Public Information, Price Volatility and Trading Volume in US Bond Markets

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1. Introduction

The market axiom that "it takes volume to make prices move" has important implications for financial markets and asset price behaviour.[1] As such, a considerable theoretical and empirical literature has evolved that investigates the nature of the relationship between trading volume and price dynamics.

The theoretical literature focuses on the sequential information arrival hypothesis and the mixture of distributions hypothesis, both of which imply a positive relationship between volume and price changes (see Kocagil and Shachmurove, 1998, for discussion). Testing of these two theories has failed to find in favour of one over the other, and often produce results which suggest that both may possess explanatory power (see, inter alia, Mahieu and Bauer, 1998, Darrat, Rahman and Zhong, 2003 Li and Wu, 2006, Darrat, Zhong and Cheng, 2007).

The early empirical research on this issue suggests that while the causality implicit in the adage is questionable, a relationship between prices and volume exists for a wide variety of assets and markets (see Karpoff, 1987, for a survey). More recent research however, suggests that the nature of the relationship may be more complicated than was first thought. For example, Jones, Kaul and Lipson (1994) find that it is the number of transactions and not trading volume that is important. Xiaoqing and Wu (1999) conclude that both the frequency of transactions and the average trade size are important factors in explaining return volatility.

More importantly, a number of papers have questioned the significance and nature of the relationship between volatility and volume. For example, Chan and Fong (2000) find that when controlling for order imbalance, the relationship between volume and volatility is less pronounced. In a related paper, Daigler and Wiley (1999) distinguish between different types of traders and conclude that the trading activities of the general public, who do not have access to order flow information, are responsible for the positive relationship between volume and volatility. Other papers have also pursued this theme of asymmetric information and have produced results that call into question the assumed nature of the relationship between volatility and volume. For example, Li and Wu (2006) argue that the relationship between volatility and volume is driven by the informed component of trading. They control for information flow and find that volatility is negatively related to trading volume. Kiymaz and Berument (2003) generate a similar result in their study of daily data for five major stock market indices sampled. They find that the days with the highest volatility typically have the lowest trading volume. Foster and Viswanathan (1990) argue that this negative relationship is the result of liquidity traders leaving the market in periods of high volatility.

This issue is further complicated by the evidence of Fleming and Remolona (1999) who find that prices may move in the absence of trading volume.[2] The authors

[1] The importance of volume in understanding price dynamics is highlighted by the research of Lamoureaux and Lastrapes (1990) who find that volume can account for the presence of ARCH effects. Subsequent research however, suggests that volatility clustering may persist even when volume is considered (see Fleming, Kirby and Ostdiek, 2006, and Gillemot, Farmer and Lillo, 2006).

[2] Kalimipalli and Warga (2002) study US corporate bonds and find volatility is positively related to spreads and volume is negatively related to spreads.

empirically investigate the impact of macroeconomic news announcements on US bond markets.[3] Goodhart and O'Hara (1997) argue that bond markets present an ideal environment for this type of study as they are arguably the most important financial market for transmitting news on macroeconomic conditions. Fleming and Remolona (1999) find that the arrival of news to the market produces a near instantaneous price change with a corresponding reduction in volume. This is shortly thereafter followed by a second stage in which volumes increase and volatility persists. Thus, Fleming and Remolona (1999, p 1902) state that "price reactions to public information do not require trading".

The purpose of this paper is to revisit the results of Fleming and Remolona (1999) and reassess the role of volume in bond price discovery. We argue that an empirical study that focuses on the physical bond markets response to news announcements does not fully capture the dynamics of the bond price discovery process. Specifically, the trading cost hypothesis suggests that informed traders will choose to exploit their informational advantage in the futures market (see *inter alia* Kawaller, Koch and Koch, 1987, and Stoll and Whaley, 1990, Fleming, Ostdiek and Whaley, 1996). Thus, bond price discovery will take place, not in the cash market, but in the futures markets. Brandt, Kavajecz and Underwood (2006) and Chung, Campbell and Hendry (2007) provide evidence on the importance of the futures market in bond price discovery.

In this paper, we empirically assess the price and liquidity of US treasury bond and bond futures markets at the time of important macroeconomic news announcement releases. We argue that price discovery takes place in the futures market where the standard positive volume and volatility responses to news are expected. The physical bond market observes the response of the futures market to the news and adjusts prices to restore equilibrium. This cash market price response however, will take place in the absence of any significant increase in trading volume. This is because the markets reponse to the news is revealed to the cash market, not by its own trading as is the standard case, but by the trading of informed participants in the futures market who provide a price signal from which the physical market updates is prices.

To test this hypothesis, we focus on high frequency data for the 10-year US treasury bond sampled over the period January 2, 2002 to September 29, 2006. The bond price data is sourced from the Cantor-Fitzgerald eSpeed database and a full description of this data may be found in Dungey McKenzie and Smith (2007). A matched bond futures database is sourced directly from the U.S. Commodity Futures Trading Commission (CFTC). Using this data, we investigate the price and trading volume response to major macroeconomic news announcements. The results suggest that a large increase in bond price volatility is observed in the minute immediately following a news announcement and volatility remains high. While an increase in trading activity is observed in the minute of the news release, a much large response is observed in the minute following the news release. These results should not be

[3] F&R form a part of a much larger literature that looks at the impact of scheduled macroeconomic news announcements on the stock market (see inter alia Pearce and Roley, 1983, 1985, French and Roll, 1986, McQueen and Roley, 1993, Sun and Tong, 2000), the foreign exchange rate market (see inter alia Ito and Roley, 1987, Hardouvelis, 1988, Ederington and Lee, 1994, DeGennaro and Shreives, 1997, Almeida, Goodhart and Payne, 1998), and the bond market (see inter alia Becker, Finnerty and Kopecky, 1996, Jones, Lamont and Lumsdaine, 1998, Fleming and Remolona, 1999a).

interpreted however, as suggesting that it doesn't take volume to move bond prices. To understand why, we consider a matched database of 10-year treasury futures price and trading information. An examination of this data reveals that for futures, a similar increase in futures and cash price volatility is observed at the time of an announcement. Most importantly, an immediate and large jump in futures trading intensity and volume is observed in the minute following an announcement. Thus, the old addage applys, however in this case it might more aptly be states as "it takes futures trading volume to move bond prices".

2. Treasury Market Data

Until recently, most US bond market research has focussed on data sampled from the GovPx database. In 2000 however, the US Treasury market underwent a number of changes that resulted in a significant drop in the coverage of the GoxPx database. In its place the Cantor Fitzgerald eSpeed and the ICAP BrokerTec databases have emerged. These two new bond databases represent a boon for bond related research as they overcome many of the problems of the GovPx database in terms of identifying trades and calculating volume. Further, Mizrach and Neely (2006) suggest that there are qualitatively few differences between eSpeed and BrokerTec and that both provide a reliable representation of the state of the market at any given point in time.

In this paper, on-the-run 10-year US treasury bond data is sourced from the Cantor database beginning with the first available observation on January, 2 2002 to September 29, 2006.[4] The data has been filtered to remove US public holidays leaving a sample of 1,166 days and X million trades, which averages to over X thousand trades each day.

For each day, trading data for the the 10-year bond is sampled at a one minute frequency. To gain an appreciation of this data, Figure 1 plots the daily closing 10-year bond price over the sample period. This price information is converted to returns using the log price relative and to aid interpretation is rescaled by a factor of 1,000. A summary descriptive statistics for this data as well as the trading volume and intensity is presented in Table 1. The mean return over the period is only 0.00026 with a standard deviation of 0.534 (ie. 0.0534%). There are some large price movements in the series that are associated with changes in the on-the-run bond and the maximum is 6.7159%. The largest negative price movement is a price fall of -4.5009%. This returns data is found to exhibit positive skewness and excess kurtosis and fails the Jarque-Bera test of normality.

This one minute cash market data is matched to a corresponding database of US 10-year treasury bond futures data sampled from the Chicago Board of Trade (CBOT). This futures contract is for one unit of the underlying with a face value of US$100,000 and a minimum time to maturity of 6.5 years. The contract expires quarterly on a March rotation and the last trading day is the seventh business day preceeding the last business day of the delivery month. Settlement is by physical delivery of the underlying asset.

[4] A trading day is defined as starting at 07:30 and finishing at 17:30, where all time references are US EST denoted with a 24 hour clock.

A plot of this bond futures price data is presented in Figure 1 and, as expected, the two series are highly correlated. These price data are converted to returns using a log differential filter and a summary of the transformed data as well as trading volume and intensity is presented in Table 1. The mean futures return (0.00015) and the standard deviation (0.0311) are both less than the equivalent metrics for the cash series. A number of large futures price changes are present in the series and these coincide with the aforementioned bond price jumps around the time of a change in the referernce on-the-run bond. While the futures returns series fails the jarque-Bera test of normality, it is interesting that the level of excess kurtosis is less compared to the bond returns data and the series is negative skewed.

3. The Price Response of US 10-Year Bonds to Macroeconomic News

A wide variety of regularly scheduled macroeconomic announcements occur throughout the year and Table 2 presents a summary of the top 48 (all?) main news items including their source, frequency and the time of their release. This information is used to categorise the sample period into non-announcement and announcement days, ie. those days on which at least one announcement is made. For the sample of 1,166 trading days, 1,366 announcements occurred on 1,020 days leaving a sample of 146 non-announcement days. It is interesting to note that a large number of announcements occur across all of the days-of-the-week, although a bias does exist towards announcements being made in the second half of the week. More specifically, 12% of all announcements occurred on a Monday, 19% occurred on a Tuesday or a Wednesday, 23% occurred on a Thursday and 27% on a Friday.

Some of these announcements will be more keenly followed by the market compared to others. As such, the scope of this study is limited to consider only the most important news items. Following Fleming and Remolona (1999), the producer price index, consumer price index and employment announcements are selected, as the literature has found them to have a significant impact on the Treasury market (see Fleming and Remolona, 1997). Specifically, the whole economy unemployment rate (UE) is compiled by the Bureau of Labor Statistics and is released at 8:30 A.M. (EST) in the first week after month-end.[5] National consumer price index (CPI) data (U.S. city averages) are released each month by the Bureau of Labor Statistics at 08:30 (EST), approximately 2 weeks after the reference period. Finally, information relating to the producer price index (PPI), also compiled by the Bureau of Labor Statistics, is released at 08:30 (EST) on or near the day preceding the release of the CPI figures. Of the 1,366 announcements made during the sample period, X of them were PPI, CPI or UE announcements giving a total of X announcement days (*these should be the same number!*).

We characterise the bond market response to these macroeconomic announcements using a minute by minute analysis of trading around the time of these announcements and compare it to an equivalent set of data sampled across non-announcement days. To construct this minute by minute data, the following procedure is adopted. On each

[5] The unemployment rate data were announced along with other employment statistics such as employment numbers, changes in the labour force, number of hours worked, in a document entitled Employment Situations (labelled ‘Employment Report’ in Anderson and Bollerslev, 1998) released by the Bureau of Labor Statistics.

trading day in the sample, 10-year bond price and volume data is sampled in one-minute intervals commencing at 08:25 and finishing at 08:36. Within each interval, the last traded price is recorded as well as the total number of trades and the aggregate trading volume. Returns to the 10-year bond are calculated as the log change of the last traded price in each interval. The volatility of these price changes is proxied by the standard deviation of the returns series.

Panel A of Table 1 presents a summary of the price volatility information. Across the entire sample of all news and non-news trading days, the average price volatility in the 08:25 -08:26 interval is 0.187 and this remains fairly constant until the 08.30 interval is reached. In the first 1-minute after 08.30 however, price volatility increases markedly to almost five times its level in the prior minute (1.336). This increase in volatility is fairly short lived however, as in the next inverval of 08:31-08:32, the observed average level of volatility is less. Volatility continues to fall across each successive minute until the final interval of 08:35-08:36, where the standard deviation of returns has returned to a level that is similar to that observed in the minute immediately prior to 08:30. Thus, it is clear that there is a sudden spike in price volatility around 08.30, which is the time at which the CPI, PPI and UE announcements are made.

The next two rows of Panel A, present the same set of information distinguishing between macroeconomic announcement and non-announcement days. For the days on which PPI, CPI and UE announcements are made, the average level of price volatility in the 08:25-08:26 interval is actually lower than for the non-news days, ie. 0.184 compared to 0.223 respectively. The ratio of announcement day to non-announcement day standard deviations in this interval is 0.826. As the time to announcement draws closer however, the price volatility of the announcement day data increases such that in the trading interval immediately prior to the announcement, the volatility has increased threefold. The non-announcement day price volatility however remains constant across the same period of time. Thus, the standard deviation ratio has increased from 0.826 to 2.735 in the minute immediately prior to the announcement minute.

At the time of the announcement, the price volatilty of the announcement days increases by over 500% to 2.943, whereas no discernible change in the non-announcement day price volatility is evident in the announcement minute or any other following trading interval. The standard deviation ratio increases to 13.115 in the announcement minute and falls successively thereafter. This trend is driven by the spike in price volatility on announcement days in the 1-minute interval immediately following 08.30. While the level of observed volatility decreases in each interval, it does not fall to its preannouncement levels by the time of the last trading interval at 08:35-08:36 and that standard deviation ratio remains above 2. Thus, clear evidence of large price movements in the 1-minute trading interval immediately after 08.30 is found, which is driven by the release of CPI, PPI or UE macroeconomic news.

Panel B of Table 1 presents the average aggregate trading volume within each 1-minute trading interval for all days in the sample as well as announcement and non-announcement days. On non-announcement days, the aggregate trading volume is 31.053 contracts on average in the 08.25-08.26 interval. This is 15.343 contracts less than the average aggregate trading volume on macro news announcement days in the same interval (46.396). As the 08.30 trading interval draws nearer, the average trading volume in the non-announcement data remains fairly constant. The announcement day average volume estimate actually falls slightly in the interval immediately prior to 08.30 however, such that the difference in means falls to 11.226 in the 08.29-08.30 interval.

In the 08.30-08.31 trading interval, the average aggregate trading volume on announcement days increases by a factor of 3 to 126.353, while the average trading volume of the announcement days is typically the same in this (and all successive) interval(s). Thus, the difference is means rises to 93.383. In the next trading interval however, the average aggregate trading volume increases again such that the trading volume for announcement days in the 08.31-08.32 interval is an average of 172.083 contracts and the difference in means increases to 135.583. Thus, while the average aggregate trading volume does increase in the first minute following a macroeconomic news announcement, a greater level of trading volume is observed in the 08.31-08.32 interval. In fact, the average aggregate trading volume is greater in every 1-minute interval from 08.31 to 08.36 than in the minute immediately after the actual announcement.

A summary of the average number of trades in each one minute inerval in presented in Panel C of Table 1. For non-announcement days, the average number of trades ranges between 7 and 9 trades per minute. On announcement days, a similar number of trades is observed in the intervals leading up to the announcement however, after the announcement the number of trades increases threefold to 30 in the 08.30-08.31 interval and similar levels of trading intensity are observed thereafter.

Thus, the 10-year bond market market data suggests that on non-macroeconomic announcement days, the price volatility, trading volume and trading intensity do not vary much over the time period 08.25-08.36. Where a macro news announcement is released to the market however, a large increase in price volatility is observed in the minute immediate following the announcement and volatility remains above preannouncement levels over the next five minutes of trading. The trading volume response to the macroeconomic news announcement however, does not necessarily coincide with the price movements. Specifically, while an increase in trading activity is observed in the minute of the news release, a much large response is observed in the minute following the news release.

One interpretation of these results is that it doesn't take volume to move bond prices, which is in essence the conclusion of Fleming and Remolona (1999).[6] In this paper however, we argue that to fully understand the price dynamics of bond markets around the time of macroeconomic news announcements, the role of the futures markets must be taken into account and we explore this hypothesis in the following section.

[6] Fleming and Remolona's (1999) results are somewhat different to the extent that they did not find any significant change in trading volume in the minute of the announcement, and a significant decrease in the trading volume in the minute after the announcement when comparing news to non-news days.

4. The Role of Futures Markets in Treasury Price Discovery

To investigate the role of the futures market in the act of bond price discovery, a database of CFTC futures prices and trading volume is assembled. This futures contract is written against the 10 year Treasury bond, whose trading dynamics were explored in Section 3. Thus, for the sample of announcement and non-announcement days, 10-year bond futures price and volume data is sampled in one-minute intervals commencing at 07:25 and finishing at 07:36. Note that the CFTC 10-year bond futures contract is traded in Chicago, which is 1 hour behind the New York based cash market. Thus, the first trading interval in the futures market is 07.25-07.26 Chicago time, which corresponds to 08.25-08.26 New York time. Within each interval, the last traded price is recorded as well as the aggregate trading volume and the total number of trades. The volatility of the returns to the 10-year bond future is proxied by the standard deviation of the returns series.

Panel A of Table 1 presents a summary of the price volatility information. In the first trading interval of 07.25-07.26, the futures price volaitlity is lower on announcement days compared to non-announcement days. The futures price volatility increases across each successive trading interval however, such that the standard deviation ratio increases form 0.851 to 7.449 in the minute immediately prior to the announcement. This trend is similar to that which is observed in the cash market, however, the increase in price volatility immediately prior to the announcement is more pronounced in the futures market. For the minute immediately prior to the announcement, the standard deviation ratio is 2.735 in the cash market, whereas it is 7.449 in the futures market.

In the first trading minute after the announcement, the price futures volatility increases to an average of 3.089 and this increase is similar to that observed in the cash market where price volatility rose to 2.943 (the standard deviation ratio of the futures market is 12.023, which is slighly less than the cash market ratio of 13.115). The jump in futures price volatiltity exhibits less persisitence compared to the cash market however, as price volatility in the 07.31-07.32 interval is less than one, whereas the cash market did not return to this level for another two minutes.

The average aggregate futures trading volume in each interval is summarised in Panel B of Table 2. The level of futures trading is higher for announcement days compared to non-announcement days in every trading interval prior to 07.30. In particular, the minute immediately prior to the announcement exhibits a noticable jump in trading volume in what appears to be some last minute position taking by traders. The difference in means in the 07.29-07.30 is over 150% higher than the average for the previous four trading intervals. This increase in trading is minor however, when compared to the increase in futures trading in the minute of the news announcement. The aggregate trading volume for all announcement days increases almost six fold to an average of 10,219.549 contracts and the difference in means increases from 788.832 to 9,260.318 contracts. By way of contrast, the trading volume on non-announcement days is generally unchanged over this trading window. While the level of trading volume falls in the following minute to 7,280.445 contracts, it remains higher for the remainder of the sample period when compared to the levels of observed pre-07.30 trading volume.

The average number of trades (Panel C of Table 4) produces a qualitatively similar set of results to the trading volume. That is, the average number of trades on announcement days is greater compared to non-announcement days. Further, a jump in trading intensity is observed in the minute prior to 07.30, which is not observed on non-news days. In the minute following an announcement, the number of trades increases over 500% to an average of 329 trades per minute and the trading intensity remains higher to the end of the observed trading intervals.

Thus, for the bond futures market, the pre-announcement price volatility increases by more in comparison to the cash market. At the time of an announcement however, a similar increase in futures and cash price volatility is observed. The persistence of this volatility increase however, is greater in the cash market suggesting the futures market prices respond faster to the news. In addition to these differences in volatility, an important difference in futures trading volume and intensity is observed. That is, unlike the bond cash market, an immediate and large jump in trading volume and the number of trades is observed on announcement days. By way of contrast, the same set of trading measures do not exhibit any real change over the observed one-minute trading intervals.

5. Conclusion

A substantial literature has developed that investigates the relationship between prices and volume. A particularly interesting contribution to this literature came from Fleming and Remolona (1999) who investigated the US Treasury market and found that prices may move in the absence of trading volume. In this paper, we reassess the role of trading volume in bond price discovery and argue bond price discovery takes place in the futures markets.

To test this hypothesis, we begin by sampling 10-year bond data over the period 2002 to 2006. A sample of macroeconomic news announcement and non-announcement days is selected and summary statistics within 1-minute intervals around the 08.30 announcement time are presented. The results suggest that on non-macroeconomic announcement days, the price volatility, trading volume and trading intensity do not vary much around the announcement time. Where a macro news announcement is released to the market however, a large increase in price volatility is observed in the minute immediate following the announcement and volatility remains high, in particular over the next two minutes of trading. While an increase in trading activity is observed in the minute of the news release, a much large response is observed in the minute following the news release. In the absence of any further information, these results may be interpreted as suggesting that it doesn’t take volume to move bond prices.

Recognising the potential for price discovery in the bond futures market, a matching database of 10-year treasury futures price and trading information is sampled. An examination of this data reveals that for futures, a similar increase in futures and cash price volatility is observed at the time of an announcement. The persistence of this volatility increase however, is greater in the cash market suggesting the futures market prices respond faster to the news. Most importantly, an immediate and large jump in futures trading intensity and volume is observed in the minute following an announcement.

Thus, we conclude that bond markets do not possess a special set of price dynamics that distinguish them from other asset markets. Previous research that has considered the cash market in isolation is misleading and once the price discovery role of futures markets is taken into account, volume and price in bond markets are closely related.

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Figure 1
10-year Treasury Bond and Futures Price

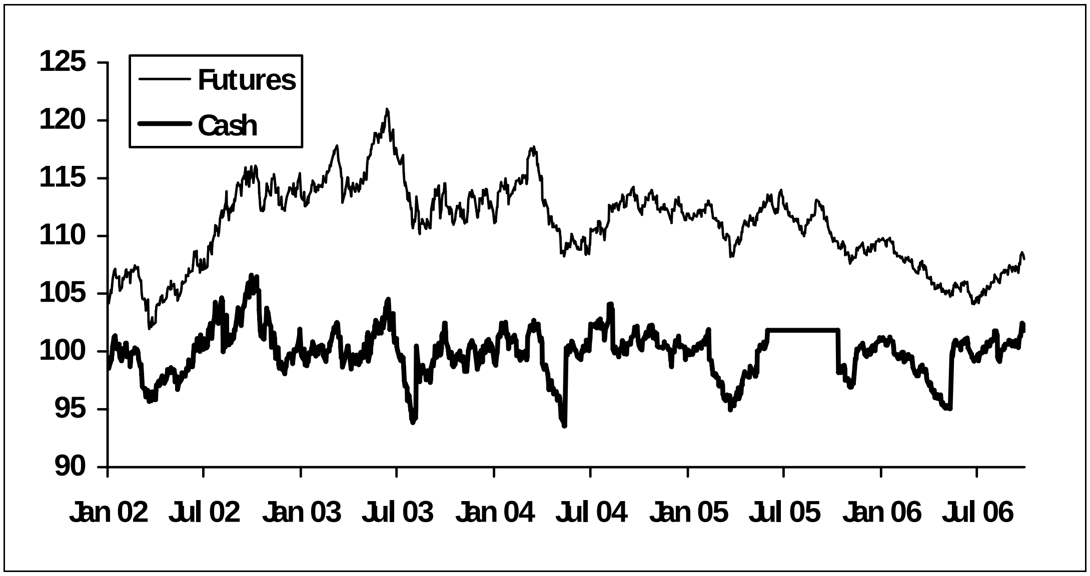

Table 1

US 10-year Treasury Bond and Futures Descriptive Statistics

This table summarises the returns data (rescaled by a factor of 1,000) for a 10-year bond and its corresponding futures contract sampled over the period Jan. 2002 – Sept. 2006.

	Bond Returns	Futures Returns
Mean	0.00026	0.00015
Median	0.000	0.000
Maximum	67.159	15.958
Minimum	-45.009	-21.123
Std. Dev.	0.534	0.311
Skewness	13.002	-3.985
Kurtosis	3461.711	490.367
Jarque-Bera P-value	0.000	0.000

Table 2
List of Macroeconomic Announcements

Announcement	Source	Frequency	Time
Federal Funds Rate (target)	Federal Reserve	8 p.a.	2.15pm
Gross Domestic Product Annualised	Bureau of Eco. Analysis	Quarterly	8.30am
Producer Price Index	Bureau of Labor Stats.	Monthly	8.30am
Nonfarm Payrolls	Bureau of Labor Stats.	Monthly	8.30am
Unemployment Rate	Bureau of Labor Stats.	Monthly	8.30am
Retail Sales	U.S. Census Bureau	Monthly	8.30am
Trade Balance	U.S. Census Bureau	Monthly	8.30am
Consumer Credit	Federal Reserve	Monthly	3.00pm
Factors Affecting Reserve Balances	Federal Reserve	Weekly	4.30pm
Industrial Production	Federal Reserve	Monthly	9.15am
Capacity Utilization	Federal Reserve	Monthly	9.15am
Money Stock Measures	Federal Reserve	Weekly	4.30pm
Consumer Price Index	Bureau of Labour Stats.	Monthly	8.30am
Housing Starts	U.S. Dept. of Commerce	Monthly	8.30am
Building Permits	U.S. Dept. of Commerce	Monthly	8.30am
NAHB Housing Market Index	Nat. Assoc. of Home Builders	Monthly	1.00pm
Business Inventories	U.S. Census Bureau	Monthly	10.00am
ABC Consumer Confidence	ABC News Washington Post	Weekly	5.00pm
MBA Mortgage Applications	Mortgage Bankers Assoc.	Weekly	7.00am
Initial Jobless Claims	Department of Labour	Weekly	8.30am
Continuing Claims	Department of Labour	Weekly	8.30am
Leading Indicators	Conference Board	Monthly	10.00am
Philadelphia Fed	Philadelphia Fed. Reserve	Monthly	12.00pm
S&P/CS Composite 20 Home Price Index	Case-Shiller	Monthly	9.00am
ISM Manufacturing	Institute for Supply Management	Monthly	10.00am
ISM Prices Paid	Institute for Supply Management	Monthly	10.00am
Pending Home Sales MoM	National Assoc. of Realtors	Monthly	10.00am
Challenger Job Cuts	Challenger, Gray & Christmas	Monthly	7.30am
ADP Employment Change	Automatic Data Processing Inc.	Monthly	8.15am
Construction Spending MoM	U.S. Census Bureau	Monthly	10.00am
Factory Orders	U.S. Census Bureau	Monthly	10.00am
Total Vehicle Sales	Bloomberg Indices	Monthly	N/A
Domestic Vehicle Sales	Bloomberg Indices	Monthly	N/A

ISM Non-Manufacturing	Institute for Supply Management	Monthly	10.00am

Table 2 (Cont.)
List of Macroeconomic Announcements

Announcement	Source	Frequency	Time
Wholesale Industries	U.S. Census Bureau	Monthly	10.00am
Import Price Index MoM	Bureau of Labor Statistics	Monthly	8.30am
Monthly Budget Statement	U.S. Treasury	Monthly	2.00pm
Empire Manufacturing	Federal Reserve	Monthly	8.30am
Net Foreign Security Purchases	U.S. Treasury	Monthly	9.00am
University of Michigan Confidence	University of Michigan Research	Monthly	9.45am
Richmond Fed Manufacturing Index	Richmond Fed	Monthly	10.00am
Existing Home Sales	National Association of Realtors	Monthly	10.00am
Durable Goods Orders	U.S. Census Bureau	Monthly	8.30am
Help Wanted Index	Conference Board	Monthly	10.00am
New Home Sales	U.S. Census Bureau	Monthly	10.00am
Personal Income	Department of Commerce	Monthly	8.30am
Personal Spending	Bureau of Economic Analysis	Monthly	8.30am
Employment Cost Index	Bureau of Labor Statistics	Quarterly	8.30am

Table 3

Dynamics of Bond Price Volatility, Trading Volume, and the Number of Trades across One-Minute Intervals, 2002-2006

	8:25-8:26	8:26-8:27	8:27-8:28	8:28-8:29	8:29-8:30	8:30-8:31	8:31-8:32	8:32-8:33	8:33-8:34	8:34-8:35	8:35-8:36
						Panel A: Price Volatility					
All	0.187	0.217	0.214	0.249	0.282	1.336	0.963	0.544	0.362	0.323	0.290
Announcement Day	0.184	0.345	0.338	0.478	0.552	2.943	2.130	1.171	0.660	0.531	0.450
Nonannouncement Day	0.223	0.211	0.214	0.211	0.202	0.224	0.253	0.236	0.235	0.233	0.198
Standard Deviation Ratio	0.826	1.632	1.575	2.269	2.735	13.115	8.429	4.958	2.807	2.277	2.275
						Panel B: Trading Volume					
All	36.540	36.878	39.114	37.965	36.315	74.887	83.334	75.592	71.921	71.063	67.437
Announcement Day	46.396	46.325	48.506	48.059	42.232	126.353	172.083	146.314	149.699	149.353	133.218
Nonannouncement Day	31.053	35.373	31.583	31.876	31.006	32.970	36.500	36.224	35.128	35.753	33.090
Difference in Means	15.343	10.952	16.924	16.182	11.226	93.383	135.583	110.090	114.571	113.600	100.128
						Panel C: Number of Trades					
All	9	9	9	9	9	18	18	17	16	16	15
Announcement Day	10	10	10	11	9	30	33	30	30	31	26
Nonannouncement Day	8	8	7	8	7	7	8	9	8	8	7
Difference in Means	3	2	3	3	2	23	24	21	21	23	19

Note: One-minute log price change standard deviations, trading volume means and number of trades means are reported and compared for announcement and nonannouncement days for bond prices. The reported log price change standard deviation is the actual standard deviation times 1000. Announcement days are defined as those with a consumer price index, employment price index, or producer price index announcement but no other announcements. Nonannouncement days are those with no 48 different types of announcements (US announcement dates rev.xls lists all 48 announcements). All one-minute intervals between 8:25 and 8:36 a.m. are examined. The period of analysis is January 2, 2002 to September 29, 2006.

Table 4

Dynamics of Futures Price Volatility, Trading Volume, and the Number of Trades across One-Minute Intervals, 2002-2006

	7:25-7:26	7:26-7:27	7:27-7:27	7:27-7:29	7:29-7:30	7:30-7:31	7:31-7:32	7:32-7:33	7:33-7:34	7:34-7:35	7:35-7:36
						Panel A: Price Volatility					
All	0.158	0.211	0.180	0.249	0.640	1.302	0.429	0.392	0.309	0.301	0.287
Announcement Day	0.165	0.227	0.232	0.488	1.662	3.089	0.881	0.748	0.570	0.548	0.516
Nonannouncement Day	0.194	0.177	0.198	0.263	0.223	0.257	0.248	0.201	0.217	0.215	0.180
Standard Deviation Ratio	0.851	1.283	1.174	1.854	7.449	12.023	3.555	3.712	2.622	2.544	2.864
						Panel B: Trading Volume					
All	1358.405	1228.516	1068.702	1175.414	1214.585	4896.810	3362.515	2828.111	2736.789	2584.333	2449.198
Announcement Day	1215.396	1193.348	1078.275	1180.791	1734.154	10219.549	7280.445	6081.417	5646.566	5399.221	4974.388
Nonannouncement Day	985.686	1013.157	906.057	871.205	945.323	959.231	1016.771	1060.487	1045.522	987.058	998.761
Difference in Means	229.710	180.191	172.218	309.586	788.832	9260.318	6263.675	5020.929	4601.044	4412.163	3975.627
						Panel C: Number of Trades					
All	26	26	26	27	33	129	75	62	58	54	52
Announcement Day	31	31	34	40	62	329	186	152	132	122	117
Nonannouncement Day	20	22	21	19	20	22	20	23	23	21	20
Difference in Means	11	9	13	20	42	307	166	129	109	101	97

Note: One-minute log price change standard deviations, trading volume means and number of trades means are reported and compared for announcement and nonannouncement days for futures prices. The reported log price change standard deviation is the actual standard deviation times 1000. Announcement days are defined as those with a consumer price index, employment price index, or producer price index announcement but no other announcements. Nonannouncement days are those with no 48 different types of announcements (US announcement dates rev.xls lists all 48 announcements). All one-minute intervals between 7:25 and 7:36 a.m. are examined. The period of analysis is January 2, 2002 to December 29, 2006. Rows with missing volume and number of trades observations are omitted.