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The Price Impact of Economic News, Private Information and Trading Intensity

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Abstract

In this paper we use three years high-frequency data to investigate the role played by public and private information in the process of price formation in two secondary government bond markets. As public information we examine the impact of regularly scheduled macroeconomic news announcements. We identify those announcements with the greatest impact on these markets. As private information we estimate the price impact of order flow. In fact, according to the microstructure models, private information in this context is related to the subjective evaluation of information and order flow can reflect difference of opinions among market participants. Thus, market participant may infer information about the subjective beliefs of other market participants looking at the aggregate order flow. We then use a vector autoregressive model for prices and trades to empirically test the role played by intraday trading intensity and by the waiting time between consecutive transactions in the process of price formations.

JEL codes: E44; G10; G14

Keywords: News Effects; Order Flow; High Frequency Data; Market Microstructure

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1 Introduction

We investigate the role played by public and private information in the process of price formation in the secondary government bond market. In a frictionless market, asset prices should immediately adjust to public news surprises. As a consequence, we should observe price jumps only in presence of announcements. However, asset prices fluctuate also during non-announcement days. Hence, the necessity to introduce possible market frictions capable to explain the behaviour of asset prices. One possible friction is private information. Pasquariello and Vega (2007) theoretically identify and empirical verify the effect of two complementary mechanisms explaining daily price changes, i.e. the aggregation of public news and the aggregation of order flow.

Central to the analysis of market microstructure is the notion that in a market with asymmetrically informed agents, trades convey information and therefore cause a persistent impact on the security price. The magnitude of the price effect for a given trade size is generally held to be a positive function of the proportion of potentially informed traders in the population, the probability that such a trader is in fact informed (i.e., the probability that a private information signal has in fact been observed), and the precision of the private information. The close dependence of the price impact on these factors, which may be referred to as the extent of the information asymmetry, provides a strong motivation for the empirical determination of this impact (Hasbrouck, 1991).

Inventory control effects are inherently transient, while the information inferred from a trade due to asymmetric information is permanently impounded in the security price. The practical implication is that the information effect of a trade should be measured as that which persists over a substantial period.

Theory on financial asset prices states that movements in prices should reflect new information about fundamental asset values. For the stock markets the results are not completely responding to the theory.

The literature on announcement effects in the bond market is also extensive. Moreover, the increasing availability of high frequency data in the bond market has improved the estimation of announcement effects.

Macro models of bond markets assume that all traders share the same information and price beliefs. The importance of *fundamentals* in the bond market is very high. Nevertheless, microstructure models recognize that individuals use different information in forming their beliefs. Most literature has focused on the order flow as a possible source of explanation of private information that some market participants possess. A central prediction of market microstructure theory is that order flow affects prices. In a context where individuals use different information to form their beliefs, order flow acts as a means of measuring them.

We focus on ten-year Italian government fixed rate bonds (Buoni Pluriennali del Tesoro-BTP), traded on two secondary electronic platforms: the business-to-business (B2B) MTS platform and the business-to customer (B2C) BondVision one. We consider nineteen Italian, European and American public news announcements.

After having identified the most important news for our two platforms, we perform a VAR analysis in two equations, one for price changes (returns) and one for signed trades, with lagged values of both variables as explanatory variables. Accordingly with market microstructure theory, in market with asymmetrically informed agents, trades convey information and therefore cause a persistent impact on prices. Moreover, other trade-related variables might be informative beyond trading volume, so we consider also the time elapsed between trades, that is a signal as well about the trading information and thus affects market price behaviour.

The paper proceeds as follows. Section 2 briefly reviews theoretical and empirical works which analysed the role played by public news in process of price formation, for different financial markets. Section 3 describes the institutional environment. Section 4 illustrates the database. Section 5 analyses which announcements matter for the government bond market. Section 6 contains the estimation of the vector autoregressive model (VAR). Section 7 concludes.

2 The effects of macroeconomic announcements on financial markets

Do financial markets respond to macroeconomic news release? Theory suggests that movements in financial asset prices should reflect the availability of new information about fundamental asset values. There is a vast empirical literature studying the possible connections between macroeconomic news announcements and the movements in financial markets prices. However, depending on the market of interest –stock, bond or foreign exchange– the empirical evidence is more or less mixed and relatively weak in confirming theory, especially for studies until the early 1990s that rely on daily, weekly or monthly data. The most recent literature has moved toward the use of high-frequency intraday data, which have notably improved the results.

The link between macroeconomic news and stock market prices is ambiguous. As stated in Anderson et al. (2004) this ambiguity is due to the fact that stock prices depend on expected cash flows, the discount rate, and the risk premium, that work in opposite directions. In fact, holding the risk premium constant, a positive macroeconomic shock increases expected cash flows and the discount rate, the former in turn increases the stock price whereas the latter increases it, leaving the the final result uncertain.

The theory concerning the effect of news on foreign exchange markets generally predicts that good domestic news strengthen the domestic currency. Most empirical studies support this hypothesis, even if subjected to various conditions, such as announcement timing, asymmetries, and sign effects.

Finally, theory predicts an unambiguous link between macroeconomic announcements and bond market prices. Due to the fact that Treasury cash flow are fixed in nominal terms, while stock cash flows depend on economic conditions, unexpected upward revision of the real activity increases the discount rate whit an unambiguously negative final effect of decreasing prices (Fleming and Remolona, 1997). The empirical results generally confirm these theoretical predictions. Balduzzi et al. (2001), for example, find empirical support to the view that positive real activity and inflation shocks affect bond prices negatively.

There is an extensive literature concerning how macroeconomic fundamentals news

affect stock prices, bond prices and foreign exchange rates. Doing a literature reviews of the most important contributions to all these financial markets go beyond the aim of this paper, thus we will focus on the literature concerning the bond market and more precisely the Treasury bond market. Moreover, we will focus most on the most recent literature which has moved towards the use of high-frequency intraday data, opposite to earlier studies which relied mainly on monthly, weekly and daily data. The use of high-frequency data has allowed not only to improve the results in examining the price response to announcements but it has also extended the analysis to the behaviour of other aspects such as the trading volume or the bid-ask spreads.

The empirical literature concerning the link between bond prices and economic announcement effects is extensive.

Fleming and Remolona (1999) analyse the response of prices, trading volume and bid-ask spreads to macroeconomic announcements for the U.S. Treasury market. Balduzzi et al. (2001)

Green (2004) examines the impact of trading on intraday five-year government bond prices surrounding the release of U.S. macroeconomic news announcements. He shows that the release of economic news increases the level of information asymmetry in the government bond market, suggesting that some market participants are better able to determine the precise impact of the news.

Kim and Verrecchia (1991) attribute the increasing information asymmetry following public information releases to the different market participants ability to interpret the information. It might be objected that it is unlikely that Treasury market participant are aware of economic news before it is released, however, the same Green (2004) states that if certain traders are better able to estimate the impact of economic news on bond prices, their trades may reveal information to other market participants following announcements.

Cao et al. (2006) instead attribute the increased information content of trading following the news release to dealer's private access to announcement-induced customer order flow. The results in Green (2004) are actually consistent with this last view.

3 Institutional environment

In this paper we study the microstructure of two electronic bond trading systems, one is a business-to-business (B2B) platform and the other is a business-to-customer (B2C) one.

The B2B platform that we consider is MTS, acronym of *Mercato Telematico dei Titoli di Stato*, it is a wholesale screen-based inter-dealer market for government securities. As an inter-dealer platform, individual customers are not admitted, instead only dealers are allowed to participate (i.e. banks and financial institutions and other professional intermediaries who buy and sell securities for their own account and on behalf of their customers).

The B2C platform is BondVision, part of the MTS Group, it is a wholesale screen-based multi-dealer-to-customer electronic market for fixed income securities. On this platform, primary dealers trade directly with institutional investors (such as insurance and asset management companies) by means of a multiple price auction system.

The European sovereign bond market is the world's largest market for debt securities. With an outstanding aggregate value of around 4,395.9 billion Euros in 2006, it exceeds the size of the US sovereign bond market with an aggregate value of around 4,413.5 billion Dollars (roughly 3 billion Euros) (Dunne et al., 2008). Without loss of generality, we consider only the Italian secondary government bonds. In fact, with 1,184.244 billion in 2004, 1,213.032 billion in 2005 and 1,256.946 billion in 2006 in outstanding Treasury securities, Italy is the largest of the Eurozone bond markets. Among the Italian debt instruments the BTP represent the 59 per cent over the period taken into consideration.

3.1 MTS

MTS was first introduced in Italy in 1988, it is a regulated market which provides wholesale electronic trading of government bonds and other types of fixed income securities¹. During the last two decades, the MTS platform has been typified by many changes. In 1999, with the introduction of Euro as the single European currency, EuroMTS platform was created. From that moment on, fixed income securities can be traded not only on a domestic platform (i.e. MTS France, MTS Germany, MTS Italy, for example) but also on a general

¹MTS is regulated by the Italian Ministry of Economy and Finance, Bank of Italy and CONSOB.

one. However, on the EuroMTS can be traded only *on-the-run* securities, i.e. the most liquid ones.

On MTS there are two types of market participants: dealers and primary dealers. Primary dealers act as market makers, continuously quoting two-way proposals (bid and ask prices) that are valid for all participants and for the whole day, unless they are not modified, cancelled, automatically matched or hit by incoming orders.

Market takers have no market making obligations and they can only accept the quotes posted by market makers if they want to trade. Since primary dealers, unlike dealers, may also formulate proposals on any other tradable product and issue orders for proposals made by other market participants, they can act both as price makers and as price takers².

There are precise rules governing the functioning of MTS. The trading time spans from 8:15 am to 17:30 pm CET time. The maximum spread of the securities traded on MTS are pre-specified depending on their liquidity and maturity. On MTS, primary dealers insert a proposal on the *best page* and all the market participants hit the bid or ask price depending on whether they want to sell or buy. Subsequently the contract is finalised, i.e. the ‘click and trade’ system, and finally settlement instructions are automatically generated.

Before 1997 the system was fully transparent, when anonymity was introduced in order to avoid “fee-riding”, because the reputation of a market maker had impact on the price process. Anonymity prevents dealers from managing the counterpart risk, furthermore, in order to mitigate this risk, traders can rely on a central counterpart service. The role of the central counterpart is to interpose itself between the parties involved in the trades, becoming the buyer to the seller and the seller to the buyer in order to guarantee the execution of the trades by relying on the margin that the trades must deposit. Thus, anonymity is guaranteed at least until the execution of trades, when the identity of the counterpart is revealed for clearing and settlement procedures. However, if the parties are using the central counterpart, anonymity is guaranteed also after the execution of trades³.

²A list of current market makers and market takers is available on the MTS website, www.mtsspa.it/index.php.

³For a more detailed description of how MTS works, see Cheung et al. (2005) and Dufour and Skinner (2004)

3.2 BondVision

The other platform is BondVision, a multi-dealer-to-customer electronic bond trading market. It is another regulated market, launched in 2001 in response to continuous requests from institutional investors for access to the liquidity of the MTS markets⁴.

BondVision allows participants, qualified as primary dealers, to trade directly with clients, qualified as institutional investors, such as investment managers, hedge funds and private banks. This is a quote-driven platform, so a contract is generated only as a consequence of a request from a client (end-user). Three phases characterize the process of trading: request, proposal and acceptance.

During the request phase, clients can select a product, the amount and the direction of their trade (if they want buy or sell), then via the Request for Quote (RFQ) or request for switch quote (RFSWQ) functionalities, simultaneously send an electronic trade request to a maximum number of dealers, hence starting an auction⁵.

During the proposal phase, each dealer participating in the auction send a responding bid or offer allowing the client to execute the trade at the best price. Dealers are not required to provide quotes when requested and clients are not obliged to accept the quotes they receive. They have 90 seconds to decide.

There are precise rules governing also the functioning of BondVision. Also on BondVision there is a Best Page, however the prices are indicative and not executable and it is absolutely not necessary that the requests are present in a list on the Best Page, so there is not a proper order book as for MTS. The trading time spans from 8:30 am to 18:00 pm CET time. Furthermore, on BondVision, the client can also ask for a different settlement time. There exists a minimum request obligation of €100.000⁶.

We have to point it out that BondVision is not an anonymous environment, since, when a client send a RFQ, he selects the dealers and the dealers selected, in turn, know who

⁴BondVision is supervised by the Italian Ministry of Economy and Finance for the government bonds and by CONSOB for the non-government trading section.

⁵Each client is not allowed to send a RFQ to every dealer, but he can request quotes only to a certain number of dealers (At the moment five). More precisely, when a new client joins BondVision, he gives preference to some dealers and each dealer selected, in turn, agrees to trade with the client and chooses the titles on which is willing to offer liquidity.

⁶The Bank of Italy is currently revising the regulation, in order to diminish the minimum tradable quantity to €1.000.

is the client who sent them the request. Furthermore, when a dealer sends a proposal to answer a request of a client, he knows the prices that other dealers involved have quoted but he does not know their identities.

During the last phase, the contracts concluded are regulated directly by the parts. There is no regulation for the settlement. Thus, since there is no regulation for the settlement procedure, of course there is no possibility to make use of the central counterpart, so there is not anonymity neither in this phase.

4 Dataset

Our dataset covers every transaction of Italian long-term government bonds (BTP - Buoni Pluriennali del Tesoro), with an original ten-year maturity, being traded on the MTS and BondVision platforms. The securities have been on-the-run and off-the-run during the period taken into consideration.

These data are high-frequency data which allow us to study a number of market microstructure issues in detail. Records include the direction of the trade (buy or sell), the price, the quantity and a very accurate time stamp. One of the principal advantage of our database is that it records the trade direction, i.e. whether a trade was a buyer or a seller initiated, which is an important piece of information to conduct empirical analysis.

Before proceeding with the analysis, we filter our database in order to drop biased data and errors and to make comparable our result for the two platforms. We eliminate all observations for the 1st, 2nd and 3rd August 2004⁷. Then, we exclude those days that are not in common to both platforms and all the transactions conducted on BondVision during the last thirty minutes, since the platform close at 18:00 pm, thirty minutes after MTS. It is important to highlight that at least the 80 percent of dealers on BondVision are market makers on MTS and of the remaining percentage the half are market takers on the same

⁷The Financial Services Authority (FSA) found that City Group Global Markets Limited (CGML) executed a trading strategy on the European government bond markets on 2nd August 2004 which involved the firm building up and then rapidly exiting from very substantial long positions in European government bonds over a period of an hour. The trade caused a temporary disruption to the volumes of bonds quoted and traded on the MTS platform, a sharp drop in bond prices and a temporary withdrawal by some participants from quoting on that platform. The FSA fined CGML on 28 June 2005, £13.9 million (20.9mm Euros) for Eurobond trades. Source: www.fsa.gov.uk

platform. We end up with a total of 700 days from January 2004 to November 2006.

5 Which announcements move the bond market?

If the market's movements are a reaction to new information, it is reasonable that some announcements induce a stronger reaction than others, on the base of their informativeness about the economy. We consider nineteen announcements, twelve for the Italian government bond market, the ECB meetings at European level and six announcements for the US. Table 2 provides a brief description of salient aspects of economic news announcements. All the announcements are released at regularly scheduled times, however, for the announcements released by the Italian Bureau of Statistics, when during the same day are release more announcements the first is released at 10:00 am and the others at 10:30 am and 11:00 am respectively. Moreover, since we are considering also US news release, we convert the EDT time in CET time, so the announcement released at 8:30 am EDT time are considered at 14:30 CET, those released at 10:00 am EDT are converted into 16:00 pm CET. Finally, the Target Fed Funds Rate that is released at a time when the market is closed, we consider the announce as released at 8:30 am of the next day and the same for the Jobless Claims, but in this case we consider the announce also two days later, since it is released always on Saturday.

5.1 The impact of announcements on market volatility

In measuring the impact of individual announcements on market volatility, we rely on the study of Ederington and Lee (1993) who use high-frequency data on Treasury bond, Eurodollar and Deutsche mark futures markets to examine the impact of sixteen monthly economic announcements on price volatility. They focus on these markets, since they are interested in price adjustments over very short periods of time, so they need heavily traded contracts. They find that seven of the sixteen announcements took in consideration have a significant effect. Greatest announcements impact coming from the employment, the consumer price index, the producer price index and durable good orders.

Other studies use either a time series or a survey forecast to separate anticipated and

surprise components (i.e. the part of release information that is unexpected). However, this procedure does not delineate the impact of announcement on market volatility and does not capture the relative importance of various announcements, for this reason Ederington and Lee (1993) rely on dummy variables rather than on surprise components. Moreover, Fleming and Remolona (1997) further support this choice asserting that studies relying on surprises do not identify more significant announcements than do studies relying only on announcement dummy variables.

To test which announcements are more important, following the work of Ederington and Lee (1993), we run regressions with a series of dummy variables for every announcement taking in consideration.

We define a series of dummy variables D_{kn} , where $D_{kn} = 1$ if announcement k is made on day n and $D_{kn} = 0$ otherwise. The dependent variable is the absolute value of the difference between the actual return R_{jn}^i for the five-minute interval j on day n and the mean return \bar{R}_j^i for interval j over all 700 trading days. The return is defined as the change in the natural logarithm of the trading prices for each day⁸. It is important to notice that, since we construct five-minute intervals, the great majority of the time we do not have a trading price. This results in a return series with a high percentage of zeros. The superscript i indicates whether the platform is the B2B or the B2C, the subscript j indicates the 5-minute intervals and n the day. k is the number of announcements included in the regression which varies with interval j , since we control for announcements released earlier during the day⁹. We do not insert the intercept to avoid perfect multicollinearity and to have as results the actual coefficient estimates of dummies¹⁰. This is the formula for the least square dummy variable regression:

$$|R_{jn}^i - \bar{R}_j^i| = \sum_{k=1}^K a_{kj}^i D_{kn} + e_{jn}^i \quad (1)$$

⁸In measuring the price impact of trades, the most natural definition of returns is based on quote midpoints. However, since we want to compare the results on the two platforms we use transaction prices because BondVision does not have quoting prices, being an order-driven platform.

⁹This means that when we consider the interval of 10:00A.M.-10:005A.M., for example, we consider not only the news released at 10:00A.M., but also those released at 8:30 A.M. and at 9:30 A.M.. We do the same for each subinterval until the end of the day.

¹⁰The R^2 and the adjusted R^2 are incorrect when we suppress intercept, so we do not report these values in the table of results.

Table 1. Brown-Forsythe-modified Levene test of homoskedasticity

Brown-Forsythe-modified Levene F-statistics for tests of equality of variances across the 109 intraday five-minute intervals.

| | Announcement Days | Nonannouncement Days | All Days |
|------------|-------------------|----------------------|----------|
| MTS | 5.74 | 7.37 | 11.81 |
| BondVision | 10.21 | 14.69 | 23.17 |

The F-statistics are all significant at the 0.001 percent level.

For this and all the other estimations we use the White's standard errors, since, as reported in Table 1, the Brown-Forsythe-modified Levene test statistics for equality of the variances across the intervals reject the null hypothesis of homoskedasticity.

Results for the government bonds traded on MTS and BondVision are reported respectively in Tables 3 and 4. Ederington and Lee (1993) states that since there are many announcements and time periods, to consider an announcement as clearly significant, they require that the probability of Type I error must be 0.005 or lower.

Only one 8:30 announcement, the target Fed funds rate, is significant in explaining the 8:30 to 8:35 volatility both for MTS and BondVision. For MTS, for the following two five-minute intervals only the jobless claims results significant. The other announcements that are significant at five percent level are the trade balance, the consumer price confidence and the retail sales for the 10:00 to 10:05 interval, the US consumer confidence and the NAPM survey. The NAPM survey is the only announcement with a negative coefficient in the five-minute periods in which it is released. We can conclude that it is ignored by the market.

For BondVision, instead there are more significantly announcements. For the interval 9:30 to 9:35 are significant the target Fed funds rate, the jobless claims and the business confidence and they continue to have an impact also on successive time intervals. For the interval 10:00 to 10:05 the announcements more significant are consumer confidence, GDP final, trade balance, consumer price index and retail sales. In particular the GDP final influences also the other temporal intervals. For the second last time temporal interval the only significant announcements are again the GDP final and the ECB meetings for the five-

minute interval after the 14:30. Any announcement is significant for the last five-minute intervals.

5.2 The impact of announcements on trading activity

The research on trading activity has been considered the effects of announcements on prices and trading activity separately. Instead, the most recent literature has focused on the idea that price changes and trading activity both reflect the arrival of private information.

In the bond market the public information has a major role with respect to other financial markets, because much of the relevant information is released through scheduled announcements. However, there are many studies that highlight as trading activity can be seen as the expression of differences of opinion among market participants.

Following Fleming and Remolona (1997), we run other regressions consider as dependent variable trading activity, measured as the number of transactions during the one-hour interval following the news announcement.

The regression equation becomes:

$$Y_{nt}^i = \sum_{k=1}^K a_{kt}^i D_{knt}^i + e_{kn}^i \quad (2)$$

where the dependent variable Y_{nt}^i indicates the number of tradings in each one-hour interval t during the day n and the superscript i indicates again the platform that we consider. The dummy variable $D_{knt} = 1$ one-hour trading interval t after the announcement k made on day n and $D_{kn} = 0$ otherwise. For our case we have eight one-hour intervals, since there are some news released at 10:00 am that sometimes are released at 10:30 am or 11:00 am.

Almost every announcement result significant both for MTS and BondVision at least at five percent level. In particular, for the MTS platform, every announcement results significant at 0.005 level or less at least in one one-hour interval. The other important thing to highlight is that almost every announcement remains significant, also if the level of significance can be lower, until the last time interval. The exceptions are the GDP preliminary, which results significant only for the 10:00 to 10:05 interval, the employment

and the producer price index that are not significant during the last three time periods.

The results are more or less the same for the BondVision platform, even if in this case less variables are significant with respect to MTS. Almost every announcement is significant for at least one trading interval with a significance level at least of five percent. The only exception is the employment that is never significant. The consumer confidence is not significant for the last two time intervals, instead Treasury auction results loses its significance during the last interval. GDP preliminary, industrial orders and producer price index are not significant during some intervals.

6 The information content of order flow

Assuming that the interpretation of the announcement is common knowledge among all market participants, a release of public information about macroeconomic fundamentals should immediately affect treasury bond prices. This means that in absence of relevant public news, the prices should not change. However, there is another mechanism that affects the prices, i.e. the aggregation of heterogeneous private information through the trading. Heterogeneous at least in the interpretation of the information, in fact this is the notion of private information for the bond market. Brandt and Kavajecz (2004) label this mechanism *price discovery*.

Although the type of private information in government bond market is different form that in the stock market, the information value of order flow, is still comparable with the client based order flow, in the sens of Evans and Lyons (2002) for currency markets. Some traders may have private information in the traditional meaning of the word¹¹, some others not, so they should trade only on the base of their subjective evaluations. Market participants can infer information about the subjective evaluations of other market participants looking at the aggregate order flow. This process of observing the order flow, may lead them to revise their beliefs.

If we consider private information in the sense defined by Ito et al. (1998) then we can

¹¹Brandt and Kavajecz (2004) states the example of hedge-fund with an ex-member of the Federal Reserve Board.

think at the presence of private information also in the bond market. Ito et al. (1998) define private information as anything that is not common knowledge and that is price relevant.

This is the reason why price changes are not always closeness to the release time of public information. In fact, the following figures show that there is substantial variation in the price volatility and the number of trades in absence of public information releases, suggesting that both public and private information play a role in determining how and why prices and trades changes form day to day and trough each trading day.

Order flow is defined as the difference between the number of the buyer-initiated and the seller-initiated trades.

Microstructure studies of government securities markets have predominantly focused on U.S. Treasury markets. For example, Green (2004) and Pasquariello and Vega (2007) who analyse respectively the impact of macroeconomic news announcements and order flow on the five-year and on the two-year, five-year and ten-year Treasury bond markets respectively.

7 Estimation of the bivariate vector autoregressive model

We apply the vector autoregression (VAR) model proposed by Dufour and Engle (2000). They extend the Hasbrouck (1991) model, adding the informational role of market activity measured by the time interval between two consecutive transactions. A typical feature of any asymmetric information model is that trades convey information, however the theoretical literature is not unanimous about the effect of trading intensity on price dynamics. Diamond and Verrecchia (1987) argue that informed traders always trade both with good and with bad news, however if short sale constraints exist, than bad news takes more time to reveal so that long durations are more likely to be associated with bad news. In Easley and O'Hara (1992) model informed traders always trade irrespective of the signal they receive, but only as long as they receive a signal ("news"). Thus, long durations are likely associated with no news. Moreover, since the trading decision of an uninformed trader is independent of the any information, instead informed traders only trade when they know

information, the variations in trading intensity are associated with the changing numbers of informed traders. These considerations suggest that time actually conveys information and it is reasonable to assume that variations in the trading intensity are positively related to the behaviour of informed traders. Therefore, trading intensity may provide information to market participants.

We estimate the following system for trading prices and direction

$$r_t = \sum_{i=1}^p \alpha_i^r r_{t-i} + \sum_{i=0}^p \beta_i^r x_{t-i}^0 + v_{1,t}$$

$$x_t^0 = \sum_{i=1}^p \alpha_i^x r_{t-i} + \sum_{i=1}^p \beta_i^x x_{t-i}^0 + v_{2,t} \quad (3)$$

$$\beta_i = \left[\gamma_i + \sum_{j=1}^J \lambda_{j,i} D_{j,t-i} + \delta_i \ln(T_{t-i}) \right] \quad (4)$$

where $r_t = \ln(P_t/P_{t-1})$ is the natural logarithm of the trading prices at time t , x_t^0 is a dummy variable which Hasbrouck (1991) calls the *trade indicator*. This variable takes value of one if a trade is initiated by a buyer and a value of minus one if a trade is initiated by a seller¹². Time duration, T_t is the difference in seconds between the time stamp for a trade and for the previous one. We add one second to the whole series of durations because there are trades that occur at the same time but with a different price. Following Dufour and Engle (2000) we control for other intraday periodicities that could influence the trade durations, inserting diurnal dummy variables (D_j) in the VAR. We consider a dummy variable for each trading hour and two dummy variables for the two fifteen minutes intervals during the last trading hour, for a total of ten dummy variables.

7.1 Empirical results

In the estimation we truncated the lagged variable at $p=3$. Furthermore, no one of the dummy variables was significant, so we don't insert them.

¹²Hasbrouck (1991) uses as x_t a vector of trade related variables (e.g. trade sign and the interaction between the trade sign and volume). We use the simplest version of the model, considering only the trade sign.

The estimated VAR becomes:

$$\begin{aligned}
 r_t &= \sum_{i=1}^3 \alpha_i^r r_{t-i} + \sum_{i=0}^3 \beta_i^r x_{t-i}^0 + v_{1,t} \\
 x_t^0 &= \sum_{i=1}^3 \alpha_i^x r_{t-i} + \sum_{i=1}^3 \beta_i^x x_{t-i}^0 + v_{2,t}
 \end{aligned} \tag{5}$$

$$\beta_i = [\gamma_i + \delta_i \ln(T_{t-i})] \tag{6}$$

We estimate the model using heteroskedastic consistent standard errors. The most important set of parameters to investigate the effects of trades on the returns r_t are the signed quantity indicator (γ_i) and the interaction between the signed quantity and the duration (δ_i). Results are reported in Tables 7 and 8.

The interaction between the signed trade and the return is reflected in the parameter γ_i^r . For MTS it is significant only the lagged variable $\gamma_2 = 0.0004$, which is positive and significant at the five percent level.

The most important parameter for the analysis is δ_i^r , which indicates the interaction of duration and signed trading on return. The results show that the parameter $\delta_2 = -0.0001$ is the only lag to be significant at ten percent level. Moreover, $\delta_2 < 0$ indicating an increase in price when the previous trade was a sell and a decrease when the previous trade was a buy. All the other lagged values are positive but insignificant.

For BondVision we find that the parameter which indicates the interaction signed trade and the return ($\gamma_1 = 0.0016$), is positive and significant only for the first lag at the ten percent level. Also the parameter which indicates the interaction of duration and signed trading on return ($\delta_1 = -0.0003$) is significant only for the first lag at five percent level and, as for MTS, it is negative, indicating an increase in price when the previous trade was a sell and a decrease when the previous trade was a buy.

Now we focus our attention on the trade equation in the vector autoregression, to analyse the effect of trades on the trade equation. For MTS, the γ_i^x parameters are all positive and significant at 0.001 level. This means that a buy trade is likely to be followed

by some additional buy trades and the same in the case of a sell trade. For BondVision only the first two lagged values are positive and significant at 0.001 level, instead the third lagged value is insignificant. The estimates of the duration coefficients δ_i^x for MTS result all negative and significant at 0.001 level, meaning that the likelihood that a buy is followed by another buy decreases when the time between the trades increases. In stead, for BondVision only the second lagged duration coefficient is significant at five percent level. All the results for the MTS platform are consistent with the results of Cheung et al. (2005).

Finally, following Cheung et al. (2005), we re-estimate the model considering the effect of the news. Thus, we see the effect of the order flow on return with and without news announcements. This effect is given by the parameter γ_0 . On the MTS platform, the instantaneous impact of an incoming order is largest for days with news announcements ($\gamma_0^{(news)}=0.26$) that without announcements ($\gamma_0^{(no-news)}=0.20$). The same it is true for BondVision ($\gamma_0^{(news)}=0.27$) that without announcements ($\gamma_0^{(no-news)}=0.18$)¹³.

8 Conclusion

This paper analyses the microstructure of two secondary electronic platforms for the Italian government bond market. We first considered news announcements and the effect that these could have on the price volatility and trading activity. We found that the significant announcements which have an impact on price volatility are consumer confidence, consumer price index, retail sales, trade balance and treasury auction results for the Italian news; ECB meetings at European level and the target Fed funds rate, jobless claims, CPI and NAPM survey for the American news. For BondVision platform are significant also the GDF preliminary and final, industrial production, employment and business confidence. Furthermore, almost all the announcements matter for trading activity, at least in one interval of time, both on MTS and BondVision platforms.

We then focused our attention on the price impact of trades and trading duration. Our results show that order flow and trading intensity are both important determinants of the

¹³The coefficients are the actual coefficients multiplied by 10^3 .

price fluctuations on the Italian government bond market on both platforms.

Finally, we divide the dataset into days with and without important macroeconomic news announcements and re-estimate the model. We found that the impact of order flow is larger during the days with announcements than during the days without announcements.

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Figure 1. Intraday Price Volatility on Announcement and Nonannouncement Days

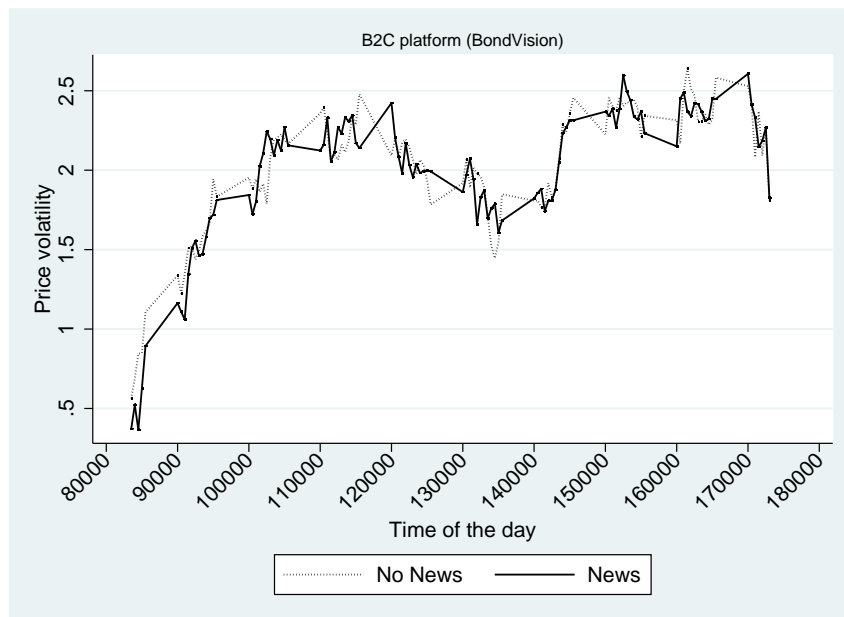
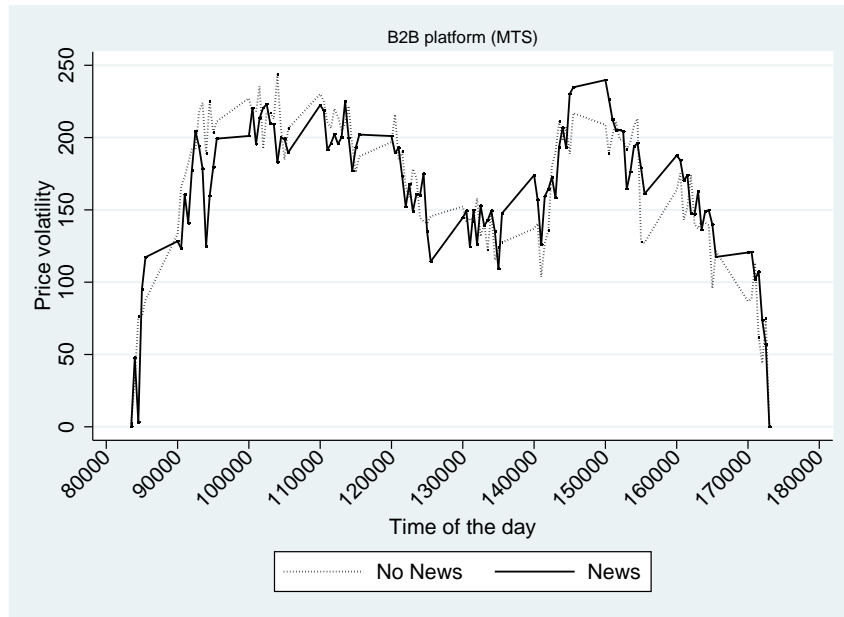


Table 2. Macroeconomic Announcements

Announcement time, observations and reporting agencies for nineteen regularly scheduled announcements.

| News | Observations | Time | Reporting Agency |
|---------------------------|--------------|-------------|-------------------------------------------------|
| Quarterly Announcements | | | |
| GDP Preliminary | 11 | 10:00 A.M. | Italian Bureau of Statistics |
| GDP Final | 11 | 10:00 A.M. | Italian Bureau of Statistics |
| Employment | 11 | 10:00 A.M. | Italian Bureau of Statistics |
| Monthly Announcements | | | |
| Trade Balance | 36 | 10:00 A.M. | Italian Bureau of Statistics |
| Consumer Price Index | 36 | 10:00 A.M. | Italian Bureau of Statistics |
| Producer Price Index | 36 | 10:00 A.M. | Italian Bureau of Statistics |
| Industrial Production | 36 | 10:00 A.M. | Italian Bureau of Statistics |
| Retail Sales | 36 | 10:00 A.M. | Italian Bureau of Statistics |
| Industrial Orders | 35 | 10:00 A.M. | Italian Bureau of Statistics |
| Consumer Confidence | 36 | 09:30 A.M. | The Institute for Studies and Economic Analyses |
| Business Confidence | 34 | 09:30 A.M. | The Institute for Studies and Economic Analyses |
| Treasury Auction Results | 33 | 11:05 A.M. | Department of Italian Treasury |
| ECB Meetings** | 33 | 14:30 P.M. | European Central Bank |
| Consumer Price Index (US) | 36 | 08:30 A.M.* | Bureau of Labour Statistics |
| Producer Price Index (US) | 36 | 08:30 A.M.* | Bureau of Labour Statistics |
| Consumer Confidence (US) | 36 | 10:00 A.M.* | Conference Board |
| NAPM Survey (US) | 36 | 10:00 A.M.* | National Association of Purchasing Management |
| Six-Week Announcements | | | |
| Target Fed Funds Rate | 24 | 14:15 P.M.* | Federal Reserve |
| Weekly Announcements | | | |
| Jobless Claims | 157 | 08:30 A.M.* | Employment and Training Administration |

* For these news releases we refer to the EDT time, for all the others to the CET time. In order to see the effect of the US news release on the Italian Treasury bond market we convert the EDT time to the CET time. **Press conferences about monetary policy decisions.

Table 3. The Impact of Announcements on the Five-Minute Interval Returns (MTS)

The reported coefficients are the actual coefficients times 10³.

| | 8:30-8:35 | 9:30-9:35 | 10:00-10:05 | 10:30-10:35 | 11:00-11:05 | 11:05-11:10 | 14:30-14:35 | 16:00-16:05 |
|---------------------------------|---------------------|--------------------|--------------------|-------------------|-------------------|-------------------|-------------------|--------------------|
| 8:30 A.M. Announcements | | | | | | | | |
| Target Fed Funds Rate | 1.988*** (34.99) | 64.62 (1.56) | -7.471 (-0.69) | 75.19 (1.58) | 72.85 (1.31) | 73.78 (1.53) | 86.93 (1.80) | 52.28 (1.30) |
| Jobless Claims | 7.003 (1.38) | 52.72*** (3.52) | 71.47*** (3.69) | 51.62** (3.03) | 47.19* (2.57) | 61.88** (3.25) | 43.98** (3.11) | 38.39* (2.43) |
| 9:30 A.M. Announcements | | | | | | | | |
| Consumer Confidence | | 102.3* (2.37) | 88.99 (1.93) | 38.17 (1.00) | 29.54 (0.90) | 54.21 (1.25) | 11.04 (0.39) | 55.70 (1.41) |
| Business Confidence | | 60.39 (1.58) | 42.82 (1.10) | 65.64 (1.30) | 107.8 (1.82) | 111.8 (1.89) | -6.717 (-0.19) | 33.11 (0.88) |
| 10:00 A.M. Announcements | | | | | | | | |
| GDP Preliminary | | | 11.42 (0.88) | 6.510 (0.52) | 30.36 (0.52) | -2.898 (-0.18) | -31.80 (-1.33) | 67.37 (0.82) |
| GDP Final | | | 92.25 (1.26) | 0.0430 (0.00) | 63.81 (0.93) | 0.613 (0.07) | 43.14 (0.72) | -8.746 (-0.93) |
| Employment | | | 68.69 (0.81) | 37.79 (0.56) | -35.37 (-1.64) | 80.75 (1.02) | 14.22 (0.19) | -38.80 (-1.80) |
| Trade Balance | | | 54.48 (1.67) | 65.30 (1.77) | 104.3* (2.31) | 106.4* (2.33) | 37.78 (1.23) | 35.92 (0.97) |
| Consumer Price Index | | | 58.80 (1.50) | 122.8* (2.46) | 64.17 (1.49) | 2.770 (0.12) | -14.85 (-1.88) | 24.06 (0.63) |
| Producer Price Index | | | 67.87 (1.31) | 95.49 (1.74) | 91.60 (1.63) | 17.23 (0.37) | 20.85 (0.68) | 25.44 (0.54) |
| Industrial Production | | | -8.809 (-1.09) | -12.83 (-1.71) | 37.33 (0.99) | 5.112 (0.23) | 8.104 (0.33) | 73.41 (1.70) |
| Retail Sales | | | 43.73 (0.94) | 144.8* (2.13) | 45.84 (1.32) | 34.33 (0.96) | 37.91 (1.11) | 18.45 (0.59) |
| Industrial Orders | | | 42.66 (1.05) | 2.914 (0.09) | -21.40 (-0.92) | 12.90 (0.30) | -1.706 (-0.08) | 14.17 (0.38) |
| 11:05 A.M. Announcements | | | | | | | | |
| Treasury Auction Results | | | | | | 155.4** (2.82) | 34.05 (1.20) | 47.07 (1.16) |
| 14:30 P.M. Announcements | | | | | | | | |
| ECB Meetings | | | | | | | 22.17 (0.99) | 75.87 (1.93) |
| Consumer Price Index (US) | | | | | | | -4.368 (-0.55) | 86.54 (1.93) |
| Producer Price Index (US) | | | | | | | 101.8* (2.29) | 28.15 (0.89) |
| 16:00 P.M. Announcements | | | | | | | | |
| Consumer Confidence (US) | | | | | | | | 0.997 (0.04) |
| NAPM Survey (US) | | | | | | | | -22.31* (-2.58) |
| Observations | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4. The Impact of Announcements on the Five-Minute Interval Returns (BondVision)

The reported coefficients are the actual coefficients times 10³.

| | 8:30-8:35 | 9:30-9:35 | 10:00-10:05 | 10:30-10:35 | 11:00-11:05 | 11:05-11:10 | 14:30-14:35 | 16:00-16:05 |
|---------------------------------|-----------------------------|----------------------|---------------------|--------------------|---------------------|--------------------|--------------------|---------------------|
| 8:30 A.M. Announcements | | | | | | | | |
| Target Fed Funds Rate | 0.000138*** (2.43e + 16) | 0.0800*** (23.10) | -0.145 (-0.11) | 1.841*** (5.12) | 1.165*** (3.89) | -1.323 (-0.55) | 0.227 (0.08) | -0.131 (-0.11) |
| Jobless Claims | 0.000138 | 0.0822*** (86.06) | -0.0678 (-0.08) | 2.185*** (5.18) | 1.416* (2.56) | 4.904 (1.13) | 0.337 (0.16) | 5.015 (0.90) |
| 9:30 A.M. Announcements | | | | | | | | |
| Consumer Confidence | | 0.359 (1.33) | 0.838*** (3.67) | 26.86 (1.07) | -6.053 (-0.80) | -3.487 (-1.00) | 0.709 (0.45) | 1.554 (0.84) |
| Business Confidence | | 0.0614*** (9.45) | -8.396 (-0.93) | 1.059*** (4.17) | 1.481* (2.52) | -0.982 (-0.51) | 15.06 (1.07) | -0.124 (-0.12) |
| 10:00 A.M. Announcements | | | | | | | | |
| GDP Preliminary | | | 0.867 | 1.284** (3.03) | 0.645 (1.29) | -1.871 (-0.55) | 2.035 (1.00) | 59.05 (1.03) |
| GDP Final | | | 0.883*** (6.23) | 1.777*** (9.26) | 1.923*** (17.26) | 1.314*** (4.86) | 2.016*** (5.40) | 4.194 (1.27) |
| Employment | | | 0.910* (2.16) | 0.694 (1.79) | 0.649 (1.48) | -4.357 (-0.48) | 0.288 (0.07) | -0.00433 (-0.00) |
| Trade Balance | | | 0.837*** (28.09) | 0.597 (0.39) | 0.356 (0.21) | 42.20 (1.31) | 19.63 (1.09) | 0.979 (0.75) |
| Consumer Price Index | | | 0.864*** (3.37) | 0.434 (0.35) | 3.228* (2.05) | 20.64 (1.00) | -4.599 (-0.73) | -3.145 (-1.08) |
| Producer Price Index | | | 31.82 (1.04) | 1.349*** (4.06) | 0.239 (0.20) | 1.741 (1.05) | 12.68 (1.04) | -1.821 (-1.45) |
| Industrial Production | | | 0.848** (3.11) | 1.126*** (5.26) | 1.245*** (4.73) | -0.881 (-0.45) | 1.237 (0.96) | 8.662 (0.91) |
| Retail Sales | | | 0.634*** (4.47) | -5.942 (-0.79) | 25.88 (1.07) | -0.516 (-0.21) | -1.908 (-0.69) | 0.483 (0.28) |
| Industrial Orders | | | 1.514 (1.84) | -1.299 (-0.49) | 1.977 (1.57) | 14.21 (0.55) | -4.553 (-0.78) | -1.656 (-0.42) |
| 11:05 A.M. Announcements | | | | | | | | |
| Treasury Auction Results | | | | | | 0.284 (0.51) | 16.79 (1.09) | 1.622 (1.02) |
| 14:30 P.M. Announcements | | | | | | | | |
| ECB Meetings | | | | | | | 1.656** (2.85) | 2.001 (1.26) |
| Consumer Price Index (US) | | | | | | | 18.62 (1.09) | 0.346 (0.44) |
| Producer Price Index (US) | | | | | | | 0.239 (0.14) | -6.082 (-0.96) |
| 16:00 P.M. Announcements | | | | | | | | |
| Consumer Confidence (US) | | | | | | | | 1.467 (0.99) |
| NAPM Survey | | | | | | | | -1.358 (-0.86) |
| Observations | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |

t statistics in parentheses
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5. The Impact of Announcements on the One-Hour Trading Intervals (MTS)

| | 8:30-9:30 | 9:30-10:30 | 10:00-11:00 | 10:30-11:30 | 11:00-12:00 | 11:05-12:05 | 14:30-15:30 | 16:00-17:00 |
|---------------------------------|--------------------|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| 8:30 A.M. Announcements | | | | | | | | |
| Target Fed Funds Rate | 5.478*** (4.41) | 13.09*** (4.18) | 5.680* (2.06) | 5.912* (2.28) | 8.117** (3.30) | 11.52*** (3.90) | 8.045*** (4.61) | 4.190* (2.13) |
| Jobless Claims | 4.691*** (9.16) | 11.23*** (10.80) | 7.839*** (6.46) | 7.267*** (6.38) | 8.090*** (6.96) | 7.704*** (6.51) | 8.457*** (7.73) | 5.301*** (7.59) |
| 9:30 A.M. Announcements | | | | | | | | |
| Consumer Confidence | | 15.97*** (5.58) | 9.950*** (3.94) | 7.180** (3.21) | 8.453*** (3.40) | 10.58*** (4.04) | 10.45*** (3.53) | 5.811*** (3.60) |
| Business Confidence | | 15.01*** (5.69) | 15.63*** (4.17) | 15.68*** (3.61) | 14.54*** (3.37) | 7.287* (2.12) | 10.14* (2.00) | 3.875 (1.63) |
| 10:00 A.M. Announcements | | | | | | | | |
| GDP Preliminary | | | 14.50*** (4.05) | 7.409 (1.73) | 4.181 (1.80) | 3.809 (1.63) | -1.274 (-0.30) | 1.013 (0.37) |
| GDP Final | | | 12.81*** (4.25) | 8.899** (2.96) | 11.09*** (5.54) | 10.85*** (5.73) | 10.63** (3.06) | 2.579 (0.87) |
| Employment | | | 12.10 (1.66) | 5.852** (2.69) | 6.800* (2.18) | 3.026 (0.76) | -1.462 (-0.45) | 3.328 (0.83) |
| Trade Balance | | | 17.97*** (5.15) | 19.16*** (4.88) | 14.26*** (3.90) | 15.13*** (4.12) | 6.900*** (3.33) | 6.757*** (3.92) |
| Consumer Price Index | | | 14.69*** (3.72) | 14.53** (3.09) | 11.85*** (3.40) | 11.25*** (3.51) | 5.700* (2.44) | 4.305* (2.57) |
| Producer Price Index | | | 18.69** (2.97) | 19.71*** (3.68) | 9.268** (2.65) | 3.368 (1.22) | 3.130 (0.76) | 2.573 (1.01) |
| Industrial Production | | | 12.44*** (4.01) | 10.27*** (3.80) | 5.718** (2.59) | 5.340* (2.43) | 10.19*** (3.37) | 6.528** (3.11) |
| Retail Sales | | | 12.60*** (4.03) | 10.83*** (3.35) | 10.44*** (4.82) | 8.437*** (4.18) | 8.729** (2.91) | 5.610*** (4.56) |
| Industrial Orders | | | 8.120* (2.45) | 4.364 (1.26) | 7.038* (2.14) | 7.762* (2.40) | 8.544** (2.97) | 6.227** (3.07) |
| 11:05 A.M. Announcements | | | | | | | | |
| Treasury Auction Results | | | | | | 24.40*** (5.94) | 11.68* (2.53) | 5.499* (2.50) |
| 14:30 P.M. Announcements | | | | | | | | |
| ECB Meetings | | | | | | | 14.05*** (9.55) | 10.18*** (6.28) |
| Consumer Price Index (US) | | | | | | | 12.20*** (4.42) | 7.011*** (3.63) |
| Producer Price Index (US) | | | | | | | 13.34*** (6.71) | 6.774*** (4.43) |
| 16:00 P.M. Announcements | | | | | | | | |
| Consumer Confidence (US) | | | | | | | | 5.471*** (4.17) |
| NAPM Survey | | | | | | | | 4.332*** (3.42) |
| Observations | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6. The Impact of Announcements on the One-Hour Trading Intervals(BondVision)

| | 8:30-9:30 | 9:30-10:30 | 10:00-11:00 | 10:30-11:30 | 11:00-12:00 | 11:05-12:05 | 14:30-15:30 | 16:00-17:00 |
|---------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| 8:30 A.M. Announcements | | | | | | | | |
| Target Fed Funds Rate | 0.217* (2.52) | 0.958*** (3.70) | 1.074*** (3.81) | 1.685*** (4.28) | 1.518** (3.05) | 1.755*** (3.49) | 1.757*** (4.11) | 1.195* (2.26) |
| Jobless Claims | 0.581*** (3.75) | 1.144*** (6.21) | 1.115*** (4.59) | 1.459*** (5.77) | 1.550*** (7.58) | 1.585*** (7.91) | 1.671*** (8.20) | 1.725*** (8.18) |
| 9:30 A.M. Announcements | | | | | | | | |
| Consumer Confidence | | 1.333*** (4.28) | 1.011** (2.71) | 0.878** (2.60) | 0.684* (2.16) | 0.905* (2.42) | 0.871 (1.91) | 0.564 (1.32) |
| Business Confidence | | 1.486*** (3.46) | 1.331** (3.18) | 1.052** (2.63) | 1.448* (2.03) | 1.008 (1.46) | 1.162* (2.25) | 1.551** (2.61) |
| 10:00 A.M. Announcements | | | | | | | | |
| GDP Preliminary | | | 3.250*** (5.91) | 1.511 (1.81) | 1.188 (1.63) | 1.073 (1.36) | 2.397* (2.14) | 1.659 (1.50) |
| GDP Final | | | 2.103** (3.16) | 2.257** (3.14) | 2.248*** (3.37) | 2.424*** (3.63) | 2.294** (3.13) | 2.401** (2.90) |
| Employment | | | -0.0525 (-0.14) | -0.247 (-0.63) | 1.746 (1.61) | 1.966 (1.62) | -0.317 (-0.43) | 0.838 (1.29) |
| Trade Balance | | | 1.642*** (4.41) | 3.382*** (4.07) | 4.193*** (3.37) | 3.849*** (3.46) | 1.576*** (3.35) | 2.413*** (3.57) |
| Consumer Price Index | | | 1.368*** (3.90) | 1.139** (2.65) | 1.579** (2.86) | 1.637** (3.01) | 0.621 (1.68) | 1.615*** (3.64) |
| Producer Price Index | | | 1.807* (2.51) | 1.474* (2.24) | 0.982 (1.83) | 0.500 (0.99) | 0.246 (0.43) | 1.853** (2.67) |
| Industrial Production | | | 1.509*** (3.95) | 1.714*** (3.68) | 1.337** (3.17) | 1.327** (3.07) | 1.229** (3.06) | 1.846*** (3.52) |
| Retail Sales | | | 1.938* (2.47) | 1.093 (1.73) | 1.574*** (4.39) | 1.498** (3.28) | 1.625* (2.22) | 2.294*** (3.72) |
| Industrial Orders | | | 1.514* (2.43) | 0.596 (1.04) | 0.450 (0.75) | 0.681 (1.05) | 1.284* (2.56) | 0.545 (0.99) |
| 11:05 A.M. Announcements | | | | | | | | |
| Treasury Auction Results | | | | | | 1.776*** (3.45) | 2.477** (2.83) | 1.080 (1.87) |
| 14:30 P.M. Announcements | | | | | | | | |
| ECB Meetings | | | | | | | 2.820*** (4.47) | 3.599*** (4.90) |
| Consumer Price Index (US) | | | | | | | 2.236*** (6.03) | 1.368** (2.92) |
| Producer Price Index (US) | | | | | | | 2.152*** (4.90) | 1.649** (2.90) |
| 16:00 P.M. Announcements | | | | | | | | |
| Consumer Confidence (US) | | | | | | | | 1.495** (3.30) |
| NAPM Survey | | | | | | | | 2.129** (3.02) |
| Observations | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 |

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7. Price change equation in the vector autoregression

| | Coefficients | MTS | BondVision |
|------------------------|-------------------------|------------------------|------------|
| Lag Price Revision | | | |
| α_1 | -0.6405*** (-116.51) | -0.7031*** (-59.34) | |
| α_2 | -0.4065*** (-67.13) | -0.4601 (-34.23) | |
| α_3 | -0.2197*** (-40.80) | -0.2516*** (-21.32) | |
| Lag Trade | | | |
| γ_0 | 0.0000 (0.16) | -0.0011 (-1.23) | |
| γ_1 | -0.0001 (-0.68) | 0.0016* (1.69) | |
| γ_2 | 0.0004** (2.12) | -0.0006 (-0.65) | |
| γ_3 | 0.0002 (0.97) | -0.0014 (-1.43) | |
| Lag Trade*Lag Duration | | | |
| δ_0 | 0.0000 (0.18) | 0.000 (0.32) | |
| δ_1 | 0.0001 (1.01) | -0.0003** (-2.19) | |
| δ_2 | -0.0001* (-1.65) | -0.0000 (-0.32) | |
| δ_3 | 0.0000 (-1.45) | 0.0000 (0.14) | |

t statistics in parentheses * p<0.10 ** p<0.05 ***p<0.001

Table 8. Trade equation in the vector autoregression

| | Coefficients | MTS | BondVision |
|------------------------|--------------|------------------------|----------------------|
| Lag Price Revision | | | |
| | α_1 | -0.2965 (-1.31) | 9.564*** 20.12) |
| | α_2 | -0.3964 (-1.60) | 6.2941*** (11.52) |
| | α_3 | -0.3769 (-1.71) | 2.9971 (6.22) |
| Lag Trade | | | |
| | γ_1 | 0.5965*** (67.92) | 0.1542*** (3.56) |
| | γ_2 | 0.1747*** (17.65) | 0.1869*** (4.46) |
| | γ_3 | 0.0987*** (10.09) | 0.0663 (1.54) |
| Lag Trade*Lag Duration | | | |
| | δ_1 | -0.0934*** (-50.74) | -0.0025 (-0.38) |
| | δ_2 | -0.0212*** (-10.63) | -0.0139** (-2.20) |
| | δ_3 | -0.0107*** (-5.36) | 0.0023 (0.36) |

t statistics in parentheses * p<0.10 ** p<0.05 ***p<0.001

Figure 2. Intraday Trading Activity on Announcement and Nonannouncement Days

