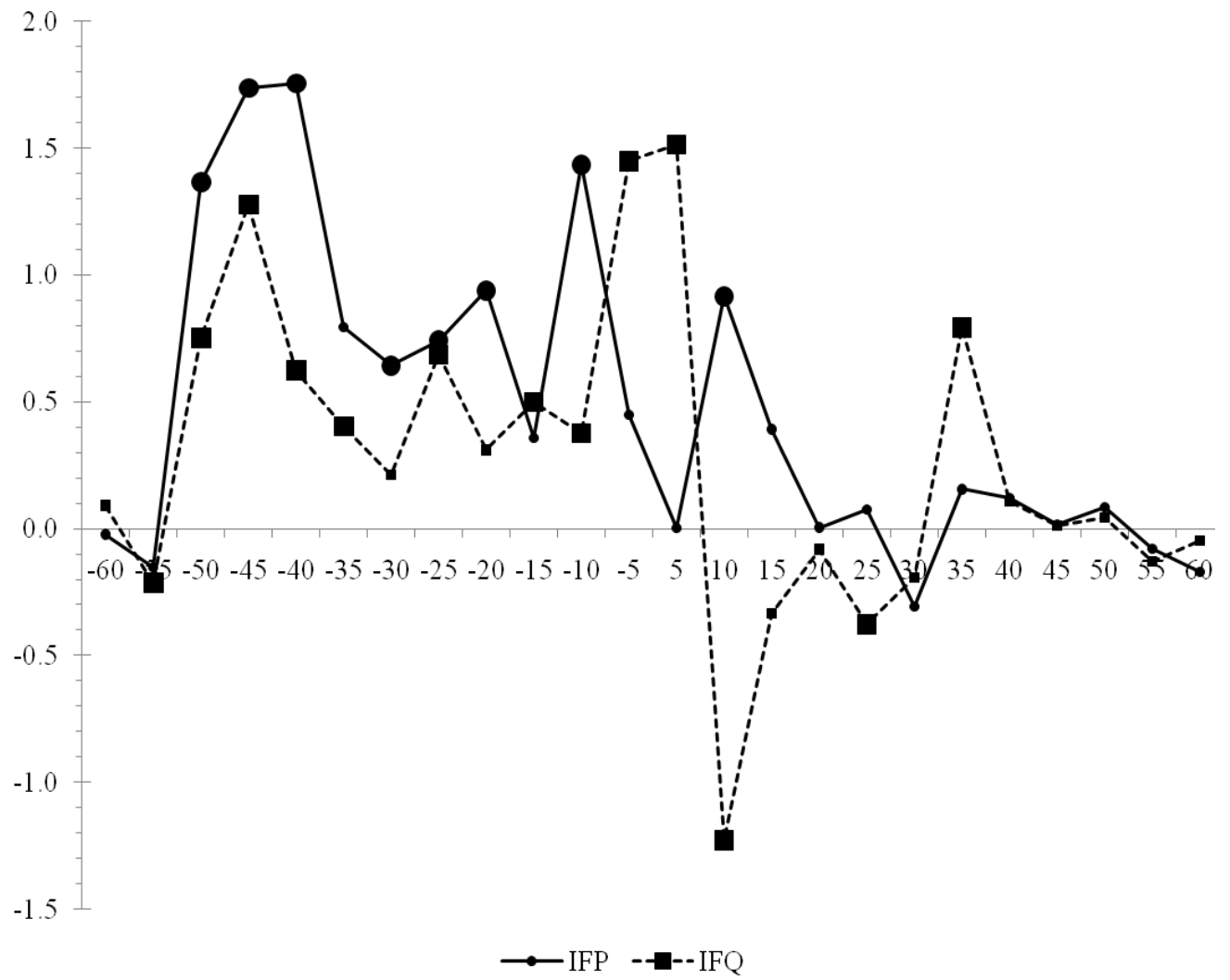
**Figure 3: IFP and IFQ Point Estimates Before and After a Speech**  
(●'s and ▲'s Denote Significance at the 5% Level)



**Figure 4: IFP and IFQ Point Estimates Before and After a Testimony**  
 (●'s and ▲'s Denote Significance at the 5% Level)



**Figure 5: IFP and IFQ Point Estimates Before and After an FOMC Meeting**  
 (●'s and ▲'s Denote Significance at the 5% Level)



these two effects by decomposing the  $F_t$  variable into one variable that identifies FOMC meetings accompanied by a change in the target federal funds rate ( $F1_t$ ) and another for FOMC meetings not accompanied by a change in the rate ( $F2_t$ ),

$$Y_t = G[S_t * Z_t, T_t * Z_t, F1_t * Z_t, F2_t * Z_t : IFQ_{t-1}] \quad (16)$$

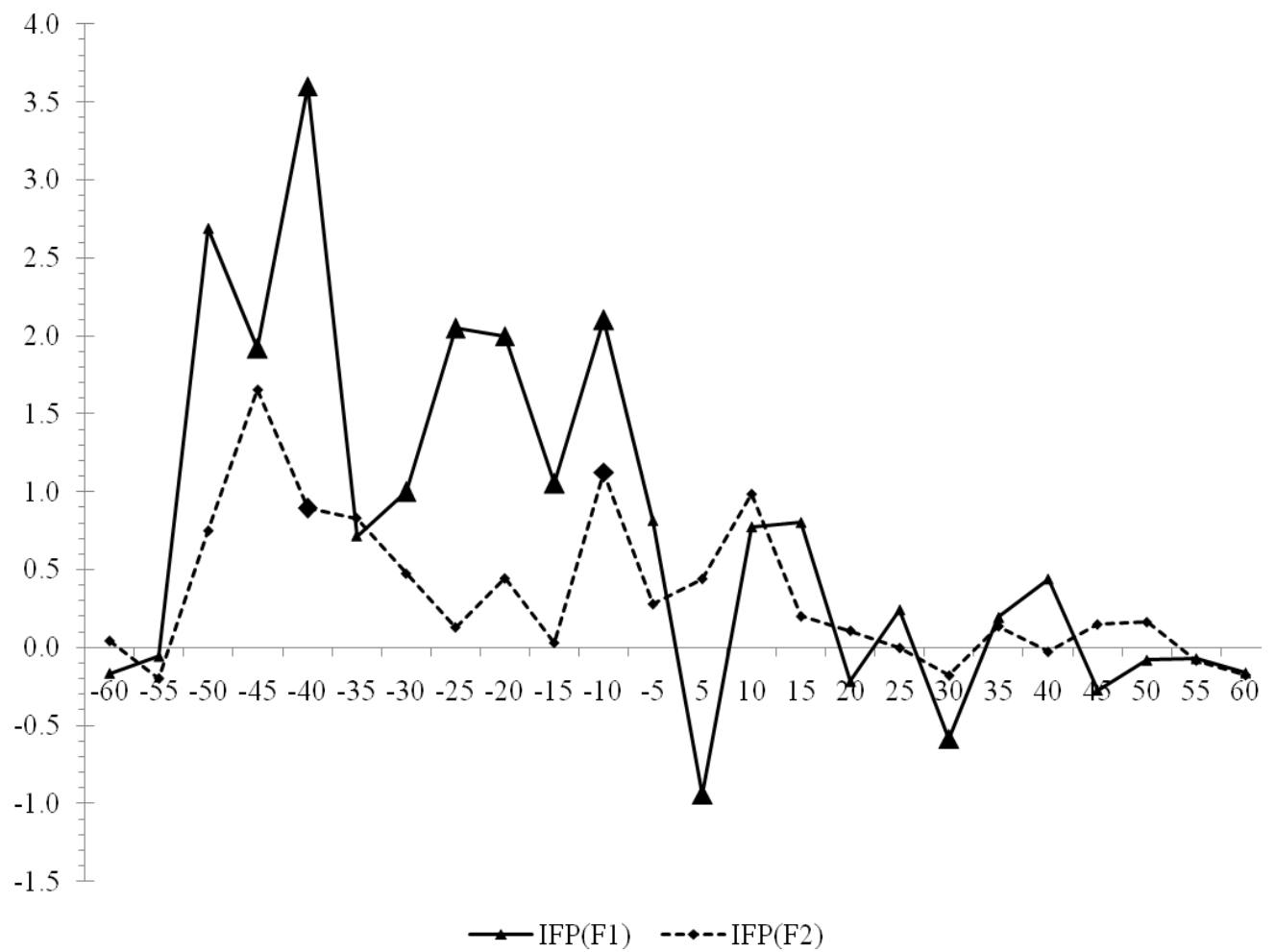
$$Y_t = \{IFP_t, IFQ_t\}.$$

Figure 6 contains the plots for  $IFP_t$  for the  $F1_t$  and  $F2_t$  pronouncements. The responses of  $IFP_t$  to  $F1_t$  are larger than to  $F2_t$ . More information seems to be transmitted by FOMC pronouncements when rates are not altered. However, this pattern is not sustained with trading volume. In Figure 7, the relative response of  $IFQ_t$  to  $F1_t$  and  $F2_t$  is reversed, though the differences are not as large as those for  $IFP_t$ .

Our second additional test examines the importance of a key change in communication policy on the information flows associated with STF's. Beginning in May 1999, the FOMC policy directives about the balance-of-risks were released. Prior to this date, this information was not shared with the public. This communication policy change increases the information contained in the FOMC statements, and we would expect volatility to be more sensitive to these particular pronouncements beginning in May 1999. This increased information flow decreases uncertainty about monetary policy, and we would expect speeches and testimonies to have less impact on the bond market after the change. Table 5 examines the impact of this change on volatility by comparing results for the full sample (columns 1 to 3) to results from the sample truncated in April 1999 (columns 4 to 6). For the truncated period, the AFTER results continue to be estimated imprecisely, and no discernible pattern emerges. The BEFORE results are statistically significant for T and F for both the full and truncated samples. Testimonies did not become appreciably more important (3.88 vs. 4.02), but the impact of FOMC meetings rose from 5.75 prior to May 1999 to 7.79 for the full sample., a large movement relative to standard errors. These results are consistent with those reported by Ehrmann and Fratzscher (2007a), who conclude that markets have extracted more information from FOMC statements since the communication policy change.

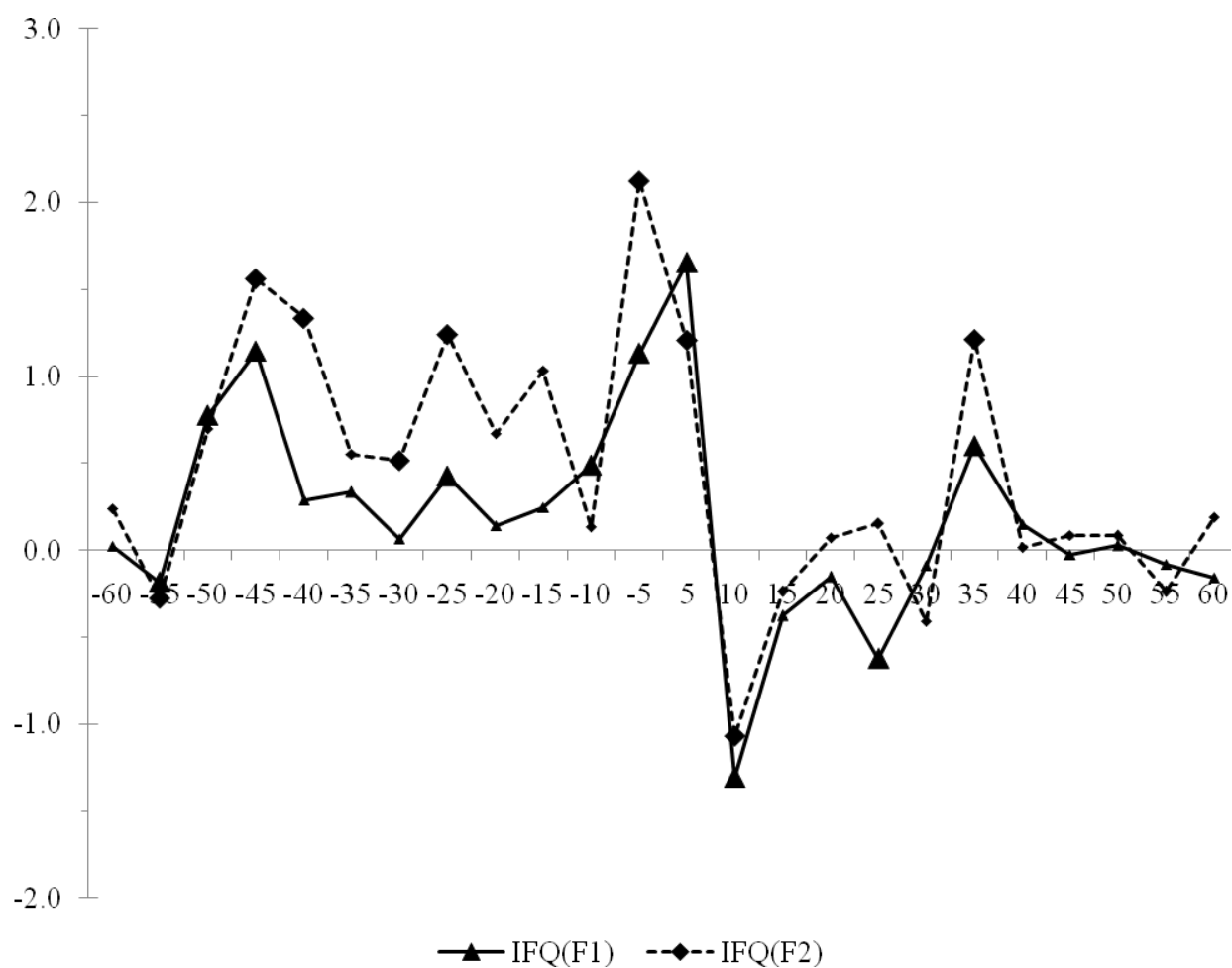
**Figure 6: IFP Point Estimates Before and After an FOMC Meeting**

**With (F1) or Without (F2) a Change in the Target Federal Funds Rate  
(●'s and ▲'s Denote Significance at the 5% Level)**



**Figure 7: IFQ Point Estimates Before and After an FOMC Meeting**

**With (F1) or Without (F2) a Change in the Target Federal Funds Rate  
(●'s and ▲'s Denote Significance at the 5% Level)**



**Table 5: OLS estimates one hour before/after an S, T, or F with split samples**

	(1)	(2)	(3)	(4)	(5)	(6)
	<u>January 1997 to December 1999</u>			<u>January 1997 to April 1999</u>		
	IFP	IFQ	IFQ	IFP	IFQ	IFQ
S *	0.2053	0.7115	1.0270	0.1316	0.3291	0.8893
BEFORE	(0.1598)	(0.5217)	(0.4079)	(0.1773)	(0.6043)	(0.4692)
S *	0.2426	1.1556	-0.0081	0.2265	1.0269	-0.1395
AFTER	(0.2093)	(0.6533)	(0.5244)	(0.1773)	(0.7780)	(0.6236)
T *	2.1062	9.6534	4.0227	1.9408	9.3255	3.8833
BEFORE	(0.3652)	(0.7996)	(0.6028)	(0.1797)	(0.8373)	(0.6264)
T *	0.1275	2.1779	0.6315	0.0717	1.6154	0.3591
AFTER	(0.1432)	(0.5177)	(0.4090)	(0.1797)	(0.5350)	(0.4198)
F *	3.2573	14.6555	7.7900	1.9926	10.0815	5.7486
BEFORE	(0.5014)	(1.2059)	(0.8762)	(0.2651)	(1.2159)	(0.8944)
F *	0.3936	3.9922	0.0987	0.3151	3.8715	0.3632
AFTER	(0.2996)	(1.0575)	(0.8832)	(0.2651)	(1.2200)	(1.0394)
LDV	—	—	0.5939 (0.0051)	—	—	0.5974 (0.0057)
R <sup>2</sup>	0.0062	0.0122	0.3611	0.0040	0.0094	0.3632
SER	3.8028	12.5860	10.1216	3.7860	12.3901	9.9332
p.	0.1614	0.5927	-0.0601	0.1634	0.5965	-0.0643
Durbin m	17.3548	116.2157	-9.3906	15.8641	104.6491	-9.0563

*Notes:* Estimates are based on equation (10). The dependent variables -- IFP<sub>t</sub> and IFQ<sub>t</sub>, -- are defined in equations (1,2) and (3), respectively. The indicator variables -- BEFORE<sub>t</sub> and AFTER<sub>t</sub>, -- are defined in equations (5a), and (5b), respectively. The indicator variables -- S, T, and F -- equal 1 for the occurrence of a speech, testimony, or FOMC meeting, respectively. LDV is a lagged dependent variable. Standard errors are heteroskedasticity-consistent using the White correction and are displayed in parentheses. R<sup>2</sup> is the customary goodness of fit measure. SER is the standard error of the regression. The p parameter and the Durbin m statistic measure first-order autocorrelation in the residuals; see footnote 14 for details. For columns 1 to 3, the sample period extends from January 1997 to December 1999 and contains 56,936 observations; for columns 4 to 6, the sample period extends from January 1997 to April 1999 and contains 42,823 observations.

## VI. Discussion

Perhaps the most interesting findings from our empirical analysis are the substantial effects of STF's before the release and the need to examine responses at high frequencies (5 minute time periods in our analysis). While several studies have examined the impact of macroeconomic announcements on the Treasury bond market, they either use daily data (Jones, Lamont, and Lumsdaine, 1998) or do not examine responses many periods before the release (Ederington and Lee, 1993; Fleming and Remolona, 1999a, 1999b). The one exception is Balduzzi, Elton, and Green (2001), who examine the impact of announcements on trading volume in two pre-release intervals, 30 to 5 minutes before the release and the 5 minutes before the release. Interestingly, they too find statistically significant impacts on the 10-year note for 8 of 23 announcements for the 30 to 5 minute interval; the monetary policy announcement is one of the 8 announcements. These results were not discussed by Balduzzi, et al. and are similar to those presented in Figures 2 to 7.

There are several interpretations of significant prerelease effects. One explanation is that the impending STF exposes traders carrying long or short positions to additional risk, and they hedge prior to the STF. After release, trading books are rebalanced. This account implies that trading volume should be both high and of nearly the same magnitude before and after the release (to re-balance positions) and that this heightened trading activity should occur close to the release time (to minimize risk exposure). Our figures contain little evidence of a rebalancing effect after the release.

A second interpretation is that the impending STF initiates a flow of reports from companies supporting the trading community (e.g., investment banks, forecasting firms) that stimulates trading. This flow of reports resembles a focal point in a global games model. Whether the processing of stale information leads to new information in markets is unclear, though the resolution of this question has important welfare implications.

Our preferred interpretation of significant prerelease effects is that STFs affect markets through coordination in global games or herding models. The global games model developed by Morris and Shin (2002) has the particularly striking implication that central bank communication can be excessive and can lower welfare. That is, central bankers can talk too much. Given this controversial conclusion, the model has received much attention. Woodford (2005, pp. 414–421) raises several concerns with the Morris and Shin model, including the appropriate specification



of the social welfare function. Svensson (2006) carefully examines the original Morris and Shin model and raises an important question about the plausibility of the precisions of the public and private signals. (Other studies challenging the Morris and Shin finding are listed in Svensson's footnotes 1 and 2.) Morris, Shin, and Tong (2006) acknowledge Svensson's concern, but note that the model in question is one that assumes that the public and private signals (conditional on the true state) are independent. In more general models where these two signals are correlated (as might arise if there is a flawed conventional wisdom; for example, that housing prices do not fall) or where the informativeness of the aggregate price level is endogenous (Amador and Weill 2009), the original Morris and Shin finding holds.

While rigorous examinations and critiques are always welcome, we believe that the criticism of Morris and Shin's specific model is somewhat beside the central point. The key insight from their model is that public information can crowd-out private information when investors care about the opinions of other investors, regardless of the accuracy of those opinions. This point is nicely summarized by Donald Kohn, vice chair of the Board of Governors (Kohn 2005, pp. 1–2):

One consideration involves the nature of information and its relationship to market pricing. In fact, economists do not fully understand how markets incorporate information. Herding behavior, information cascades, multiple equilibria, and the amount of investment in financial research all pose puzzles about markets and information. The situation is complicated still more when an important participant is seen as having superior information owing to its investment in research or its understanding of its own behavior.

In such circumstances, certain types of central bank talk might actually impinge on welfare-enhancing market pricing by being misunderstood and receiving too much weight relative to private judgments.

There is a very large literature examining the effects of policymakers' pronouncements on a variety of economic activity. Blinder et al. (2008) have surveyed part of this literature and placed the studies into two broad categories depending on whether pronouncements affect financial markets or inflation performance. Here we largely discuss studies in the former category and focus on those that relate to our findings with government bond markets.

Some early studies examine the impact of various forms of communication on the level and volatility of bond market rates. Guthrie and Wright (2000) study the effects of news articles containing phrases linked to New Zealand monetary policy, and they report a substantial effect of this form of communication on the level of interest rates. Most of their results are with daily

data. One of their analyses is based on hourly data for 13 months (their figure 8.2, p. 507) and, in contrast to our results, they do not find any impact before the release. Kohn and Sack (2004) examine the impact of STFs on the volatility of Treasury securities with maturities up to and including four years. Based on daily data and conditioning on unanticipated information in the pronouncements and macroeconomic announcements (using the technique of Kuttner 2001), they report the following impact hierarchy for maturities up to two years: FOMC meetings > testimonies > speeches. For maturities of two to four years ahead, testimonies are the only STF that have a significant impact. Bligh and Hess (2010) introduce their measures of certainty, pessimism, and macroeconomic language (derived by content analysis of STFs); among other results, they find that macroeconomic language has the largest impact on financial market variables. While these and other studies with daily data are very informative, they do not permit an examination of effects before and after the release on the same day and of hypotheses contrasting coordination versus content.

The study by Reeves and Sawicki (2007) sheds some additional light on the relevance of using higher-frequency data. They present results with data at both daily and higher frequencies (5-, 15-, and 60-minute time periods). They examine data for the response of 10-year spot yields on futures contracts of UK government securities of different maturities to minutes of the Monetary Policy Committee (MPC) meetings, the inflation report, speeches by MPC members, and testimonies by MPC members. For daily data, the volatility of the 3-month, 6-month, and 12-month short sterling futures and a 10-year security are increased by the release of the MPC minutes relative to the five working days before the release. These increases are statistically significant. (In contrast to the results by Kohn and Sack (2004) and in our paper, testimonies were found to have no significant impact.) For higher-frequency data, the release of the MPC minutes, as well as of the inflation report, have statistically significant impacts on the same four government securities relative to the five working days before the release. Gürkaynak, Sack, and Swanson (2005, section 1.3 and table 1) document the different results obtained from using daily data, intraday data with a wide window, and intraday data with a narrow window when assessing the effects of monetary policy actions and statements. Higher-frequency data appear to be more powerful in capturing the impacts of pronouncements.

Some results suggest that communication channels depend on the current and past macroeconomic and policy environments. Clare and Courtenay (2001) find that, since the

independence of the Bank of England in May 1997, the sensitivity of UK long gilt futures (among other assets) has fallen and the speed of reaction has risen. The latter development is attributed to increased transparency by the Bank of England. Joyce and Read (2002) find that the sensitivity of UK bond prices to unexpected movements in the retail price index (RPI) increased after inflation targets were announced, suggesting that the information contained in RPI releases increased in the inflation-targeting environment. Ehrmann and Fratzscher (2007b) document that the effects of Federal Reserve pronouncements are state-dependent. Andersen et al. (2007) show that the response of asset prices to macroeconomic announcements is sensitive to the state of the business cycle. Shifts in the macroeconomic and policy environments can affect communication channels, and hence estimates of the effects of pronouncements over long sample periods may be unreliable.

The above studies generally find that pronouncements matter for financial markets. This conclusion is confirmed by studies that directly examine the impact of pronouncements on monetary policy variables. Siklos and Bohl (2007) study the behavior of the Bundesbank in a VAR framework. While actions speak louder than words, they find that communication does also play a role and serves as a substitute for interest rate smoothing (see Geraats (2010) for a related theoretical model). Sturm and de Haan (2010) examine the incremental information introduced by ECB pronouncements above that contained in a Taylor rule. They find that ECB pronouncements add information useful in predicting policy decisions. There are dissenting opinions. Bomfim and Reinhart (2000) study the impact of FOMC decisions on financial markets, and Berger, de Haan, and Sturm (2011) examine the impact of the monetary pillar (as expressed in the ECB's monthly press conferences) on monetary policy. Both studies report that pronouncements are not effective relative to actions. These disparate results suggest that the effects of pronouncements may depend on the nature of the pronouncement, the macroeconomic and policy environments, and the history of past policies.

## **VII. Summary**

This paper has explored one aspect of central bank communication policy—formal pronouncements by central bankers—to obtain a better understanding of whether this channel matters and, if so, the nature of the information being transmitted. We examine the relationship between Chairman Alan Greenspan's speeches and testimonies and the FOMC meetings and

volatility in the 30-year bond market at five-minute intervals. The pattern of hypothesis tests and our results are summarized in Figure 8. We find that STFs matter for bond market volatility, that this impact depends on the transmission of information (rather than just noise), and that this information reflects both substantive content and a coordination signal. We further find that speeches only deliver content, that testimonies are largely a coordination device, and that FOMC meetings play both roles. These findings of a quantitatively important coordination channel document the relevance of the “global games” model of Morris and Shin and the herding model of Banerjee.

Our results have several important policy implications, including the possibility that one or more aspects of the STFs may be counterproductive by crowding out private information. More generally, they raise questions about the optimal communication policy, how a central bank becomes transparent, and the tradeoff between releasing information to the public and amplifying volatility in financial markets.

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**Greenspan Shrugs: Central Bank Communication,  
Formal Pronouncements and Bond Market Volatility**

**Appendix: Detailed Listing of Speeches, Testimonies, and FOMC Statements, 1997-1999**

Part A: Speeches and Testimony Included in the Sample

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
1	1/14/97	Wednesday	9/15/97	7:30	9/15/97	15:00	Speech	Central banking and global finance	Catholic University Leuven, Leuven, Belgium
2	1/21/97	Tuesday	1/21/97	10:10	1/21/97	10:10	Testimony	Performance of the U.S. economy	Before the Committee on the Budget, U.S. Senate
3	1/30/97	Thursday	1/30/97	10:25	1/30/97	10:25	Testimony	The consumer price index	Before the Committee on Finance, U.S. Senate

		Event Day	Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
4	2/13/97	Thursday	2/13/97	10:10	2/13/97	10:10	Testimony	Modernization of the financial system	Before the Subcommittee on Financial Institutions and Consumer Credit of the Committee on Banking and Financial Services, U.S. House of Representatives
5	2/21/97	Friday	2/21/97	8:50	2/21/97	8:50	Speech	Government regulation and derivative contracts	Financial Markets Conference of the Federal Reserve Bank of Atlanta, Coral Gables, Florida
6	2/26/97	Wednesday	2/26/97	10:00	7/21/98	10:15	Testimony	The Federal Reserve's semi-annual monetary policy report	Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate
7	3/4/97	Tuesday	3/4/97	10:00	3/4/97	10:00	Testimony		Before the Committee on the Budget, U.S. House of Representatives
8	3/7/97	Monday	3/10/97	7:30	3/7/97	3:10	Speech	Privacy in the information age	Conference on Privacy in the Information Age, Salt Lake City, Utah

		Event Day	Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
9	3/19/97	Wednesday	3/19/97	10:00	3/19/97	10:00	Testimony	Supervision of banking organizations	Before the Subcommittee on Capital Markets, Securities and Government-Sponsored Enterprises of the Committee on Banking and Financial Services, U.S. House of Representatives
10	3/20/97	Thursday	3/20/97	10:00	3/20/97	10:00	Testimony	Performance of the U.S. economy	Before the Joint Economic Committee, U.S. Congress
11	3/22/97	Monday	3/24/97	7:30	3/24/97	9:00	Speech	Financial reform and the importance of a decentralized banking structure	Financial reform and the importance of a decentralized banking structure
12	4/12/97	Monday	4/14/97	7:30	4/14/97	9:00	Speech	The evolution of banking in a market economy	Annual Conference of the Association of Private Enterprise Education, Arlington, Virginia
13	4/29/97	Tuesday	4/29/97	13:30	4/29/97	13:30	Speech	G-7 economic summit meeting	Spring Meeting of the Institute of International Finance, Washington, D.C.

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
14	5/1/97	Thursday	5/1/97	9:25	5/1/97	9:25	Speech	Technological change and the design of bank supervisory policies	Conference on Bank Structure and Competition of the Federal Reserve Bank of Chicago, Chicago, Illinois
15	5/2/97	Monday	5/5/97	7:30	5/5/97	9:25	Speech	Financial reform and importance of the state charter	Annual Meeting and Conference of the Conference of State Bank Supervisors, San Diego, California
16	5/8/97	Friday	5/9/97	7:30	5/8/97	21:15	Speech	Current monetary policy	1997 Haskins Partners Dinner of the Stern School of Business, New York University, New York, New York
17	5/22/97	Thursday	5/22/97	10:00	5/22/97	10:00	Testimony	H.R. 10, the Financial Services Competitiveness Act of 1997	Before the Committee on Banking and Financial Services, U.S. House of Representatives

		Event Day	Information/market		Posted				
	Date	of the Week	Date	Time	Date	Time	Description	Title	Location
18	6/10/97	Wednesday	6/11/97	7:30	6/10/97	21:00	Speech	The embrace of free markets	Woodrow Wilson Award Dinner of the Woodrow Wilson International Center for Scholars, New York, New York
19	7/17/97	Thursday	7/17/97	10:00	7/17/97	10:00	Testimony	The Financial Services Competition Act of 1997	Before the Subcommittee on Finance and Hazardous Materials of the Committee on Commerce, U.S. House of Representatives
20	7/22/97	Wednesday	7/23/97	7:30	7/21/98	10:15	Testimony	The Federal Reserve's semiannual monetary policy report	Before the Subcommittee on Domestic and International Monetary Policy of the Committee on Banking and Financial Services, U.S. House of Representatives
21	9/5/97	Monday	9/8/97	7:30	9/5/97	23:30	Speech	Rules vs. discretionary monetary policy	15 <sup>th</sup> Anniversary Conference of the Center for Economic Policy Research at Stanford University, Stanford, California

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
22	9/12/97	Friday	9/12/97	12:20	9/12/97	12:20	Speech	Education, technology, and economic growth	Building Dedication Ceremonies Keenan-Flagler Business School, University of North Carolina, Chapel Hill, North Carolina
23	10/5/97	Monday	10/6/97	7:30	10/8/97	10:00	Speech	Technological change and the economy	Annual Convention of the American Bankers Association, Boston, Massachusetts
24	10/8/97	Wednesday	10/8/97	10:00	10/8/97	10:00	Testimony	Economic and budgetary outlook	Before the Committee on the Budget, U.S. House of Representatives
24	10/11/97	Friday	10/14/97	7:30	10/14/97	16:00	Speech	Consumer credit and financial modernization	Economic Development Conference of the Greenlining Institute, San Francisco, California
26	10/14/97	Tuesday	10/14/97	9:00	10/14/97	9:00	Speech	Globalization of finance	15 <sup>th</sup> Annual Monetary Conference of the Cato Institute, Washington, D.C.
27	10/14/97	Wednesday	10/15/97	7:30	10/14/97	14:30	Speech	Inaugural speech for economic seminar series	University of Connecticut, Storrs, Connecticut

		<b>Event Day</b>	<b>Information/market</b>		<b>Posted</b>				
	<b>Date</b>	<b>of the Week</b>	<b>Date</b>	<b>Time</b>	<b>Date</b>	<b>Time</b>	<b>Description</b>	<b>Title</b>	<b>Location</b>
28	10/29/97	Wednesday	10/29/97	10:00	10/29/97	10:00	Testimony	Turbulence in world financial markets	Before the Joint Economic Committee, U.S. Congress
29	11/7/97	Friday	11/7/97	8:45	11/7/97	8:45	Speech	Price measurement	Center for Financial Studies Frankfurt, Germany
30	11/20/97	Thursday	11/20/97	10:00	11/20/97	10:00	Testimony	Social security	Before the Task Force on Social Security of the Committee on the Budget, U.S. Senate
31	12/2/97	Wednesday	12/3/97	7:30	12/2/97	20:30	Speech	Growth and flexibility: Lessons from Asia	Economic Club of New York, New York, N.Y.
32	12/3/97	Thursday	12/4/97	7:30	12/3/97	14:30	Speech	The role of education during rapid economic change	At Syracuse University, Syracuse, New York
33	1/3/98	Monday	1/4/98	7:30	1/5/98	15:30	Speech	The problems of price measurement	Annual meeting of the American Economic Association in Chicago

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
34	1/12/98	Monday	1/12/98	13:00	1/12/98	13:00	Speech	Economic development in low- and moderate-income communities	At a Community Forum on Community Reinvestment and Access to Credit: California's Challenge, Los Angeles, California
35	1/29/98	Thursday	1/29/98	10:00	1/29/98	10:00	Testimony	The current fiscal situation	Before the Committee on the Budget, U.S. Senate
36	2/12/98	Thursday	2/13/97	7:30	2/12/98	14:00	Testimony	The current Asian crisis and the dynamics of international finance	Before the Committee on Foreign Relations, U.S. Senate
37	2/24/98	Tuesday	2/24/98	10:00	7/21/98	10:15	Testimony	The Federal Reserve's semiannual report on economic conditions and the conduct of monetary policy	Before the Subcommittee on Domestic and International Monetary Policy of the Committee on Banking and Financial Services, U.S. House of Representatives



		Event Day	Information/market		Posted				
	Date	of the Week	Date	Time	Date	Time	Description	Title	Location
38	2/26/98	Friday	2/27/98	7:30	2/27/98	17:45	Speech	The role of capital in optimal banking supervision and regulation	Before the Conference on Capital Regulation in the 21 <sup>st</sup> Century, Federal Reserve Bank of New York, New York, NY
39	2/27/98	Friday	2/27/98	11:30	12/27/98	11:30	Speech	Risk management in the global financial system	Before the Annual Financial Markets Conference of the Federal Reserve Bank of Atlanta, Miami Beach, Florida
40	3/3/98	Tuesday	3/4/98	7:30	3/3/98	14:05	Speech	Implications of recent Asian developments for community banking	Before the Annual Convention of the Independent Bankers Association of America, Honolulu, Hawaii
41	3/3/98	Tuesday	3/3/98	10:30	3/3/98	10:30	Testimony	The current Asian crisis	Before the Subcommittee on Foreign Operations of the Committee on Appropriations, U.S. Senate
42	3/4/98	Wednesday	3/4/98	10:00	3/4/98	10:00	Testimony	Coming budgetary challenges	Before the Committee on the Budget, U.S. House of Representatives

		<b>Event Day</b>	<b>Information/market</b>		<b>Posted</b>				
	<b>Date</b>	<b>of the Week</b>	<b>Date</b>	<b>Time</b>	<b>Date</b>	<b>Time</b>	<b>Description</b>	<b>Title</b>	<b>Location</b>
43	4/2/98	Friday	4/3/98	7:30	4/2/98	14:30	Speech	The ascendance of market capitalism	Before the Annual Convention of the American Society of Newspaper Editors, Washington, D.C.
44	4/20/98	Monday	4/20/98	13:00	4/20/98	13:00	Testimony	The allocation of the economy's resources between Medicare and competing needs	Before the National Bipartisan Commission on the Future of Medicare
45	5/2/98	Monday	5/4/98	7:30	5/2/98	12:15	Speech	Our banking history	Before the Annual Meeting and Conference of the Conference of State Bank Supervisors, Nashville, Tennessee
46	5/7/1998	Thursday	5/7/98	12:00	5/7/98	12:00	Speech	Understanding today's international financial system	Before the 34th Annual Conference on Bank Structure and Competition of the Federal Reserve Bank of Chicago

		<b>Event Day</b>	<b>Information/market</b>		<b>Posted</b>				
	<b>Date</b>	<b>of the Week</b>	<b>Date</b>	<b>Time</b>	<b>Date</b>	<b>Time</b>	<b>Description</b>	<b>Title</b>	<b>Location</b>
47	5/20/98	Wednesday	5/20/98	11:15	5/20/98	11:15	Speech	On the announce- ment of a new cur- rency design	Bureau of Engraving and Printing, Washington, D.C.
48	5/21/98	Thursday	5/21/98	10:30	5/21/98	10:30	Testimony	The current Asian crisis and the fi- nancial resources of the IMF	Before the Committee on Agriculture, U.S. House of Representatives
49	6/10/98	Wednesday	6/10/98	11:00	6/10/98	11:00	Testimony	An update on eco- nomic conditions in the United States	Before the Joint Economic Commit- tee, U.S. Congress
50	6/16/98	Tuesday	6/16/98	10:00	6/16/98	10:00	Testimony	The effects of mergers	Before the Committee on the Judici- ary, U.S. Senate
51	6/17/98	Wednesday	6/17/98	11:00	6/17/98	11:00	Testimony	H.R. 10, the Fi- nancial Services Act of 1998	Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
52	6/24/98	Wednesday	6/24/98	10:00	6/24/98	10:00	Testimony	The regulation of OTC derivatives	Before the Committee on Banking and Financial Services, U.S. House of Representatives
53	7/10/98	Friday	7/10/98	12:30	7/10/98	12:30	Speech	The implications of technological changes	Charlotte Chamber of Commerce, Charlotte, North Carolina
54	7/21/98	Tuesday	7/21/98	10:15	7/22/98	10:00	Testimony	The Federal Reserve's midyear report on monetary policy	Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate <i>Chairman Greenspan presented identical testimony before the Subcommittee on Domestic and International Monetary Policy of the Committee on Banking and Financial Services, U.S. House of Representatives, July 22, 1998</i>
55	7/30/98	Thursday	7/30/98	10:00	7/30/98	10:00	Testimony	The Commodity Exchange Act and OTC Derivatives	Before the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate

		<b>Event Day</b>	<b>Information/market</b>		<b>Posted</b>				
	<b>Date</b>	<b>of the Week</b>	<b>Date</b>	<b>Time</b>	<b>Date</b>	<b>Time</b>	<b>Description</b>	<b>Title</b>	<b>Location</b>
56	9/4/98	Tuesday	9/8/98	7:30	9/4/98	19:00	Speech	Is there a new economy?	Haas Annual Business Faculty Research Dialogue, University of California, Berkeley, California
57	9/16/98	Wednesday	9/16/98	13:00	9/16/98	13:00	Testimony	International economic and financial system	Before the Committee on Banking and Financial Services, U.S. House of Representatives
58	9/23/98	Thursday	9/24/98	7:30	9/23/98	14:00	Testimony	The crisis in emerging market economies	Before the Committee on the Budget, U.S. Senate
59	10/1/98	Thursday	10/1/98	10:00	10/1/98	10:00	Testimony	Private-sector refinancing of the large hedge fund, Long-Term Capital Management	Before the Committee on Banking and Financial Services, U.S. House of Representatives
60	11/5/98	Thursday	11/5/98	12:15	11/5/98	12:15	Speech	The structure of the international financial system	Annual Meeting of the Securities Industry Association, Boca Raton, Florida

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
61	1/20/99	Wednesday	1/20/99	10:00	1/20/99	10:00	Testimony	State of the Economy	Before the Committee on Ways and Means, U.S. House of Representatives
62	1/28/1999	Thursday	1/28/1999	8:30	1/28/1999	8:30	Testimony	Social Security	Before the Committee on the Budget, U.S. Senate
63	2/11/1999	Thursday	2/11/1999	10:00	2/11/1999	10:00	Testimony	H.R. 10 and the need for financial reform	Before the Committee on Banking and Financial Services, U.S. House of Representatives
64	2/23/99	Tuesday	2/23/99	10:00	2/23/99	10:00	Testimony	Need for financial modernization	Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate
65	2/16/99	Tuesday	2/16/99	12:00	2/16/99	12:00	Speech	The interaction of education and economic change	81st Annual Meeting of the American Council on Education, Washington, D.C.

		Event Day	Information/market		Posted		Description	Title	Location
Date		of the Week	Date	Time	Date	Time			
66	2/23/99	Tuesday	2/23/99	10:00	2/24/99	10:00	Testimony	The Federal Reserve's semiannual report on monetary policy	Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate <i>Chairman Greenspan presented identical testimony before the Committee on Banking and Financial Services, U.S. House of Representatives, February 24, 1999</i>
67	3/3/99	Wednesday	3/3/99	10:00	3/./99	10:00	Testimony	On investing the social security trust fund in equities	Before the Subcommittee on Finance and Hazardous Materials, Committee on Commerce, U.S. House of Representatives
68	3/8/1999	Tuesday	3/9/99	7:30	3/8/99	15:00	Speech	Mortgage finance	At the Mortgage Bankers Association, Washington, D.C.
69	3/9/1999	Tuesday	3/9/1999	12:00	3/9/1999	12:00	Speech	Changes in small business finance	At the Federal Reserve System Research Conference on Business Access to Capital and Credit, Arlington, Virginia

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
70	3/16/1999	Tuesday	3/17/1999	7:30	3/18/99	16:30	Speech	The farm economy	At the Annual Convention of the Independent Bankers Association of America, San Francisco, California
71	3/19/99	Friday	3/19/99	9:15	3/19/99	9:15	Speech	Financial derivatives	Before the Futures Industry Association, Boca Raton, Florida
72	4/16/99	Friday	4/16/99	14:00	4/16/99	14:00	Speech	Technology and trade	Before the Dallas Ambassadors Forum, Dallas, Texas
73	4/28/1999	Wednesday	4/28/1999	10:00	4/28/1999	10:00	Testimony	H.R. 10 and financial modernization	Before the Subcommittee on Finance and Hazardous Materials, Committee on Commerce, U.S. House of Representatives
74	4/29/99	Friday	4/30/99	7:30	4/29/99	16:00	Speech	Currency reserves and debt	Before the World Bank Conference on Recent Trends in Reserves Management, Washington, D.C.
75	5/6/99	Thursday	5/6/99	9:25	5/6/99	9:25	Speech	The American economy in a world context	35th Annual Conference on Bank Structure and Competition of the Federal Reserve Bank of Chicago, Chicago, Illinois



	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
76	5/20/99	Thursday	5/20/99	10:00	5/20/99	10:00	Testimony	Efforts to improve the “architecture” of the international financial system	Before the Committee on Banking and Financial Services, U.S. House of Representatives
77	6/2/1999	Wednesday	6/2/99	13:00	6/2/99	13:00	Speech	Trade and technology	Before the Alliance for the Commonwealth, Conference on International Business, Boston, Massachusetts
78	6/10/1999	Thursday	6/10/99	15:30	6/10/99	15:30	Speech	Commencement address	Harvard University, Boston, Massachusetts
79	6/14/99	Monday	6/14/99	10:00	6/14/99	10:00	Testimony	High-tech industry in the U.S. economy	Before the Joint Economic Committee, U.S. Congress
80	6/17/99	Thursday	6/17/99	10:00	6/17/99	10:00	Testimony	Monetary policy and the economic outlook	Before the Joint Economic Committee, U.S. Congress

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
81	7/22/99	Thursday	7/22/99	11:00	7/28/99	10:00	Testimony	The Federal Reserve's semiannual report on monetary policy	Before the Committee on Banking and Financial Services, U.S. House of Representatives <i>Chairman Greenspan presented identical testimony before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, on July 28, 1999</i>
82	8/27/99	Friday	8/27/99	10:00	8/27/99	10:00	Speech	New challenges for monetary policy	Before a symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming
83	9/8/99	Wednesday	9/8/99	11:45	9/8/99	11:45	Speech	Maintaining economic vitality	Millennium Lecture Series, sponsored by the Gerald R. Ford Foundation and Grand Valley State University, Grand Rapids, Michigan
84	9/17/99	Friday	9/17/99	8:45	9/17/99	8:45	Speech	Status of Y2K preparedness	Before the President's Council on Year 2000 Conversion, Financial Sector Group, Year 2000 Summit, Washington, D.C.

	Event Day		Information/market		Posted		Description	Title	Location
	Date	of the Week	Date	Time	Date	Time			
85	9/27/99	Tuesday	9/28/99	7:30	9/27/99	17:15	Speech	Lessons from the global crises	Before the World Bank Group and the International Monetary Fund, Program of Seminars, Washington, D.C.
86	9/30/1999	Thursday	9/30/1999	21:30	9/30/1999	21:30	Speech	Trade and technology	Before Minnesota Meeting, Minneapolis, Minnesota
87	10/11/1999	Monday	10/11/98	11:00	10/11/98	11:00	Speech	The evolution of bank supervision	Before American Bankers Association, Phoenix, Arizona
88	10/14/99	Friday	10/15/99	7:30	10/14/99	19:00	Speech	Measuring financial risk in the twenty-first century	Before a conference sponsored by the Office of the Comptroller of the Currency, Washington, D.C.
89	10/19/99	Tuesday	10/19/99	13:00	10/19/99	13:00	Speech	Do efficient financial markets mitigate financial crises?	Before the 1999 Financial Markets Conference of the Federal Reserve Bank of Atlanta, Sea Island, Georgia
90	10/28/99	Friday	10/29/99	7:30	10/28/99	19:30	Speech	Information, productivity, and capital investment	Before The Business Council, Boca Raton, Florida

		Event Day	Information/market		Posted				
	Date	of the Week	Date	Time	Date	Time	Description	Title	Location
91	11/2/99	Tuesday	11/2/99	9:15	11/2/99	9:15	Speech	Mortgage markets and economic activity	Before a conference on Mortgage Markets and Economic Activity sponsored by America's Community Bankers, Washington, D.C.
92	11/15/99	Monday	11/15/99	9:15	11/15/99	9:15	Speech	Insurance companies and banks under the new regulatory law	Before the Annual Meeting of the American Council of Life Insurance, Washington, D.C.

**Part B: FOMC Meetings Included in the Sample**

<b>Meeting date</b>	<b>Policy result as presented in a policy statement</b>	<b>F1<sup>#</sup></b>	<b>F2<sup>#</sup></b>
February 4/5, 1997	No statement	0	1
March 25, 1997	“The Federal Open Market Committee decided today to tighten money market conditions slightly, expecting the federal funds rate to rise 1/4 percentage point to around 5-1/2 percent.... No change was made in the Federal Reserve discount rate, which remains at 5 percent.”	1	0
May 20, 1997	No statement	0	1
July 1/2, 1997	No statement	0	1
August 19, 1997	No statement	0	1
September 30, 1997	No statement	0	1
November 12, 1997	No statement	0	1
December 16, 1997	No statement	0	1
February 3/4, 1998	No statement	0	1
March 31, 1998	No statement	0	1
May 19, 1998	No statement	0	1
June30/July 1, 1998	No statement	0	1
August 18, 1998	No statement; this meeting is excluded because there are no bond market data for August of 1998.	NR	NR
September 29, 1998	The Federal Open Market Committee decided today to ease the stance of monetary policy slightly, expecting the federal funds rate to decline 1/4 percentage point to around 5-1/4 percent.... The discount rate remains unchanged at 5 percent.	1	0

Meeting date	Policy result as presented in a policy statement	F1 <sup>#</sup>	F2 <sup>#</sup>
October 15, 1998	<p>“The Federal Reserve today announced the following set of policy actions:</p> <ul style="list-style-type: none"> <li>• The Board of Governors approved a reduction in the discount rate by 25 basis points from 5 percent to 4-3/4 percent.</li> <li>• The federal funds rate is expected to fall 25 basis points from around 5-1/4 percent to around 5 percent”</li> </ul>	1	0
November 17, 1998	<p>“The Federal Reserve today announced the following set of policy actions:</p> <ul style="list-style-type: none"> <li>• The Board of Governors approved a reduction in the discount rate by 25 basis points from 4-3/4 percent to 4-1/2 percent.</li> <li>• The federal funds rate is expected to fall 25 basis points from around 5 percent to around 4-3/4 percent.”</li> </ul>	1	0
December 22, 1998	No statement	0	1
February 2/3, 1999	No statement	0	1
March 30, 1999	No statement	0	1
May 18, 1999	<p>“While the FOMC did not take action today to alter the stance of monetary policy, the Committee was concerned about the potential for a buildup of inflationary imbalances that could undermine the favorable performance of the economy and therefore adopted a directive that is tilted toward the possibility of a firming in the stance of monetary policy.”</p>	1	0
June 29/30, 1999	<p>“The Federal Open Market Committee today voted to raise its target for the federal funds rate 25 basis points to 5 percent. Last fall the Committee reduced interest rates to counter a significant seizing-up of financial markets in the United States. Since then much of the financial strain has eased, foreign economies have firmed, and economic activity in the United States has moved forward at a brisk pace. Accordingly, the full degree of adjustment is judged no longer necessary.”</p>	1	0

Meeting date	Policy result as presented in a policy statement	F1 <sup>#</sup>	F2 <sup>#</sup>
August 24, 1999	“The Federal Open Market Committee today voted to raise its target for the federal funds rate by 25 basis points to 5-1/4 percent. In a related action, the Board of Governors approved a 25 basis point increase in the discount rate to 4-3/4 percent.”	1	0
October 5, 1999	“The Federal Open Market Committee decided today to leave its target for the federal funds rate unchanged.”	0	1
November 16, 1999	“The Federal Open Market Committee today voted to raise its target for the federal funds rate by 25 basis points to 5-1/2 percent. In a related action, the Board of Governors approved a 25 basis point increase in the discount rate to 5 percent.”	1	0
December 21, 1999	“The Federal Open Market Committee made no change today in its target for the federal funds rate.”	0	1

<sup>#</sup> F1 equals 1 if the FOMC statements is accompanied by a change in the target Federal Funds rate,; 0 otherwise.

F2 is the complementary class of FOMC statements and equals 1 - F1.