Price and Volume Response to Public Information *

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Abstract

It is well known that public information affects prices before anyone can trade on it (French and Roll (1986)). In contrast, several models assuming heterogeneous investors show that a public news release is directly followed by a high trading volume. This paper examines the process of price adjustment to public news in an electronic limit order market. The problem is analysed based on a very precise data set from the largest European bond futures market and a higher frequency than in all previous empirical studies on this issue. I find that the price response to public news occurs through trading. Good news releases are initially followed by a large buying and bad news releases by a large selling activity observed already in the first ten seconds after an event.

Keywords: macroeconomic announcements; market microstructure; volatility; trading volume; bid-ask spread;
JEL classification: E44; G14

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1 Introduction

The way in which new information is incorporated into prices is one of the most important issues in the market microstructure theory. When all market participants receive the same signal, are prices being revised *before* anyone can trade? Or does the trading behavior of investors drive prices so that they adjust to a new equilibrium *through* trading? These two contradictory scenarios can be derived from different theoretical models. However, little empirical evidence on this issue has been found so far. This paper examines the process of price adjustment to new public information in an electronic limit order market and tests whether this adjustment occurs before or through trading.

In their seminal paper French and Roll (1986) postulate that public information affects prices before anyone can trade on it. This prediction is based on the assumption that agents interpret public announcements identically and that everybody receives the information at the same time. Therefore, everyone has the same judgement about the new fair price and nobody is willing to buy above or sell below it. In contrast, several models assuming heterogeneous investors state that public information releases are directly followed by a high trading volume. Kim and Verrecchia (1991a, 1991b) show that abnormal trading occurs only if there is some type of asymmetry among investors, either in their risk aversion or private information. After a public news release, investors revise their beliefs and the average change is reflected in the price movement. Differences in belief revision cause trading.[1] He and Wang (1995) generalize the model of Kim and Verrecchia (1991b) to a multiperiod dynamic setting and show that exogenous public information generates trading if investors have differential information about the true value of the stock.[2] A related argument is provided by Foster

[1] Differences in belief revision occur because, for example, new information is relatively less important to the better informed investors than to the worse informed investors.

[2] They show that the trading volume is closely related to the flow and the nature of information. In their model, exogenous information includes new private signals and public announcements while endogenous information is simply the observed market-clearing price. Private information not only generates trading in the current period, but also leads to possible trading in future periods. Public information generates trading mainly in the current period. Moreover, the volume generated by the exogenous information, private or public,

and Viswanathan (1993) who show that if public information is substantially different from investors' expectations, the trading volume increases.[3] In the model of Kim and Verrecchia (1991a), mere differences of opinion among investors can cause trading after news releases even if new information is immediately reflected in prices. A similar argument is provided by Kandel and Pearson (1995) who assume that agents interpret an announcement differently and thus trade intensively after an event. Another strand of literature providing supporting arguments assumes sequential information diffusion where investors have different access to new information (e.g. Copeland (1976) or Fellingham, Jennings, and Starks (1981)).

While a substantial body of theoretical literature on price formation concerns market-maker markets, only a few models analyse electronic limit order markets where liquidity arises endogenously from the submitted orders.[4] In such markets, traders can either provide liquidity, i.e. submit orders to buy or sell at a particular price (limit orders), or they can absorb liquidity, i.e. hit unexecuted limit orders with a new market order. Foucault, Kadan, and Kandel (2005) model the interaction of patient and impatient traders and show that the first group tends to choose limit orders while the second group prefers market orders.[5] While market makers provide liquidity in price driven markets, patient traders can be seen as liquidity suppliers in limit order markets since they offer the volume at a limit price and wait for transactions.

Empirical studies for various markets include the results supporting each of the two theoretical predictions regarding the price and trading response to public news. Increased trading on the stock market on days with public earnings announcements is documented in Lee, Mucklow, and Ready (1993) and Kandel and Pearson (1995). Love and Payne (2008) analyse intraday

is always accompanied by large price changes, while the volume generated by the existing information is not.

[3]This result is obtained when the beliefs of perfectly informed traders are represented by elliptically contoured distributions.

[4]Bloomfield, O'Hara, and Saar (2005), Section 2, provide a very good discussion of the literature on limit order markets.

[5]Traders differ in their costs of delaying execution: patient traders have low waiting costs and impatient traders have high waiting costs.

trading and order flow patterns in the forex market and show that on average one third of the final price reaction to news comes via the order flow channel. The impact of macroeconomic news releases on the bond market is examined in Balduzzi, Elton, and Green (2001). They find that the trading volume increases significantly already in the first 5-minute interval after an information event and remains high through an hour afterwards.[6] Fleming and Remolona (1999), who use the U.S. Treasury market data describing the interdealer broker activity, confirm these results for the same frequency. However, they also analyse trading for 1-minute intervals and find that announcements induce a sharp and immediate price change with a reduction in the trading volume and widening spreads. This demonstrates that the price reaction directly after news releases does not require trading (French and Roll (1986)). A few minutes afterwards, the trading volume surges, volatility persists and spreads remain moderately wide as investors trade to reconcile individual differences of opinion (Kim and Verrecchia (1991a)). This paper examines the process of price adjustment to new public information using a very long and precise data set and the frequency higher than in all previous empirical studies on this issue. Furthermore, this paper is the first one to study the price and trading response to announcements in a limit order market in such detail.

I use data on the German Bund Future which is one of the most liquid titles traded electronically at the Eurex, the world's largest futures market. In contrast to Fleming and Remolona (1999), I focus on an electronic limit order market. This data set is very precisely time-stamped and spans over a very long period, i.e. 15 years. Additionally, this market operates long before the U.S. news arrive so that disturbing opening effects can be excluded. I investi-

[6]Other empirical results in line with the prediction that public information is incorporated into prices through trading can be found in the event studies that explore the informativeness of the order flow for prices. Brandt and Kavajecz (2004) find that the order flow accounts for up to 26% of the variation in yields on days without major macroeconomic announcements. Green (2004) examines the effect of the order flow on intraday bond price changes surrounding U.S. macroeconomic news announcements. Pasquariello and Vega (2007) show theoretically and empirically that bond yield changes are higher correlated with the unanticipated order flow when the dispersion of beliefs across informed traders is high and the public announcement is noisy. Evans and Lyons (2008) investigate the daily order flow and price changes in the forex market and find that the two-thirds of the macro news' effect on currency prices is transmitted via order flow, the remainder being the direct effect of news.

gate the price and volume reaction during the periods of exceptionally high information flow, i.e. the releases of the U.S. Employment Report. Particularly, analyst forecasts and actual releases for two headline figures (the nonfarm payroll employment and the unemployment rate) are available and therefore unanticipated information flow can be observed. The further advantage of this release is that it does not overlap with other scheduled announcements. To check the robustness of results, I investigate the price response and the trading activity for different types of the released news (good, bad and contradictory).

The arrival of public information is immediately followed by an increased trading activity and a price adjustment. Even in the first 10 seconds after the news release, the trading volume is significantly higher than on nonannouncement days. This result for a limit order market is in contrast with the findings for a market-maker market reported in Fleming and Remolona (1999). Furthermore, I find that good news releases are initially followed by a large buying and bad news releases by a large selling activity. This finding suggests that old unexecuted limit orders are quoted at advantageous prices directly after a news release. For example, if the announced information is good, i.e. the equilibrium price increases, old limit sell orders are quoted at relatively low ask prices. Such a possibility of advantageous trading results in an immediate large submission of buy orders. A large flow of one type of market orders is accompanied by unusually high spreads.[7] After the first 40 seconds, when the price advantage of immediate trading disappears, spreads and volatility start to return to their normal levels and the trading volume remains high as investors trade to reconcile individual differences of opinion.[8] All findings are significant and robust for the periods of high and low liquidity.

The remainder of the paper is organized as follows. Section 2 describes the trading data from the European bond market as well as the announcement data. Section 3 presents the results

[7] Angel (1994) and Harris (1998) model the behavior of informed traders in limit order markets and show that they are more likely to use market orders when the actual asset value is farther away from the expected value. A high trading volume immediately after the announcement found in this paper is consistent with this prediction. A related argument is provided by Cohen, Maier, Schwartz, and Whitcomb (1981) who develop a model of limit order markets and show that spreads widen as traders shift from limit orders to market orders.

[8] The second stage is consistent with the one described in Fleming and Remolona (1999).

regarding the reaction of volatility, volume and bid-ask spreads to public information releases. Section 4 presents the robustness tests. Section 5 concludes.

2 The Bond Market and Public Information

This section presents firstly high frequency trading data on the German Bund Future. Further, announcement data on the U.S. Employment Report are described.

2.1 Trading Data

I use high frequency data on the German Bund Future which is one of the most liquid titles on the European bond market. The Bund Future is a futures contract on a notional German Government Bond with an annual coupon of 6% and residual maturity of 8.5 to 10 years at contract expiration. It is traded electronically at the Eurex which is now the world's largest futures market. Additionally, this market operates long before the U.S. news arrive so that disturbing opening effects can be excluded. Eurex is organized as a limit order market, where liquidity arises endogenously from the submitted orders of traders. Since the data stem directly from the electronic trading system, they are extremely precise. The sample covers the period from Nov. 1990 to Dec. 2005. During this period 67 contracts were traded, expiring in March, June, September or December.[9] Due to the introduction of the Euro in Jan. 1999, the contract design changed. 37 contracts traded between Nov. 1990 and Dec. 1999 are denominated in DM (1 contract = 250 000 DM) and 30 contracts traded between Jan. 1999 and Dec. 2005 are denominated in EUR (1 contract = 100 000 EUR).[10] I focus on the most actively traded contract on a given day.[11]

[9] The contracts expire between the 6. and 8. calendar day.

[10] I standardize the trading volume, which is measured in the quantities of contracts, in order to be able to compare 1 standardized DM-contract with 1 EUR-contract. I multiply all quantity records in the Bund data sets with $e_{DM/Eur}/2.5$ where the official exchange rate $e_{DM/Eur} = 1.95583$ DM/Eur.

[11] There are about 62 days for each contract on which it was the most actively traded. The contracts usually cease to be traded intensively about 3-4 trading days before the expiration date.

I exclude the first years of data, i.e. until the end of 1993, when the contract was not yet established and thus trading activity was quite low. In addition, a few days with obvious technical problems in the data recording system are excluded. However, no announcement day is affected by this adjustment.[12] I divide the sample into two periods, i.e. 1994-1998 and 1999-2005. The first reason is the mentioned change of the contract design and currency.[13] The second reason is a substantial increase of the EUREX market share in the Bund futures trade until the end of 1998.[14] Therefore, liquidity is in general much larger in the second period. I focus on the time window of 9:00 to 17:00 CET excluding the opening and closing phases that could be affected by the uncontollable information flow overnight and by the prolongation of the trading time.[15]

The data set inludes exactly time-stamped and precise information about the best bid, best ask and last traded prices and quantities stemming directly from the electronic order matching system. I use this information to compute returns, the trading volume and bid-ask spreads for various intraday time intervals.[16] Additionally, I compute the volume of buys and sells as the sum of trades resulting from orders signed as buyer- and seller-initiated.[17] Table 1

[12]The trading days with the following problems were excluded: the closing time was before 15:30 CET (5 days), the opening time was after 9:00 CET (1 day), or there was an interruption in the data set entries due to technical problems which was longer than 20 minutes and took place between 9:00 and 17:00 CET (4 days).

[13]Although I adjust all quantity records before 1999 to account for the change in currency and the contract value, there might be other effects that are not corrected by this adjustment. For example, the number of investors could increase due to the fact that the title started to be denominated in the Euro zone currency.

[14]Bund futures was traded at the DTB (Deutsche Terminbörse, renamed EUREX after a merge with SOFFEX in 1998) and the LIFFE (London International Financial Futures Exchange) until the end of 1998. The market share of the DTB went up dramatically in 1997 and 1998 and exceeded 99.95 percent in the last quarter of 1998. Franke and Hess (2000) report that presumably one reason for this increase was the remote cross border access of traders which has been promoted by the DTB since 1996. Another reason was the broader DM futures portfolio of the EUREX which allowed for more sophisticated EURO convergence trading strategies.

[15]The opening hours of the EUREX have changed twice in the sample period: firstly on 01.08.1997 from 8:00-17:30 to 8:00-19:00 CET and secondly on 21.11.2005 to 8:00-22:00 CET.

[16]The best bid (ask) price is the current best offer to sell (buy) a contract. As in Fleming and Remolona (1999), the spread is defined as the mean proportional spread. I compute the trade size using the information on the last traded quantity. Note that the information on prices and the number of traded contracts is available for every record. This feature of the data set enables to analyse the trading process during the periods of high information flow in detail. Fleming and Remolona (1999), Fleming (2001) and Green (2004) use a similar data set provided by GovPX, Inc. that describes the interdealer broker activity in the U.S. Treasury market-maker market. However, their data is stamped every minute.

[17]I use the Lee and Ready (1991) algorithm to sign trades. I leave the trades unsigned if the prices and

Table 1: Trading and Liquidity in the Sample Period

Year	Trading Volume per Minute	Number of Trades per Minute	Trading Volume per Trade	Average Spread	Volatility per Hour
1994	87.3	4.0	20.6	1.73	1.86
1995	78.9	3.6	20.2	1.33	0.87
1996	102.3	4.0	23.5	1.21	0.88
1997	185.4	5.6	31.0	1.07	0.75
1998	456.1	9.2	47.2	0.93	0.75
1999	660.7	13.3	45.6	0.93	1.25
2000	714.4	11.5	58.5	0.96	0.84
2001	865.2	11.1	72.0	0.93	0.71
2002	893.2	12.0	67.8	0.93	0.77
2003	1053.0	15.1	64.0	0.88	1.02
2004	1045.4	12.6	73.9	0.87	0.57
2005	1341.6	17.0	71.9	0.82	0.59

NOTE: The table reports descriptive statistics for the sample from Jan. 1st, 1994 to Dec. 30th, 2005. The columns present the average trading volume per minute, (measured in the number of contracts), the average number of trades per minute, the average volume per trade (measured in the number of contracts), the average spread (multiplied by 10^4) and the average hourly volatility computed as the sum of squared returns. All results are computed for the most actively traded contracts during the time window between 9:00 and 17:00 CET.

presents summary statistics of the trading activity. A large increase in the number of traded and offered contracts, the number of trades per minute as well as the average trade size can be observed. This trend is accompanied by a decrease in spreads suggesting higher liquidity in the later years of the sample. I detrend the trading volume and spreads dividing them by their average contract values.[18] Since no particular trend in volatility is observed, I leave this variable unadjusted. I conduct the analysis of price and trading response to public information releases using 5-minute and 1-minute intervals in order to compare the results with those in Fleming and Remolona (1999). Moreover, I consider 30-second and 10-second intervals. This allows for a much more exact description of the price adjustment process and the trading reaction.

quotes in the current or previous record are subject to obvious recording problems, e.g. the best bid price is higher than the best ask price. Therefore, the volume of signed trades is lower than the overall trading volume.

[18]For example, I divide the volume observed in Aug 2003 by the average volume for the same contract (in this case expiring in Sep 2003) so that: $StandardizedVol_{t,c} = \frac{Vol_{t,c}}{AvrVol_c}$ where $Vol_{t,c}$ is the trading volume in e.g. 1-minute interval t in contract c and $AvrVol_c$ is the average 1-minute trading volume for a given contract. The volume of buys and sells is standardized with $0.5*AvrVol_c$. In this way, I receive the standardized variables which are comparable across years. I also considered other standardization methods like for example standardizing with the average value for all Fridays in the contract, the average in every 30-minute interval, the average in every 1-minute interval. All results are robust to other standardization methods.

2.2 Public Information

I use announcement data on the U.S. nonfarm payroll employment and the unemployment rate, which provide signals about the employment situation obtained from two independent surveys. The Employment Report is released by the Bureau of Labor Statistics on the first Friday of every month at 08:30 EST.[19] Based on a very large sample, it conveys important information about the U.S. business cycle situation very early. Therefore, it strongly influences both the U.S. market and the markets abroad. For example, Andersson et al. (2006) and Ehrmann and Fratzscher (2003) show its significant impact on the German govenment bond futures prices and the market interest rates. Moreover, this release rarely coincides with other scheduled U.S. news. Overlapping events are eliminated from the sample. Therefore, the observed market reaction should be solely due to the information conveyed by this report.[20] Additionally, the release time is very precise and information leakages are rather implausible.[21]

To compute the unanticipated information, I compare the actual releases with the investor forecasts (available from Money Market Services). I use two signals about the employment situation and define days, on which the released news was good, bad or contradictory. The

[19] The report includes also information on average hourly earnings and average workweek. However, these headlines are far less important than the nonfarm payroll employment and the unemployment rate. There are 5 cases when the employment report was released on Thursday. I exclude these observations from the sample to avoid day-of-week effects. 08:30 EST corresponds in most cases to 14:30 CET and on some days to 13:30 CET or 15:30 CET, dependent on the summer time periods in both time zones. I consider only observations at 14:30 CET to avoid the effects of intraday patterns of the trading volume and spreads. However, only 4 announcement days are excluded due to this correction. The results including the announcements released at 13:30 CET or 15:30 CET remain qualitatively the same.

[20] I exclude all Fridays, on which there was a release of a U.S. announcement on 08:30 EST (8 announcements out of 26 analysed), as well as all Fridays when there was a release of a German announcement between 12:30 and 16:30 CET (4 announcements out of 23 analysed). U.S. announcements released on Fridays at 08:30 EST include: Business Inventories, Consumer Price Index, Durable Goods Orders, Housing Starts, Leading Indicators, Personal Income, Producer Price Index and Retail Sales. German announcements released on Fridays between 12:30 and 16:30 CET include: Consumer Price Index, Import Prices, Industrial Production and Producer Price Index.

[21] See e.g. Fleming and Remolona (1999, p. 1905) for a detailed description of the announcement procedure applied at the Bureau of Labor Statistics.

first signal is the surprise in the nonfarm payroll employment (S_{NP}):

$$S_{NP} = A_{NP} - F_{NP},$$

where A_{NP} is the announced number of new nonfarm payrolls and F_{NP} is the median of analysts' forecasts of new nonfarm payrolls (both figures measured in thousands). Good signal for the bond market corresponds to a negative surprise in nonfarm payrolls, $S_{NP} < 0$. Actual employment lower than the median of forecasts ($S_{NP} < 0$) is a signal for a worse than expected business cycle situation. This information should have a positive impact on the bond price. The second signal is the surprise in the unemployment rate (S_{UR}) defined as:

$$S_{UR} = A_{UR} - F_{UR}$$

where A_{UR} is the announced unemployment rate and F_{UR} is the median of analysts' forecasts of the unemployment rate (both figures measured in percentage points). A positive surprise in the unemployment rate, $S_{UR} > 0$, is a good signal for the bond market. The actual unemployment rate higher than the median of forecasts ($S_{UR} > 0$) is a signal for a worse than expected business cycle situation. This information should also have a positive impact on the bond price.

Considering information conveyed by these two signals from the Employment Report, I classify announcements into three groups: good, bad and contradictory. Good news releases mean the cases when the signal about the nonfarm payroll employment was good ($S_{NP} < 0$) and the signal about the unemployment rate was good or neutral ($S_{UR} \geq 0$). Bad news releases are defined as $S_{NP} > 0$ and $S_{UR} \leq 0$. News releases are classified as contradictory when $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$. The sample includes 69 announcement Fridays (20 good, 27 contradictory and 22 bad news releases) and 130 nonannouncement Fridays between Apr. 1st, 1999 and Dec. 31st, 2005.

3 Results

Price formation and liquidity around public news releases is investigated in this section. The analysis is conducted for the intraday frequencies used in the previous empirical studies (5-minute and 1-minute intervals) as well as higher frequencies which have not been considered previously (30-second and 10-second intervals). Since the data set is very precise, it is possible to extract infomration about the exact price response, trading and liquidity immediately after the event. I report and compare standard deviations of log midquote returns, the average trading volume and bid-ask spreads for announcement and nonannouncement days.[22] Tables 2 and 3 and Figures 1 and 2 present the results of the descriptive analysis.

The results for 5-minute intervals are very similar to the previous studies for the bond market (e.g. Fleming and Remolona (1999) and Balduzzi, Elton, and Green (2001)). I find that log return standard deviation increases in the last 5 minutes before the event, peaks in the first minutes after the news release and remains significantly higher than on nonannouncement days afterwards.[23] Spreads depict a similar pattern but return to the level comparable with nonannouncement days faster than volatility. I find also that the trading volume increases immediately after the announcement and remains significantly higher than on nonannouncement days during around an hour afterwards.[24] The results for 1-minute intervals reveal a similar pattern: volatility and spreads are significantly higher than on nonannouncemnnet days already around 3 minutes before the event, peak immediately after the news release and

[22] I report robust statistics calculated by using winsorising as described in Dixon (1960), Tukey (1962) or Huber (1981).

[23] The volatility pattern observed here is in line with the results of other empirical studies on price formation and volatility around announcements (e.g. Andersen and Bollerslev (1998), Andersen, Bollerslev, Diebold, and Vega (2003, 2006) or Hautsch and Hess (2002, 2007).)

[24] The results for the later time intervals are not reported in the table but they are available from the author. The average trading volume on nonannouncement days is significantly above 1 after 08:30 EST. This pattern may be due to the fact that the trading of several interest rate products at the CBOT starts shortly before this time. I accounted for 26 most important U.S. announcements and eliminated those 8 released on Fridays at 8:30 EST and I accounted for 23 most important German announcements and eliminated those 4 released on Fridays between 12:30 and 16:30 CET. However, several other news are released at this time which are usually not perceived as very important by market participants. Nevertheless, in some seldom cases when they are particularly surprising, they can cause increased trading.

remain quite high in the following minutes.

The most important finding is that the trading volume is very high and significantly different from its usual value already in the first minute after the event. The observation of a significant price response *along with* an increase in the trading volume is different from the findings for a market-maker market reported in Fleming and Remolona (1999).[25] To verify the results, I analyse the price and trading response for 30-second and 10-second intervals and find that the trading volume increases substantially already in the first ten seconds following the event. I conclude that public news releases are followed by an immediate price response combined with a very high trading volume and low liquidity.

Furthermore, I test whether the price adjustment occurs *through* trading. If this is the case, I should observe an abnormal volume of buys after good news and an abnormal volume of sells after bad news. Table 4 presents the comparison of the average volume of buys and sells for days with good, contradictory and bad announcements conducted for 10-second intervals. I find that good news are initially followed by a high buying activity (the trading volume of buys is around seven times higher as the volume of sells). Bad news are followed by an excessive selling activity. I conclude that the contracts are initially offered at advantageous prices making buying after good news and selling after bad news profitable. To summarize, the results for an electronic limit order market presented here do not support the theory of French and Roll (1986) and are in this respect different from the results for a market-maker market reported in Fleming and Remolona (1999). I find that the price response following public news events occurs here partially *through* trading (buying after good news and selling after bad news). The patterns of volatility and spreads are similar to the findings in the

[25]Note that the structure of the market analysed in this paper (an electronic limit order market) differs from the market analysed in Fleming and Remolona (1999) (a multiple-dealer over-the-counter market). However, there is a cetrain similarity in the structure of both markets. In the price driven market, the quotes of market makers are binding until and unless they are withdrawn, similarily as unexecuted limit orders offered at the best quotes in the limit order market. A further difference between these two studies is that I use only one macroeconomic announcement which does not coincide with other scheduled news releases. Fleming and Remolona (1999) analyse, however, the whole set of macroannouncements.

previous studies.

Table 2: Dynamics of Volatility, Trading Volume and Spread Around Announcements

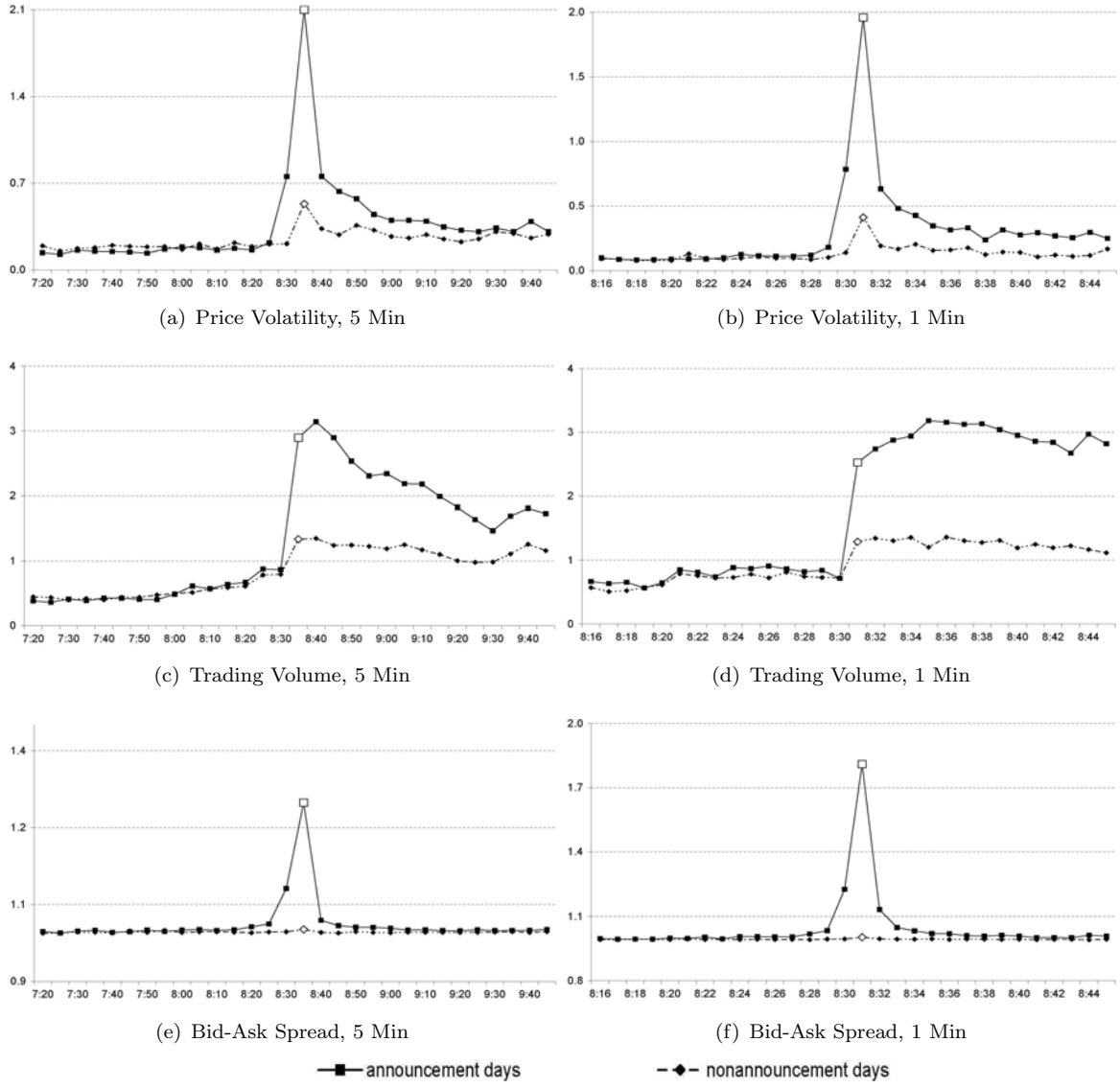
Panel A: Five-Minute Intervals										
	08:10	08:15	08:20	08:25	08:30	**08:35**	08:40	08:45	08:50	08:55
	Price Volatility									
Ann. Fr.	0.159	0.173	0.160	0.218	0.753	2.099	0.754	0.632	0.573	0.447
Nonann. Fr.	0.168	0.218	0.187	0.207	0.209	0.532	0.332	0.283	0.359	0.320
St. Dev. Ratio	0.946	0.792	0.853	1.054	3.598	3.944	2.267	2.234	1.597	1.394
F-ratio p-value	0.830	0.723	0.529	0.424	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.571	0.640	0.670	0.876	0.865	2.894	3.142	2.896	2.534	2.306
Nonann. Fr.	0.566	0.589	0.611	0.785	0.793	1.337	1.347	1.242	1.246	1.226
Diff. in Means	0.005	0.051	0.059	0.092	0.072	1.558	1.795	1.654	1.289	1.080
t-stat p-value	0.456	0.121	0.110	0.030	0.055	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	0.999	1.001	1.006	1.012	1.081	1.249	1.019	1.009	1.006	1.005
Nonann. Fr.	0.997	0.996	0.995	0.996	0.997	1.001	0.996	0.994	0.997	0.996
Diff. in Means	0.003	0.005	0.011	0.016	0.084	0.247	0.023	0.014	0.009	0.010
t-stat p-value	0.157	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Panel B: One-Minute Intervals										
	08:26	08:27	08:28	08:29	08:30	**08:31**	08:32	08:33	08:34	08:35
	Price Volatility									
Ann. Fr.	0.111	0.111	0.119	0.180	0.783	1.959	0.632	0.480	0.426	0.346
Nonann. Fr.	0.095	0.095	0.085	0.101	0.139	0.411	0.191	0.166	0.203	0.155
St. Dev. Ratio	1.165	1.169	1.400	1.779	5.646	4.765	3.313	2.893	2.098	2.225
F-ratio p-value	0.071	0.197	0.005	0.005	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.911	0.864	0.821	0.843	0.716	2.525	2.738	2.878	2.940	3.183
Nonann. Fr.	0.724	0.813	0.745	0.730	0.723	1.291	1.346	1.308	1.359	1.205
Diff. in Means	0.187	0.052	0.075	0.113	-0.006	1.234	1.392	1.570	1.581	1.978
t-stat p-value	0.003	0.212	0.124	0.031	0.544	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.005	1.005	1.019	1.034	1.227	1.810	1.133	1.049	1.033	1.021
Nonann. Fr.	0.992	0.993	0.992	0.994	0.995	1.003	0.995	0.994	0.993	0.996
Diff. in Means	0.013	0.012	0.027	0.039	0.233	0.807	0.137	0.055	0.039	0.025
t-stat p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: Five-minute (Panel A) and one-minute (Panel B) log price change standard deviations, the trading volume means and bid-ask spreads are reported and compared for announcement and nonannouncement Fridays. The time denoting each column means the end of the interval. The reported log price change standard deviation is the actual value times 10^3, the trading volume and the spread are standardized with their average values per contract. The bid-ask spread is the 5-minute (1-minute) robust average of the mean proportional spread weighted with time when each spread value was valid. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

Table 3: Dynamics of Volatility, Trading Volume and Spread Around Announcements

Panel A: Thirty-Second Intervals										
	8:28:00	8:28:30	8:29:00	8:29:30	8:30:00	**8:30:30**	8:31:00	8:31:30	8:32:00	8:32:30
	Price Volatility									
Ann. Fr.	0.071	0.089	0.164	0.178	0.761	1.960	0.622	0.480	0.310	0.323
Nonann. Fr.	0.076	0.073	0.079	0.083	0.124	0.377	0.155	0.137	0.132	0.105
St. Dev. Ratio	0.929	1.221	2.084	2.155	6.155	5.194	4.011	3.495	2.343	3.069
F-ratio p-value	0.528	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.830	0.835	0.794	0.724	0.684	2.462	2.296	2.676	2.700	2.744
Nonann. Fr.	0.698	0.707	0.730	0.707	0.722	1.197	1.267	1.328	1.283	1.236
Diff. in Means	0.132	0.128	0.064	0.018	-0.038	1.265	1.029	1.348	1.417	1.508
t-stat p-value	0.039	0.062	0.178	0.390	0.700	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.012	1.016	1.010	1.080	1.299	2.145	1.396	1.159	1.089	1.048
Nonann. Fr.	0.991	0.993	0.992	0.992	0.995	0.998	0.998	0.993	0.994	0.993
Diff. in Means	0.022	0.023	0.019	0.088	0.305	1.147	0.398	0.165	0.095	0.055
t-stat p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Ten-Second Intervals										
	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
	Price Volatility									
Ann. Fr.	0.098	0.078	0.088	0.144	0.705	1.075	0.988	0.672	0.273	0.396
Nonann. Fr.	0.052	0.050	0.057	0.054	0.103	0.295	0.193	0.111	0.095	0.080
St. Dev. Ratio	1.895	1.552	1.542	2.646	6.846	3.638	5.105	6.081	2.858	4.936
F-ratio p-value	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.681	0.653	0.733	0.455	0.522	2.142	2.039	2.304	1.874	2.047
Nonann. Fr.	0.487	0.750	0.670	0.602	0.530	1.103	1.123	1.062	0.964	1.216
Diff. in Means	0.193	-0.097	0.063	-0.147	-0.008	1.039	0.915	1.242	0.911	0.832
t-stat p-value	0.011	0.859	0.255	0.975	0.539	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.064	1.059	1.105	1.213	1.420	2.329	1.877	1.736	1.436	1.287
Nonann. Fr.	0.992	0.992	0.992	0.992	0.994	0.998	0.995	0.996	0.994	0.994
Diff. in Means	0.073	0.067	0.112	0.221	0.426	1.331	0.882	0.740	0.442	0.293
t-stat p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: Thirty-second (Panel A) and ten-second (Panel B) log price change standard deviations, the trading volume means and bid-ask spreads are reported and compared for announcement and nonannouncement Fridays. The time denoting each column means the end of the interval. The reported log price change standard deviation is the actual value times 10^3, the trading volume and the spread are standardized with their average values per contract. The bid-ask spread is the 30-second (10-second) robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.



(a) Price Volatility, 5 Min

(b) Price Volatility, 1 Min

(c) Trading Volume, 5 Min

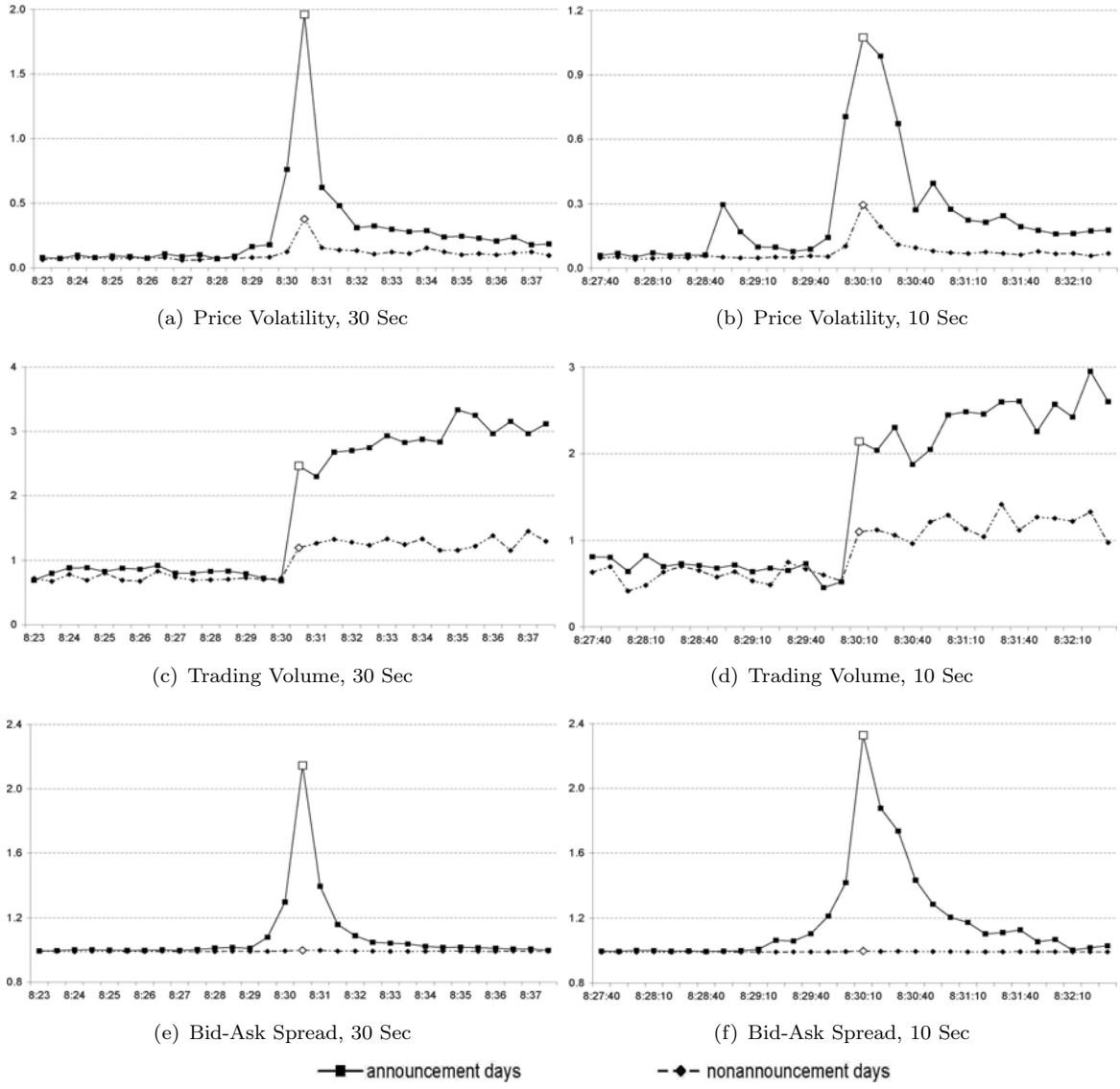
(d) Trading Volume, 1 Min

(e) Bid-Ask Spread, 5 Min

(f) Bid-Ask Spread, 1 Min

Figure 1: Price and Trading Dynamics on Announcement and Nonannouncement Days

Intraday patterns around the announcement time (08:30 EST) are plotted by five-minute and one-minute intervals for Fridays with announcements of the U.S. Employment Report (solid line) and Fridays with no announcements (dashed line). The first time interval after the release is marked in the figure with a larger white symbol. Standard deviations of log price changes times 10^3 are reported in subfigures (a) and (b), the robust means of the trading volume (as a ratio of the average contract value) are reported in subfigures (c) and (d) and the robust means of bid-ask spreads (as a ratio of the average contract value) are reported in subfigures (e) and (f). The sample period regarded here: Apr. 1st, 1999 to Dec. 30th, 2005.



(a) Price Volatility, 30 Sec

(b) Price Volatility, 10 Sec

(c) Trading Volume, 30 Sec

(d) Trading Volume, 10 Sec

(e) Bid-Ask Spread, 30 Sec

(f) Bid-Ask Spread, 10 Sec

Figure 2: Price and Trading Dynamics on Announcement and Nonannouncement Days

Intraday patterns around the announcement time (08:30 EST) are plotted by thirty-second and ten-second intervals for Fridays with announcements of the U.S. Employment Report (solid line) and Fridays with no announcements (dashed line). The first time interval after the release is marked in the figure with a larger white symbol. Standard deviations of log price changes times 10^3 are reported in subfigures (a) and (b), the robust means of the trading volume (as a ratio of the average contract value) are reported in subfigures (c) and (d) and the robust means of bid-ask spreads (as a ratio of the average contract value) are reported in subfigures (e) and (f). The sample period regarded here: Apr. 1st, 1999 to Dec. 30th, 2005.

Table 4: Transaction Imbalance Around Announcements

Ten-Second Intervals										
	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
	Good News									
Vol. Buys	0.429	0.721	0.316	0.357	0.099	4.682	4.422	3.305	2.016	2.560
Vol. Sells	0.366	0.293	0.709	0.212	0.201	0.187	0.945	0.837	1.167	2.030
Diff. in Means	0.064	0.428	-0.393	0.145	-0.102	4.495	3.477	2.468	0.849	0.530
t-stat p-value	0.336	0.010	0.990	0.091	0.906	0.000	0.002	0.011	0.077	0.226
	Contradictory News									
Vol. Buys	0.664	0.546	0.920	0.492	0.203	0.866	0.371	1.650	1.630	1.579
Vol. Sells	0.728	0.589	0.806	0.345	0.525	1.436	1.123	1.276	1.915	1.008
Diff. in Means	-0.064	-0.044	0.114	0.147	-0.322	-0.570	-0.752	0.375	-0.285	0.572
t-stat p-value	0.614	0.601	0.328	0.145	0.995	0.912	0.994	0.227	0.703	0.050
	Bad News									
Vol. Buys	0.614	0.676	0.578	0.417	0.404	0.297	1.210	1.749	1.693	1.324
Vol. Sells	0.441	0.523	0.539	0.344	0.330	3.173	2.082	1.874	1.346	1.926
Diff. in Means	0.173	0.153	0.039	0.073	0.073	-2.877	-0.872	-0.124	0.347	-0.602
t-stat p-value	0.856	0.789	0.586	0.731	0.689	0.002	0.094	0.424	0.748	0.126

NOTE: Ten-second mean volumes of buys and sells are reported and compared for good, contradictory and bad news releases. The time denoting each column means the end of the interval. The reported trading volume is standardized with its average contract value. I report p-values from the robust t-statistc comparing the means for the volume of buys and the volume of sells assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

4 Robustness

This section presents the tests for the robustness of results. As mentioned before, the sample period includes the changes in the contract desing and currency as well as in the trading hours that occured at the end of 1998. Moreover, Eurex gained a very strong position as the leading exchange in the Bund futures trade in this period. Due to these effects, the period between 1994 and 1998 is far less liquid than the later part of the sample. I test whether all results hold for the early subsample.[26] Figures 3 and 4 and Table 5 present the results (see also Tables 6 and 7 in Appendix) and show that the findings are very similar. Note that even for the less liquid period, I observe a significant increase in the trading volume already in the first 10 seconds after the event. Moreover, good news are immediately followed by a large buying and bad news by a large selling activity.

[26]The sample includes 40 announcement Fridays (10 good, 10 contradictory and 20 bad news releases) and 119 nonannouncement Fridays between Jan. 1st, 1994 and Dec. 31st, 1998.

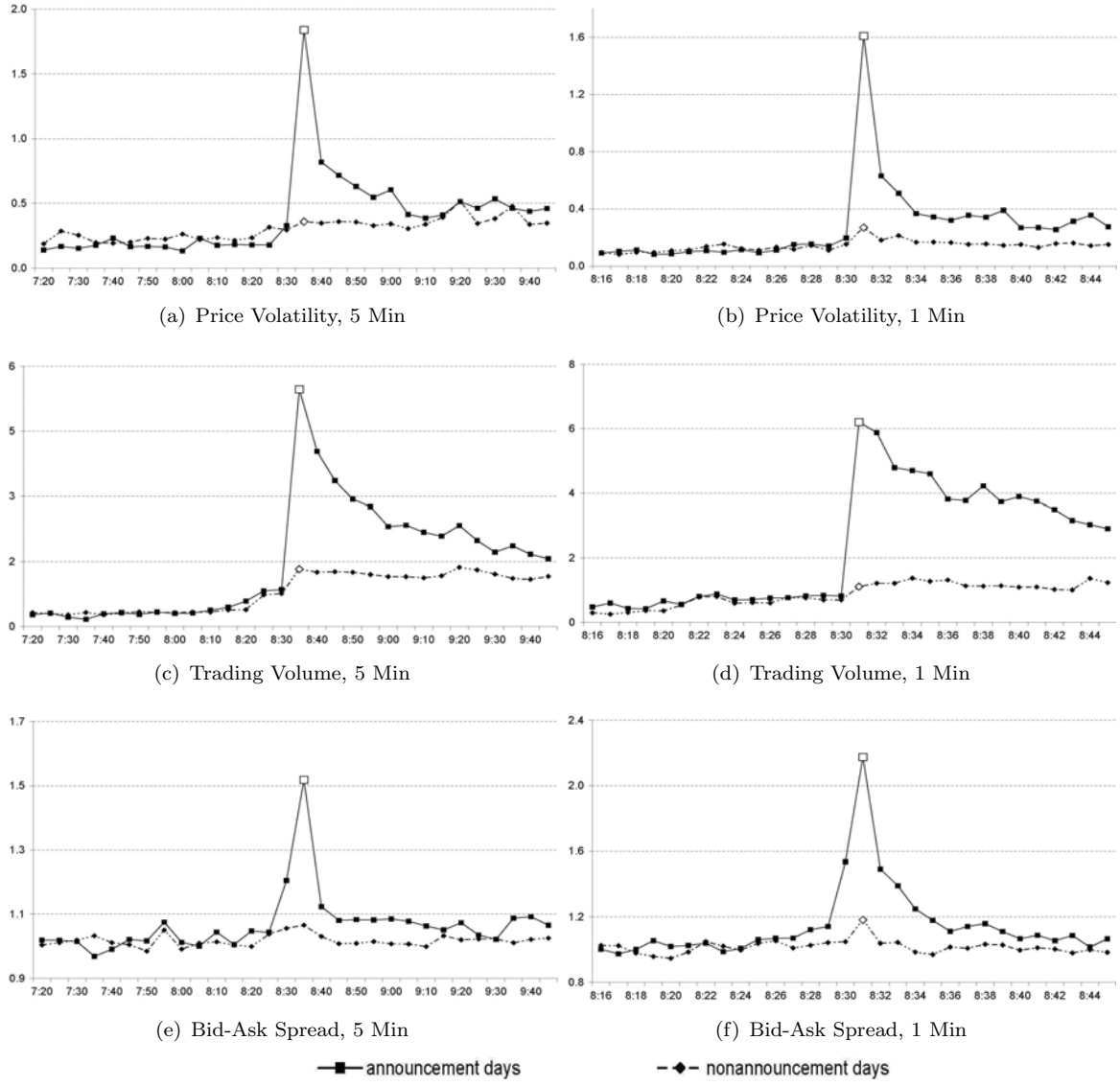
Furthermore, I test whether the results are robust for different types of news. I split the sample of announcement days into days with good, contradictory and bad news releases. All findings regarding the reaction of prices, the trading volume and bid-ask spreads around information events hold for all three groups of announcements (see Tables 8 to 11 in Appendix). Finally, I check the results for another, more common, definition of spreads. In previous section, I computed the bid-ask spread as the average spread weighted with time when each value was valid.[27] This definition allows one to observe spreads more accurately since the values that were valid only a few seconds long are weighted less than the ones that were valid longer. Another approach is to use the last value observed before the end of the time interval. Table 12 in Appendix shows that results for the spreads calculated in this way are very similar (although less significant for 5-minute intervals).

Table 5: Transaction Imbalance Around Announcements: Sample 1994-1998

Ten-Second Intervals										
	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
	Good News									
Vol. Buys	0.286	0.188	0.278	0.387	0.666	8.015	9.304	14.987	5.137	3.129
Vol. Sells	0.000	0.000	0.163	0.811	0.000	0.000	0.000	4.617	7.516	6.320
Diff. in Means	0.286	0.188	0.115	-0.425	0.666	8.015	9.304	10.370	-2.380	-3.192
t-stat p-value	0.033	0.037	0.271	0.823	0.027	0.008	0.001	0.015	0.800	0.929
	Contradictory News									
Vol. Buys	1.859	0.605	1.144	0.000	1.059	6.197	8.318	5.094	1.280	7.563
Vol. Sells	0.394	0.019	0.000	0.255	0.000	1.670	5.715	3.728	4.676	1.799
Diff. in Means	1.465	0.586	1.144	-0.255	1.059	4.527	2.603	1.366	-3.396	5.763
t-stat p-value	0.045	0.034	0.024	0.967	0.018	0.072	0.239	0.283	0.942	0.032
	Bad News									
Vol. Buys	0.909	0.444	0.359	0.104	0.068	0.000	2.534	4.064	4.485	4.126
Vol. Sells	0.125	0.097	0.000	0.007	0.688	6.391	5.818	5.156	3.596	5.848
Diff. in Means	0.784	0.348	0.359	0.097	-0.620	-6.391	-3.284	-1.092	0.889	-1.722
t-stat p-value	0.993	0.979	0.997	0.990	0.012	0.000	0.014	0.197	0.737	0.144

NOTE: Ten-second mean volumes of buys and sells are reported and compared for good, contradictory and bad news releases. The time denoting each column means the end of the interval. The reported trading volume is standardized with its average contract value. I report p-values from the robust t-statistc comparing the means for the volume of buys and the volume of sells assuming unequal veriances. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998.

[27] For example, the bid-ask spread for a given 1-minute interval is an average of all spreads observed within the interval weighted with time, during which each value was observed. The values for each interval were further standardized with the average contract values.



(a) Price Volatility, 5 Min

(b) Price Volatility, 1 Min

(c) Trading Volume, 5 Min

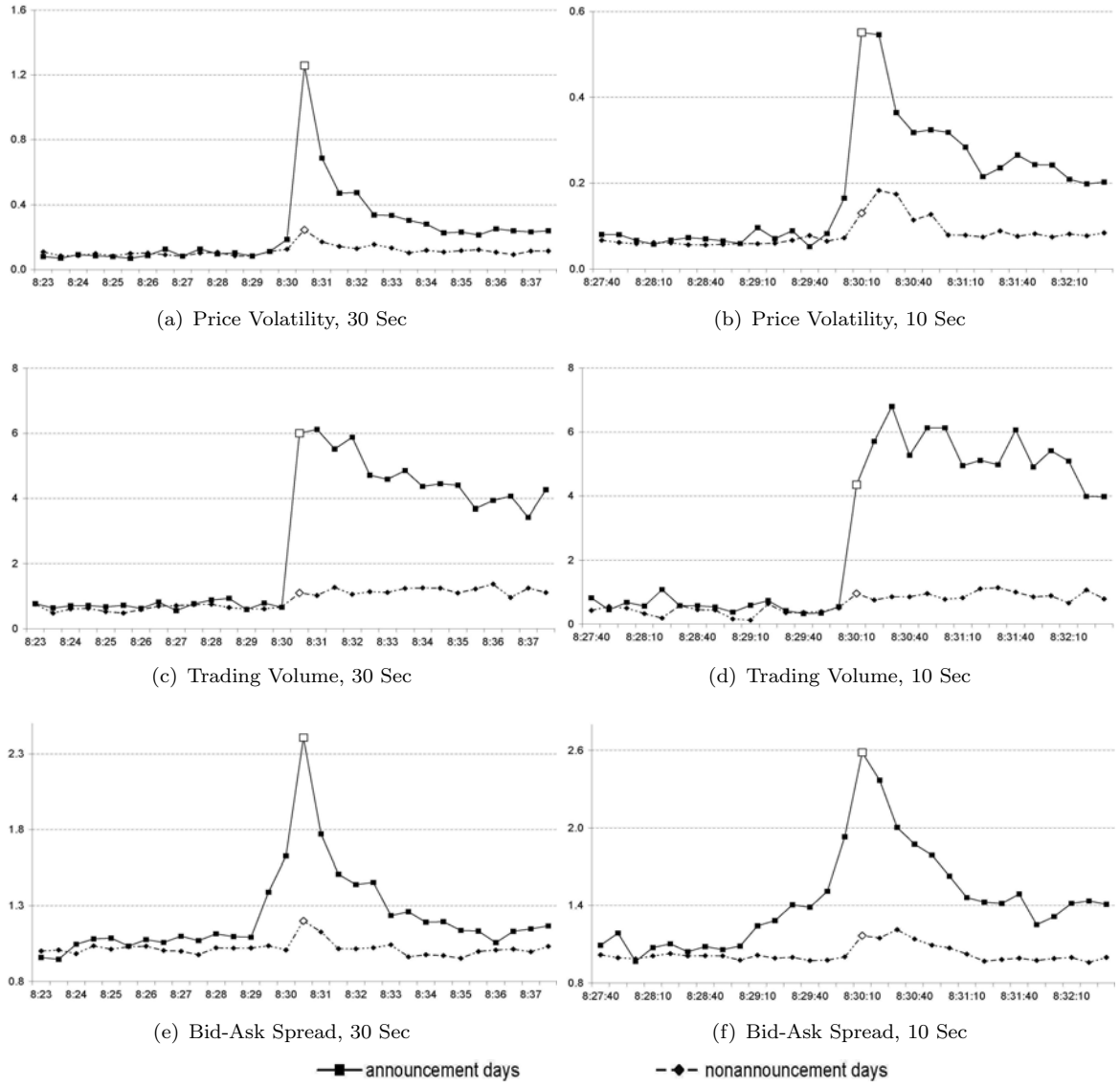
(d) Trading Volume, 1 Min

(e) Bid-Ask Spread, 5 Min

(f) Bid-Ask Spread, 1 Min

Figure 3: Price and Trading Dynamics on Announcement and Nonannouncement Days

Intraday patterns around the announcement time (08:30 EST) are plotted by five-minute and ten-minute intervals for Fridays with announcement of the U.S. Employment Report (solid line) and Fridays with no announcements (dashed line). The first time interval after the release is marked in the figure with a larger white symbol. Standard deviations of log price changes times 10^3 are reported in subfigures (a) and (b), the robust means of the trading volume (as a ratio of the average contract value) are reported in subfigures (c) and (d) and the robust means of bid-ask spreads (as a ratio of the average contract value) are reported in subfigures (e) and (f). The sample period regarded here: Jan. 1st, 1994 to Dec. 30th, 1998.



(a) Price Volatility, 30 Sec

(b) Price Volatility, 10 Sec

(c) Trading Volume, 30 Sec

(d) Trading Volume, 10 Sec

(e) Bid-Ask Spread, 30 Sec

(f) Bid-Ask Spread, 10 Sec

Figure 4: Price and Trading Dynamics on Announcement and Nonannouncement Days

Intraday patterns around the announcement time (08:30 EST) are plotted by thirty-second and ten-second intervals for Fridays with announcement of the U.S. Employment Report (solid line) and Fridays with no announcements (dashed line). The first time interval after the release is marked in the figure with a larger white symbol. Standard deviations of log price changes times 10^3 are reported in subfigures (a) and (b), the robust means of the trading volume (as a ratio of the average contract value) are reported in subfigures (c) and (d) and the robust means of bid-ask spreads (as a ratio of the average contract value) are reported in subfigures (e) and (f). The sample period regarded here: Jan. 1st, 1994 to Dec. 30th, 1998.

5 Conclusion

A famous theory formulated by French and Roll (1986) states that public information affects prices before anyone trades. Several other models show that new information is directly followed by trading. Fleming and Remolona (1999) test the theory of French and Roll (1986) using high frequency data for a market-maker market and find that public scheduled announcements induce a sharp and immediate price change with a reduction in the trading volume and widening spreads. This paper examines the process of price adjustment to public news in an electronic limit order market using a very long and precise data set from the largest European bond futures market. Moreover, the problem is analysed based on a higher frequency than in all previous empirical studies on this issue.

I find that the price reaction following public information events occurs partially *through* trading. A large and significant increase of the trading volume can be observed already in the first ten seconds immediately after the announcement. In particular, good news are initially followed by a large buying and bad news by a large selling activity. This indicates that old unexecuted limit orders are quoted at advantageous prices directly after the news release. For example, if the announced information is good, i.e. the equilibrium price increases, old limit sell orders are quoted at relatively low ask prices. Such a possibility of advantageous trading results in an immediate large submission of buy orders. A large flow of one type of market orders in the first seconds is accompanied by increased spreads. After the first 40 seconds, when the price advantage of immediate trading disappears, spreads and volatility start to return to the normal level and the trading volume remains high as investors trade to reconcile individual differences of opinion. All findings are significant and hold for the periods of high and low liquidity.

The results for an electronic limit order market presented here do not support the theory of French and Roll (1986) and are in this respect different from the results for a market-maker

market reported in Fleming and Remolona (1999). I find that the price response following public news events occurs here partially through trading (buying after good news and selling after bad news). The patterns of volatility and spreads are similar to the findings in the previous studies.

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Appendix: Robustness Tests

Table 6: Dynamics of Volatility, Trading Volume and Spread Around Announcements: Sample 1994-1998

Panel A: Five-Minute Intervals										
	08:10	08:15	08:20	08:25	08:30	**08:35**	08:40	08:45	08:50	08:55
	Price Volatility									
Ann. Fr.	0.176	0.182	0.179	0.178	0.328	1.839	0.818	0.716	0.630	0.546
Nonann. Fr.	0.235	0.214	0.234	0.316	0.295	0.359	0.348	0.359	0.356	0.328
St. Dev. Ratio	0.748	0.851	0.766	0.565	1.112	5.125	2.355	1.993	1.771	1.668
F-ratio p-value	0.403	0.293	0.731	0.066	0.101	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.375	0.441	0.586	0.821	0.853	5.467	4.035	3.360	2.935	2.761
Nonann. Fr.	0.333	0.384	0.387	0.732	0.760	1.323	1.255	1.266	1.253	1.200
Diff. in Means	0.042	0.057	0.199	0.089	0.093	4.144	2.780	2.094	1.682	1.561
t-stat p-value	0.190	0.162	0.001	0.131	0.086	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.044	1.005	1.048	1.044	1.205	1.518	1.124	1.081	1.083	1.082
Nonann. Fr.	1.014	1.004	0.999	1.038	1.056	1.066	1.031	1.008	1.009	1.015
Diff. in Means	0.030	0.002	0.048	0.005	0.149	0.452	0.093	0.073	0.074	0.067
t-stat p-value	0.134	0.471	0.046	0.402	0.000	0.000	0.000	0.002	0.004	0.004
Panel B: One-Minute Intervals										
	08:26	08:27	08:28	08:29	08:30	**08:31**	08:32	08:33	08:34	08:35
	Price Volatility									
Ann. Fr.	0.110	0.151	0.153	0.139	0.196	1.608	0.630	0.509	0.367	0.343
Nonann. Fr.	0.132	0.117	0.144	0.109	0.153	0.269	0.181	0.213	0.166	0.168
St. Dev. Ratio	0.831	1.294	1.063	1.268	1.278	5.979	3.473	2.389	2.203	2.048
F-ratio p-value	0.295	0.187	0.531	0.047	0.007	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.753	0.763	0.821	0.835	0.819	6.205	5.882	4.791	4.701	4.599
Nonann. Fr.	0.601	0.773	0.761	0.699	0.696	1.111	1.215	1.216	1.372	1.275
Diff. in Means	0.152	-0.009	0.060	0.136	0.124	5.094	4.667	3.575	3.329	3.324
t-stat p-value	0.068	0.532	0.282	0.118	0.102	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.069	1.070	1.122	1.142	1.536	2.175	1.493	1.391	1.249	1.179
Nonann. Fr.	1.055	1.010	1.027	1.043	1.049	1.182	1.039	1.044	0.985	0.970
Diff. in Means	0.014	0.060	0.096	0.098	0.487	0.993	0.453	0.347	0.264	0.209
t-stat p-value	0.367	0.035	0.036	0.041	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: Five-minute (Panel A) and one-minute (Panel B) log price change standard deviations, the trading volume means and bid-ask spreads are reported and compared for announcement and nonannouncement Fridays. The time denoting each column means the end of the interval. The reported log price change standard deviation is the actual value times 10^3, the trading volume and the spread are standardized with their average values per contract. The bid-ask spread is the 5-minute (1-minute) robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998.

Table 7: Dynamics of Volatility, Trading Volume and Spread Around Announcements: Sample 1994-1998

Panel A: Thirty-Second Intervals										
	8:28:00	8:28:30	8:29:00	8:29:30	8:30:00	**8:30:30**	8:31:00	8:31:30	8:32:00	8:32:30
	Price Volatility									
Ann. Fr.	0.096	0.102	0.083	0.111	0.185	1.257	0.689	0.472	0.475	0.337
Nonann. Fr.	0.106	0.084	0.082	0.111	0.125	0.245	0.170	0.142	0.129	0.154
St. Dev. Ratio	0.906	1.217	1.012	1.000	1.480	5.138	4.044	3.323	3.693	2.183
F-ratio p-value	0.777	0.040	0.668	0.769	0.002	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.881	0.935	0.589	0.789	0.658	5.998	6.118	5.514	5.876	4.707
Nonann. Fr.	0.752	0.651	0.604	0.611	0.670	1.102	1.023	1.273	1.056	1.138
Diff. in Means	0.129	0.284	-0.015	0.178	-0.012	4.896	5.095	4.241	4.820	3.569
t-stat p-value	0.197	0.020	0.554	0.066	0.543	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.115	1.096	1.093	1.390	1.626	2.408	1.771	1.508	1.440	1.454
Nonann. Fr.	1.022	1.020	1.021	1.036	1.008	1.200	1.127	1.016	1.016	1.023
Diff. in Means	0.093	0.076	0.072	0.354	0.618	1.207	0.644	0.492	0.424	0.431
t-stat p-value	0.053	0.081	0.093	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Ten-Second Intervals										
	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
	Price Volatility									
Ann. Fr.	0.071	0.089	0.052	0.082	0.165	0.551	0.546	0.365	0.318	0.324
Nonann. Fr.	0.060	0.067	0.078	0.065	0.072	0.130	0.183	0.174	0.114	0.127
St. Dev. Ratio	1.176	1.332	0.667	1.271	2.277	4.232	2.984	2.094	2.792	2.554
F-ratio p-value	0.503	0.130	0.026	0.350	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Ann. Fr.	0.735	0.424	0.330	0.346	0.547	4.343	5.703	6.797	5.269	6.128
Nonann. Fr.	0.638	0.353	0.363	0.395	0.507	0.959	0.756	0.855	0.853	0.958
Diff. in Means	0.097	0.070	-0.033	-0.049	0.040	3.384	4.947	5.942	4.416	5.170
t-stat p-value	0.266	0.240	0.651	0.709	0.382	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Ann. Fr.	1.283	1.405	1.387	1.510	1.932	2.585	2.370	2.005	1.875	1.791
Nonann. Fr.	0.993	0.999	0.974	0.977	1.003	1.167	1.148	1.213	1.141	1.093
Diff. in Means	0.291	0.406	0.413	0.533	0.930	1.418	1.221	0.792	0.735	0.698
t-stat p-value	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: Thirty-second (Panel A) and ten-second (Panel B) log price change standard deviations, the trading volume means and bid-ask spreads are reported and compared for announcement and nonannouncement Fridays. The time denoting each column means the end of the interval. The reported log price change standard deviation is the actual value times 10^3, the trading volume and the spread are standardized with their average values per contract. The bid-ask spread is the 30-second (10-second) robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998.

Table 8: Dynamics of Volatility, Trading Volume and Spread by Five-Minute Intervals: Different News

	08:10	08:15	08:20	08:25	08:30	**08:35**	08:40	08:45	08:50	08:55
	Price Volatility									
Nonann. Fr.	0.168	0.218	0.187	0.207	0.209	0.532	0.332	0.283	0.359	0.320
Good News	0.172	0.152	0.183	0.187	0.808	1.538	0.903	0.665	0.553	0.340
St. Dev. Ratio	1.024	0.698	0.975	0.900	3.864	2.890	2.717	2.348	1.543	1.060
F-ratio p-value	0.965	0.114	0.839	0.811	0.000	0.000	0.000	0.000	0.020	0.253
Con. Ann.	0.138	0.167	0.131	0.174	0.845	1.928	0.704	0.549	0.546	0.506
St. Dev. Ratio	0.821	0.768	0.699	0.838	4.040	3.622	2.119	1.940	1.522	1.579
F-ratio p-value	0.819	0.772	0.098	0.223	0.000	0.000	0.000	0.000	0.002	0.000
Bad News	0.165	0.197	0.160	0.291	0.563	1.801	0.653	0.674	0.645	0.463
St. Dev. Ratio	0.986	0.903	0.854	1.404	2.691	3.383	1.964	2.381	1.798	1.444
F-ratio p-value	0.421	0.365	0.696	0.005	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Nonann. Fr.	0.566	0.589	0.611	0.785	0.793	1.337	1.347	1.242	1.246	1.226
Good News	0.491	0.493	0.534	0.772	0.755	3.286	3.090	3.123	2.587	2.336
Diff. in Means	-0.076	-0.095	-0.076	-0.012	-0.038	1.949	1.742	1.880	1.341	1.110
t-stat p-value	0.822	0.974	0.929	0.578	0.709	0.000	0.000	0.000	0.000	0.000
Contr. News	0.625	0.716	0.763	0.926	0.941	2.658	3.124	2.820	2.512	2.327
Diff. in Means	0.059	0.128	0.153	0.142	0.148	1.322	1.776	1.578	1.266	1.101
t-stat p-value	0.190	0.030	0.054	0.034	0.021	0.000	0.000	0.000	0.000	0.000
Bad News	0.569	0.688	0.704	0.940	0.873	2.848	3.214	2.825	2.582	2.299
Diff. in Means	0.003	0.099	0.094	0.155	0.080	1.511	1.866	1.583	1.336	1.073
t-stat p-value	0.477	0.077	0.066	0.031	0.042	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Nonann. Fr.	0.997	0.996	0.995	0.996	0.997	1.001	0.996	0.994	0.997	0.996
Good News	1.001	1.000	1.007	1.013	1.066	1.210	1.018	1.011	1.004	1.007
Diff. in Means	0.004	0.004	0.012	0.017	0.070	0.208	0.022	0.016	0.007	0.012
t-stat p-value	0.144	0.183	0.013	0.008	0.000	0.000	0.002	0.009	0.039	0.001
Contr. News	1.004	1.000	1.008	1.016	1.089	1.195	1.013	1.005	1.003	1.005
Diff. in Means	0.007	0.004	0.013	0.020	0.092	0.194	0.018	0.010	0.006	0.009
t-stat p-value	0.056	0.108	0.010	0.005	0.000	0.000	0.001	0.010	0.070	0.008
Bad News	0.993	1.003	1.005	1.007	1.089	1.372	1.037	1.015	1.014	1.006
Diff. in Means	-0.003	0.007	0.010	0.010	0.093	0.371	0.041	0.021	0.017	0.010
t-stat p-value	0.812	0.076	0.039	0.030	0.000	0.000	0.000	0.001	0.004	0.015

NOTE: Five-minute log price change standard deviations, the trading volume means and bid-ask spreads are reported here. The time denoting each column means the end of the interval. Values for nonannouncement Fridays are compared with the announcement Fridays, on which good, contradictory or bad news were released. Good News = news releases with a negative nonfarm payroll surprise ($S_{NP} < 0$) and a positive unemployment rate surprise ($S_{UR} \geq 0$)), Contr. News = news releases with $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$, Bad News = news releases with $S_{NP} > 0$ and $S_{UR} \leq 0$. The reported log price change standard deviation (Panel A) is the actual value times 10^3, the trading volume is reported in number of contracts and the bid-ask spread is the 5-minute robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

Table 9: Dynamics of Volatility, Trading Volume and Spread by One-Minute Intervals: Different News

	08:26	08:27	08:28	08:29	08:30	**08:31**	08:32	08:33	08:34	08:35
	Price Volatility									
Nonann. Fr.	0.095	0.095	0.085	0.101	0.139	0.411	0.191	0.166	0.203	0.155
Good News	0.078	0.078	0.076	0.113	0.814	1.169	0.606	0.565	0.346	0.364
St. Dev. Ratio	0.823	0.823	0.890	1.115	5.865	2.844	3.178	3.402	1.704	2.345
F-ratio p-value	0.551	0.366	0.982	0.018	0.000	0.000	0.000	0.000	0.000	0.000
Con. Ann.	0.117	0.110	0.116	0.247	0.921	1.821	0.711	0.370	0.442	0.261
St. Dev. Ratio	1.238	1.160	1.372	2.442	6.640	4.430	3.728	2.226	2.173	1.678
F-ratio p-value	0.024	0.050	0.009	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Bad News	0.128	0.138	0.154	0.125	0.546	1.802	0.576	0.463	0.477	0.407
St. Dev. Ratio	1.346	1.455	1.815	1.238	3.935	4.383	3.019	2.789	2.348	2.619
F-ratio p-value	0.007	0.049	0.000	0.046	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Nonann. Fr.	0.724	0.813	0.745	0.730	0.723	1.291	1.346	1.308	1.359	1.205
Good News	0.726	0.709	0.826	0.788	0.602	3.097	2.836	3.173	3.000	3.918
Diff. in Means	0.003	-0.103	0.081	0.058	-0.121	1.806	1.490	1.866	1.641	2.713
t-stat p-value	0.490	0.855	0.193	0.226	0.901	0.000	0.000	0.000	0.000	0.000
Contr. News	0.941	0.908	0.937	0.965	0.834	2.212	2.767	2.439	2.804	2.807
Diff. in Means	0.218	0.096	0.191	0.235	0.112	0.920	1.421	1.131	1.445	1.601
t-stat p-value	0.012	0.150	0.061	0.003	0.067	0.000	0.000	0.000	0.000	0.000
Bad News	1.038	0.945	0.730	0.728	0.654	2.445	2.660	3.062	3.100	3.094
Diff. in Means	0.314	0.132	-0.015	-0.002	-0.068	1.153	1.315	1.754	1.741	1.889
t-stat p-value	0.001	0.072	0.581	0.511	0.847	0.000	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Nonann. Fr.	0.992	0.993	0.992	0.994	0.995	1.003	0.995	0.994	0.993	0.996
Good News	1.009	1.000	1.019	1.036	1.238	1.591	1.223	1.062	1.034	1.020
Diff. in Means	0.017	0.008	0.027	0.041	0.243	0.588	0.227	0.068	0.040	0.025
t-stat p-value	0.013	0.050	0.007	0.004	0.000	0.000	0.000	0.000	0.001	0.003
Contr. News	1.002	1.013	1.009	1.046	1.267	1.710	1.089	1.029	1.026	1.016
Diff. in Means	0.010	0.021	0.018	0.052	0.272	0.707	0.093	0.035	0.032	0.021
t-stat p-value	0.016	0.001	0.002	0.000	0.000	0.000	0.000	0.001	0.000	0.002
Bad News	1.011	1.002	1.039	1.020	1.186	2.168	1.146	1.085	1.047	1.032
Diff. in Means	0.019	0.009	0.047	0.026	0.191	1.165	0.151	0.091	0.054	0.036
t-stat p-value	0.029	0.076	0.001	0.006	0.000	0.000	0.000	0.001	0.000	0.002

NOTE: One-minute log price change standard deviations, the trading volume means and bid-ask spreads are reported here. The time denoting each column means the end of the interval. Values for nonannouncement Fridays are compared with the announcement Fridays, on which good, contradictory or bad news were released. Good News = news releases with a negative nonfarm payroll surprise ($S_{NP} < 0$) and a positive unemployment rate surprise ($S_{UR} \geq 0$)), Contr. News = news releases with $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$, Bad News = news releases with $S_{NP} > 0$ and $S_{UR} \leq 0$. The reported log price change standard deviation (Panel A) is the actual value times 10^3, the trading volume is reported in number of contracts and the bid-ask spread is the 1-minute robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

Table 10: Dynamics of Volatility, Trading Volume and Spread by Thirty-Second Intervals: Different News

	8:28:00	8:28:30	8:29:00	8:29:30	8:30:00	**8:30:30**	8:31:00	8:31:30	8:32:00	8:32:30
	Price Volatility									
Nonann. Fr.	0.076	0.073	0.079	0.083	0.124	0.377	0.155	0.137	0.132	0.105
Good News	0.065	0.081	0.091	0.134	0.812	1.143	0.526	0.448	0.268	0.440
St. Dev. Ratio	0.854	1.120	1.154	1.618	6.562	3.028	3.392	3.260	2.027	4.180
F-ratio p-value	0.805	0.168	0.007	0.038	0.000	0.000	0.000	0.000	0.000	0.000
Con. Ann.	0.062	0.090	0.231	0.238	0.870	1.666	0.619	0.395	0.381	0.250
St. Dev. Ratio	0.819	1.239	2.939	2.882	7.033	4.413	3.992	2.878	2.879	2.373
F-ratio p-value	0.706	0.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bad News	0.081	0.097	0.107	0.122	0.541	2.047	0.718	0.604	0.245	0.232
St. Dev. Ratio	1.069	1.330	1.356	1.482	4.370	5.425	4.633	4.397	1.852	2.199
F-ratio p-value	0.061	0.047	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Nonann. Fr.	0.698	0.707	0.730	0.707	0.722	1.197	1.267	1.328	1.283	1.236
Good News	0.918	0.611	0.954	0.615	0.589	3.313	2.642	3.081	2.534	3.059
Diff. in Means	0.220	-0.096	0.225	-0.091	-0.133	2.116	1.375	1.753	1.251	1.822
t-stat p-value	0.075	0.803	0.037	0.834	0.867	0.000	0.000	0.000	0.001	0.000
Contr. News	0.886	1.069	0.803	0.824	0.813	1.946	2.180	2.466	2.848	2.458
Diff. in Means	0.188	0.362	0.073	0.118	0.091	0.749	0.913	1.137	1.566	1.222
t-stat p-value	0.041	0.007	0.217	0.078	0.171	0.006	0.001	0.000	0.000	0.000
Bad News	0.724	0.763	0.663	0.716	0.601	2.507	2.164	2.717	2.659	2.778
Diff. in Means	0.026	0.055	-0.067	0.010	-0.121	1.310	0.897	1.389	1.376	1.541
t-stat p-value	0.395	0.298	0.747	0.452	0.910	0.002	0.000	0.000	0.000	0.000
	Bid-Ask Spread									
Nonann. Fr.	0.991	0.993	0.992	0.992	0.995	0.998	0.998	0.993	0.994	0.993
Good News	1.014	1.007	1.009	1.095	1.359	1.838	1.326	1.193	1.158	1.062
Diff. in Means	0.023	0.014	0.017	0.103	0.364	0.840	0.328	0.200	0.165	0.069
t-stat p-value	0.009	0.018	0.024	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Contr. News	1.009	1.017	1.033	1.077	1.366	2.042	1.298	1.103	1.078	1.025
Diff. in Means	0.018	0.024	0.041	0.085	0.371	1.043	0.300	0.109	0.085	0.033
t-stat p-value	0.008	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Bad News	1.053	1.033	0.999	1.070	1.218	2.825	1.698	1.216	1.048	1.107
Diff. in Means	0.062	0.040	0.007	0.078	0.224	1.827	0.700	0.223	0.054	0.114
t-stat p-value	0.005	0.007	0.129	0.001	0.000	0.000	0.000	0.000	0.002	0.001

NOTE: One-minute log price change standard deviations, the trading volume means and bid-ask spreads are reported here. The time denoting each column means the end of the interval. Values for nonannouncement Fridays are compared with the announcement Fridays, on which good, contradictory or bad news were released. Good News = news releases with a negative nonfarm payroll surprise ($S_{NP} < 0$) and a positive unemployment rate surprise ($S_{UR} \geq 0$)), Contr. News = news releases with $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$, Bad News = news releases with $S_{NP} > 0$ and $S_{UR} \leq 0$. The reported log price change standard deviation (Panel A) is the actual value times 10^3, the trading volume is reported in number of contracts and the bid-ask spread is the 30-second robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

Table 11: Dynamics of Volatility, Trading Volume and Spread by Ten-Second Intervals: Different News

	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
	Price Volatility									
Nonann. Fr.	0.052	0.050	0.057	0.054	0.103	0.295	0.193	0.111	0.095	0.080
Good News	0.078	0.079	0.077	0.171	0.695	0.633	0.980	0.417	0.279	0.300
St. Dev. Ratio	1.500	1.570	1.344	3.155	6.751	2.143	5.068	3.770	2.925	3.738
F-ratio p-value	0.004	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Con. Ann.	0.111	0.071	0.098	0.145	0.835	1.120	0.585	0.549	0.227	0.346
St. Dev. Ratio	2.152	1.421	1.713	2.678	8.110	3.791	3.023	4.969	2.376	4.310
F-ratio p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Bad News	0.102	0.088	0.076	0.116	0.532	0.923	1.206	0.957	0.326	0.527
St. Dev. Ratio	1.960	1.748	1.331	2.137	5.169	3.126	6.231	8.660	3.419	6.573
F-ratio p-value	0.000	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Trading Volume									
Nonann. Fr.	0.487	0.750	0.670	0.602	0.530	1.103	1.123	1.062	0.964	1.216
Good News	0.486	0.636	0.577	0.334	0.314	2.718	3.082	2.967	2.424	2.520
Diff. in Means	-0.001	-0.113	-0.093	-0.268	-0.215	1.615	1.958	1.905	1.460	1.304
t-stat p-value	0.504	0.813	0.821	0.997	0.984	0.003	0.003	0.001	0.008	0.004
Contr. News	0.910	0.688	1.001	0.559	0.654	1.988	1.577	1.935	1.885	1.547
Diff. in Means	0.423	-0.061	0.332	-0.043	0.124	0.885	0.454	0.873	0.921	0.331
t-stat p-value	0.007	0.697	0.049	0.651	0.149	0.014	0.080	0.005	0.002	0.061
Bad News	0.686	0.623	0.739	0.409	0.531	1.927	2.104	2.426	1.814	2.302
Diff. in Means	0.199	-0.127	0.069	-0.193	0.001	0.825	0.980	1.364	0.850	1.086
t-stat p-value	0.027	0.893	0.336	0.988	0.496	0.045	0.019	0.001	0.002	0.002
	Bid-Ask Spread									
Nonann. Fr.	0.992	0.992	0.992	0.992	0.994	0.998	0.995	0.996	0.994	0.994
Good News	1.123	1.056	1.150	1.372	1.448	2.011	1.684	1.438	1.406	1.225
Diff. in Means	0.131	0.064	0.158	0.380	0.454	1.014	0.689	0.443	0.411	0.231
t-stat p-value	0.005	0.010	0.003	0.002	0.007	0.000	0.000	0.000	0.000	0.000
Contr. News	1.071	1.037	1.137	1.199	1.483	2.205	1.717	1.647	1.347	1.164
Diff. in Means	0.080	0.045	0.144	0.207	0.489	1.207	0.722	0.651	0.352	0.170
t-stat p-value	0.001	0.002	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Bad News	1.041	1.094	1.000	1.185	1.353	2.911	2.470	2.088	1.968	1.465
Diff. in Means	0.050	0.102	0.008	0.193	0.359	1.913	1.475	1.092	0.973	0.471
t-stat p-value	0.020	0.003	0.103	0.001	0.001	0.000	0.000	0.000	0.000	0.001

NOTE: One-minute log price change standard deviations, the trading volume means and bid-ask spreads are reported here. The time denoting each column means the end of the interval. Values for nonannouncement Fridays are compared with the announcement Fridays, on which good, contradictory or bad news were released. Good News = news releases with a negative nonfarm payroll surprise ($S_{NP} < 0$) and a positive unemployment rate surprise ($S_{UR} \geq 0$)), Contr. News = news releases with $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$, Bad News = news releases with $S_{NP} > 0$ and $S_{UR} \leq 0$. The reported log price change standard deviation (Panel A) is the actual value times 10^3, the trading volume is reported in number of contracts and the bid-ask spread is the 10-second robust average of the mean proportional spread weighted with time when each spread value was valid multiplied with 10^4. I report p-values from the Brown-Forsythe-modified Levene F-statistic comparing variances for announcement and nonannouncement days and p-values from the robust t-statistc comparing the means for the two groups of days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.

Table 12: Dynamics of Spreads Around Announcements

	Panel A: Five-Minute Intervals									
	08:10	08:15	08:20	08:25	08:30	**08:35**	08:40	08:45	08:50	08:55
Ann. Fr.	0.988	0.988	0.988	0.989	1.432	0.987	0.988	0.990	0.988	0.987
Nonann. Fr.	0.988	0.988	0.988	0.988	0.989	0.988	0.988	0.988	0.988	0.988
Diff. in Means	0.000	0.000	0.000	0.001	0.442	-0.001	0.000	0.002	0.000	-0.001
t-stat p-value	0.430	0.483	0.399	0.343	0.000	0.632	0.417	0.136	0.560	0.707
	Panel B: One-Minute Intervals									
	08:26	08:27	08:28	08:29	08:30	**08:31**	08:32	08:33	08:34	08:35
Ann. Fr.	0.990	0.992	0.992	0.989	1.434	1.000	0.992	0.991	0.991	0.989
Nonann. Fr.	0.989	0.989	0.990	0.989	0.991	0.990	0.990	0.989	0.990	0.990
Diff. in Means	0.001	0.002	0.002	0.000	0.443	0.010	0.002	0.002	0.001	0.000
t-stat p-value	0.370	0.094	0.171	0.517	0.000	0.000	0.129	0.198	0.249	0.597
	Panel C: Thirty-Second Intervals									
	8:28:00	8:28:30	8:29:00	8:29:30	8:30:00	**8:30:30**	8:31:00	8:31:30	8:32:00	8:32:30
Ann. Fr.	0.991	0.991	0.990	0.993	1.434	1.671	0.999	0.996	0.992	0.992
Nonann. Fr.	0.990	0.989	0.990	0.991	0.991	0.991	0.990	0.990	0.990	0.989
Diff. in Means	0.002	0.001	0.000	0.002	0.443	0.680	0.008	0.006	0.002	0.003
t-stat p-value	0.192	0.209	0.498	0.139	0.000	0.000	0.001	0.004	0.121	0.058
	Panel D: Ten-Second Intervals									
	8:29:20	8:29:30	8:29:40	8:29:50	8:30:00	**8:30:10**	8:30:20	8:30:30	8:30:40	8:30:50
Ann. Fr.	0.992	0.993	1.001	1.000	1.383	1.949	1.732	1.632	1.003	1.005
Nonann. Fr.	0.989	0.990	0.989	0.990	0.991	0.991	0.990	0.990	0.990	0.990
Diff. in Means	0.002	0.002	0.011	0.010	0.392	0.958	0.741	0.641	0.013	0.015
t-stat p-value	0.136	0.126	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000

NOTE: Five-minute (Panel A), one-minute (Panel B), thirty-second (Panel C) and ten-second (Panel D) bid-ask spreads are reported and compared for announcement and nonannouncement Fridays. The time denoting each column means the end of the interval. The bid-ask spread is the mean proportional spread observed at the end of each interval and standardized with their average values per contract. I report p-values from the robust t-statistc comparing means for announcement and nonannouncement days assuming unequal veriances. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005.