Liquidity Provision in Periods of High Information Flow *

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Abstract

This paper examines liquidity provision in an electronic limit order market around macroeconomic news releases when fast execution of orders is especially important. In limit order markets, where there is no designated liquidity provider, the liquidity situation is primarily determined by specific trading patterns. We find that scheduled information events are followed by a high immediate trading desire. However, the volume offered at limit prices is unusually low. This imbalance between liquidity demand and supply leads to a liquidity shortage reflected in high spreads. Moreover, we find that the shortage is asymmetric depending on the type of announced information and the absolute amount of its unexpected component.

Keywords: macroeconomic announcements; market microstructure; liquidity; bid-ask spread; trading volume; market depth; order flow;
JEL classification: E44; G14

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1 Introduction

Financial markets are driven by information. Surprising news influence prices and increase trading but even the most relevant signal turns out to be useless when no transaction is possible. Liquidity is a prerequisite for the sound functioning of markets. For example, a price shock hitting the financial market may cause large costs for the owner of a title. However, when such a shock is driving a liquidity breakdown, the investors are forced to hold the assets without any possibility of adjusting their portfolios which may increase the losses substantially. This paper examines liquidity provision in the largest European bond futures market, organized as an electronic limit order market, in periods of intensive public information flow, i.e. periods when fast execution of orders is especially important.

In limit order markets, where there is no designated liquidity provider, liquidity arises endogenously from the orders submitted by traders. Outstanding information events such as scheduled macroeconomic releases may cause unusual trading behavior which can lead to imbalances between liquidity demand and supply. For example, when the announced news is much better than expected, a high liquidity demand should be observed resulting in a sharp increase of market buy orders. On the other hand, liquidity supplied through available limit sell orders may be even reduced since unexecuted orders will be withdrawn. Such an imbalance between high immediate trading demand and low liquidity supply may result in a liquidity shortage. Furthermore, it is likely that very few traders will place orders immediately before the time scheduled for important news releases because they may wish to avoid extensive risk. Hence, in contrast to a market-maker market, the liquidity situation here is primarily determined by specific trading patterns preceding and following public news events.

Macroeconomic announcements are an example of public information shocks that appear on a regular basis. They have been shown to move the markets enormously causing immediate price changes and increased volatility (e.g. Ederington and Lee (1993), Andersen and Bollerslev

(1998), Andersen, Bollerslev, Diebold, and Vega (2003, 2006)). However, the mechanism of liquidity creation and absorption around such events has not been described thoroughly yet. Event studies analysing the bond market find weak indications of low liquidity before and rather strong evidence for a shortage after the announcements (e.g. Fleming and Remolona (1999) or Balduzzi, Elton, and Green (2001)). While these studies document certain patterns in spreads and trading volume, they cannot describe the mechanism leading to liquidity shortages. We close this gap by investigating explicitly how liquidity demand and supply is affected by exceptional news. Our analysis is based on a long and precise intraday data set. This allows us to investigate liquidity provision in the phases preceding and following the information arrival. In particular, we analyze the interaction between liquidity supply and trading demand that determines liquidity shortages in a limit order market.

Liquidity can be assessed precisely when the whole order book is known. However, a disadvantage of order book data sets is that they are available only for rather short periods. In contrast, we use a high frequency data set which spans over 15 years and contains very precise information on transactions as well as quoted volumes and prices. Our data covers German Bund Future trading, i.e. one of the most liquid futures contracts. Using this data, liquidity is measured in 1-minute intervals on the basis of several proxies suggested in the literature (bid-ask spreads, the volume offered at the best bid/ask price and the trading volume of buys/sells). Additionally, we introduce a measure that compares directly liquidity demand (the trading volume resulting from market buy and sell orders) with liquidity supply (the volume offered at the best quotes). This measure allows us to identify liquidity shortages. We investigate liquidity during 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. A further advantage of this release is that it does not overlap with other scheduled announcements.

As a result, we identify significant liquidity shortages around scheduled information events confirming previous findings for the bond market (e.g. Fleming and Remolona (1999) or Balduzzi, Elton, and Green (2001)). Moreover, we find that the decrease in liquidity is caused by the imbalances between liquidity supply and trading demand. Decreasing offered volume and rather normal trading volume before the announcement cause low and decreasing liquidity in anticipation of the news release. The shortage becomes very high immediately after the event because the flow of market orders by far exceeds market depth. Afterwards, slowly recovering offered volume and very high trading volume cause low and increasing liquidity.

Furthermore, we find that the liquidity reaction depends on the type of the announced information and its surprise component. Good news are directly followed by a very high flow of market buy orders. This massive buying creates pressure on the volume offered for sale at the best ask price. When this volume is traded away, the best ask price increases. This means an increase in transaction costs and a liquidity shortage. Similarly, the opposite reaction is observed after bad news releases. Moreover, large surprises result in a higher order flow and a higher liquidity shortage than small surprises. This is caused by the fact that liquidity supply increases less with the absolute suprise than liquidity demand. Finally, we find that liquidity shortages are particularly high after large bad news.

The remainder of the paper is organized as follows. Section 2 contains a literature overview and introduces our hypotheses about liquidity creation around the news releases. Section 3 describes the data set as well as the used liquidity measures. Section 4 presents the empirical results including a descriptive analysis of liquidity measureas around macroeconomic announcements as well as the estimation results of the GARCH models showing the relation between liquidity and the size and sign of the news component. Section 5 concludes.

2 Related Literature and Hypotheses

A market may be defined as liquid when even large trades can be executed with no cost (O'Hara (1995), Fleming (2001)). The role of information on liquidity in price driven markets has been investigated in many theoretical studies (see Madhavan (2000) and Biais, Glosten, and Spatt (2005) for a recent survey of this literature).[1] While a substantial body of literature is concerned with the price setting in market-maker markets, only a few models analyze liquidity in electronic limit order markets where it arises endogenously from the submitted orders.[2] 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.[3] 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.

Beside literature on liquidity creation in general, little empirical evidence on the effects occuring in periods of public information arrival can be found so far.[4] The problem is that

[1] In such markets, also referred to as market-maker markets, market makers supply liquidity. Their revenues correspond to the spread and reflect the incurred costs which are due to adverse selection (Kyle (1985), Glosten and Milgrom (1985), Admati and Pfleiderer (1988) or Glosten (1994)) or inventory control (Stoll (1978), Amihud and Mendelson (1980) or Ho and Stoll (1981)). The first group of models assumes that trading with privately informed investors leads to the losses for market makers. Consequently, liquidity decreases (transaction costs increase) with the level of information asymmetry. In the second group of models, the spread reflects the cost of market makers building up positions to accomodate public order flow. In result, high order flow causes a decrease in liquidity (increasing transaction costs). One of the further consequences of these models might be that the arrival of new public information decreases liquidity before the event since the investors want to avoid losses from trading with better informed market participants (adverse selection argument). Another possible scenario would be that liquidity decreases after the news release because of the massive order flow causing large costs (inventory control argument).

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

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

[4] For example, Amihud and Mendelson (1991) examine liquidity using the bid-ask spread and show that the bond yields include premium for liquidity risk. The same issue is examined in Elton and Green (1998) who use the daily trading volume as a proxy for liquidity. Intraday liquidity patterns are documented in Fleming

measuring liquidity is not straightforward. The most precise assessment can be made when the whole order book is known. Order book data sets are available for some markets or can be reconstructed from order flow data. However, the length of such samples is by far not sufficient to conduct event studies with macroeconomic announcements.[5] To obtain a sufficient data set we use high frequency data on the German Bund Future which spans over a period of 15 years and contains very precise information on trading and offered volumes and prices. However, for such data only proxies like bid-ask spreads, trading and quoted volumes can be used to measure liquidity. Previous event studies usually conduct an isolated analysis of some of these proxies.[6] However, this may not reflect the real liquidity situation in some cases. For example, Lee, Mucklow, and Ready (1993) argue that it is impossible to make inferences about overall liquidity based only on spreads or the quoted volumes. A similar argument is provided by Pascual, Escribano, and Tapia (2004) who introduce a bi-dimensional measure of liquidity taking both spreads and the quoted depth into accout.[7] In this study, we provide a more comprehensive analysis of the liquidity creation mechanism and investigate jointly liquidity supply and demand around public news events. We show that imbalances between the volume offered at the best quotes (liquidity supply) and the volume of incoming market

(1997) who studies bid-ask spreads and the trading volume in the U.S. Treasury market. Chordia, Roll, and Subrahmanyam (2005) use the volume of buys and sells to explore the predictive ability of order imbalances for the intraday stock returns.

[5]For example Chan, Kim, and Rhee (2005) use 24 months of order book data from the Kuala Lumpur Stock Exchange to examine the impact of price limits on the arrival rates of informed traders and order imbalance. The data on order flow from the New York Stock Exchange is used in Bacidore, Battalio, and Jennings (2003) to examine changes in displayed liquidity around the reduction in the minimum price variation and in Ready (1999) to examine the specialist's behavior in competition with limit order traders. Sandȧs (2001) uses similar data for the Stockholm Stock Exchange and finds evidence that limit order books offer too little depth. Evans and Lyons (2002) use order flow data in the foreign exchange market (data from the interdealer trading system called Reuters Dealing 2000-1) and show that order flow has the ability to forecast future returns. Two recent studies by Green (2004) and Pasquariello and Vega (2007) use order flow data to examine the effect of order flow on bond price changes (U.S. Treasury Market) surrounding macroeconomic announcements.

[6]For example, Fleming and Remolona (1999) and Balduzzi, Elton, and Green (2001) investigate liquidity in the bond market using spreads and the trading volume, Kavajecz (1999) focuses on the stock market and analyses the quoted volumes and Evans and Lyons (2005, 2008) and Love and Payne (2008) analyse trading and order flow in the forex market after news releases. Fleming (2001) examines how various liquidity proxies correlate with the episodes when the reported liquidity was poor (such as the fall 1998 financial markets turmoil). His results suggest that different measures convey different information about liquidity.

[7]A similar, bi-dimensional approach to measuring liquidity can be found in Engle and Lange (2001) and Gomber, Schweickert, and Theissen (2004).

orders (liquidity demand) lead to liquidity shortages.

Deriving testable hypotheses, a very interesting starting point is the question how liquidity supply and demand are affected by the information arrival. Among theoretical models on market microstructure, only a few allow to formulate predictions about the changes in quoted depth around news events. Dupont (2000) and Caglio and Kavajecz (2006) develop models where market makers specify bid and ask prices along with the bid and ask volumes and show that quoted depth is used strategically to address changes in the trading environment and, in particular, adverse-selection risk.[8] If this risk increases before a public news release, we should observe a reduction of the quoted volume. Lee, Mucklow, and Ready (1993) and Kavajecz (1999) find empirical evidence for a decrease of the quoted volume in the stock market in anticipation of the earnings announcements.[9] Pasquariello and Vega (2007) develop a model of speculative trading that allows to study the impact of public information on the equlibrium market depth. After the arrival of a public signal, representing an additional source of information about the asset's payoff, market makers increase market depth since the adverse selection risk is lower.[10]

In limit order markets, liquidity supply is reflected in the volume of unexecuted limit orders offered at the best quotes. We expect that the effects regarding the quoted volume predicted theoretically for market-maker markets can be also observed in limit order markets. Particularly, we expect that traders withdraw their unexecuted limit orders before the announcement. The reason is that the old limit orders are likely to be executed at disadvantageous prices after

[8]Kavajecz and Odders-White (2001) show empirically that market makers react to changes in the trading environment by updating their quoted depths.

[9]Lee, Mucklow, and Ready (1993) analyze the joint reaction of spreads, the trading volume and the quoted volume and find that spreads widen and quoted volumes fall in anticipation of the earnings announcements. They do not find any significant liquidity reaction after announcements. Kavajecz (1999), who uses order flow data, finds that both specialists and limit order traders reduce depth around information events.

[10]Kim and Verrecchia (1994, 1997) and Livne (2000) show, however, that it is not clear whether the announcement per se decreases the adverse selection risk. Public announcements eliminate the information asymmetry that prevailed in the preannouncement period between informed and uninformed traders. But a new information asymmetry can be created in the market since information published in the released report can be better processed by some investors.

the news release because new information often changes the equilibrium price. For example, if this price increases after the announcement, old limit sell orders are offered at relatively low prices and thus are likely to be immediately bought. Moreover, we expect that speculative traders will submit cautiously new limit orders after the event. However, we would assume that traders submit fewer (or no) limit orders until they believe that the new information is widely reflected in prices. Hence we expect that the volume of bid and ask quotes remains subdued for a while. This leads to hypothesis H1:

H1: The bid volume and the ask volume decrease before public news releases and return slowly to a normal level afterwards.

In contrast, we expect a different pattern for liquidity demand reflected by the trading volume resulting from the submission of market orders (hypothesis H2).[11] Kim and Verrecchia (1991a, 1991b) show that abnormal trading occurs if there is some type of asymmetry among investors, either in their risk aversion or private information. However, trading behavior of investors is not considered explicitely in these studies. 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 substantially different from the expected value. After the announcement, when a new signal about the equilibrium price is released, not every trader offering volume at old prices (i.e. prices quoted before the event) may be fast enough to adjust his limit order immediately. This leads to differences between actually offered prices and expected equilibrium prices. This should induce, in line with the above mentioned models, a large flow of market orders. Consequently, we expect to observe a large trading volume after the news release. Indeed, previous empirical studies for the market-maker bond market indicate that the trading volume increases after announcements (e.g. Fleming and Remolona (1999) or Balduzzi, Elton, and Green (2001)).

[11] The trading volume can be also caused by the submission of aggressive limit orders, i.e. orders with limits above the current best ask price (in case of buy orders) or below the current best bid price (for sell orders). Similar to the market orders, they result in a direct absorbtion of liquidity offered at the best quotes and add to our measure of current liquidity demand.

We are explicitely interested in capturing the changes in liquidity demand. However, they may be not identified sufficiently if the analysis is based only on the trading volume. For example, even if the trading volume is large, the liquidity situation may be still very different when most trades result from market sell orders compared to the situation when the number of buys and sells is similar. For this reason, we differentiate between the volume resulting from buy market orders and the volume resulting from sell market orders. We expect that after a good announcement, i.e. after a signal that the true equilibrium price is above the recently traded price, the best ask price quoted before the event turns out to be relatively low and thus a large flow of market buy orders should be observed. Similarly, a large volume of sells should be observed after bad announcements. We assume here that the traders whose unexecuted limit orders are quoted at the moment of a news release are not systematically faster in adjusting the limit prices (through withdrawal of old limit orders and submission of new ones) than the traders who submit market orders.

H2: The trading volume increases after news releases. Good (bad) news increase particularly the volume resulting from buy (sell) orders.

The third hypothesis (H3) refers to a liquidity shortage resulting from the imbalace between liquidity supply and demand. In hypothesis H1, we expect that liquidity supply decreases before the announcement and remains subdued for a while after the event. This is caused by the fact that traders withdraw their limit orders. In hypothesis H2, we expect that liquidity demand increases after the release of new information. This is reflected in a large arrival of market orders resulting in the large trading volume. To combine both effects, we introduce a measure comparing liquidity supply and demand. We construct buy-to-ask and sell-to-bid volume ratios, i.e. the ratios of the volume of buys (sells) to the volume quoted at the best ask (bid) price. These measures allow us to identify the imbalance between depth at the best quotes (liquidity supply) and the incoming market orders (liquidity demand). For example, if traders want to buy aggressively and submit large market buy orders but the

volume offered for sale at the current best ask price is low, liquidity supply is going to be exploited. This imbalance of liquidity demand and supply drives up the best ask price and results in a wider spread. Such a scenario should be particularly relevant for the case when positive news is released (see H2). Given our expectations regarding liquidity supply (H1) and demand (H2), we expect to observe that buy-to-ask and sell-to-bid ratios increase before public news releases, increase even further directly after the event and return to a normal level afterwards.

Furthermore, we complete our analysis of overall liquidity provision by investigating the most popular proxy for liquidity, the bid-ask spread. We expect to observe a similar pattern as for buy-to-ask and sell-to-bid ratios. In particular, we expect that the spreads widen before the news release if the whole volume quoted at the best ask or bid price is withdrawn by cautious traders. Directly after the event, we expect a further increase in spreads due to the arrival of a large market order volume and a suppressed liquidity supply. 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. Finally, we expect that spreads return to a normal level after the new information is widely reflected in prices. Previous event studies for bond markets (organized, however, as market-maker markets) provide some evidence that spreads increase before macroeconomic announcements, increase even further directly after the information arrival and recover afterwards. For example, Balduzzi, Elton, and Green (2001) find that spreads widen in the 5-minute interval after the news release. Furthermore, they find weak evidence for some announcements suggesting that spreads increase in the last five minutes before the release time. Fleming and Remolona (1999) consider 1-minute intervals and find that spreads widen significantly already two minutes before the announcement, increase further immediately after the release and recover afterwards.

H3: Bid-ask spreads, buy-to-ask and sell-to-bid ratios increase before public news

releases, increase even further directly after the event and return to a normal level afterwards.

Hypothesis H4 regards the role of the surprise component in an announcement for liquidity creation. The response of the trading volume to surprises can be derived from several models. For example, Kim and Verrecchia (1991b) show that the trading volume depends positively on the size of surprises and on the information assymetry. After a public news release, investors revise their beliefs differently. The average change of beliefs is reflected in the price movement and the residual differences cause trading.[12] These differences are larger the larger the surprises are. A related argument is provided by Foster and Viswanathan (1993) who show that if public information is substantially different from what investors expect, an increase in the trading volume occurs.[13] Hence we expect that the overall trading volume depends positively on absolute surprises. Moreover, we anticipate that the direction of trade, i.e. whether the volume of buys or sells is larger, depends on the sign of a surprise, i.e. whether an announcement provides good or bad news. As explained in H2, the arrival of market buy (sell) orders is expected to be particulary high after good (bad) news.

H4: The trading volume increases in absolute surprises. The volume resulting from buy (sell) orders depends positively on the absolute surprise in good (bad) news.

Our final hypothesis (H5) regards the dependence of a liquidity shortage on absolute surprises. Foucault, Kadan, and Kandel (2005) show in the model of a limit order market that impatient traders prefer market orders. We anticipate that large surprises increase the number of impatient traders beacuse of the opportunity to trade (buy or sell, dependent on the surprise sign) at advantageous prices quoted for old unexecuted limit orders. In result, large surprises should increase liquidity demand (the flow of market orders) stronger than liquidity supply

[12]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.

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

(the flow of limit orders). This, in turn, should lead to a more pronounced liquidity shortage. Finally, we expect an asymmetric response of liquidity shortages to absolute surprises. Several theoretical models justify such asymmetries in the price response (for example, Veronesi (1999), Barberis, Shleifer, and Vishny (1998) and Daniel, Hirshleifer, and Subrahmanyam (1998)).[14] Empirical studies on price formation in the bond market during periods of intensive public information flow find that the price reaction and volatility increase in absolute surprises and that the reaction to bad news is stronger than to good news (e.g. Hautsch and Hess (2002, 2007) or Andersen, Bollerslev, Diebold, and Vega (2006)). Hence we expect that traders' impatiency, and thus the submission of market orders (liquidity demand), increases stronger for bad news than for good news with similar absolute surprises. Therefore, large bad surprises should result in higher liquidity shortages than large good surprises.

H5: Liquidity shortage increases in absolute surprises. Large bad news result in a higher liquidity shortage than large good news.

To illustrate the introduced hypotheses, Figure 1 presents an example of a liquidity shortage caused by a large buying activity after a good news release. Tick data on price and trade response to the U.S. Employment Report announced on Jul. 3rd, 2003 is presented.[15] Subfigure (a) shows the traded and the best quoted prices, subfigure (b) shows liquidity supply proxied by the volume offered at the best quotes and subfigure (c) shows liquidity demand proxied by the trading volume resulting from market buy and sell orders. The price response is almost immediate and applies to the trading and quoted prices. However, the adjustment to a new equilibrium price is rather gradual and depicts a positive trend. Liquidity supply (the quoted volume) falls before the news release and recovers after the event. Liquidity demand (the trading volume) increases after the announcement dramatically. During the first minute, almost

[14]These models regard, however, mainly stock markets and not bond markets.

[15]The released figures on this day were: the change in the nonfarm payroll employment (NP), -30 Thousands and the unemployment rate (UR), 6.4%. The medians of analysts' forecasts were: NP = 0 Thousands and UR = 6.2%. This corresponds, according to our surprise definition, to good news about the nonfarm payroll employment and the unemployment rate. Therefore, the announcement carried positive information to investors.

all transactions result from market buy orders. This example might suggest that liquidity is low in the periods around announcements and that transaction costs are particularly high immediately after information events due to low liquidity supply and large liquidity demand. In the remainder of the paper we want to test, whether this example illustrates a stable pattern or an exception to a common liquidity reaction.

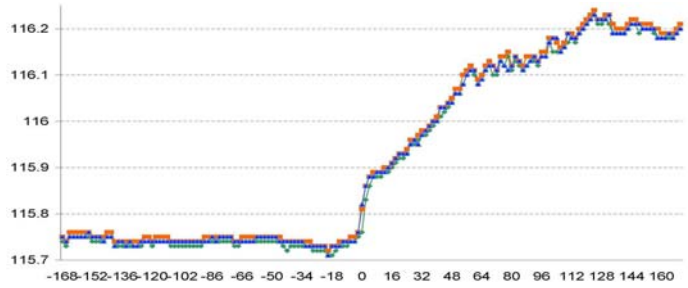
3 Data

3.1 Announcement Data

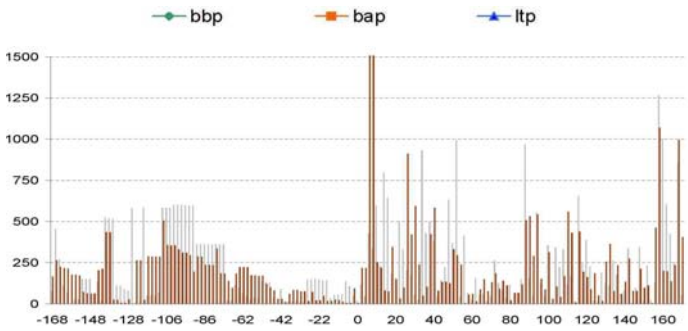
We use announcement data on the U.S. nonfarm payroll employment and the unemployment rate, which provide signals about the employment situation obtained from two independent surveys. The Employment Report is released by the Bureau of Labor Statistics on the first Friday of every month at 08:30 EST.[16] 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, Hansen, and Sebestyn (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. announcements. Overlapping events are eliminated from our sample. Therefore, the observed market reaction should be solely due to the information conveyed by this report.[17] Additionally, the release time is very precise and information

[16]The report includes also information on the average hourly earnings and the 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. We exclude these observations from our sample. 08:30 EST corresponds in most cases to 14:30 CET and on four days to 13:30 CET or 15:30 CET, dependent on the summer time periods in both time zones. The results reported here use all observations and eliminating the announcements released at 13:30 CET or 15:30 CET does not change the results qualitatively.

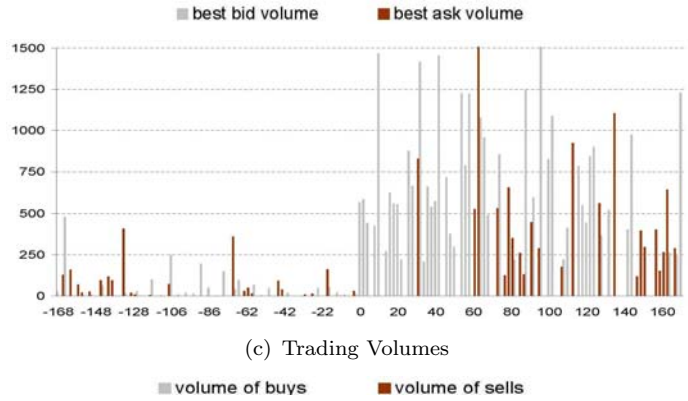
[17]We exclude all Fridays, on which there was a release of a U.S. announcement on 08:30 EST (8 announcements out of 26 analysed), as well as all Fridays when there was a release of a German announcement between 12:30 and 16:30 CET (4 announcements out of 23 analysed). U.S. announcements released on 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.



(a) Prices



(b) Quoted Volumes



(c) Trading Volumes

Figure 1: Example: Price and Liquidity Reaction to News Release

NOTE: Figures (a), (b) and (c) present the response of prices (a), the quoted volumes (b) and trading volumes (c) after an announcement of the U.S. Employment Report on Jul. 3rd, 2003. Announced figures: the change in the nonfarm payroll employment (NP), -30 Thousands and the unemployment rate (UR), 6.4%. Median forecast: NP = 0 Thousands and UR = 6.2%. This corresponds to good news about nonfarm payrolls and about the unemployment rate which is why the announcement carried positive information to investors. Subfigure (a): blue lines denote traded, red lines - ask and green lines - bid prices. Subfigure (b): light grey bars denote the best bid volume and dark red bars denote the best ask volume. Subfigure (c): light grey bars denote the volume of buys and dark red bars denote the volume of sells. The reported time interval: 08:27:00-08:32:59. The seconds around the 08:30 EST (the release time) are denoted on the x-axis, 0 denotes 08:30:00.

leakages are rather implausible.[18]

To compute the unanticipated information, we compare the actual releases with the investor forecasts (available from Money Market Services). We use two signals about the employment situation and define days, on which the released news was good, bad or contradictory. The first signal is the surprise in the nonfarm payroll employment ($S_{NP,m}$):

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

where $A_{NP,m}$ is computed as the announced payroll change in month m in percent of the previously announced payroll level, $F_{NP,m}$ is the median of analysts' forecasts and is also standardized by the previously announced payroll level. Good news for the bond market corresponds to a negative surprise in nonfarm payrolls, $S_{NP,m} < 0$. The actual employment growth lower than the median of forecasts ($S_{NP,m} < 0$) 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 ($S_{UR,m}$) defined as:

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

where $A_{UR,m}$ denotes the announced unemployment rate in month m, $F_{UR,m}$ is the median of analysts' forecasts about the unemployment rate in month m (both figures measured in percentage points). A positive surprise in unemployment rate, $S_{UR,m} > 0$, is good news for the bond market. The actual unemployment rate higher than the median of forecasts ($S_{UR,m} > 0$) is a signal for a worse than expected business cycle situation. This information should also have a positive impact on the bond price. Note that according to these definitions surprises in both, nonfarm payrolls and the unemployment, are measured on the same scale. Hence a further standardization is not needed. In the following, we drop the index m in $S_{NP,m}$ and $S_{UR,m}$ for the ease of notation.

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

Considering information conveyed by both of these headlines of the Employment Report, we classify announcements into three groups: good, bad and contradictory. Good announcements mean the cases when the news about the nonfarm payroll employment was good ($S_{NP} < 0$) and the news about the unemployment rate was good or neutral ($S_{UR} \geq 0$). Bad announcements are defined as $S_{NP} > 0$ and $S_{UR} \leq 0$. Announcements are classified as contradictory when $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$.

3.2 Trading Data

We 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.[19] 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).[20] We focus on the most actively traded contract on a given day.[21]

We exclude the first years of data, i.e. until the end of 1993, when the contract was not

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

[20]We standardize the figures measured in the quantities of contracts in order to be able to compare 1 standardized DM-contract with 1 EUR-contract. We multiply all quantity records in the DM-data set with $e_{DM/Eur}/2.5$ where the official exchange rate $e_{DM/Eur} = 1.95583$ DM/Eur.

[21]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.

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.[22] We divide our sample into two periods, i.e. 1994-1998 and 1999-2005. The first reason is the mentioned change of the contract design and currency.[23] The second reason is a substantial increase of the EUREX market share in the Bund futures contract until the end of 1998.[24] Therefore, liquidity is in general much larger in the second period. We 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.[25] Table 1 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.

3.3 Liquidity Measures

Our data set inludes exactly time-stamped and precise information about the best bid, the best ask and the last traded prices and quantities stemming directly from the electronic order matching system. We use this information to compute liquidity measures for 1-minute intervals.[26] To calculate liquidity demand, we implement the Lee and Ready (1991) algorithm

[22]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).

[23]Although we 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.

[24]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.

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

[26]The best bid (ask) price is the current best offer to sell (buy) a contract. The last traded price gives information on the price of the latest transaction. The best bid (ask) quantity denotes the number of contracts for which the best bid (ask) price is valid. We compute the trade size using the information on the last traded quantity. Note that the information on the number of contracts, for which the current best offer to sell or buy

Table 1: The Developement of Trading in the Sample Period

Year	Trading Volume per Minute	Average Bid Volume	Average Ask Volume	Number of Trades per Minute	Trading Volume per Trade	Average Spread
1994	68.3	37.0	38.2	4.0	16.1	1.73
1995	61.7	41.7	45.8	3.6	15.8	1.33
1996	80.0	54.1	55.8	4.0	18.4	1.21
1997	145.0	86.3	88.4	5.6	24.2	1.07
1998	356.8	217.5	222.1	9.2	36.9	0.93
1999	635.6	235.4	230.4	13.3	43.9	0.93
2000	714.4	349.1	349.6	11.5	58.5	0.96
2001	865.2	501.7	492.7	11.1	72.0	0.93
2002	893.2	447.4	438.9	12.0	67.8	0.93
2003	1053.0	410.7	402.3	15.1	64.0	0.88
2004	1045.4	815.1	809.1	12.6	73.9	0.87
2005	1341.6	794.8	801.3	17.0	71.9	0.82

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, the average bid and ask volumes (all three figures measured in the number of contracts), the average number of trades per minute, the average volume per trade (measured in the number of contracts) and the average spread (multiplied by 10^4). All results are computed for the most actively traded contracts during the time window between 9:00 and 17:00 CET.

to identify the volume resulting from buy and sell market orders.[27] We compute the volume resulting from buy (sell) orders in a 1-minute interval as the sum of the volumes of all trades signed as buyer (seller) initiated occurring during this interval. Similarly, the 1-minute trading volume is obtained as the aggregated trading volumes during a 1-minute interval. Liquidity supply is measured by the volume offered at the best quoted prices. The 1-minute bid (ask) volume is computed as the average volume offered at the best bid (ask) price weighted with the time when the price was valid. The average 1-minute spread is computed in a similar way.[28] Descriptive statistics presented in Table 1 indicate a strong positive trend of variables describing trading activity as well as a negative trend in spreads. To be able to compare these

a contract is valid, is available for every record. This feature of our data set enables us to analyze the trading process during the periods of high information flow in detail.

[27] We compare the last traded price with the best bid and the best ask prices in the former record for each trade that occured. If the last traded price was below the last midquote, the trade is signed as a sell, if it was above the midquote, the trade is signed as a buy. Trades where the last traded price equals the midquote remain unsigned. Moreover, we leave the trades unsigned if the prices and 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.

[28] The bid-ask spread is defined as the mean proportional spread and computed as $Spr_i = \frac{2(BAP_i - BBP_i)}{BAP_i + BBP_i}$ where Spr_i is the spread, BAP_i is the best ask price and BBP_i is the best bid price in record i.

measures for different contracts, we standardize them by the average contract values.[29]

Additionally, to capture the effects due to the imbalance between liquidity supply and demand, we introduce two liquidity measures, buy-to-ask and sell-to-bid ratios, which are computed as:

$$BuyToAsk_t = \frac{1}{B_t}\sum_{i=1}^{B_t}\frac{BuyVol_i}{AskVol_i}, \qquad SellToBid_t = \frac{1}{S_t}\sum_{i=1}^{S_t}\frac{SellVol_i}{BidVol_i}$$

where $BuyVol_i$ ($SellVol_i$) is the trade size of the i-th buy (sell) transaction in minute t, $BidVol_i$ ($AskVol_i$) is the volume offered at the best bid (ask) just before the transaction i occured and B_t (S_t) is the number of buys (sells) in minute t.[30] The buy-to-ask ratio provides information whether the size of market buy order exceeds, on average, the volume offered for sale at the best ask price. The larger this measure is, the more often the liquidity offered for sale is not sufficient to meet the demand. Similar to the other liquidity measures, we standardize buy-to-ask and sell-to-bid ratios by their average contract values to eliminate possible differences in trends between the trading volume and the quoted volume.[31]

This measure captures the imbalance between liquidity demand and supply and thus conveys different information than spreads. For example, if a large market buy order is submitted and the volume offered for sale at the best ask price is not sufficient, the best ask price

[29] All averages for the contract are computed using 1-minute intervals between 9:00 and 17:00 CET for all days on which the contract was the most actively traded one. We considered also other standardization methods like for example standardizing with the average on 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.

[30] All results involving this measure are robust to other specifications. We also used buy-to-ask and sell-to-bid ratios for 1-minute interval t in contract c calculated as:

$$BuyToAsk_t = \frac{AvgBuyVol_t}{AskVol_t}, \qquad SellToBid_t = \frac{AvgSellVol_t}{BidVol_t}$$

where $AvgBuyVol$ ($AvgSellVol$) is the average size of trades resulting from buy (sell) orders for each 1-minute interval computed as the volume of all buys (sells) divided by the number of the corresponding transactions in the interval, $BidVol_{t,c}$ ($AskVol_{t,c}$) is the bid (ask) volume in the 1-minute interval t in contract c, i.e. the average volume offered for purchase (sale) at the best bid (ask) price. The results were qualitatively the same.

[31] The results for the unstandardized buy-to-ask and sell-to-bid ratios are qualitatively the same. We decided to report the results for the standardized values for the sake of consistency of the interpretation for all liquidity measures. In this way, each value can be seen as the deviation from the contract average.

increases (if no additional sell market orders arrive at exactly the same time[32]) and the spread widens (given no change in the best bid price). The value of buy-to-ask is high due to a large imbalance between liquidity demand and supply. In the next second, if the volume offered for sale at a higher best ask price is large (e.g. due to the order book structure), buy-to-ask returns to a low level. This example illustrates that buy-to-ask (and sell-to-bid) is not necessarily high when spreads are high. It rather indicates an imbalance between liquidity demand and supply which, if high, depicts a liquidity shortage.

4 Empirical Results

4.1 Liquidity Provision Around Announcements

This section presents a descriptive analysis of liquidity provision around the release time of the U.S. Employment Report. First, we investigate liquidity supply and test whether the volume offered at the best quotes falls before announcements and recovers afterwards as predicted in hypothesis H1. In the second step, demand for liquidity measured by the trading volume resulting from market buy and sell orders is explored. This allows us to test hypothesis H2 saying that the trading volume rises after public information releases and that good news are followed by a large flow of market buy orders while bad news are followed by a large sell order flow. Finally, we test whether liquidity falls in anticipation of the announcement, decreases further directly after the information release and recovers afterwards due to the return of liquidity demand and supply to their normal levels (hypothesis H3). Apart from using the bid-ask spread, a conventional measure to identify liquidity shortage, we analyze

[32]For the cases when a market buy order and a market sell order are submitted at exactly the same moment, our measure might be imprecise. A market buy order may be matched not only with the volume of a limit order offered at the best ask price but also by a market sell order arriving at exactly the same moment. However, our data set is very precisely time-stamped and even several observations per second are recorded. Most of the records in the periods of intensive trading occur every one or two seconds. For this reason, the probability that a market buy order and a market sell order are recorded jointly is extremely low. Moreover, we do not consider trades appearing at the midquote price and signed as unknown. Even when two market orders (one sell and one buy) are submitted in the same instant and recorded in the same record, they are probably (given that they are of similar sizes) executed at the midquote price and thus signed as unknow. For these reasons, we expect no systematic error in buy-to-ask or sell-to-bid ratios.

the imbalance between liquidity supply and demand described by buy-to-ask and sell-to-bid ratios.

Tables 8 - 10 and in Figures 2 - 4 present the investigated liquidity measures for 1-minute intervals around the announcement time. The following groups of days are considered: all days in the sample, nonannouncement Fridays, announcement Fridays, announcement Fridays with good, contradictory and bad news.[33] We report the robust means of the investigated measures for each group of days.[34] Significance from the robust t-statistic comparing the means with 1 is reported at the top of each value.[35] Significance from the robust t-statistic comparing the means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value.[36] The results presented here regard the sample of contracts denominated in EUR (from Apr. 1st, 1999 to Dec. 30th, 2005). The results regarding the sample of contracts denominated in DM (from Jan. 1st, 1994 to Dec. 30th, 1998) are reported in Appendix I.

Our results regarding liquidity supply and demand in the bond futures market organized as an electronic limit order market confirm the patterns found in the empirical studies conducted

[33]Good announcements mean the case when the news about the nonfarm payroll employment was good ($S_{NP} < 0$ which, according to our surprise definition means that the announced nonfarm payroll employment was lower than the median of analyst's forecasts) and the news about the unemployment rate was good or neutral ($S_{UR} \geq 0$ i.e. when the actual unemployment rate was not lower than expected). Bad announcements are defined as $S_{NP} > 0$ and $S_{UR} \leq 0$. Announcements are classified as contradictory when $S_{NP} < 0$ and $S_{UR} < 0$ or $S_{NP} > 0$ and $S_{UR} > 0$. For a better overview, the results for all days are reported only in the figures. The period covered in the tables: 08:24 EST to 08:37 EST (U.S. Employment Report is released at 08:30 EST). "1" means the first minute after the news release, i.e. time between 08:30:00 and 08:30:59 EST.

[34]We calculate robust statistics by using winsorising as described in Dixon (1960), Tukey (1962) or Huber (1981).

[35]The one-sample t-test with H_0: $\overline{x} = 1$ has the following form: $t = \frac{\overline{x}-1}{s_x/n}$ with $\overline{x}$ the robust sample mean, s_x the robust sample standard deviation, n the sample size and the degree of freedom $df = n - 1$. In the tables for liquidity supply, we test if the means are smaller than 1 ($t = \frac{1-\overline{x}}{s_x/n}$). *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively.

[36]The heteroscedastic t-test with H_0: $\overline{x} = \overline{y}$ used here has the following form: $t = \frac{\overline{x}-\overline{y}}{\sqrt{s_x^2/n_x + s_y^2/n_y}}$ with $\overline{x}$, $\overline{y}$ the robust sample means, s_x, s_y the robust sample standard deviations, n_x, n_y the sample sizes and the degree of freedom $df = \frac{(s_x^2/n_x + s_y^2/n_y)^2}{(s_x^2/n_x)^2/(n_x-1) + (s_y^2/n_y)^2/(n_y-1)}$. In the tables for liquidity supply, we test if the means on announcement days are smaller than on noannouncement days. The test was developed by W. S. Gossett and used also in Fleming and Remolona (1999) and Balduzzi, Elton, and Green (2001). ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

for other markets. Table 8 and Figure 2 present the results for the volume offered at the best bid price (labelled "bid volume") and the best ask price (labelled "ask volume"). The volume offered on average on announcement days decreases before the news release, is extremely low in the last minute before the event and returns to its usual level afterwards. Liquidity supply on announcement days is significantly lower than one on nonannouncement days. This corresponds to the prediction formulated in H1. These findings are in line with the results in Lee, Mucklow, and Ready (1993) and Kavajecz (1999) for equity markets. Table 9 and Figure 3 present the analysis of the overall trading volume and the volume resulting from buy and sell orders. The average overall trading volume on announcement days increases in the first minute after news releases and remains high afterwards. This pattern is the same for the volume resulting from buy and sell orders. In each case, liquidity demand after announcements is significantly higher than one on nonannouncement days.[37] This result supports the first part of H2 and is in line with the results in Balduzzi, Elton, and Green (2001) and in Fleming and Remolona (1999) for the bond market-maker market and Lee, Mucklow, and Ready (1993) for the equity market.[38]

To investigate the mechanisms determining liquidity provision, we focus firstly on liquidity demand in more detail and then analyse the imbalance between liquidity supply and demand. The second part of hypothesis H2 states that good announcements are followed by a higher volume resulting from buy market orders than sell market orders. Similarly, bad announcements should be followed by a higher volume of sells. Based on the heteroscedastic t-statistic

[37]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. We accounted for 26 most important U.S. announcements and eliminated those 8 released on Fridays at 8:30 EST and we 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.

[38]The drop in the trading volume in the first minute reported in Fleming and Remolona (1999) is not found for our data for the same frequency. It may be due to different structures of the markets analysed in this paper (an electronic limit order market) and in Fleming and Remolona (1999) (a multiple-dealer over-the-counter market). Another difference between these two studies is that we use only one macroeconomic release which does not coincide with other scheduled announcements.

comparing the mean volume of buys and sells after good and bad announcements, we are able to confirm this hypothesis for the first minute after an announcement at the 99 percent significance level. This finding suggests 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 market buy orders. Therefore, a large volume of buys is observed after good news releases and a large volume of sells follows bad news releases. The price advantage seems to disappear after the first minute. An unusually high trading demand in the first minute should result in an extreme imbalance between liquidity supply and demand and cause a large liquidity shortage directly after the event.

Finally, we investigate the liquidity situation resulting from the imbalance between liquidity supply and demand. This allows us to test hypothesis H3. Table 10 and Figure 4 present the results for bid-ask spreads, the imbalance between the volume of buys and the volume offered for sale at the best ask price (the buy-to-ask ratio) and the analogous imbalance for the other market side captured by the sell-to-bid ratio. The imbalance between liquidity supply and demand increases before the announcement, becomes extremely high in the first minute after the event, when a high flow of market orders is observed, and returns slowly to a normal level afterwards. The fact that a similar pattern is observed for spreads, shows that our measure of the imbalance between liquidity supply and demand captures the overall liquidity situation quite well.[39] Moreover, it depicts the pressures leading to the changes in spreads in a market where the offered prices are not being set by a market maker.

Overall, the results allow us to describe the mechanism of liquidity creation around macroeconomic news releases. Before the announcement, the volume offered at the best quotes

[39]The results for spreads confirm the findings in Balduzzi, Elton, and Green (2001) and in Fleming and Remolona (1999) for the market-maker bond market and in Lee, Mucklow, and Ready (1993) for the equity market.

decreases. This is probably caused by the fact that cautious traders are removing their limit orders. Liquidity supply in the last minute is extremely low. Since there is no similarly large decrease in the market order flow, a large imbalance between liquidity demand and supply arises before the event (increasing buy-to-ask and sell-to-bid ratios). We can observe an increasing liquidity shortage, depicted by widening spreads. Directly after the announcement, trading activity is very high. Extreme liquidity demand is probably caused by the possibility of trading at advantageous prices immediately after the event. It is depicted by a very large flow of market buy orders in the first minute after good news releases and of market sell orders after bad news. Since liquidity demand increases faster than supply, liquidity shortage is even higher than before the announcement. Extreme price advantages disappear apparently after the first minute since we observe a high flow of both buy and sell market orders and a decreasing imbalance between liquidity supply and demand. Afterwards, the volume offered at the best quotes recovers, the volume of market orders remains high and liquidity returns slowly to its normal level.

All results presented here are robust to the time series properties (like heteroscedasticity) of our measures of liquidity supply, demand and shortage. Appendix II presents the estimation results of GARCH models with each measure as dependent variable.

Table 2: Liquidity Supply Around Announcements: Bid and Ask Volume

	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Bid Volume												
Nonann. Fr.	0.69^{***}	0.71^{***}	0.70^{***}	0.69^{***}	0.64^{***}	0.61^{***}	0.61^{***}	0.73^{***}	0.75^{***}	0.79^{***}	0.74^{***}	0.83^{***}	0.89^{***}
Ann. Fr.	$0.56^{***}_{\ddagger\ddagger\ddagger}$	$0.57^{***}_{\ddagger\ddagger\ddagger}$	$0.48^{***}_{\ddagger\ddagger\ddagger}$	$0.44^{***}_{\ddagger\ddagger\ddagger}$	$0.36^{***}_{\ddagger\ddagger\ddagger}$	$0.25^{***}_{\ddagger\ddagger\ddagger}$	$0.43^{***}_{\ddagger\ddagger\ddagger}$	$0.61^{***}_{\ddagger\ddagger\ddagger}$	$0.62^{***}_{\ddagger\ddagger\ddagger}$	$0.69^{***}_{\ddagger\ddagger}$	0.71^{***}	$0.76^{***}_{\ddagger}$	$0.78^{***}_{\ddagger\ddagger}$
Good News	0.62^{***}	$0.56^{***}_{\ddagger\ddagger}$	$0.53^{***}_{\ddagger\ddagger\ddagger}$	$0.55^{***}_{\ddagger}$	$0.45^{***}_{\ddagger}$	$0.22^{***}_{\ddagger\ddagger\ddagger}$	$0.51^{***}_{\ddagger}$	0.70^{***}	0.75^{***}	0.73^{***}	0.88	0.82^{**}	0.85^{**}
Contr. News	$0.55^{***}_{\ddagger\ddagger}$	$0.56^{***}_{\ddagger\ddagger}$	$0.44^{***}_{\ddagger\ddagger\ddagger}$	$0.39^{***}_{\ddagger\ddagger\ddagger}$	$0.36^{***}_{\ddagger\ddagger\ddagger}$	$0.27^{***}_{\ddagger\ddagger\ddagger}$	$0.37^{***}_{\ddagger\ddagger\ddagger}$	$0.50^{***}_{\ddagger\ddagger\ddagger}$	$0.52^{***}_{\ddagger\ddagger\ddagger}$	$0.59^{***}_{\ddagger\ddagger\ddagger}$	$0.59^{***}_{\ddagger\ddagger\ddagger}$	$0.67^{***}_{\ddagger\ddagger}$	$0.73^{***}_{\ddagger\ddagger}$
Bad News	$0.52^{***}_{\ddagger\ddagger\ddagger}$	$0.59^{***}_{\ddagger}$	$0.48^{***}_{\ddagger\ddagger\ddagger}$	$0.45^{***}_{\ddagger\ddagger\ddagger}$	$0.30^{***}_{\ddagger\ddagger\ddagger}$	$0.24^{***}_{\ddagger\ddagger\ddagger}$	$0.48^{***}_{\ddagger\ddagger}$	0.70^{***}	0.68^{***}	0.82^{**}	0.84^{*}	0.82^{***}	$0.79^{***}_{\ddagger}$
	Ask Volume												
Nonann. Fr.	0.71^{***}	0.68^{***}	0.67^{***}	0.64^{***}	0.67^{***}	0.61^{***}	0.60^{***}	0.69^{***}	0.76^{***}	0.77^{***}	0.77^{***}	0.77^{***}	0.78^{***}
Ann. Fr.	$0.53^{***}_{\ddagger\ddagger\ddagger}$	$0.50^{***}_{\ddagger\ddagger\ddagger}$	$0.49^{***}_{\ddagger\ddagger\ddagger}$	$0.43^{***}_{\ddagger\ddagger\ddagger}$	$0.34^{***}_{\ddagger\ddagger\ddagger}$	$0.23^{***}_{\ddagger\ddagger\ddagger}$	$0.42^{***}_{\ddagger\ddagger\ddagger}$	$0.54^{***}_{\ddagger\ddagger\ddagger}$	$0.66^{***}_{\ddagger\ddagger\ddagger}$	$0.68^{***}_{\ddagger\ddagger}$	$0.71^{***}_{\ddagger}$	0.73^{***}	0.80^{***}
Good News	0.64^{***}	$0.57^{***}_{\ddagger}$	$0.51^{***}_{\ddagger\ddagger}$	$0.47^{***}_{\ddagger\ddagger\ddagger}$	$0.42^{***}_{\ddagger\ddagger\ddagger}$	$0.28^{***}_{\ddagger\ddagger\ddagger}$	0.57^{***}	0.66^{***}	0.80^{**}	0.75^{***}	0.93	0.76^{***}	0.98
Contr. News	$0.43^{***}_{\ddagger\ddagger\ddagger}$	$0.42^{***}_{\ddagger\ddagger\ddagger}$	$0.50^{***}_{\ddagger\ddagger\ddagger}$	$0.47^{***}_{\ddagger\ddagger\ddagger}$	$0.33^{***}_{\ddagger\ddagger\ddagger}$	$0.23^{***}_{\ddagger\ddagger\ddagger}$	$0.36^{***}_{\ddagger\ddagger\ddagger}$	$0.46^{***}_{\ddagger\ddagger\ddagger}$	$0.52^{***}_{\ddagger\ddagger\ddagger}$	$0.59^{***}_{\ddagger\ddagger\ddagger}$	$0.61^{***}_{\ddagger\ddagger\ddagger}$	$0.64^{***}_{\ddagger\ddagger\ddagger}$	$0.71^{***}_{\ddagger}$
Bad News	$0.53^{***}_{\ddagger\ddagger\ddagger}$	$0.54^{***}_{\ddagger\ddagger\ddagger}$	$0.47^{***}_{\ddagger\ddagger\ddagger}$	$0.37^{***}_{\ddagger\ddagger\ddagger}$	$0.28^{***}_{\ddagger\ddagger\ddagger}$	$0.20^{***}_{\ddagger\ddagger\ddagger}$	$0.40^{***}_{\ddagger\ddagger\ddagger}$	$0.56^{***}_{\ddagger\ddagger}$	0.72^{***}	0.73^{***}	0.76^{***}	0.84^{**}	0.84^{**}

NOTE: The table presents descriptive statistics for the volume quoted at the best bid and the best ask prices in 1-minute intervals around 8:30 EST. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, the significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

Table 3: Liquidity Demand Around Announcements: Trading Volume of Buys and Sells

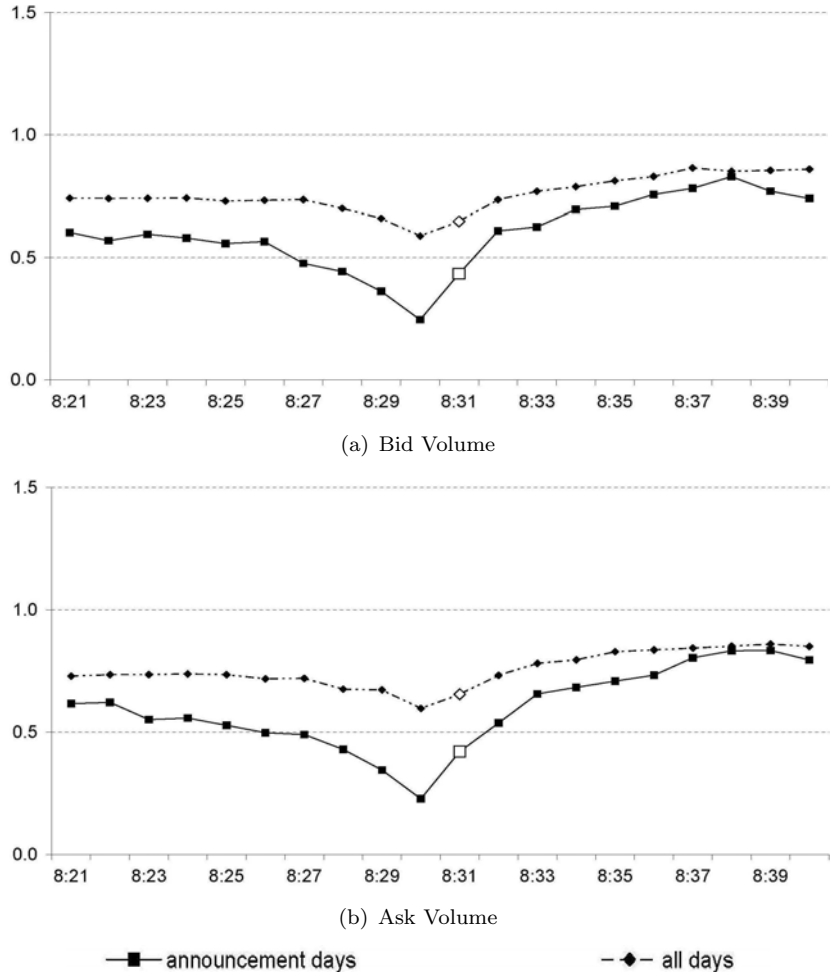
	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Trading Volume												
Nonann. Fr.	0.78	0.72	0.81	0.76	0.74	0.72	1.29^{***}	1.36^{***}	1.31^{***}	1.36^{***}	1.22^{***}	1.38^{***}	1.31^{***}
Ann. Fr.	0.84	$0.92_{\ddagger\ddagger\ddagger}$	0.84	0.83	$0.86_{\ddagger\ddagger}$	0.71	$2.45^{***}_{\ddagger\ddagger\ddagger}$	$2.70^{***}_{\ddagger\ddagger\ddagger}$	$2.87^{***}_{\ddagger\ddagger\ddagger}$	$2.91^{***}_{\ddagger\ddagger\ddagger}$	$3.11^{***}_{\ddagger\ddagger\ddagger}$	$3.14^{***}_{\ddagger\ddagger\ddagger}$	$3.12^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.77	0.73	0.71	0.83	0.79	0.60	$3.10^{***}_{\ddagger\ddagger\ddagger}$	$2.84^{***}_{\ddagger\ddagger\ddagger}$	$3.17^{***}_{\ddagger\ddagger\ddagger}$	$3.00^{***}_{\ddagger\ddagger\ddagger}$	$3.92^{***}_{\ddagger\ddagger\ddagger}$	$3.24^{***}_{\ddagger\ddagger\ddagger}$	$2.87^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	0.84	$0.95_{\ddagger\ddagger\ddagger}$	0.85	$0.94_{\ddagger}$	$0.99_{\ddagger\ddagger\ddagger}$	0.81	$2.09^{***}_{\ddagger\ddagger\ddagger}$	$2.67^{***}_{\ddagger\ddagger\ddagger}$	$2.49^{***}_{\ddagger\ddagger\ddagger}$	$2.76^{***}_{\ddagger\ddagger\ddagger}$	$2.69^{***}_{\ddagger\ddagger\ddagger}$	$3.07^{***}_{\ddagger\ddagger\ddagger}$	$3.02^{***}_{\ddagger\ddagger\ddagger}$
Bad News	$0.93_{\ddagger}$	$1.04_{\ddagger\ddagger\ddagger}$	$0.94_{\ddagger}$	0.73	0.73	0.65	$2.44^{***}_{\ddagger\ddagger\ddagger}$	$2.66^{***}_{\ddagger\ddagger\ddagger}$	$3.06^{***}_{\ddagger\ddagger\ddagger}$	$3.10^{***}_{\ddagger\ddagger\ddagger}$	$3.09^{***}_{\ddagger\ddagger\ddagger}$	$3.17^{***}_{\ddagger\ddagger\ddagger}$	$3.54^{***}_{\ddagger\ddagger\ddagger}$
	Volume of Buys												
Nonann. Fr.	0.69	0.68	0.79	0.70	0.69	0.75	1.16^{**}	1.36^{***}	1.34^{***}	1.29^{***}	1.10	1.30^{***}	1.21^{***}
Ann. Fr.	$0.84_{\ddagger\ddagger}$	$0.81_{\ddagger}$	0.79	$0.81_{\ddagger}$	$0.87_{\ddagger\ddagger}$	0.68	$2.26^{***}_{\ddagger\ddagger\ddagger}$	$2.71^{***}_{\ddagger\ddagger\ddagger}$	$2.51^{***}_{\ddagger\ddagger\ddagger}$	$2.55^{***}_{\ddagger\ddagger\ddagger}$	$2.79^{***}_{\ddagger\ddagger\ddagger}$	$2.96^{***}_{\ddagger\ddagger\ddagger}$	$2.96^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.76	0.72	0.63	$0.88_{\ddagger}$	0.85	0.62	$3.98^{***}_{\ddagger\ddagger\ddagger}$	$2.90^{***}_{\ddagger\ddagger\ddagger}$	$2.90^{***}_{\ddagger\ddagger\ddagger}$	$2.58^{***}_{\ddagger\ddagger\ddagger}$	$3.16^{***}_{\ddagger\ddagger\ddagger}$	$3.23^{***}_{\ddagger\ddagger\ddagger}$	$2.44^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	$0.83_{\ddagger}$	0.76	0.76	$0.96_{\ddagger\ddagger}$	$0.96_{\ddagger\ddagger}$	0.78	$1.82^{***}_{\ddagger\ddagger}$	$2.76^{***}_{\ddagger\ddagger\ddagger}$	$1.99^{***}_{\ddagger\ddagger\ddagger}$	$2.39^{***}_{\ddagger\ddagger\ddagger}$	$2.28^{***}_{\ddagger\ddagger\ddagger}$	$2.87^{***}_{\ddagger\ddagger\ddagger}$	$3.14^{***}_{\ddagger\ddagger\ddagger}$
Bad News	$1.00_{\ddagger\ddagger}$	$1.02_{\ddagger\ddagger}$	$0.96_{\ddagger}$	0.71	0.78	0.63	$1.82^{***}_{\ddagger\ddagger\ddagger}$	$2.57^{***}_{\ddagger\ddagger\ddagger}$	$2.77^{***}_{\ddagger\ddagger\ddagger}$	$2.84^{***}_{\ddagger\ddagger\ddagger}$	$3.21^{***}_{\ddagger\ddagger\ddagger}$	$2.91^{***}_{\ddagger\ddagger\ddagger}$	$3.08^{***}_{\ddagger\ddagger\ddagger}$
	Volume of Sells												
Nonann. Fr.	0.75	0.64	0.71	0.70	0.67	0.64	1.19^{**}	1.17^{**}	1.16^{**}	1.17^{**}	1.19^{**}	1.16^{**}	1.17^{**}
Ann. Fr.	0.79	$0.91_{\ddagger\ddagger\ddagger}$	0.80	0.73	0.74	0.66	$1.83^{***}_{\ddagger\ddagger\ddagger}$	$2.22^{***}_{\ddagger\ddagger\ddagger}$	$2.69^{***}_{\ddagger\ddagger\ddagger}$	$2.92^{***}_{\ddagger\ddagger\ddagger}$	$2.99^{***}_{\ddagger\ddagger\ddagger}$	$2.91^{***}_{\ddagger\ddagger\ddagger}$	$3.00^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.76	0.64	0.71	0.68	0.75	0.54	$1.54^{***}_{\ddagger\ddagger}$	$2.26^{***}_{\ddagger\ddagger\ddagger}$	$2.97^{***}_{\ddagger\ddagger\ddagger}$	$2.92^{***}_{\ddagger\ddagger\ddagger}$	$3.84^{***}_{\ddagger\ddagger\ddagger}$	$2.96^{***}_{\ddagger\ddagger\ddagger}$	$3.12^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	0.80	$1.08_{\ddagger\ddagger\ddagger}$	0.78	0.80	$0.87_{\ddagger\ddagger}$	0.74	$1.74^{***}_{\ddagger\ddagger\ddagger}$	$2.13^{***}_{\ddagger\ddagger\ddagger}$	$2.39^{***}_{\ddagger\ddagger\ddagger}$	$2.80^{***}_{\ddagger\ddagger\ddagger}$	$2.82^{***}_{\ddagger\ddagger\ddagger}$	$2.82^{***}_{\ddagger\ddagger\ddagger}$	$2.66^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.81	$0.91_{\ddagger\ddagger}$	$0.97_{\ddagger\ddagger}$	0.73	0.59	0.68	$2.57^{***}_{\ddagger\ddagger\ddagger}$	$2.35^{***}_{\ddagger\ddagger\ddagger}$	$2.88^{***}_{\ddagger\ddagger\ddagger}$	$3.13^{***}_{\ddagger\ddagger\ddagger}$	$2.80^{***}_{\ddagger\ddagger\ddagger}$	$3.06^{***}_{\ddagger\ddagger\ddagger}$	$3.64^{***}_{\ddagger\ddagger\ddagger}$

NOTE: The table presents descriptive statistics for the total trading volume as well as the trading volume resulting from market orders signed as buys and sells in 1-minute intervals around 8:30 EST. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, the significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

Table 4: Liquidity Provision Around Announcements: Spread, Buy-to-Ask and Sell-to-Bid

	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Spread												
Nonann. Fr.	0.99	0.99	0.99	0.99	0.99	0.99	1.00^{*}	1.00	0.99	0.99	1.00	0.99	0.99
Ann. Fr.	$1.01^{**}_{\ddagger\ddagger\ddagger}$	$1.00^{*}_{\ddagger\ddagger\ddagger}$	$1.01^{**}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$	$1.22^{***}_{\ddagger\ddagger\ddagger}$	$1.85^{***}_{\ddagger\ddagger\ddagger}$	$1.13^{***}_{\ddagger\ddagger\ddagger}$	$1.05^{***}_{\ddagger\ddagger\ddagger}$	$1.04^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.01^{***}_{\ddagger\ddagger\ddagger}$
Good News	$1.01^{*}_{\ddagger\ddagger}$	$1.01^{*}_{\ddagger\ddagger}$	$1.00_{\ddagger\ddagger}$	$1.02^{**}_{\ddagger\ddagger\ddagger}$	$1.04^{***}_{\ddagger\ddagger\ddagger}$	$1.24^{***}_{\ddagger\ddagger\ddagger}$	$1.59^{***}_{\ddagger\ddagger\ddagger}$	$1.22^{***}_{\ddagger\ddagger\ddagger}$	$1.06^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{**}_{\ddagger\ddagger\ddagger}$	$1.02^{**}_{\ddagger\ddagger\ddagger}$	$1.01^{*}_{\ddagger\ddagger}$
Contr. News	$1.01^{**}_{\ddagger\ddagger\ddagger}$	$1.00_{\ddagger\ddagger\ddagger}$	$1.01^{***}_{\ddagger\ddagger\ddagger}$	$1.01^{**}_{\ddagger\ddagger\ddagger}$	$1.04^{***}_{\ddagger\ddagger\ddagger}$	$1.26^{***}_{\ddagger\ddagger\ddagger}$	$1.84^{***}_{\ddagger\ddagger\ddagger}$	$1.09^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.00_{\ddagger\ddagger}$
Bad News	$1.00_{\ddagger}$	$1.01_{\ddagger\ddagger}$	$1.00_{\ddagger}$	$1.04^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{**}_{\ddagger\ddagger\ddagger}$	$1.19^{***}_{\ddagger\ddagger\ddagger}$	$2.17^{***}_{\ddagger\ddagger\ddagger}$	$1.15^{***}_{\ddagger\ddagger\ddagger}$	$1.08^{***}_{\ddagger\ddagger\ddagger}$	$1.05^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$	$1.02^{***}_{\ddagger\ddagger\ddagger}$	$1.03^{***}_{\ddagger\ddagger\ddagger}$
	Buy-to-Ask												
Nonann. Fr.	0.73	0.68	0.72	0.74	0.72	0.73	0.95	0.94	0.83	0.92	0.80	0.83	0.70
Ann. Fr.	$0.90_{\ddagger\ddagger\ddagger}$	$0.87_{\ddagger\ddagger\ddagger}$	$1.11_{\ddagger\ddagger\ddagger}$	$0.90_{\ddagger\ddagger\ddagger}$	$1.00_{\ddagger\ddagger\ddagger}$	$1.36^{***}_{\ddagger\ddagger\ddagger}$	$3.35^{***}_{\ddagger\ddagger\ddagger}$	$2.74^{***}_{\ddagger\ddagger\ddagger}$	$1.73^{***}_{\ddagger\ddagger\ddagger}$	$1.57^{***}_{\ddagger\ddagger\ddagger}$	$1.60^{***}_{\ddagger\ddagger\ddagger}$	$1.65^{***}_{\ddagger\ddagger\ddagger}$	$1.51^{***}_{\ddagger\ddagger\ddagger}$
Good News	$1.01_{\ddagger}$	$0.83_{\ddagger\ddagger}$	0.81	$1.01_{\ddagger\ddagger}$	0.74	$1.16_{\ddagger\ddagger}$	$4.18^{***}_{\ddagger\ddagger\ddagger}$	$2.69^{***}_{\ddagger\ddagger\ddagger}$	$1.29^{**}_{\ddagger\ddagger\ddagger}$	$2.33^{***}_{\ddagger\ddagger\ddagger}$	$1.46^{**}_{\ddagger\ddagger\ddagger}$	$1.35^{**}_{\ddagger\ddagger\ddagger}$	$1.22_{\ddagger\ddagger\ddagger}$
Contr. News	$0.89_{\ddagger\ddagger}$	$0.90_{\ddagger\ddagger}$	$1.42^{***}_{\ddagger\ddagger\ddagger}$	0.82	$1.06_{\ddagger\ddagger\ddagger}$	$1.67^{***}_{\ddagger\ddagger\ddagger}$	$3.63^{***}_{\ddagger\ddagger\ddagger}$	$3.62^{***}_{\ddagger\ddagger\ddagger}$	$2.09^{***}_{\ddagger\ddagger\ddagger}$	$1.48^{***}_{\ddagger\ddagger\ddagger}$	$1.76^{***}_{\ddagger\ddagger\ddagger}$	$1.88^{***}_{\ddagger\ddagger\ddagger}$	$1.63^{***}_{\ddagger\ddagger\ddagger}$
Bad News	$0.88_{\ddagger}$	$0.89_{\ddagger\ddagger}$	$0.91_{\ddagger\ddagger}$	$0.91_{\ddagger}$	$1.18^{*}_{\ddagger\ddagger\ddagger}$	$1.29^{**}_{\ddagger\ddagger\ddagger}$	$2.34^{***}_{\ddagger\ddagger\ddagger}$	$2.06^{***}_{\ddagger\ddagger\ddagger}$	$1.89^{***}_{\ddagger\ddagger\ddagger}$	$1.27^{**}_{\ddagger\ddagger\ddagger}$	$1.55^{***}_{\ddagger\ddagger\ddagger}$	$1.73^{***}_{\ddagger\ddagger\ddagger}$	$1.63^{***}_{\ddagger\ddagger\ddagger}$
	Sell-to-Bid												
Nonann. Fr.	0.79	0.74	0.78	0.70	0.70	0.79	1.11^{**}	0.87	0.86	0.89	0.84	0.88	0.88
Ann. Fr.	$0.98_{\ddagger\ddagger\ddagger}$	0.94	0.86	$0.94_{\ddagger\ddagger\ddagger}$	$1.03^{**}_{\ddagger\ddagger\ddagger}$	$1.29^{***}_{\ddagger\ddagger\ddagger}$	$3.76^{***}_{\ddagger\ddagger\ddagger}$	$2.75^{***}_{\ddagger\ddagger\ddagger}$	$2.07^{***}_{\ddagger\ddagger\ddagger}$	$1.52^{***}_{\ddagger\ddagger\ddagger}$	$1.81^{***}_{\ddagger\ddagger\ddagger}$	$1.45^{***}_{\ddagger\ddagger\ddagger}$	$1.25^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.89	0.85	0.87	$0.87_{\ddagger}$	$1.03_{\ddagger\ddagger}$	$1.29^{**}_{\ddagger\ddagger\ddagger}$	$2.40^{***}_{\ddagger\ddagger\ddagger}$	$2.54^{***}_{\ddagger\ddagger\ddagger}$	$2.61^{***}_{\ddagger\ddagger\ddagger}$	$1.32^{**}_{\ddagger\ddagger}$	$1.98^{***}_{\ddagger\ddagger\ddagger}$	$1.94^{***}_{\ddagger\ddagger\ddagger}$	$1.03_{\ddagger}$
Contr. News	$1.38^{**}_{\ddagger\ddagger\ddagger}$	$0.97_{\ddagger\ddagger}$	0.92	$1.03_{\ddagger\ddagger\ddagger}$	$1.15^{*}_{\ddagger\ddagger\ddagger}$	$1.21^{**}_{\ddagger\ddagger\ddagger}$	$5.06^{***}_{\ddagger\ddagger\ddagger}$	$3.18^{***}_{\ddagger\ddagger\ddagger}$	$2.14^{***}_{\ddagger\ddagger\ddagger}$	$1.68^{***}_{\ddagger\ddagger\ddagger}$	$2.15^{***}_{\ddagger\ddagger\ddagger}$	$1.38^{***}_{\ddagger\ddagger\ddagger}$	$1.30^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.89	$0.97_{\ddagger\ddagger}$	0.80	$0.86_{\ddagger\ddagger}$	$0.90_{\ddagger\ddagger\ddagger}$	$1.42^{**}_{\ddagger\ddagger\ddagger}$	$3.88^{***}_{\ddagger\ddagger\ddagger}$	$2.66^{***}_{\ddagger\ddagger\ddagger}$	$1.67^{***}_{\ddagger\ddagger\ddagger}$	$1.50^{**}_{\ddagger\ddagger\ddagger}$	$1.43^{**}_{\ddagger\ddagger\ddagger}$	$1.36^{**}_{\ddagger\ddagger\ddagger}$	$1.38^{**}_{\ddagger\ddagger\ddagger}$

NOTE: The table presents descriptive statistics for spreads, buy-to-ask and sell-to-bid ratios in 1-minute intervals around 8:30 EST. The sample period: Apr. 1st, 1999 - Dec. 30th, 2005. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, the significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

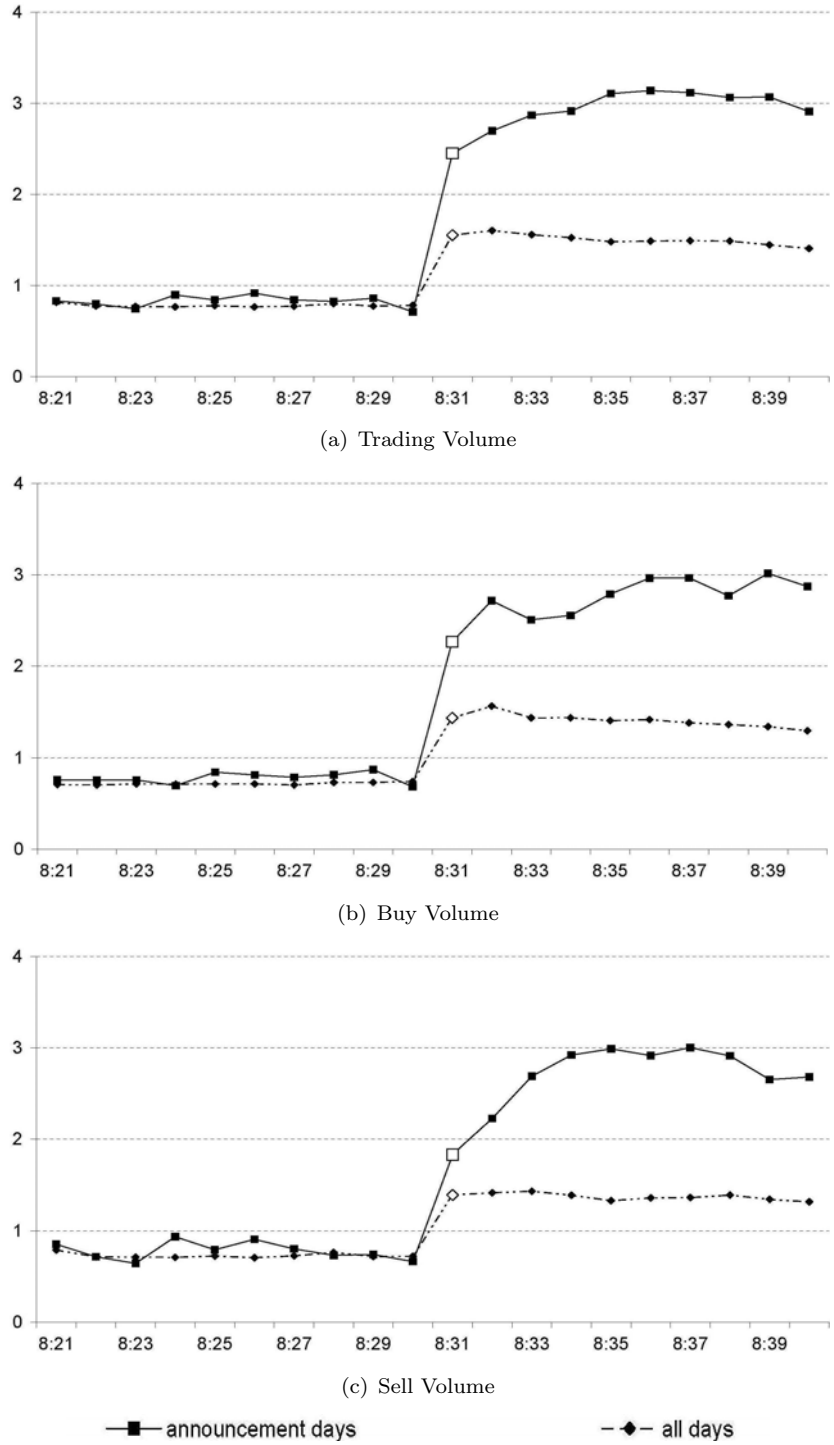


(a) Bid Volume

(b) Ask Volume

Figure 2: Liquidity Supply Around Announcements

The figure presents liquidity supply (the bid and ask volumes, subfigures (a) and (b)) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Apr. 1st, 1999 to Dec. 30th, 2005.



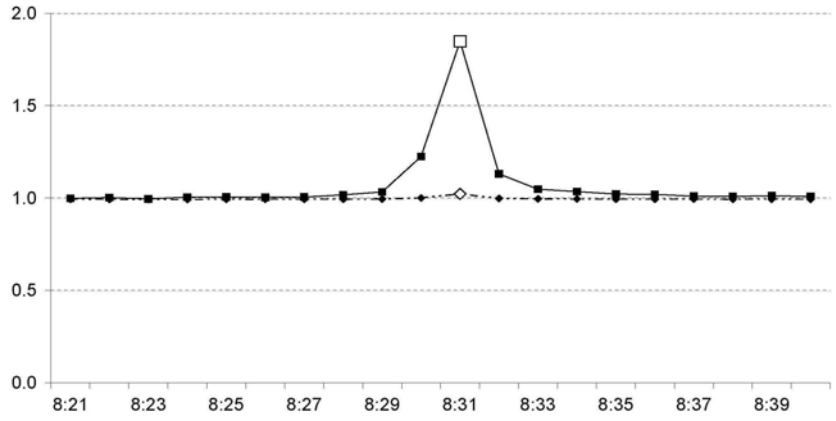
(a) Trading Volume

(b) Buy Volume

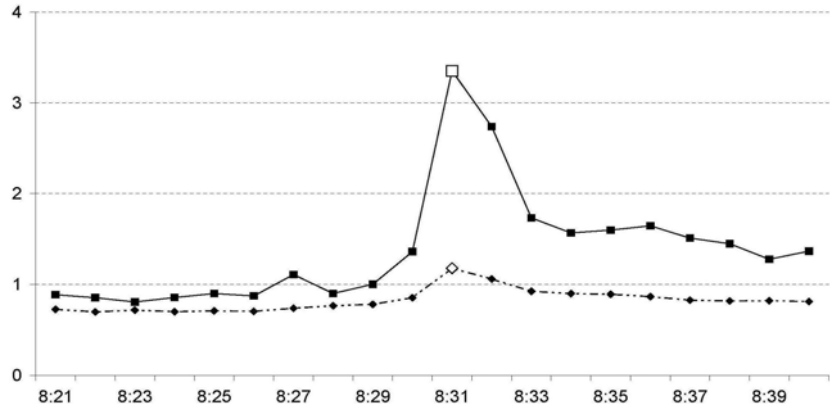
(c) Sell Volume

Figure 3: Liquidity Demand Around Announcements

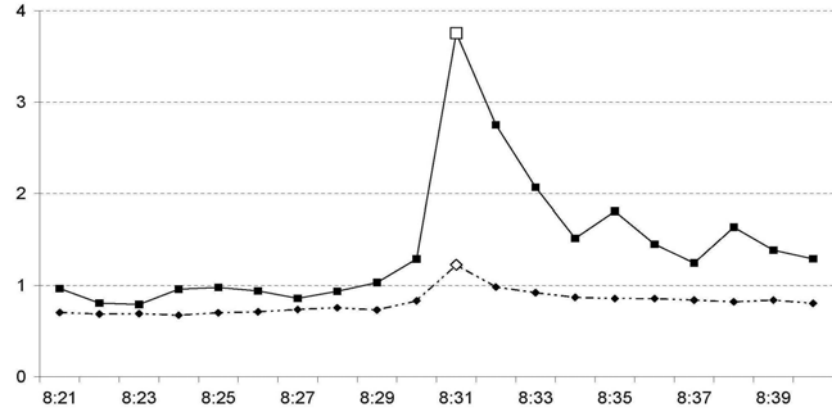
The figure presents liquidity demand (the overall trading volume (subfigure (a)), the trading volume resulting from buy orders (b) and sell orders (c)) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Apr. 1st, 1999 to Dec. 30th, 2005.



(a) Spread



(b) Buy-to-Ask



(c) Sell-to-Bid

Figure 4: Liquidity Provision Around Announcements

The figure presents liquidity provision (spreads (subfigure (a)), buy-to-ask (b) and sell-to-bid (c) imbalance ratios) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Apr. 1st, 1999 to Dec. 30th, 2005.

4.2 Liquidity Provision and the Surprise Component

In this section, we investigate whether news containing large surprises affect liquidity stronger than news containing small surprises. To test hypothesis H4, we analyse whether the size of the surprise component influences liquidity demand. This hypothesis predicts that the trading volume depends positively on the absolute surprise and that this relation is especially strong for the volume of buys (sells) after good (bad) news. Hypothesis H5 states that the magnitude and the sign of surprise affect liquidity provision after an event. To address these questions, we estimate time series models with each of our previously defined measures of liquidity supply, demand and shortage as dependent variables.

We construct the time series of 1-minute liquidity measures covering the 90-minute window around the annoucement time from 08:00 to 09:30 EST.[40] The results of the unit root tests presented in Table 5 show that all considered variables are stationary. Since the dependent variables are measured on very short time intervals and the sample includes the periods of different trading activity, we expect that volatility of the dependent variables changes over time. For example, the changes of liquidity demand are probably much higher immediately after the news release than one hour afterwards when new information is already reflected in prices and the trading driven by the differences of opinion diminishes. To account for heteroscedasticity, we choose a GARCH(1,1) model. Since dependent variables are positive, the error term is assumed to follow a Generalized Error Distribution (GED) with parameters $\alpha = \sqrt{2}\sigma$ and $\beta > 0$. The GED is a normal distribution if $\beta = 2$, and fat-tailed if $\beta < 2$.

To model liquidity patterns around announcements, we introduce time dummies to the un-

[40] We report here the results for the subsample with contracts denominated in EUR traded from Apr. 1st, 1999 to Dec. 30th, 2005. The results for the subsample with contracts denominated in DM traded from Jan. 1st, 1994 to Dec. 30th, 1998 are qualitatively similar. We considered also 2-minute intevals covering the 90-minute window around the annoucement time from the 29th 2-minute interval before 08:30 EST until the 15th 2-minute interval after 08:30 EST (3375 observations) and 2-minute intevals covering the 60-minute window around the annoucement time from the 14th 2-minute interval before 08:30 EST until the 15th 2-minute interval after 08:30 EST including the data from the begining of 1994 to 2005 (3750 observations). All subsamples were chosen so as to minimize the number of intervals in which there was no trade at all. The results hold for all investigated subsamples.

Table 5: Unit Root Tests for the Liquidity Measures

	ADF Test Statistic	ADF Critical	Lag Length	BIC	DW	Number of Observations
Volume of Buys						
99-05	-17.5^{***}	-3.43	5	3.42	2.01	6564
94-98	-14.7^{***}	-3.43	5	4.31	2.00	3954
Volume of Sells						
99-05	-15.4^{***}	-3.43	7	3.43	2.00	6562
94-98	-13.8^{***}	-3.43	6	3.40	2.00	3952
Bid Volume						
99-05	-16.0^{***}	-3.43	8	1.16	2.00	6561
94-98	-22.1^{***}	-3.43	3	1.64	2.00	3956
Ask Volume						
99-05	-19.5^{***}	-3.43	5	1.04	2.00	6564
94-98	-16.6^{***}	-3.43	5	1.54	2.00	3954
Trading Volume						
99-05	-14.1^{***}	-3.43	6	2.72	2.00	6563
94-98	-13.2^{***}	-3.43	5	3.78	2.01	3954
Spread						
99-05	-43.4^{***}	-3.43	1	-0.11	2.00	6568
94-98	-16.9^{***}	-3.43	5	0.45	2.00	3954
Buy-to-Ask Ratio						
99-05	-53.1^{***}	-3.43	1	5.10	2.00	6568
94-98	-41.2^{***}	-3.43	1	4.02	2.00	3958
Sell-to-Bid Ratio						
99-05	-35.8^{***}	-3.43	3	5.17	2.00	6566
94-98	-59.8^{***}	-3.43	0	4.17	2.00	3959

NOTE: The table reports the results of the Augmented Dickey Fuller tests with intercept and without trend for the level of liquidity measures. The lag length is chosen according to the BIC. The table reports the ADF test statistics and its critical value at 1% confidence level, the lag length, the BIC, the DW statistics and the number of included observations. The tests are made for the following subsamples: "99-05" regards the period between Apr. 1st, 1999 and Dec. 30th, 2005 when contracts denominated in EUR were traded and "94-98" regards the period between Jan. 1st, 1994 and Dec. 30th, 1998 when contracts in DM were traded. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively.

derlying GARCH process. The reaction to the magnitude of unexpected information is investigated by introducing the absolute surprise:

$$\begin{aligned} y_t &= \sum_{i=1}^{21} \phi_{1,i} D_i + \sum_{j=1}^{5} \phi_{2,j} |S_j| + \epsilon_t, \qquad \epsilon_t \sim GED(\sqrt{2}\sigma, \beta) \\ \sigma_t^2 &= \omega + \psi_1 \epsilon_{t-1}^2 + \psi_2 \sigma_{t-1}^2 + z_t \end{aligned} \tag{1}$$

where y_t denotes the dependent variable in the minute t. Dummy D_i is 1 for the i-th time interval after 08:00 EST and 0 otherwise. We use 1-minute intervals from 08:25 to 08:35 and 5-minute intervals in the remaining period. S_j is the surprise in nonfarm payroll employment recorded in the j-th minute after 8:30 EST. Furthermore, we differentiate between the cases when the announcement contained good, contradictory and bad news by introducing the following dummies for the first 5 minutes after the event: $D_{G,j}$ for good, $D_{C,j}$ for contradictory and $D_{B,j}$ for bad news. Although we use two figures released in the Employment Report, the nonfarm payroll employment and the unemployment rate, we report the results where the amount of new information is proxied only by the surprise in nonfarm payrolls. The results of the regressions including surprises in the unemployment rate (S_{UR}) and both surprises (S_{NP} and S_{UR}) are qualitatively the same.

Tables 6 and 7 present the estimation results. To test hypothesis H4, we focus first on liquidity demand. We can observe a significantly positive and a very strong relation between the trading volume and the absolute suprise. This result holds also for the volume of buys and sells. Liquidity demand is higher for large surprises than for small ones supporting the first part of H4. The results of the model that differentiates among the types of news show that the second part of H4 holds only for the first minute after the event. The volume of buys (sells) increases much stronger in the absolute surprise for good (bad) news than for bad (good) news. This finding suggests that there is a price advantage immediately after the news release. For example, after a good announcement (when the equilibrium price appears to be higher than the last traded prices), some unexecuted limit orders are still offered for

sale at an old and relatively low best ask price. Thus, a large flow of market buy orders is observed imediately after the event. The larger the good news is, the larger the profit that can be achieved by the submission of market buy orders. For this reason, the volume of buys in the first minute depends much stronger on absolute positive surprises than on negative ones.

In the last test (H5), we investigate the dependence of liquidity provision on the magnitude of surprise and find that the larger the surprise, the higher the liquidity shortage. The surprise coefficient in the regression with spreads is large and positive. The same result is found for two other measures of the liquidity shortage describing the imbalance between liquidity supply and demand. Note that liquidity supply, measured by the volume offered at the best quotes increases significantly with the magnitude of new information. Nevertheless, a much higher increase of liquidity demand leads to a high liquidity shortage. Finally, we find that liquidity is much lower for large bad news than for equally large good news (the second part of H5): spreads, buy-to-ask and sell-to-bid imbalance ratios depend much stronger on the absolute surprise for bad news than for good ones. This is caused by the fact that the selling activity after bad information events is very large and the volume offered at the best bid is low. Consequently, the bid-ask spread increases indicating a large liquidity shortage.

Table 6: Liquidity Provision and the Surprise Component

Sample 1999-2005

Variable	Buy Volume		Sell Volume		Bid Volume		Ask Volume	
$D_{801:805}$	0.42	0.42	0.43	0.43	$0.62^{\ddagger\ddagger\ddagger}$	$0.62^{\ddagger\ddagger\ddagger}$	$0.66^{\ddagger\ddagger\ddagger}$	$0.66^{\ddagger\ddagger\ddagger}$
$D_{806:810}$	0.42	0.42	0.37	0.37	$0.61^{\ddagger\ddagger\ddagger}$	$0.61^{\ddagger\ddagger\ddagger}$	$0.58^{\ddagger\ddagger\ddagger}$	$0.58^{\ddagger\ddagger\ddagger}$
$D_{811:815}$	0.46	0.47	0.46	0.46	$0.58^{\ddagger\ddagger\ddagger}$	$0.58^{\ddagger\ddagger\ddagger}$	$0.55^{\ddagger\ddagger\ddagger}$	$0.55^{\ddagger\ddagger\ddagger}$
$D_{816:820}$	0.48	0.48	0.51	0.51	$0.52^{\ddagger\ddagger\ddagger}$	$0.52^{\ddagger\ddagger\ddagger}$	$0.53^{\ddagger\ddagger\ddagger}$	$0.53^{\ddagger\ddagger\ddagger}$
$D_{821:825}$	0.67	0.67	0.72	0.72	$0.51^{\ddagger\ddagger\ddagger}$	$0.51^{\ddagger\ddagger\ddagger}$	$0.49^{\ddagger\ddagger\ddagger}$	$0.49^{\ddagger\ddagger\ddagger}$
D_{826}	0.72	0.72	0.76	0.77	$0.46^{\ddagger\ddagger\ddagger}$	$0.46^{\ddagger\ddagger\ddagger}$	$0.47^{\ddagger\ddagger\ddagger}$	$0.47^{\ddagger\ddagger\ddagger}$
D_{827}	0.70	0.70	0.74	0.74	$0.39^{\ddagger\ddagger\ddagger}$	$0.39^{\ddagger\ddagger\ddagger}$	$0.44^{\ddagger\ddagger\ddagger}$	$0.44^{\ddagger\ddagger\ddagger}$
D_{828}	0.73	0.74	0.66	0.66	$0.36^{\ddagger\ddagger\ddagger}$	$0.37^{\ddagger\ddagger\ddagger}$	$0.37^{\ddagger\ddagger\ddagger}$	$0.37^{\ddagger\ddagger\ddagger}$
D_{829}	0.71	0.72	0.74	0.71	$0.31^{\ddagger\ddagger\ddagger}$	$0.31^{\ddagger\ddagger\ddagger}$	$0.29^{\ddagger\ddagger\ddagger}$	$0.29^{\ddagger\ddagger\ddagger}$
D_{830}	0.59	0.59	0.64	0.64	$0.20^{\ddagger\ddagger\ddagger}$	$0.21^{\ddagger\ddagger\ddagger}$	$0.19^{\ddagger\ddagger\ddagger}$	$0.18^{\ddagger\ddagger\ddagger}$
$\lvert S_{NP,831}\rvert$	24.68***		17.54***		4.54***		3.78***	
$\lvert S_{NP,832}\rvert$	26.11***		25.13***		5.84***		5.01***	
$\lvert S_{NP,833}\rvert$	32.08***		27.19***		6.43***		5.98***	
$\lvert S_{NP,834}\rvert$	27.17***		28.43***		7.58***		6.90***	
$\lvert S_{NP,835}\rvert$	34.82***		35.33***		8.03***		8.20***	
$D_{G,831} * \lvert S_{NP,831}\rvert$		32.17***		11.62***		4.07***		3.11***
$D_{G,832} * \lvert S_{NP,832}\rvert$		19.97***		20.08***		5.84***		3.92***
$D_{G,833} * \lvert S_{NP,833}\rvert$		26.63***		22.87***		5.23***		5.54***
$D_{G,834} * \lvert S_{NP,834}\rvert$		16.13***		27.14***		5.08***		6.00***
$D_{G,835} * \lvert S_{NP,835}\rvert$		22.23***		35.40***		6.35***		8.39***
$D_{C,831} * \lvert S_{NP,831}\rvert$		19.38***		16.42***		3.67***		3.43***
$D_{C,832} * \lvert S_{NP,832}\rvert$		24.61***		24.97***		4.19***		4.11***
$D_{C,833} * \lvert S_{NP,833}\rvert$		21.05***		21.18***		5.35***		3.63***
$D_{C,834} * \lvert S_{NP,834}\rvert$		34.23***		35.75***		7.54***		5.37***
$D_{C,835} * \lvert S_{NP,835}\rvert$		34.94***		36.87***		8.00***		5.42***
$D_{B,831} * \lvert S_{NP,831}\rvert$		23.66***		49.10***		9.35***		5.61***
$D_{B,832} * \lvert S_{NP,832}\rvert$		39.75***		35.57***		10.71***		5.85***
$D_{B,833} * \lvert S_{NP,833}\rvert$		47.85***		50.97***		10.53***		8.66***
$D_{B,834} * \lvert S_{NP,834}\rvert$		41.25***		46.17***		13.24***		9.14***
$D_{B,835} * \lvert S_{NP,835}\rvert$		49.28***		29.90***		12.10***		9.15***
$D_{836:840}$	2.70***	2.70***	2.66***	2.66***	$0.70^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$
$D_{841:845}$	2.53***	2.54***	2.40***	2.40***	$0.71^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$
$D_{846:850}$	2.07***	2.07***	2.10***	2.10***	$0.72^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$
$D_{851:855}$	1.85***	1.86***	1.97***	1.97***	$0.74^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$
$D_{856:900}$	1.90***	1.90***	1.80***	1.80***	$0.74^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$
$D_{901:905}$	1.90***	1.90***	1.81***	1.81***	$0.71^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$
$D_{906:910}$	1.81***	1.81***	1.67***	1.67***	$0.77^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$
$D_{911:915}$	1.66***	1.66***	1.63***	1.62***	$0.73^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$
$D_{916:920}$	1.49***	1.49***	1.30***	1.30***	$0.67^{\ddagger\ddagger\ddagger}$	$0.67^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$
$D_{921:925}$	1.21***	1.21***	1.11**	1.11**	$0.69^{\ddagger\ddagger\ddagger}$	$0.69^{\ddagger\ddagger\ddagger}$	$0.69^{\ddagger\ddagger\ddagger}$	$0.69^{\ddagger\ddagger\ddagger}$
$D_{926:930}$	1.14***	1.15***	1.08*	1.08*	$0.76^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$
Adjusted R^2	0.15	0.16	0.14	0.15	-0.10	-0.10	-0.08	-0.09
BIC	3.24	3.25	3.21	3.21	1.08	1.09	1.03	1.04
No Obs.	6750	6750	6750	6750	6750	6750	6750	6750

Note: The table reports estimation coefficients in the mean equations of GARCH(1,1) models with dependent variables corresponding to the column titles. A time dummy like $D_{801:805}$ is 1 for the minutes between 08:00:00 and 08:04:59 and 0 otherwise, a time dummy like D_{831} is 1 for the minute between 8:30:00 and 08:30:59 EST and 0 otherwise, a dummy like $D_{G,831}$ ($D_{C,831}$ or $D_{B,831}$) is equal 1 for the minute between 8:30:00 and 08:30:59 EST when the preceding announcement was good (contradictory or bad) and 0 otherwise. $|S_{NP,831}|$ denotes the absolute surprise in the nonfarm payroll employment. *, **, *** (‡, ‡‡, ‡‡‡) denote significance of the t-statistic testing whether the coefficient is larger (smaller) than 1 at the 90 percent, 95 percent and 99 percent respectively.

Table 7: Liquidity Provision and the Surprise Component

Sample 1999-2005

Variable	Trading Volume		Spread		Buy-to-Ask		Sell-to-Bid	
$D_{801:805}$	0.50	0.49	0.99	0.99	0.71	0.72	0.57	0.62
$D_{806:810}$	0.47	0.47	0.99	0.99	0.63	0.63	0.64	0.63
$D_{811:815}$	0.53	0.53	0.99	0.99	0.67	0.64	0.65	0.65
$D_{816:820}$	0.56	0.56	0.99	0.99	0.64	0.64	0.67	0.68
$D_{821:825}$	0.76	0.75	0.99	1.00	0.78	0.77	0.74	0.76
D_{826}	0.85	0.85	0.99	1.00***	0.71	0.71	0.79	0.81
D_{827}	0.80	0.79	1.00***	1.01***	0.75	0.74	0.83	0.83
D_{828}	0.76	0.77	1.02***	1.05***	0.74	0.75	0.83	0.83
D_{829}	0.81	0.77	1.06***	1.07***	0.82	0.86	0.82	0.89
D_{830}	0.59	0.59	1.20***	1.21***	0.98	0.96	1.08***	1.09***
$\lvert S_{NP,831}\rvert$	29.48***		23.33***		24.06***		37.27***	
$\lvert S_{NP,832}\rvert$	31.35***		16.63***		20.44***		26.18***	
$\lvert S_{NP,833}\rvert$	30.57***		13.28***		13.37***		19.68***	
$\lvert S_{NP,834}\rvert$	31.97***		13.28***		14.54***		12.13***	
$\lvert S_{NP,835}\rvert$	35.96***		13.26***		21.04***		25.33***	
$D_{G,831} * \lvert S_{NP,831}\rvert$		24.24***		15.06***		27.28***		11.93***
$D_{G,832} * \lvert S_{NP,832}\rvert$		18.70***		11.43***		15.68***		16.01***
$D_{G,833} * \lvert S_{NP,833}\rvert$		22.75***		10.15***		6.69***		11.76***
$D_{G,834} * \lvert S_{NP,834}\rvert$		19.27***		9.67***		14.65***		6.92***
$D_{G,835} * \lvert S_{NP,835}\rvert$		25.24***		10.15***		6.93***		14.75***
$D_{C,831} * \lvert S_{NP,831}\rvert$		26.47***		25.44***		23.14***		57.20***
$D_{C,832} * \lvert S_{NP,832}\rvert$		31.49***		16.17***		36.30***		35.15***
$D_{C,833} * \lvert S_{NP,833}\rvert$		28.15***		13.29***		21.27***		28.97***
$D_{C,834} * \lvert S_{NP,834}\rvert$		35.73***		13.26***		28.65***		16.21***
$D_{C,835} * \lvert S_{NP,835}\rvert$		34.54***		13.19***		22.75***		25.41***
$D_{B,831} * \lvert S_{NP,831}\rvert$		40.12***		35.26***		23.52***		67.84***
$D_{B,832} * \lvert S_{NP,832}\rvert$		45.54***		18.94***		50.39***		54.73***
$D_{B,833} * \lvert S_{NP,833}\rvert$		51.21***		18.08***		41.15***		33.67***
$D_{B,834} * \lvert S_{NP,834}\rvert$		46.40***		17.80***		18.00***		19.62***
$D_{B,835} * \lvert S_{NP,835}\rvert$		54.46***		18.08***		29.51***		26.70***
$D_{836:840}$	2.89***	2.89***	1.00***	1.00***	1.08***	1.17***	0.95	0.95
$D_{841:845}$	2.71***	2.70***	0.99	0.99	1.00	1.00	0.98	0.92
$D_{846:850}$	2.33***	2.33***	1.00	1.00	0.91	0.90	0.91	0.88
$D_{851:855}$	2.17***	2.17***	1.00	1.00	0.87	0.87	0.95	0.95
$D_{856:900}$	2.17***	2.17***	0.99	0.99	0.79	0.82	0.82	0.82
$D_{901:905}$	2.00***	2.00***	0.99	0.99	0.84	0.85	0.83	0.86
$D_{906:910}$	1.92***	1.92***	0.99	0.99	0.80	0.79	0.80	0.80
$D_{911:915}$	1.76***	1.77***	0.99	0.99	0.82	0.82	0.75	0.75
$D_{916:920}$	1.52***	1.52***	0.99	0.99	0.73	0.74	0.68	0.68
$D_{921:925}$	1.34***	1.34***	0.99	0.99	0.76	0.74	0.73	0.73
$D_{926:930}$	1.22***	1.22***	0.99	0.99	0.71	0.67	0.63	0.64
Adjusted R^2	0.27	0.28	-0.42	-0.26	-0.04	-0.04	-0.04	-0.03
BIC	2.74	2.74	-3.60	-3.61	2.94	2.93	2.94	2.94
No Obs.	6750	6750	6750	6750	6750	6750	6750	6750

Note: The table reports estimation coefficients in the mean equations of GARCH(1,1) models with dependent variables corresponding to the column titles. A time dummy like $D_{801:805}$ is 1 for the minutes between 08:00:00 and 08:04:59 and 0 otherwise, a time dummy like D_{831} is 1 for the minute between 8:30:00 and 08:30:59 EST and 0 otherwise, a dummy like $D_{G,831}$ ($D_{C,831}$ or $D_{B,831}$) is equal 1 for the minute between 8:30:00 and 08:30:59 EST when the preceding announcement was good (contradictory or bad) and 0 otherwise. $|S_{NP,831}|$ denotes the absolute surprise in the nonfarm payroll employment. *, **, *** denote significance of the t-statistic testing whether the coefficient is larger than 1 at the 90 percent, 95 percent and 99 percent respectively.

5 Conclusion

In the markets where large volumes are intensively traded, sufficient liquidity provision is very important for the investors. The possibility to trade at low costs enables them to adjust their portfolios directly after receiving new information. Moreover, high losses during extreme sequential price movements can be avoided by an early withdrawal from the market. Scheduled public news releases are information events that can move the equilibrium price substantially. Therefore, the changes in liquidity during such phases are crucial for the investors. Previous event studies investigate usually only certain aspects of liquidity, like the trading volume or bid-ask spreads. Moreover, they focus mainly on market-maker markets, where there are designated liquidity providers. This study focuses on limit order markets, where liquidity is provided endogenously by traders. Our analysis shows that the liquidity situation in periods of intensive information flow results from unusual trading behavior observed before and after the news arrival. The measure of imbalances between liquidity supply and demand used here proves to describe the mechanism determining overall liquidity very well.

We find that scheduled releases of new information cause an unusual trading behavior that leads to liquidity shortages. We identify significant liquidity shortages around scheduled information events confirming previous findings for the market-maker bond market (e.g. Fleming and Remolona (1999) or Balduzzi, Elton, and Green (2001)). Due to our long and precise data set and a bi-dimensional liquidity measure, we are able to describe the mechanism of liquidity creation around the news events more accurately. We find that the decrease in liquidity is caused by the imbalances between liquidity supply and trading demand. A decreasing offered volume and a rather normal trading volume before the announcement cause low and decreasing liquidity in anticipation of the news release. The shortage becomes very high immediately after the event because the arrival of new market orders by far exceeds the limit order volume. Afterwards, a slowly recovering offered volume and a very high trading volume cause low and increasing liquidity.

Furthermore, we find that the liquidity reaction depends on the type of the announced information and its surprise component. Good announcements are directly followed by a high volume resulting from market buy orders and bad announcements by a high volume of sells. This finding suggests 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 market buy orders. Therefore, a large volume of buys is observed after good news releases and a large volume of sells follows bad news releases. The price advantage seems to disappear after the first minute. An unusually high trading demand in the first minute results in an extreme imbalance between liquidity supply and demand and causes a severe liquidity shortage directly after the event. Furthermore, we find that large surprises result in a higher order flow and lower liquidity than small surprises. This is caused by the fact that liquidity supply increases less in the absolute suprise than liquidity demand. Liquidity shortages are particularly large after very surprising bad news.

References

Admati, A. R., and P. C. Pfleiderer (1988): "A Theory of Intraday Spread Patterns: Volume and Price Variability," *Review of Financial Studies*, 1, 3–40.

Amihud, Y., and H. Mendelson (1980): "Dealership Market: Market Making with Inventory," *Journal of Financial Economics*, 8, 31–53.

——— (1991): "Liquidity, Maturity, and the Yields on U.S. Treasury Securities," *Journal of Finance*, 46, 1411–1425.

Andersen, T. G., and T. Bollerslev (1998): "Deutsche Mark-Dollar Volatility: Intraday Activity Patterns, Macroeconomic Announcements, and Longer Run Dependencies," *Journal of Finance*, 53(1), 219–265.

Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega (2003): "Micro Effects of Macro Announcements: Real-Time Price Discovery in Foreign Exchange," *American Economic Review*, 93(1), 38–62.

——— (2006): "Real-time Price Discovery in Global Stock, Bond and Foreign Exchange Markets," Discussion paper, International Finance Discussion Papers 871, Board of Governors of the Federal Reserve System.

Andersson, M., L. J. Hansen, and S. Sebestyn (2006): "Which News Moves the Euro Area Bond Markets," Discussion paper, ECB Working Paper No 631.

Angel, J. J. (1994): "Limit Versus Market Orders," Discussion paper, Working Paper, Georgetown University, School of Business Administration.

Bacidore, J., R. H. Battalio, and R. H. Jennings (2003): "Order Submission Strategies, Liquidity Supply and Trading in Pennies on the New York Stock Exchange," *Journal of Financial Markets*, 6, 337362.

Balduzzi, P., E. J. Elton, and T. C. Green (2001): "Economic News and Bond Prices: Evidence from the U.S. Treasury Market," *Journal of Financial and Quantitative Analysis*, 36(4), 523–543.

Barberis, N., A. Shleifer, and R. W. Vishny (1998): "A Model of Investor Sentiment," *Journal of Financial Economics*, 49, 307–347.

Biais, B., L. Glosten, and C. Spatt (2005): "Market Microstructure: A Survey of Microfoundations, Empirical Results, and Policy Implications," *Journal of Financial Markets*, 8, 217264.

Bloomfield, R., M. O'Hara, and G. Saar (2005): "The Make or Take Decision in an Electronic Market: Evidence on the Evolution of Liquidity," *Journal of Financial Economics*, 75, 165200.

Caglio, C., and K. A. Kavajecz (2006): "A Specialist's Quoted Depth as a Strategic Choice Variable: An Application to Spread Decomposition Models," *Journal of Financial Research*, 29, 367–382.

Chan, S., K. A. Kim, and S. G. Rhee (2005): "Price Limit Performance: Evidence from Transactions Data and the Limit Order Book," *Journal of Empirical Finance*, 12, 269–290.

Chordia, T., R. Roll, and A. Subrahmanyam (2005): "Evidence on the Speed of Convergence to Market Efficiency," *Journal of Financial Economics*, 76, 271–292.

Cohen, K. J., S. F. Maier, R. A. Schwartz, and D. K. Whitcomb (1981): "Transaction Costs, Order Placement Strategy, and Existence of the Bidask Spread," *Journal of Political Economy*, 89, 287305.

Daniel, K. D., D. A. Hirshleifer, and A. Subrahmanyam (1998): "Investor Psychology and Security Market Under- und Overreactions," *Journal of Finance*, 53, 1839–1885.

Dixon, W. J. (1960): "Simplified Estimation from Censored Normal Samples," *The Annals of Mathematical Statistics*, 31, 385–391.

Dupont, D. Y. (2000): "Market Making, Prices and Quantity Limits," *Review of Financial Studies*, 13, 11291151.

Ederington, L. H., and J. H. Lee (1993): "How Markets Process Information: News Releases and Volatility," *Journal of Finance*, 48(4), 1161–1191.

Ehrmann, M., and M. Fratzscher (2003): "Interdependence Between the Euro Area and the U.S.: What Role for the EMU?," *International Finance*, 6, 309–328.

Elton, E. J., and T. C. Green (1998): "Tax and Liquidity Effects in Pricing Government Bonds," *Journal of Finance*, 53, 1533–1562.

Engle, R. F., and J. Lange (2001): "Predicting VNET: A Model of the Dynamics of Market Depth," *Journal of Financial Markets*, 4, 113–142.

Evans, M. D., and R. K. Lyons (2002): "Order Flow and Exchange Rate Dynamics," *Journal of Political Economy*, 110, 170–180.

——— (2005): "Do Currency Markets Absorb News Quickly?," *Journal of International Money and Finance*, 24(2), 197–217.

——— (2008): "How Is Macro News Transmitted to Exchange Rates?," *Journal of Financial Economics*, forthcoming.

Fleming, M. J. (1997): "The Round-the-Clock Market for U.S. Treasury Securities," *Federal Reserve Bank of New York Economic Policy Review*, 3, 9–32.

——— (2001): "Measuring Treasury Market Liquidity," *FRB of New York Staff Report No. 133*.

Fleming, M. J., and E. M. Remolona (1999): "Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information," *Journal of Finance*, 54(5), 1901–1915.

Foster, F. D., and S. Viswanathan (1993): "The Effect of Public Information and Competition on Trading Volume and Price Volatility," *Review of Financial Studies*, 6, 23–56.

Foucault, T., O. Kadan, and E. Kandel (2005): "Limit Order Book as a Market for Liquidity," *Review of Financial Studies*, 18, 1171–1217.

Franke, G., and D. Hess (2000): "Information Diffusion in Electronic and Floor Trading," *Journal of Empirical Finance*, 7(5), 455–478.

Glosten, L. R. (1994): "Is the Electronic Open Limit Order Book Inevitable?," *Journal of Finance*, 49(4), 1127–1161.

Glosten, L. R., and P. R. Milgrom (1985): "Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders," *Journal of Financial Economics*, 14(1), 71–100.

Gomber, P., U. Schweickert, and E. Theissen (2004): "Zooming in on Liquidity," Discussion paper, EFA 2004 Working Paper, University of Bonn.

Green, T. C. (2004): "Economic News and the Impact of Trading on Bond Prices," *Journal of Finance*, 59(3), 1201–1233.

Harris, L. (1998): "ptimal Dynamic Order Submission Strategies in Some Stylized Trading Problems," *Financial Markets, Institutions, and Instruments*, 7, 2674.

Hautsch, N., and D. Hess (2002): "The Processing of Non-Anticipated Information in Financial Markets: Analyzing the Impact of Surprises in the Employment Report," *European Finance Review*, 6(2), 133–161.

——— (2007): "Bayesian Learning in Financial Markets: Testing for the Relevance of Information Precision in Price Discovery," *Journal of Financial and Quantitative Analysis*, 42(1), 189–208.

Ho, T. S. Y., and H. R. Stoll (1981): "Optimal Dealer Pricing under Transactions and Return Uncertainty," *Journal of Financial Economics*, 9, 4773.

Huber, P. J. (1981): *Robust Statistics*. Wiley.

Kavajecz, K. A. (1999): "The Specialist's Quoted Depth and the Limit Order Book," *Journal of Finance*, 52, 747–771.

Kavajecz, K. A., and E. R. Odders-White (2001): "An Examination of Changes in Specialists' Posted Price Schedules," *Review of Financial Studies*, 14, 681–704.

Kim, O., and R. E. Verrecchia (1991a): "Market Liquidity and Volume Around Earnings Announcements," *Journal of Accounting and Economics*, 17, 41–67.

——— (1991b): "Market Reaction to Anticipated Announcements," *Journal of Financial Economics*, 30(2), 273–309.

——— (1991c): "Trading Volume and Price Reactions to Public Announcements," *Journal of Accounting Research*, 29, 302–321.

——— (1997): "Pre-announcement and Event-period Private Information," *Journal of Accounting and Economics*, 24(3), 395–419.

Kyle, A. S. (1985): "Continous Auctions and Insider Trading," *Econometrica*, 53(6), 1315–1336.

Lee, C. M., B. Mucklow, and M. J. Ready (1993): "Spreads, Depths and the Impact of Earnings Information: An Intraday Analysis," *Review of Financial Studies*, 6, 345374.

Lee, C. M., and M. J. Ready (1991): "Inferring Trade Direction from Intraday Data," *Journal of Finance*, 46, 733747.

Livne, G. (2000): "Information Asymmetry, Investment Horizons, and the Dual Role of Public Announcements," *Review of Accounting Studies*, 5, 127–153.

Love, R., and R. Payne (2008): "Macroeconomic News, Order Flows and Exchange Rates," *Journal of Financial and Quantitative Analysis*, forthcoming.

Madhavan, A. (2000): "Market Microstructure: A Survey," *Journal of Financial Markets*, 3, 205–258.

O'Hara, M. (1995): *Market Microstructure Theory*. Blackwell Publishers, Oxford.

Pascual, R., A. Escribano, and M. Tapia (2004): "On the Bi-dimensionality of Liquidity," *The European Journal of Finance*, 10(6), 542–566.

Pasquariello, P., and C. Vega (2007): "Informed and Strategic Order Flow in the Bond Markets," *Review of Financial Studies*, 20, 1975–2019.

Ready, M. J. (1999): "The Specialist's Discretion: Stopped Orders and Price Improvement," *Review of Financial Studies*, 12, 1075–1112.

Sandås, P. (2001): "Adverse Selection and Competitive Market Making: Empirical Evidence from a Limit Order Market," *Review of Financial Studies*, 14, 705–734.

Stoll, H. R. (1978): "The Supply of Dealer Services in Securities Markets," *Journal of Finance*, 33(4), 1133–1151.

Tukey, J. W. (1962): "The Future of Data Analysis," *The Annals of Mathematical Statistics*, 33(1), 1–67.

Veronesi, P. (1999): "Stock Market Overreaction to Bad News in Good Times: A Rational Expectations Equilibrium Model," *Review of Financial Studies*, 12(5), 975–1007.

Appendix I: Liquidity Provision Around Announcements: Sample 1994-1998

Table 8: Liquidity Supply Around Announcements: Bid and Ask Volume

	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Bid Volume												
Nonann. Fr.	0.77^{***}	0.80^{***}	0.80^{***}	0.83^{***}	0.81^{***}	0.73^{***}	0.76^{***}	0.84^{***}	0.89^{***}	0.84^{***}	0.81^{***}	0.87^{***}	0.87^{***}
Ann. Fr.	$0.67^{***}_{\ddagger}$	$0.69^{***}_{\ddagger}$	0.75^{***}	$0.67^{***}_{\ddagger\ddagger}$	$0.57^{***}_{\ddagger\ddagger\ddagger}$	$0.58^{***}_{\ddagger\ddagger\ddagger}$	0.82^{***}	1.08	0.90^{**}	0.99	0.95	0.93^{*}	0.94
Good News	$0.58^{***}_{\ddagger}$	0.98	0.92	0.68^{**}	$0.60^{***}_{\ddagger\ddagger}$	0.63^{**}	1.03	1.69	0.88^{**}	1.02	0.89	0.92	0.78^{***}
Contr. News	0.69^{***}	0.80^{*}	$0.69^{***}_{\ddagger}$	0.79^{*}	$0.54^{***}_{\ddagger\ddagger}$	0.65^{***}	0.87^{**}	0.87	0.85	1.08	1.01	0.79^{***}	0.80^{**}
Bad News	0.74^{**}	$0.54^{***}_{\ddagger\ddagger\ddagger}$	$0.66^{***}_{\ddagger}$	$0.57^{***}_{\ddagger\ddagger}$	$0.58^{***}_{\ddagger\ddagger\ddagger}$	$0.54^{***}_{\ddagger\ddagger\ddagger}$	0.71^{***}	0.94	0.95	0.98	0.96	1.04	1.17
	Ask Volume												
Nonann. Fr.	0.76^{***}	0.80^{***}	0.78^{***}	0.77^{***}	0.80^{***}	0.73^{***}	0.77^{***}	0.89^{***}	0.90^{**}	0.83^{***}	0.89^{***}	0.90^{***}	0.95
Ann. Fr.	0.76^{***}	0.81^{***}	0.76^{***}	0.78^{***}	$0.64^{***}_{\ddagger\ddagger\ddagger}$	$0.49^{***}_{\ddagger\ddagger\ddagger}$	1.04	1.04	0.97	1.15	0.99	0.95	0.98
Good News	0.91	0.70^{***}	0.84	1.02	0.84	0.60^{***}	1.00	1.19	1.17	1.25	1.14	0.93	0.99
Contr. News	$0.53^{***}_{\ddagger\ddagger}$	0.82^{*}	0.72^{***}	0.68^{***}	$0.60^{***}_{\ddagger\ddagger\ddagger}$	$0.42^{***}_{\ddagger\ddagger\ddagger}$	0.87^{*}	0.98	0.96	1.15	0.86^{*}	0.91	$0.74^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.79^{**}	0.92	0.76^{***}	0.76^{***}	$0.59^{***}_{\ddagger\ddagger\ddagger}$	$0.49^{***}_{\ddagger\ddagger\ddagger}$	1.25	1.00	0.86^{*}	1.10	1.00	1.00	1.06

NOTE: The table presents descriptive statistics for the volume quoted at the best bid and the best ask prices in 1-minute intervals around 8:30 EST. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

Table 9: Liquidity Demand Around Announcements: Trading Volume of Buys and Sells

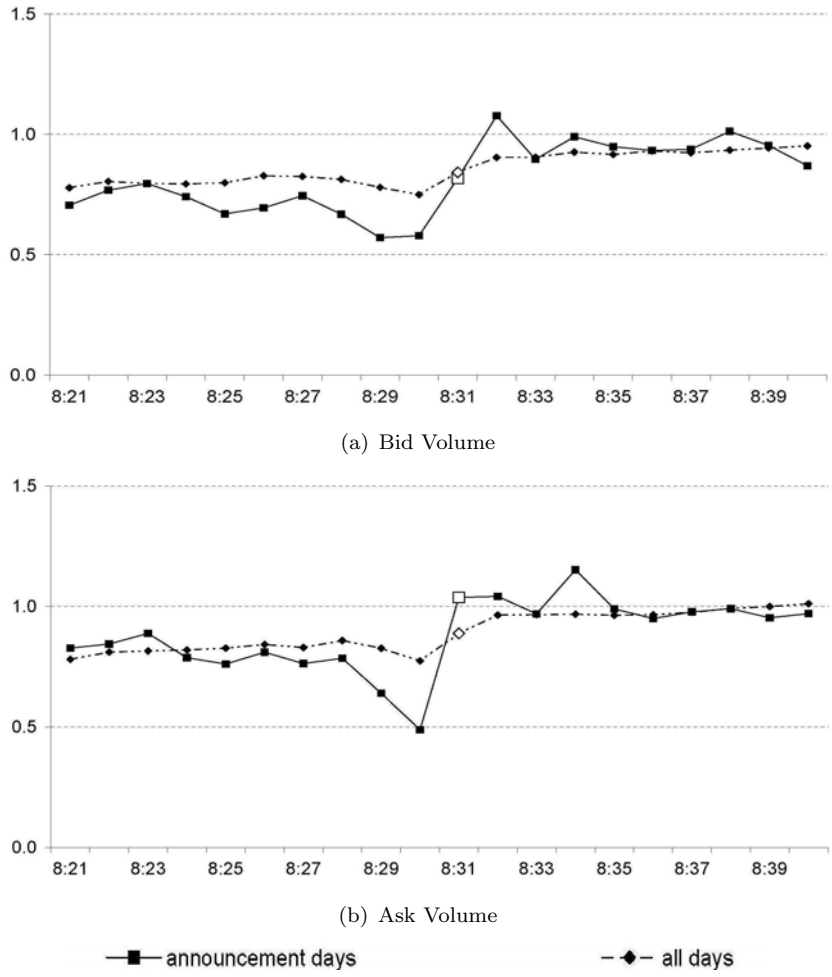
	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Trading Volume												
Nonann. Fr.	0.65	0.63	0.81	0.78	0.70	0.72	1.21^{**}	1.29^{***}	1.32^{***}	1.43^{***}	1.30^{***}	1.41^{***}	1.17^{**}
Ann. Fr.	0.73	0.75	0.81	0.82	$0.85_{\ddagger}$	$0.84_{\ddagger}$	$6.12^{***}_{\ddagger\ddagger\ddagger}$	$5.89^{***}_{\ddagger\ddagger\ddagger}$	$4.84^{***}_{\ddagger\ddagger\ddagger}$	$4.78^{***}_{\ddagger\ddagger\ddagger}$	$4.66^{***}_{\ddagger\ddagger\ddagger}$	$3.87^{***}_{\ddagger\ddagger\ddagger}$	$3.81^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.87	0.78	0.87	0.85	0.73	0.76	$6.91^{***}_{\ddagger\ddagger\ddagger}$	$7.59^{***}_{\ddagger\ddagger\ddagger}$	$5.83^{***}_{\ddagger\ddagger\ddagger}$	$4.35^{***}_{\ddagger\ddagger\ddagger}$	$4.68^{***}_{\ddagger\ddagger\ddagger}$	$3.99^{***}_{\ddagger\ddagger\ddagger}$	$3.21^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	0.59	0.76	0.91	0.84	$0.95_{\ddagger\ddagger\ddagger}$	$0.96_{\ddagger\ddagger}$	$6.56^{***}_{\ddagger\ddagger\ddagger}$	$5.51^{***}_{\ddagger\ddagger\ddagger}$	$4.74^{***}_{\ddagger\ddagger\ddagger}$	$5.54^{***}_{\ddagger\ddagger\ddagger}$	$4.98^{***}_{\ddagger\ddagger\ddagger}$	$4.00^{***}_{\ddagger\ddagger\ddagger}$	$3.72^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.79	0.74	0.70	0.85	0.92	0.82	$5.32^{***}_{\ddagger\ddagger\ddagger}$	$5.12^{***}_{\ddagger\ddagger\ddagger}$	$4.28^{***}_{\ddagger\ddagger\ddagger}$	$4.73^{***}_{\ddagger\ddagger\ddagger}$	$4.46^{***}_{\ddagger\ddagger\ddagger}$	$3.75^{***}_{\ddagger\ddagger\ddagger}$	$4.00^{***}_{\ddagger\ddagger\ddagger}$
	Volume of Buys												
Nonann. Fr.	0.56	0.61	0.65	0.72	0.56	0.64	1.07	1.35^{***}	1.18^{**}	1.41^{***}	0.96	1.39^{***}	1.29^{***}
Ann. Fr.	0.66	0.54	0.79	0.88	$0.89_{\ddagger\ddagger\ddagger}$	$0.92_{\ddagger\ddagger}$	$5.26^{***}_{\ddagger\ddagger\ddagger}$	$4.92^{***}_{\ddagger\ddagger\ddagger}$	$4.16^{***}_{\ddagger\ddagger\ddagger}$	$4.35^{***}_{\ddagger\ddagger\ddagger}$	$4.46^{***}_{\ddagger\ddagger\ddagger}$	$3.52^{***}_{\ddagger\ddagger\ddagger}$	$3.79^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.83	0.60	0.77	0.82	$1.00_{\ddagger}$	0.70	$8.43^{***}_{\ddagger\ddagger\ddagger}$	$5.49^{***}_{\ddagger\ddagger\ddagger}$	$4.53^{***}_{\ddagger\ddagger\ddagger}$	$4.28^{***}_{\ddagger\ddagger\ddagger}$	$4.86^{***}_{\ddagger\ddagger\ddagger}$	$3.63^{***}_{\ddagger\ddagger\ddagger}$	$3.69^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	0.58	0.71	$1.04_{\ddagger}$	0.96	$0.87_{\ddagger\ddagger}$	$1.28_{\ddagger\ddagger}$	$5.64^{***}_{\ddagger\ddagger\ddagger}$	$4.40^{***}_{\ddagger\ddagger}$	$4.64^{***}_{\ddagger\ddagger\ddagger}$	$5.42^{***}_{\ddagger\ddagger\ddagger}$	$4.24^{***}_{\ddagger\ddagger\ddagger}$	$3.56^{***}_{\ddagger\ddagger\ddagger}$	$3.66^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.61	0.46	0.66	0.90	$0.87_{\ddagger\ddagger}$	$0.91_{\ddagger}$	$3.96^{***}_{\ddagger\ddagger\ddagger}$	$4.98^{***}_{\ddagger\ddagger\ddagger}$	$3.63^{***}_{\ddagger\ddagger\ddagger}$	$3.83^{***}_{\ddagger\ddagger\ddagger}$	$4.44^{***}_{\ddagger\ddagger\ddagger}$	$3.42^{***}_{\ddagger\ddagger\ddagger}$	$3.93^{***}_{\ddagger\ddagger\ddagger}$
	Volume of Sells												
Nonann. Fr.	0.58	0.51	0.76	0.73	0.72	0.60	1.16^{*}	1.19^{**}	1.27^{***}	1.21^{**}	1.18^{**}	1.16^{*}	0.95
Ann. Fr.	0.64	$0.77_{\ddagger\ddagger\ddagger}$	0.67	0.81	0.68	0.58	$5.29^{***}_{\ddagger\ddagger\ddagger}$	$5.48^{***}_{\ddagger\ddagger\ddagger}$	$4.37^{***}_{\ddagger\ddagger\ddagger}$	$4.76^{***}_{\ddagger\ddagger\ddagger}$	$4.20^{***}_{\ddagger\ddagger\ddagger}$	$3.85^{***}_{\ddagger\ddagger\ddagger}$	$3.10^{***}_{\ddagger\ddagger\ddagger}$
Good News	0.55	$0.90_{\ddagger\ddagger\ddagger}$	0.62	0.84	0.42	0.46	$4.81^{***}_{\ddagger\ddagger\ddagger}$	$8.21^{***}_{\ddagger\ddagger\ddagger}$	$5.60^{***}_{\ddagger\ddagger\ddagger}$	$3.69^{***}_{\ddagger\ddagger\ddagger}$	$3.88^{***}_{\ddagger\ddagger\ddagger}$	$4.16^{***}_{\ddagger\ddagger\ddagger}$	$2.91^{***}_{\ddagger\ddagger\ddagger}$
Contr. News	0.53	0.55	0.73	0.79	0.85	0.64	$5.22^{***}_{\ddagger\ddagger\ddagger}$	$5.53^{***}_{\ddagger\ddagger\ddagger}$	$3.87^{***}_{\ddagger\ddagger\ddagger}$	$5.10^{***}_{\ddagger\ddagger\ddagger}$	$4.75^{***}_{\ddagger\ddagger\ddagger}$	$3.93^{***}_{\ddagger\ddagger\ddagger}$	$3.37^{***}_{\ddagger\ddagger\ddagger}$
Bad News	0.78	$0.84_{\ddagger\ddagger}$	0.66	0.80	0.79	0.63	$5.77^{***}_{\ddagger\ddagger\ddagger}$	$3.97^{***}_{\ddagger\ddagger\ddagger}$	$3.91^{***}_{\ddagger\ddagger\ddagger}$	$5.46^{***}_{\ddagger\ddagger\ddagger}$	$3.95^{***}_{\ddagger\ddagger\ddagger}$	$3.69^{***}_{\ddagger\ddagger\ddagger}$	$3.06^{***}_{\ddagger\ddagger\ddagger}$

NOTE: The table presents descriptive statistics for the total trading volume as well as the trading volume resulting from market orders signed as buys and sells in 1-minute intervals around 8:30 EST. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

Table 10: Liquidity Provision Around Announcements: Spread, Buy-to-Ask and Sell-to-Bid

	One-minute intervals ending at												
	8:25	8:26	8:27	8:28	8:29	8:30	**8:31**	8:32	8:33	8:34	8:35	8:36	8:37
	Spread												
Nonann. Fr.	1.04^{***}	1.05^{***}	1.02	1.03^{***}	1.04^{***}	1.05^{***}	1.19^{***}	1.05^{***}	1.05^{***}	0.99	0.98	1.02	1.01
Ann. Fr.	1.04^{*}	1.06^{**}	$1.07^{***}_{‡‡}$	$1.12^{***}_{‡‡}$	$1.15^{***}_{‡‡}$	$1.55^{***}_{‡‡‡}$	$2.18^{***}_{‡‡‡}$	$1.53^{***}_{‡‡‡}$	$1.38^{***}_{‡‡‡}$	$1.24^{***}_{‡‡‡}$	$1.18^{***}_{‡‡‡}$	$1.12^{***}_{‡‡}$	$1.14^{***}_{‡‡‡}$
Good News	0.99	1.11^{**}	1.03	1.08	1.01	$1.25^{**}_{‡}$	$1.84^{***}_{‡‡‡}$	$1.30^{**}_{‡‡}$	$1.29^{**}_{‡‡}$	$1.42^{***}_{‡‡‡}$	$1.16^{**}_{‡‡}$	$1.12^{*}_{‡}$	1.09^{*}
Contr. News	1.03	0.97	1.06	1.15^{*}	$1.25^{**}_{‡‡}$	$1.61^{***}_{‡‡‡}$	$2.58^{***}_{‡‡‡}$	$2.06^{***}_{‡‡‡}$	$1.45^{***}_{‡‡‡}$	$1.32^{***}_{‡‡‡}$	$1.26^{***}_{‡‡‡}$	$1.20^{***}_{‡‡‡}$	$1.26^{**}_{‡‡}$
Bad News	1.08^{**}	1.10^{**}	$1.13^{**}_{‡‡}$	$1.14^{**}_{‡}$	$1.15^{**}_{‡}$	$1.70^{***}_{‡‡‡}$	$2.19^{***}_{‡‡‡}$	$1.42^{***}_{‡‡‡}$	$1.39^{***}_{‡‡‡}$	$1.10^{***}_{‡‡‡}$	$1.13^{***}_{‡‡‡}$	1.07^{*}	$1.14^{***}_{‡‡‡}$
	Buy-to-Ask												
Nonann. Fr.	0.84	0.90	0.83	0.89	0.77	0.85	0.96	0.88	0.92	0.85	0.84	0.89	0.87
Ann. Fr.	0.80	0.78	0.79	0.94	0.71	0.90	$1.67^{***}_{‡‡‡}$	$1.24^{**}_{‡‡‡}$	$1.11^{*}_{‡‡}$	$1.01_{‡‡‡}$	$1.25^{***}_{‡‡‡}$	$0.99_{‡}$	$0.97_{‡‡}$
Good News	0.61	0.86	0.78	0.82	0.57	0.76	$2.69^{***}_{‡‡‡}$	$1.38_{‡}$	0.96	0.91	$1.16_{‡‡}$	$1.03_{‡}$	0.89
Contr. News	0.86	0.72	0.79	0.85	0.70	$1.17_{‡‡}$	$1.47^{**}_{‡‡}$	$1.84^{**}_{‡‡}$	$1.64^{**}_{‡‡}$	$1.21^{*}_{‡‡}$	$1.23_{‡‡}$	$1.08_{‡}$	$0.96_{‡‡}$
Bad News	0.89	0.76	0.83	$1.21^{*}_{‡‡}$	0.80	0.88	$1.54^{**}_{‡‡}$	$1.02_{‡}$	0.99	$0.99_{‡‡}$	$1.31^{**}_{‡‡‡}$	0.89	$1.15_{‡}$
	Sell-to-Bid												
Nonann. Fr.	0.86	0.87	0.80	0.80	0.90	0.82	0.93	0.88	0.91	0.88	0.92	0.88	0.80
Ann. Fr.	0.86	0.88	0.75	0.82	0.96	0.77	$2.28^{***}_{‡‡‡}$	$1.43^{***}_{‡‡‡}$	$1.30^{***}_{‡‡‡}$	$1.11^{*}_{‡‡‡}$	$1.16^{**}_{‡‡‡}$	$1.10^{*}_{‡‡‡}$	$1.04_{‡‡‡}$
Good News	0.92	0.85	0.70	0.62	0.89	0.73	$1.91^{**}_{‡‡}$	0.99	$1.20_{‡}$	$1.16_{‡}$	1.04	1.11	$1.44^{*}_{‡‡}$
Contr. News	0.69	0.76	0.72	0.84	$1.08_{‡‡}$	0.78	$2.81^{**}_{‡‡}$	$1.99^{**}_{‡‡‡}$	$1.24_{‡}$	$1.26^{*}_{‡‡}$	1.19	1.05	$0.92_{‡}$
Bad News	0.86	0.95	0.79	0.93	0.92	0.78	$2.42^{***}_{‡‡‡}$	$1.58^{***}_{‡‡‡}$	$1.75^{***}_{‡‡‡}$	$1.06_{‡‡}$	$1.23^{*}_{‡‡}$	$1.14_{‡‡}$	$1.09_{‡‡}$

NOTE: The table presents descriptive statistics for spreads, buy-to-ask and sell-to-bid ratios in 1-minute intervals around 8:30 EST. The sample period: Jan. 1st, 1994 - Dec. 30th, 1998. The first column: Nonann. Fr. = Nonannouncement Fridays, Ann. Fr. = Announcement Fridays (Fridays, on which only the U.S. Employment Report was 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 $S_{UR} \leq 0$. We report the robust means of the investigated measures for each group of days. At the top of each value, significance from the robust t-statistic comparing the means with 1 is reported. *, **, *** denote significance at the 90 percent, 95 percent and 99 percent respectively. Significance from the robust t-statistic comparing means on announcement and nonannouncement days assuming unequal variances is reported at the bottom of each value. ‡, ‡‡, ‡‡‡ denote significance at the 90 percent, 95 percent and 99 percent respectively.

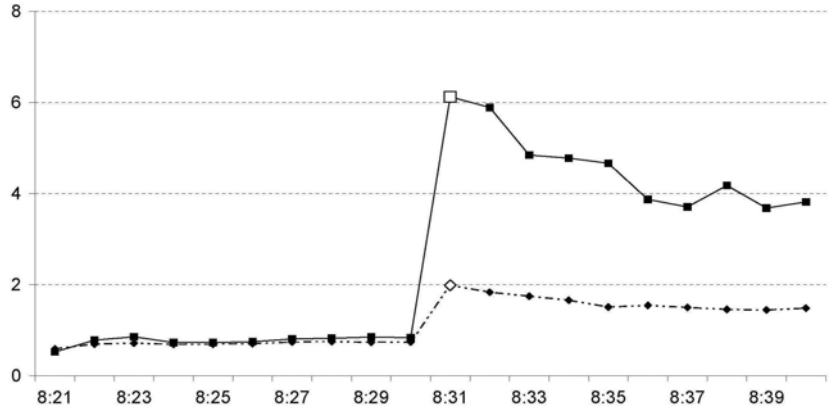


(a) Bid Volume

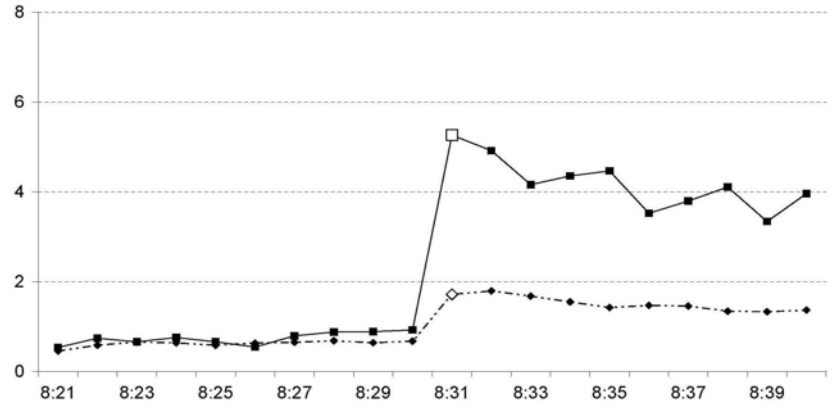
(b) Ask Volume

Figure 5: Liquidity Supply Around Announcements

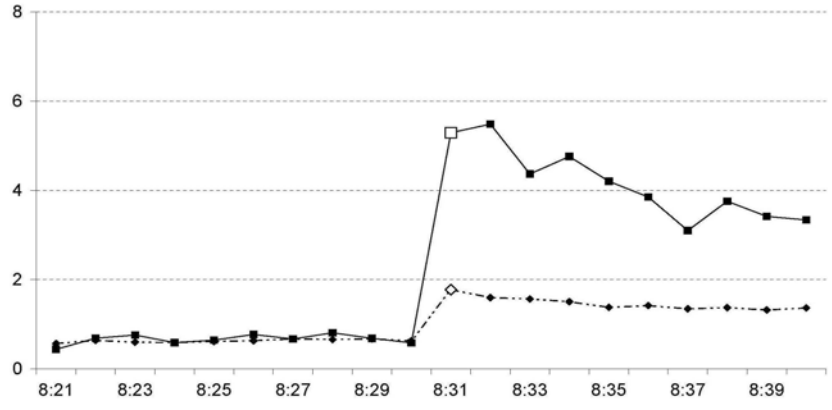
The figure presents liquidity supply (the bid and ask volumes, subfigures (a) and (b)) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Jan. 1st, 1994 to Dec. 30th, 1998.



(a) Trading Volume



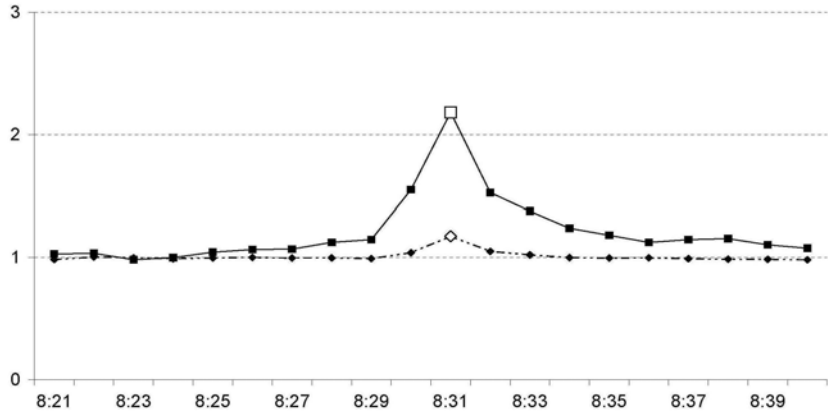
(b) Buy Volume



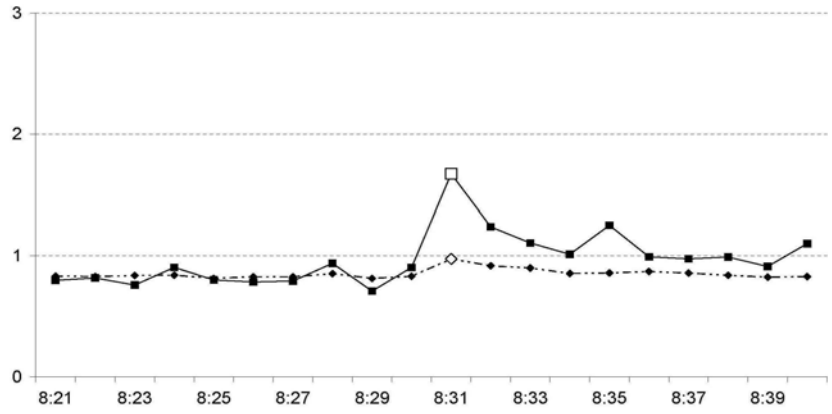
(c) Sell Volume

Figure 6: Liquidity Demand Around Announcements

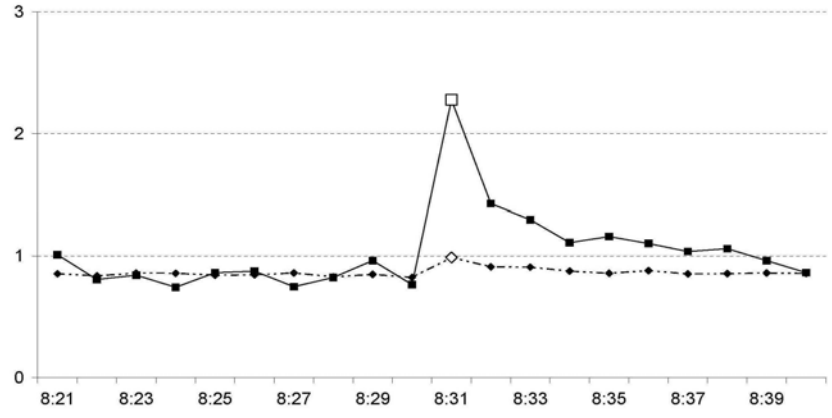
The figure presents liquidity demand (the overall trading volume (subfigure (a)), the trading volume resulting from buy orders (b) and sell orders (c)) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Jan. 1st, 1994 to Dec. 30th, 1998.



(a) Spread



(b) Buy-to-Ask



(c) Sell-to-Bid

Figure 7: Liquidity Provision Around Announcements

The figure presents liquidity provision (spreads (subfigure (a)), buy-to-ask (b) and sell-to-bid (c) imbalance ratios) for 1-minute intervals around the announcement of the U.S. Employment Report. "8:31" means the first minute after the release (time between 08:30:00 and 08:30:59 EST) and is marked in the figure with a larger white symbol. Each figure presents the results for all days and for the announcement days. The sample period regarded here: Jan. 1st, 1994 to Dec. 30th, 1998.

Appendix II: Liquidity Provision Around Announcements: Estimation Results

We construct the time series of 1-minute liquidity measures covering the 90-minute window around the annoucement time (i.e. 08:30 EST) from 08:00 to 09:30 EST. To account for heteroscedasticity, GARCH(1,1) is chosen as the undelying process. Since dependent variables are positive, we model the error term with the Generalized Error Distribution (GED). To model liquidity patterns around announcements, we introduce time dummies to the underlying GARCH process:

$$\begin{aligned} y_t &= \sum_{i=1}^{21} \phi_{1,i} D_i + \epsilon_t, \qquad \epsilon_t \sim GED(\sqrt{2}\sigma, \beta) \\ \sigma_t^2 &= \omega + \psi_1 \epsilon_{t-1}^2 + \psi_2 \sigma_{t-1}^2 + z_t \end{aligned} \tag{2}$$

where y_t denotes the dependent variable in the minute t. Dummy D_i is 1 for the i-th time interval after 08:00 EST and 0 otherwise. We use 1-minute intervals from 08:25 to 08:35 and 5-minute intervals in the remaining period. Furthermore, we differentiate between the cases when the announcement contained good, contradictory and bad news by introducing the following dummies for the first 5 minutes after the event: $D_{G,j}$ for good, $D_{C,j}$ for contradictory and $D_{B,j}$ for bad news. Although we use two figures released in the Employment Report, the nonfarm payroll employment and the unemployment rate, we report the results where the amount of new information is proxied only by the surprise in nonfarm payrolls. The results of the regressions including surprises in the unemployment rate (S_{UR}) and both surprises (S_{NP} and S_{UR}) are qualitatively the same.

Tables 11 and 12 present the estimation results. We find that, consistently with hypothesis H1, liquidity supply measured by the volume offered at the best quotes falls before the announcement and recovers to the normal level afterwards. We can observe an extreme decrease down to ca. 20% (D_{830} for "bid volume" and "ask volume" columns) of the contract average

in the last minute before the event. Liquidity demand does not decrease so extremely before the event, increases to over twice as high level as the contract average and remains high around an hour long after the event. In the first minute after the news release, the volume of buys increases particularily when the news was good and the volume of sells increases when the news was bad. This pattern of liquidity demand is in line with hypothesis H2. Finally, we investigate liquidity shortages measured by spreads, an imbalance between the volume of buys and the volume offered for sale at the best ask (buy-to-ask ratio) and a similar imbalance captured by the sell-to-bid ratio. The liquidity shortage increases before the event due to the decreasing liquidity supply and no similar decrease in liquidity demand. In the first minute after the news release, the liquidity shortage peaks due to an extreme increase in liquidity demand (particulary in the flow of buy orders after good news and the flow of sell orders after bad news) and not that large increase in liquidity supply. Afterwards, liquidity supply recovers and liquidity situation improves gradually. All these findings confirm the results presented in Section 4.1.

Table 11: Liquidity Provision Around Information Time

Sample 1999-2005

Variable	Buy Volume		Sell Volume		Bid Volume		Ask Volume	
$D_{801:805}$	0.43	0.43	0.44	0.44	$0.62^{\ddagger\ddagger\ddagger}$	$0.62^{\ddagger\ddagger\ddagger}$	$0.66^{\ddagger\ddagger\ddagger}$	$0.66^{\ddagger\ddagger\ddagger}$
$D_{806:810}$	0.43	0.43	0.37	0.37	$0.61^{\ddagger\ddagger\ddagger}$	$0.61^{\ddagger\ddagger\ddagger}$	$0.58^{\ddagger\ddagger\ddagger}$	$0.57^{\ddagger\ddagger\ddagger}$
$D_{811:815}$	0.47	0.47	0.46	0.46	$0.57^{\ddagger\ddagger\ddagger}$	$0.57^{\ddagger\ddagger\ddagger}$	$0.55^{\ddagger\ddagger\ddagger}$	$0.55^{\ddagger\ddagger\ddagger}$
$D_{816:820}$	0.48	0.48	0.51	0.51	$0.51^{\ddagger\ddagger\ddagger}$	$0.51^{\ddagger\ddagger\ddagger}$	$0.53^{\ddagger\ddagger\ddagger}$	$0.53^{\ddagger\ddagger\ddagger}$
$D_{821:825}$	0.67	0.68	0.71	0.72	$0.50^{\ddagger\ddagger\ddagger}$	$0.50^{\ddagger\ddagger\ddagger}$	$0.49^{\ddagger\ddagger\ddagger}$	$0.49^{\ddagger\ddagger\ddagger}$
D_{826}	0.72	0.73	0.77	0.77	$0.45^{\ddagger\ddagger\ddagger}$	$0.45^{\ddagger\ddagger\ddagger}$	$0.47^{\ddagger\ddagger\ddagger}$	$0.47^{\ddagger\ddagger\ddagger}$
D_{827}	0.75	0.75	0.74	0.74	$0.38^{\ddagger\ddagger\ddagger}$	$0.38^{\ddagger\ddagger\ddagger}$	$0.44^{\ddagger\ddagger\ddagger}$	$0.44^{\ddagger\ddagger\ddagger}$
D_{828}	0.74	0.74	0.67	0.67	$0.36^{\ddagger\ddagger\ddagger}$	$0.36^{\ddagger\ddagger\ddagger}$	$0.37^{\ddagger\ddagger\ddagger}$	$0.37^{\ddagger\ddagger\ddagger}$
D_{829}	0.73	0.74	0.74	0.73	$0.31^{\ddagger\ddagger\ddagger}$	$0.31^{\ddagger\ddagger\ddagger}$	$0.29^{\ddagger\ddagger\ddagger}$	$0.29^{\ddagger\ddagger\ddagger}$
D_{830}	0.60	0.61	0.64	0.64	$0.21^{\ddagger\ddagger\ddagger}$	$0.21^{\ddagger\ddagger\ddagger}$	$0.19^{\ddagger\ddagger\ddagger}$	$0.19^{\ddagger\ddagger\ddagger}$
D_{831}	2.22***		1.62***		$0.39^{\ddagger\ddagger\ddagger}$		$0.37^{\ddagger\ddagger\ddagger}$	
D_{832}	2.76***		2.14***		$0.53^{\ddagger\ddagger\ddagger}$		$0.48^{\ddagger\ddagger\ddagger}$	
D_{833}	2.41***		2.74***		$0.55^{\ddagger\ddagger\ddagger}$		$0.60^{\ddagger\ddagger\ddagger}$	
D_{834}	2.38***		2.74***		$0.63^{\ddagger\ddagger\ddagger}$		$0.60^{\ddagger\ddagger\ddagger}$	
D_{835}	2.59***		2.71***		$0.63^{\ddagger\ddagger\ddagger}$		$0.63^{\ddagger\ddagger\ddagger}$	
$D_{P,831}$		3.79***		1.54***		$0.56^{\ddagger\ddagger\ddagger}$		$0.48^{\ddagger\ddagger\ddagger}$
$D_{P,832}$		2.95***		2.28***		$0.69^{\ddagger\ddagger\ddagger}$		$0.60^{\ddagger\ddagger\ddagger}$
$D_{P,833}$		2.80***		3.00***		$0.65^{\ddagger\ddagger\ddagger}$		$0.68^{\ddagger\ddagger\ddagger}$
$D_{P,834}$		2.60***		2.78***		$0.69^{\ddagger\ddagger\ddagger}$		$0.63^{\ddagger\ddagger\ddagger}$
$D_{P,835}$		3.39***		3.50***		$0.70^{\ddagger\ddagger\ddagger}$		$0.73^{\ddagger\ddagger\ddagger}$
$D_{C,831}$		2.02***		1.80***		$0.34^{\ddagger\ddagger\ddagger}$		$0.31^{\ddagger\ddagger\ddagger}$
$D_{C,832}$		2.93***		2.12***		$0.46^{\ddagger\ddagger\ddagger}$		$0.46^{\ddagger\ddagger\ddagger}$
$D_{C,833}$		2.12***		2.59***		$0.49^{\ddagger\ddagger\ddagger}$		$0.49^{\ddagger\ddagger\ddagger}$
$D_{C,834}$		2.38***		2.56***		$0.54^{\ddagger\ddagger\ddagger}$		$0.56^{\ddagger\ddagger\ddagger}$
$D_{C,835}$		2.30***		2.57***		$0.53^{\ddagger\ddagger\ddagger}$		$0.59^{\ddagger\ddagger\ddagger}$
$D_{N,831}$		1.83***		2.61***		$0.46^{\ddagger\ddagger\ddagger}$		$0.37^{\ddagger\ddagger\ddagger}$
$D_{N,832}$		2.41***		2.26***		$0.55^{\ddagger\ddagger\ddagger}$		$0.47^{\ddagger\ddagger\ddagger}$
$D_{N,833}$		2.98***		3.01***		$0.63^{\ddagger\ddagger\ddagger}$		$0.64^{\ddagger\ddagger\ddagger}$
$D_{N,834}$		2.54***		2.84***		$0.77^{\ddagger\ddagger\ddagger}$		$0.67^{\ddagger\ddagger\ddagger}$
$D_{N,835}$		2.89***		1.96***		$0.68^{\ddagger\ddagger\ddagger}$		$0.63^{\ddagger\ddagger\ddagger}$
$D_{836:840}$	2.71***	2.71***	2.65***	2.65***	$0.70^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$
$D_{841:845}$	2.55***	2.55***	2.43***	2.43***	$0.71^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$
$D_{846:850}$	2.08***	2.09***	2.11***	2.11***	$0.71^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$
$D_{851:855}$	1.87***	1.88***	1.98***	1.98***	$0.74^{\ddagger\ddagger\ddagger}$	$0.74^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$
$D_{856:900}$	1.91***	1.93***	1.80***	1.80***	$0.73^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$	$0.75^{\ddagger\ddagger\ddagger}$
$D_{901:905}$	1.90***	1.90***	1.81***	1.82***	$0.71^{\ddagger\ddagger\ddagger}$	$0.71^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$	$0.70^{\ddagger\ddagger\ddagger}$
$D_{906:910}$	1.81***	1.81***	1.67***	1.67***	$0.77^{\ddagger\ddagger\ddagger}$	$0.77^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$
$D_{911:915}$	1.66***	1.66***	1.63***	1.63***	$0.73^{\ddagger\ddagger\ddagger}$	$0.73^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$
$D_{916:920}$	1.49***	1.50***	1.32***	1.32***	$0.67^{\ddagger\ddagger\ddagger}$	$0.67^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$	$0.72^{\ddagger\ddagger\ddagger}$
$D_{921:925}$	1.21***	1.22***	1.12**	1.12**	$0.68^{\ddagger\ddagger\ddagger}$	$0.68^{\ddagger\ddagger\ddagger}$	$0.69^{\ddagger\ddagger\ddagger}$	$0.69^{\ddagger\ddagger\ddagger}$
$D_{926:930}$	1.16***	1.16***	1.09**	1.09**	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$	$0.76^{\ddagger\ddagger\ddagger}$
Adjusted R^2	0.21	0.22	0.21	0.21	-0.07	-0.07	-0.05	-0.05
BIC	3.19	3.20	3.15	3.16	1.03	1.04	0.97	0.98
No Obs.	6750	6750	6750	6750	6750	6750	6750	6750

Note: The table reports estimation coefficients in the mean equations of GARCH(1,1) models with dependent variables corresponding to the column titles. A time dummy like $D_{801:805}$ is 1 for the minutes between 08:00:00 and 08:04:59 and 0 otherwise, a time dummy like D_{831} is 1 for the minute between 8:30:00 and 08:30:59 EST and 0 otherwise, a dummy like $D_{G,831}$ ($D_{C,831}$ or $D_{B,831}$) is equal 1 for the minute between 8:30:00 and 08:30:59 EST when the preceding announcement was good (contradictory or bad) and 0 otherwise. *, **, *** (‡, ‡‡, ‡‡‡) denote significance of the t-statistic testing whether the coefficient is larger (smaller) than 1 at the 90 percent, 95 percent and 99 percent respectively.

Table 12: Liquidity Provision Around Information Time

Sample 1999-2005

Variable	Trading Volume		Spread		Buy-to-Ask		Sell-to-Bid	
$D_{801:805}$	0.50	0.50	0.99	0.99	0.72	0.72	0.65	0.62
$D_{806:810}$	0.47	0.47	0.99	0.99	0.63	0.63	0.64	0.64
$D_{811:815}$	0.53	0.53	0.99	0.99	0.64	0.64	0.66	0.65
$D_{816:820}$	0.57	0.57	0.99	0.99	0.64	0.65	0.67	0.67
$D_{821:825}$	0.76	0.76	0.99	0.99	0.77	0.77	0.76	0.76
D_{826}	0.86	0.86	0.99	0.99	0.71	0.72	0.80	0.76
D_{827}	0.82	0.81	1.00***	1.01***	0.75	0.75	0.81	0.83
D_{828}	0.80	0.80	1.02***	1.02***	0.75	0.74	0.84	0.91
D_{829}	0.80	0.81	1.05***	1.05***	0.78	0.77	0.82	0.83
D_{830}	0.62	0.63	1.08***	1.07***	0.97	0.97	1.08***	1.09***
D_{831}	2.39***		1.34***		1.98***		2.79***	
D_{832}	2.67***		1.05***		1.87***		1.66***	
D_{833}	2.82***		1.01***		1.13***		1.28***	
D_{834}	2.82***		1.01***		1.09***		1.17***	
D_{835}	2.99***		1.00		1.26***		1.35***	
$D_{P,831}$		3.31***		1.18***		2.51***		1.01
$D_{P,832}$		2.94***		1.08***		1.98***		1.20***
$D_{P,833}$		3.27***		1.01**		0.85		2.05***
$D_{P,834}$		3.11***		1.00		1.92***		1.14***
$D_{P,835}$		3.91***		1.01***		0.98		1.00
$D_{C,831}$		2.04***		1.27***		1.97***		3.18***
$D_{C,832}$		2.65***		1.05***		2.85***		1.66***
$D_{C,833}$		2.41***		1.00		1.24***		1.47***
$D_{C,834}$		2.66***		1.02***		1.13***		1.13***
$D_{C,835}$		2.58***		1.00**		1.40***		1.88***
$D_{N,831}$		2.17***		1.61***		1.90***		1.50***
$D_{N,832}$		2.68***		1.08***		1.33***		2.49***
$D_{N,833}$		2.89***		1.01***		1.26***		1.04**
$D_{N,834}$		3.12***		1.01***		1.07***		0.78
$D_{N,835}$		2.80***		1.00		1.18***		1.44***
$D_{836:840}$	2.89***	2.91***	0.99	1.00***	1.11***	1.19***	0.92	0.95
$D_{841:845}$	2.72***	2.72***	0.99	0.99	0.96	1.00	0.93	0.94
$D_{846:850}$	2.34***	2.35***	1.00	1.00	0.92	0.92	0.91	0.91
$D_{851:855}$	2.18***	2.18***	1.00	1.00	0.87	0.90	0.96	0.96
$D_{856:900}$	2.18***	2.18***	0.99	0.99	0.85	0.82	0.82	0.82
$D_{901:905}$	2.01***	2.02***	0.99	0.99	0.84	0.84	0.83	0.86
$D_{906:910}$	1.92***	1.93***	0.99	0.99	0.80	0.80	0.80	0.80
$D_{911:915}$	1.77***	1.78***	0.99	0.99	0.83	0.82	0.74	0.75
$D_{916:920}$	1.53***	1.53***	0.99	0.99	0.74	0.73	0.71	0.69
$D_{921:925}$	1.34***	1.34***	0.99	0.99	0.74	0.74	0.73	0.73
$D_{926:930}$	1.23***	1.23***	0.99	0.99	0.65	0.67	0.62	0.63
Adjusted R^2	0.37	0.38	0.13	0.14	-0.03	-0.03	-0.03	-0.04
BIC	2.64	2.65	-3.85	-3.84	2.88	2.89	2.90	2.91
No Obs.	6750	6750	6750	6750	6750	6750	6750	6750

Note: The table reports estimation coefficients in the mean equations of GARCH(1,1) models with dependent variables corresponding to the column titles. A time dummy like $D_{801:805}$ is 1 for the minutes between 08:00:00 and 08:04:59 and 0 otherwise, a time dummy like D_{831} is 1 for the minute between 8:30:00 and 08:30:59 EST and 0 otherwise, a dummy like $D_{G,831}$ ($D_{C,831}$ or $D_{B,831}$) is equal 1 for the minute between 8:30:00 and 08:30:59 EST when the preceding announcement was good (contradictory or bad) and 0 otherwise. *, **, *** denote significance of the t-statistic testing whether the coefficient is larger than 1 at the 90 percent, 95 percent and 99 percent respectively.