EUROPEAN CENTRAL BANK
EUROSYSTEM

ECB WORKSHOP
ON THE ANALYSIS OF
THE MONEY MARKET

WORKING PAPER SERIES
NO 988 / DECEMBER 2008

THE INTERDAY AND INTRADAY PATTERNS OF THE OVERNIGHT MARKET

EVIDENCE FROM AN ELECTRONIC PLATFORM

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In 2008 all ECB publications feature a motif taken from the €10 banknote.

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ECB WORKSHOP ON THE ANALYSIS OF THE MONEY MARKET

On 14 and 15 November 2007, Alain Durré, Huw Pill and Diego Rodriguez-Palenzuela of the ECB's Monetary Policy Stance Division organised a central bank workshop titled "The Analysis of the Money Market: Role, Challenges and Implications from the Monetary Policy Perspective". This workshop provided an opportunity for participating central bank experts to exchange views and foster debate, also in interaction with international organizations and academic institutions. The first day of the workshop addressed issues related to the macro-perspective of the money market, drawing on the experiences of a large number of countries. The second day adopted a micro-perspective on the money market, looking in particular at trading behaviour in the overnight money market and its implications for the evolution of spreads.

A first version of this paper was presented at this workshop. The papers presented at the time of the workshop did not consider the potential implications of the financial turmoil for the results of the paper, given that the tensions in money markets emerged in August 2007. The published version of these papers represents an update of the original paper, which incorporates the discussion which took place at the workshop and in most cases a discussion on the developments in the money markets since August 2007.

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CONTENTS

Abstract

This paper examines the interday and intraday dynamics of the euro area overnight money market on the basis of an original set of market activity and liquidity proxies constructed from both pre- and post-trade data. The empirical literature provides extensive evidence supporting the rejection of the martingale hypothesis both between days and within days, primarily for interest rates and volatility. We extend this analysis and investigate the seasonality of market activity and liquidity in a market dominated by utilitarian traders. We provide evidence that the Eurosystem's operational framework and calendar effects cause the observed regular patterns. We additionally show that utilitarian trading intensifies at the turn of the reserve maintenance period. The increased un-certainty associated with greater information asymmetry between market participants when reserve requirements become binding lead to a deterioration of market liquidity. Our analysis additionally turns out to be sensitive to the implementation in March 2004 of structural changes to the operational framework and to the more frequent occurrence of fine-tuning operations since October 2004.

Keywords: Overnight money market, Eurosystem's operational framework, seasonality, market microstructure, tick data.

JEL Classification: E43, E58, C22, C32.

Non-technical summary

In the Eurosystem, the monetary policy is implemented according to the rules contained in the operational framework. Due to the close connection between the refinancing operations and the overnight segment of the money market, this framework is expected to significantly affect the liquidity positions of credit institutions and hence the dynamics of this market. More specifically, the influence of the framework is expected to be particularly visible on refinancing operation (MRO allotment) days or as reserve requirements eventually become more binding towards the end of the reserve maintenance period due to the averaging mechanism. In addition, on specific calendar days such as the end of a month, a quarter or a year, credit institutions are likely to face unexpected liquidity shocks, hence increasing their liquidity needs. On such calendar days, banks' reserves are thus expected to be more sensitive to both idiosyncratic and aggregate (liquidity) shocks.

On the basis of the order flow captured by the e-MID electronic platform, this paper examines the existence and statistical significance of regular patterns in the activity and liquidity of the market for unsecured funds. To this end, microstructure measures are elaborated for assessing both market activity and liquidity of the euro area overnight money market. In contrast to previous studies in the literature, this paper applies measures based on the theoretical discussion in the microstructure literature.

The first part of our work provides a general assessment of the interday operation of the market over a stylised reserve maintenance period and examines the evolution of trading activity and transaction costs over the course of a typical trading day. More specifically, this paper examines whether, despite its specific design, the overnight segment of the money market exhibits dynamics similar to what is commonly observed in other countries or under different market structures. In contrast to earlier studies, the information conveyed by the sign of the transactions, that is, buy or sell, is examined and an extensive assessment of the dynamics of liquidity in this market is provided for the first time. Since the rules contained in the operational framework for the implementation of the monetary policy or the occurrence of specific calendar days are expected to significantly affect the

behaviour of credit institutions in their management of liquidity, our work next highlights their influence on the interday and intraday dynamics of the overnight segment. Finally, we check whether the introduction in March 2004 of structural changes to the framework or a more frequent recourse to fine-tuning operations (FTOs) by the central bank since October 2004 have altered the operation of the market.

Parametric and nonparametric methods provide robust evidence of significant predictable patterns between days and within days in the activity and liquidity of the overnight segment. Our findings could notably help banks to assess the opportunity costs of carrying excess or insufficient reserves over the maintenance period. In the same vein, as our results point out, effective transaction costs tend to increase over the trading day. The timing of the decision to trade therefore also takes on particular importance within the trading day, conditioned upon the specific needs and level of stress faced by credit institutions. Consistent with our initial expectation, empirical evidence is additionally provided of a significant influence of the Eurosystem's operational framework or the occurrence of specific calendar days on the dynamics of the market. This influence is most visible over the last days of the reserve maintenance period, on MRO allotment days, on days of press conferences or at the end of a month or a quarter. This is also on these days on which banks are more sensitive to liquidity shocks that the proportion of utilitarian traders increases in the market. Our results demonstrate that the introduction of structural changes to the operational framework in March 2004 or more frequent fine-tuning operations since October 2004 have improved the ability of credit institutions to manage their liquidity positions in the interbank market. Against the market-oriented approach promoted by the central bank between its regular refinancing operations, this latter finding arguably takes on particular importance.

1 Introduction

With the start of Stage III of the Economic Monetary Union in Europe, the euro area money market has become fully integrated between the twelve Member States sharing the euro.[1] Within the entire money market, the overnight segment is of particular interest as the evolution of the related interest rates is mostly conditioned upon the results of the regular refinancing operations conducted by the European Central Bank (ECB). By nature, this is the segment of the money market in which credit institutions fill their liquidity needs in the very short run. In many respects, the operation of this segment is very specific and arguably relatively mechanical. The primary objective of these institutions is indeed to smoothly absorb short-term liquidity shocks and to end the trading day with balanced liquidity positions. In contrast to most other financial markets, utilitarian trading by nature dominates speculative motivations to trade. Moreover, this segment differs from the other segments of the money market as regards the close relationship between participants, the specific rules and practices for finding liquidity and its specific over-the-counter (OTC) design.

In the overnight segment, a significant proportion of the transactions indeed occurs over-the-counter, making the exact terms of most trades imperfectly available. The information on the transactions executed in this segment of the money market is thus imperfect, and traditionally based on the daily price and volume of the euro overnight index average (EONIA) disseminated by the European Banking Federation on the basis of a survey of the largest banks in the market or inferred from quotes posted on wire services such as Bloomberg or Reuters. Both sources nevertheless have significant drawbacks. In the case of EONIA data, its daily frequency prevents any intraday investigation. Despite the relative stability of the overnight market on a daily basis, the market may indeed display strong intraday dynamics not captured by the daily averages. In the case of wire services, the quotes do not guarantee that transactions will be executed at the quoted levels, and usually cannot be considered as best quotes since they are only mostly

[1] For homogeneity reasons, Slovenia, which joined the euro area on 1 January 2007, and Cyprus and Malta, which became member on 1 January 2008, are not included in the data sample of this study.

indicative and not extracted from an aggregate order book.

Despite its apparent limited importance in the total daily turnover of the overnight market, the e-MID electronic platform nevertheless offers the advantage of centralising all transactions executed through its systems. The exact terms of each transaction are accurately recorded which opens the way for detailed microstructure examinations. Not being, by definition, an OTC segment of the overnight market, the information on trades is nevertheless representative of all transactions realised on the e-MID platform. It is also representative of the overnight segment as the share of the overnight transactions currently represents more than 85% of e-MID's total turnover. Compared with the other partial sources of data for OTC transactions in the overnight market, e-MID data (or more generally data from the electronic platform) therefore appears more exhaustive.

This paper applies a detailed microstructure analysis based on an original set of market activity and liquidity proxies built upon e-MID data to examine the interday and intraday dynamic evolution of the euro area overnight money market. Although the literature provides theoretical support and empirical evidence of a rejection of the martingale hypothesis for the federal funds market in the United States, few studies focus on the dynamics of the euro area overnight money market. In addition, to the best of our knowledge, earlier studies dealing with e-MID data or focusing on similar markets abroad (e.g., the federal funds market in the United States) do not examine the dynamics of market liquidity. In particular, the information content of the side (buy/sell) of the transactions is never addressed.

The main motivation of this paper is essentially twofold. We first examine the presence of regular interday and intraday patterns in the activity and liquidity of the overnight money market. We segment our analysis to identify the influence of the Eurosystem's operational framework or specific calendar days on the behaviour of our measures. Second, we investigate the reaction of the market following the introduction of structural changes to the operational framework in March 2004 or more frequent fine-tuning operations (FTOs) since October 2004. In particular, we look for statistical evidence supporting the observed increase in market activity and the improvement of market liquidity over the years. This paper also adds to the microstructure literature with an examination of the dynamics of a market

dominated by utilitarian traders.

The remainder of this paper is organised as follows. Section 2 briefly recalls the importance of the overnight segment in the money market, notably from a monetary policy perspective. Against the backdrop of a short description of the Eurosystem's operational framework and the money market in the euro area, this section also describes the structure of the overnight segment and its peculiarities with respect to other financial markets. Section 3 presents the features of the electronic platform in the overnight market and the related available data. It also briefly reviews a number of studies in the literature dealing with similar data. Section 4 develops a microstructure approach to investigate the interday and intraday dynamics of the electronic platform and the significance of the observed patterns is assessed in a series of parametric and nonparametric tests. Finally, Section 5 concludes.

2 The role of the overnight segment in the money market

Within the money market, which covers maturities from one day to one year, the overnight market is one particular segment that banks essentially access to fill their short-term liquidity needs and to end the trading day in a balanced position. In contrast to other financial markets, their trading is arguably relatively mechanical and less, if not, driven by speculative motivations. In this respect, most credit institutions transacting in the overnight segment are utilitarian traders.[2] As a direct consequence of their trading, credit institutions indeed receive (or pay) the interest that is due on their overnight transactions. Their motivation to trade is nevertheless unrelated to this interest payment: banks come to this market to balance specific liquidity needs. Although utilitarian traders dominate this segment of the money market, we cannot however rule out that some informed traders access the market with speculative motivations. The proportion of utilitarian traders is however expected to become more pronounced as reserve requirements become

[2]See Harris (2003) for a detailed discussion of traders' motivations. In the author's classification, traders alternatively access markets for profit-motivated reasons.

more binding and is accordingly expected to impact the dynamics of this market.

In the euro area, the behaviour of credit institutions in the overnight segment is directly affected by the rules and practices of the Eurosystem's operational framework designed by the ECB for the implementation of the monetary policy. Before describing the structure of the overnight money market, we accordingly discuss the influence of the operational framework on the organisation of the market, the price dynamics and the nature of the transactions.

2.1 A particular link to the central bank refinancing operations

To achieve its monetary policy objective, the Eurosystem has at its disposal a set of instruments which constitutes the operational framework necessary to implement the policy. In this context, the Eurosystem conducts open market operations (OMOs), offers standing facilities at the end of each day and requires credit institutions to hold minimum reserves.

Through its open market operations, the Eurosystem steers interest rates, manages liquidity in the money market and signals the stance of the monetary policy. Among the four types of open market operations (main and longer-term refinancing operations, fine-tuning operations and structural operations), the main refinancing operations (MROs) are the most important as they provide the bulk of refinancing to the financial sector on a reverse basis and for a maturity of one week, then followed by the longer-term refinancing operations (LTROs) for a maturity of three months. Besides these regular operations, the Eurosystem also offers standing facilities on a daily basis, although at penalty rates, to provide or absorb overnight liquidity. By construction, the marginal lending rate (applied to overnight liquidity-providing operations) and the deposit rate (applied to overnight liquidity-absorbing operations) form a corridor for overnight interest rates. This corridor encompasses the monetary policy rate decided by the Governing Council of the ECB on a monthly basis. By requiring credit institutions in the euro area to hold minimum reserves over a specific period of time, the Eurosystem's operational framework additionally aims at stabilising money market interest rates and creating (or enlarging) a structural liquidity shortage. This period of time

over which credit institutions have to respect minimum reserves (calculated on the basis of their own balance sheet), is called the reserve maintenance period (RMP) and is roughly equivalent to one calendar month. To smooth interest rates, credit institutions subject to reserve requirements[3] are however enabled to make use of averaging provisions.[4]

Regarding the provision of liquidity to credit institutions, the refinancing operations of the Eurosystem remain the most important source in the overnight market. The weekly amount injected by the ECB aims at ensuring neutral liquidity conditions (called the benchmark) in the overnight market at the end of the reserve maintenance period. Liquidity is injected in the banking system in accordance with the rules contained in the Eurosystem's operational framework that was designed to reach the goals assigned to the liquidity policy (see ECB (2005a) for further details). More precisely, the main features of the liquidity policy in the Eurosystem are: (i) a direct provision of liquidity with weekly refinancing operations and (ii) a market-oriented approach between operations to encourage credit institutions to organise themselves to find the necessary liquidity on a daily basis to face liquidity shocks. This latter feature appears necessary to keep alive an overnight money market governed by market dynamics. This concern was reinforced with the introduction of a variable rate tender system in June 2000.

After a short experience with the fixed rate tender system, the ECB introduced a variable rate tender system on 27 June 2000, which *de facto* reinforced the market-oriented approach at the beginning of the liquidity provision channel. Credit institutions eligible for refinancing operations submit bids at variable rates to the ECB (via the corresponding national central banks within the Eurosystem) with the policy rate (then labelled minimum bid rate) being a floor above which all bids must be priced.[5] From 27 June 2000 to 9 March 2004, the ECB

[3]According to the Statute of the European System of Central Banks (ESCB), all credit institutions established in the euro area are subject to the minimum reserve system. These reserves are remunerated over the RMP at the average of the marginal rate on the Eurosystem's MROs. The reserve requirements are determined by the amount of the corresponding institution's liabilities with a maturity up to two years and exceeding EUR 100,000. For further details, see ECB (2005a).

[4]For a detailed description of the features of the Eurosystem's operational framework, see ECB (2005a).

[5]If bids are introduced with prices below the policy rate, that is, the minimum bid rate, these

conducted its MROs through a variable rate tender procedure with a minimum (bid) rate at which bids could be submitted to receive central bank liquidity with a two-week maturity against eligible collateral. The occurrence of underbidding episodes however resulted in occasional imbalanced liquidity conditions and led to greater volatility of the interest rate in the overnight market (ECB 2004). Underbidding essentially took place in periods where market participants expected key ECB interest rates to be cut. In this context, banks delayed their accumulation of reserve holdings to meet required reserves in anticipation of more favourable interest rate conditions. This created an incentive not to participate in weekly refinancing operations which have occasionally failed to inject the necessary liquidity to ensure the smooth operation of the banking system, leading to higher overnight interest rates.

Against this experience, the ECB introduced additional changes to its operational framework on 10 March 2004 to reduce the operational risks and the negative effects (notably an increase in the volatility of the overnight rate) implied by underbidding. First, the maturity of the main refinancing operations (MROs) was shortened from two weeks to one week (with the bulk of the banking sector's liquidity needs being met through single and non-overlapping weekly operations). Second, the start of the maintenance period for holdings of required reserves was linked to the timing of the Governing Council meetings at which decisions on policy rates can be made. Third, it was decided to apply the new level of the key ECB interest rates set by the Governing Council as of the start of the new reserve maintenance period.[6] Finally, when atypical situations occur, the ECB can take additional measures to smooth the evolution of the overnight interest rate in line with the policy objective. In this context, two measures taken by the ECB in the recent past are of particular interest. After 11 October 2004, following an episode in which the overnight interest rate experienced a marked level of volatility and departed significantly from the policy rate (after a very high net recourse to marginal lending), the frequency of fine-tuning operations (FTOs) at the end

bids are simply not considered in the system.

[6]The first measure was aimed at better segmenting maintenance periods through non-overlapping operations, whereas the second and third were intended to eliminate the impact that expectations of changes in the key ECB rates might have on counterparties' bidding behaviour in MROs. See in particular ECB (2003) and ECB (2005b) for more details.

of reserve maintenance periods increased. In the same vein, on 12 October 2005, the ECB started allotting more liquidity than justified by the benchmark to limit the then-prevailing spread between the overnight interest rate and the minimum bid rate, which had a tendency to increase systematically.

The Eurosystem's refinancing operations and the overnight money market are thus closely connected. By the magnitude of its refinancing operations, the central bank first directly affects the average level of liquidity in the system, and hence the level of the overnight interest rate. With the design of its operational framework, the central bank also promotes a market-oriented approach even at the tender level, making the realised interest rate at each refinancing operation the responsibility of credit institutions, reflecting their needs and related uncertainties. Last, the central bank offers safeguards in the system to ensure smooth and stable developments in the overnight market (through the standing facilities or exceptional refinancing operations). Against this background, investigations of the dynamics of the overnight market should not neglect the role of the monetary policy operational framework.

2.2 Structure of the market

In the overnight (money) market, reserve requirements and autonomous factors are the two principal elements driving the majority of all transactions between credit institutions. Whereas reserve requirements are known in advance[7], the evolution of the autonomous factors is more subject to shocks. These factors include banknotes in circulation, deposits of governments in the national central banks of the euro area, domestic and foreign assets held by national central banks and other assets. Even if financial institutions can extrapolate regular trends in the evolution of most components of the autonomous factors (especially banknotes and government deposits) from the past behaviour of their customers, these items remain subject to deviations from regular trends, hence constituting liquidity shocks increasing the liquidity needs of financial institutions.

[7]Indeed, the balance sheet data of each institution subject to reserve requirements referring to the end of a given calendar month are used to calculate the reserve base for the maintenance period starting in the calendar month two months later (see ECB (2005a)).

To absorb liquidity shocks and fill their liquidity needs in the short run, financial institutions essentially have two alternatives. Refinancing operations against collateral are the first option and provide the bulk of liquidity. These liquidity-providing operations by the central bank materialise through two channels: the regular refinancing operations (the MROs and the LTROs) and the non-regular operations (mostly the FTOs for the time being). In 2006, the weekly amount provided at MROs averaged EUR 300 billion while the amount of LTROs was about EUR 30 billion. These operations are conducted through a variable rate tender system. At the regular refinancing operations, eligible credit institutions submit bids at specific prices and are served in function of the liquidity amount decided by the ECB and according to a principle of decreasing tender rates (i.e., the higher the interest rate, the greater the probability of full bid execution). At each operation, a marginal and a weighted average rate are computed.[8] The marginal rate of the most recent MRO settled is used to remunerate the required reserves. By contrast, at FTOs, the type of auction depends on the nature of the operation, with a variable rate tender for liquidity-providing FTOs or a fixed rate tender for liquidity-absorbing FTOs. However, only a small fraction of credit institutions established in the euro area can participate in refinancing operations with the ECB. Indeed, among the 6,297 financial institutions trading in the overnight market, only 1,967 are eligible for regular refinancing operations.[9] In practice, between 340 and 400 institutions participate in the MROs while only 148 institutions participate in LTROs. Similarly, there are usually less than 40 bidders at FTOs.[10]

When banks do not satisfy all their liquidity needs at the central bank refinancing operations (or if they face liquidity shocks between those operations) or if they are not allowed to participate in the central bank operations, their second option for finding shortest-maturity liquidity is to trade in the unsecured market. According to a survey conducted by the ECB (2007), the unsecured market

[8] The marginal rate is the interest rate at which the total tender allotment is exhausted (ECB 2005a). The weighted average rate is the weighted average interest rate of all bids served.

[9] Note also that only 2,749 institutions are eligible for the marginal lending facility against 3,188 for the deposit facility.

[10] The number of bidders can considerably vary from one operation to another, depending notably on the nature (providing vs. absorbing) of the operations. For example, only 2 banks did participate in the liquidity-absorbing FTO conducted by the ECB on 13 March 2007.

remains primarily an overnight market segment, representing roughly 70% of volumes both in the lending and in the borrowing activities and with an average daily turnover of EUR 41 billion in 2006. In the unsecured market, one of the principal references is the euro overnight index average (EONIA), disseminated by the European Banking Federation (EBF). The EONIA is the weighted average of all uncollateralised overnight loans made by a panel of the most active banks in the money market.[11] According to the survey, these transactions are alternatively conducted via direct (bilateral) trading (representing 56% of the total turnover), voice brokers (27%) or electronic trading (17%).[12]

Compared with other financial markets, the unsecured overnight market has very distinct features. First, the information on the majority of trades is not centralised, with more than 80% of all transactions occurring over-the-counter (OTC). Second, the market is highly concentrated: the largest five players account for around 21% of market activity (36% for the largest ten). Third, given the close relationship between market participants due to the importance of direct trading, it is akin to a small world where reputation takes on particular importance. Fourth, the dynamics of the market is deeply influenced by the rules set by the monetary policy operational framework, explaining notably the relatively low volatility over the first weeks of the reserve maintenance period. Fifth, due to commercial relationships, banks sometimes prefer to deal with other banks instead of having recourse to the central bank facilities.[13] Finally, a dichotomy exists between market participants regarding their liquidity positions, with some market participants systematically loose (i.e., liquidity providers in the market) and others systematically tight (liquidity absorbers). The literature additionally

[11]The other main reference in the euro area money market is the euro interbank offered rate (EURIBOR) which is the rate prevailing in the interbank market at maturities from one month to twelve months. Together with the EONIA, the EURIBOR provides uniform price references from overnight to one year maturities. Besides these main segments, secured cash segments exist in which liquidity is only provided against equivalent collateral. The two most important related markets are the repo market and the swap market against foreign currencies, which are mainly concentrated on maturities up to one month (ECB 2004).

[12]The volume traded on e-MID however averages 40% of the volume traded by the EONIA panel over the sample covered by the analysis.

[13]It may happen for instance that a bank makes a deposit with another bank at the end of the day at a rate below the ECB's rate for the deposit facility. However, being rather rare and not representative by nature of standard trading, such observations have been removed from the data set (see Section 3). They however highlight the preferencing relationships that sometimes occur in this segment.

documents the specific configuration of the interbank system, with large banks borrowing from a number of smaller creditors (Iori, De Masi, Precup, Gabbi and Caldarelli 2008).

3 The electronic platform in the euro area overnight market

In the overnight money market, the only official source of information is the euro overnight index average (EONIA) disseminated by the European Banking Federation (EBF) on the basis of a survey of the largest banks transacting in this segment. The limited information conveyed by the EONIA (weighted average offered price and total volume) and its daily frequency however prevent extensive examinations of the market. Although the e-MID electronic platform only captures a fraction of the order flow in the overnight segment, it nevertheless conveys valuable information on the effective operation of this market. With exhaustive records of all transactions executed through their systems[14], data extracted from this platform thus represents a convenient framework for interday or intraday investigations of the overnight money market in the euro area. Although the accuracy of the electronic platform decreases in periods of heightened market pressure such as the recent financial turmoil, the evidence on the absolute and relative accuracy of alternative data sets for inferring the dynamics of the whole, mostly over-the-counter, overnight money market reported in Beaupain and Durré (2008) highlights the superior performance of the electronic platform. We accordingly conclude that the picture provided by the platform accurately mirrors the interday and intraday behaviour of the rest of the over-the-counter overnight market and that such data delivers more accurate microstructure analyses of the overnight segment.

[14] When a transaction occurs on the electronic platform, e-MID systems record an exhaustive set of information related to the deal. The time, price, size and side, that is, buy or sell, of each transaction is indeed recorded in real time.

3.1 The platform in practice

The e-MID electronic platform offers access to trading in USD and EUR segments of the overnight market with maturities ranging from 1 day to 1 year. The euro segment is open from 7:00:00 to 18:30:00. The period between 18:00:00 and 18:30:00 is the 'cut-off close period' for the overnight segment and offers the last opportunity to realise orders which have to be executed on the same day. For most maturities traded on the platform, the market distinguishes 'regular'-sized trades, which have a minimum quantity of EUR 1.5 million, from 'large'-sized transactions, for which the minimum size is EUR 100 million. Quantities are entered and displayed in millions of EUR. Traders willing to transact in the overnight market can disclose their interest to other market participants by sending 'proposals' through the platform. The details of these commitments to trade, that is, the rate, quantity and side of the transaction, then become visible to other participants. If the deal appears attractive to a counterparty, a 'standard order' is sent to the trader. Automatic execution occurs only if a bid proposal is hit. For ask-side proposals, credit line checking is first executed, before the transaction can be manually accepted. However, a trader might, for personal reasons, prefer a specific counterparty. If this counterparty is not currently proposing to transact, the trader can either send a 'request for quotes' to several counterparties or an 'issued order' to a single counterparty. Counterparties respond to a request for quotes by sending proposals to the trader, which comply with the quantity and side of the transaction specified in the request. If the trader agrees with one of the proposals, he can send an 'order' to close the deal. If, instead, an order is issued, which specifies the rate, quantity and side, the selected counterparty can either accept the terms and close the deal or reject the order.

3.2 The data: Treatment and definition

Transaction data is provided by e-MID and contains records for every trade that occurred on the electronic platform. From the available data, we extract the records of overnight transactions (ON and ONL) for the euro segment. As records of overnight large (ONL) transactions only start on 4 September 2000, we use

this date as the starting point of our sample. The sample covers the period from 4 September 2000 to 3 May 2007 which represents 1,703 trading days and 348 MRO allotment days spread over 80 reserve maintenance periods (RMPs). Quotation data is extracted from Reuters with the objective of providing an indicative picture of the information available to market participants before transacting on the electronic platform. This data comes in the form of 1-minute equally-spaced records and the sample ranges from 28 November 2000 to 25 April 2007, which represents 1,637 trading days.

Filters are implemented to identify and remove the erroneous records traditionally encountered in high-frequency data. A first series of filters is applied to transaction records, so that a trade is filtered out if: (i) its date, time, price or quantity is negative or is missing, (ii) its price is lower than the prevailing deposit rate or greater than the corresponding lending rate (i.e., beyond the interest rate corridor defined by the monetary policy operational framework)[15], or (iii) its direction, that is, buy or sell, is missing. Remaining outliers are detected by means of a dynamic filter built upon an absolute price variation in excess of 3 standard deviations from its daily average. Similarly, a quote is filtered out on the condition that: (i) its date, time, bid price or ask price is negative or missing, (ii) its bid price or ask price is lower than the current deposit rate or is greater than the corresponding lending rate, or (iii) the bid/ask spread is wider than 25 basis points. In addition to the above filters, since activity appears to start around 08:30:00 and dramatically decrease after 18:00:00, our typical trading session is assumed to open at 08:30:00 and close at 18:00:00, and records displaying a time outside this range are removed. Globally, the filters reject just above 1 percent of all transaction records, and 0.6 percent of all quotes. Our filtered data sets thus contain 780,740 transaction records and 928,601 records of quotes. In a further step and for every transaction, we identify the quotes that prevailed on Reuters at the time when the trade was executed on the electronic platform. We next operate at the transaction level and compute the following measures of market activity:

Trade Duration. Number of seconds between two consecutive trades (if executed on the same day) plus 1.

[15] Note that, as already mentioned, transactions taking place at prices outside the interest rate corridor are not automatically erroneous records.

Market Spread. Spread (difference) between the price of a trade and the prevailing minimum bid rate set by the ECB.

Deviation of Price from the EONIA. Spread (difference) between the price of a trade and the EONIA of the corresponding day computed by the ECB.

Kyle (1985) identifies three dimensions of market liquidity: tightness, depth and resiliency. We accordingly add proxies for the tightness dimension of market liquidity and compute the following liquidity measures:

Traded Half-Spread. Spread (difference) between the price of a trade and the mid-quote prevailing on Reuters at the time when the transaction occurred[16]:

$$TS_t = D_t \times \left(P_t - \frac{Bid_t + Ask_t}{2} \right) \tag{1}$$

where D_t is 1 (-1) if the transaction is a buy (sell), P_t is the price of the trade and Bid_t (Ask_t) is the bid (ask) price that prevailed on Reuters when the transaction occurred.

Proportional Traded Half-Spread. Traded half-spread expressed as a percentage of the Reuters mid-quote:

$$PTS_t = 100 \times \frac{TS_t}{(Bid_t + Ask_t)/2} \tag{2}$$

Effective Spread. Symmetric traded spread around the Reuters mid-quote, therefore assuming a similar transaction cost for buy and sell orders:

$$ES_t = 2 \times D_t \times \left(P_t - \frac{Bid_t + Ask_t}{2} \right) \tag{3}$$

where D_t is 1 (-1) if the transaction is a buy (sell), P_t is the price of the trade and Bid_t (Ask_t) is the bid (ask) price that prevailed on Reuters when the transaction occurred.

Proportional Effective Spread. Effective spread expressed as a percentage

[16] Contrary to Stoll (2000), we use the contemporaneous mid-quote in our calculations of traded spreads. This is mainly due to the non-speculative nature of the overnight money market documented in the literature. Therefore, for buy and sell orders separately, our traded spreads provide an estimate for the average cost at which transactions effectively take place on the platform.

of the Reuters mid-quote:

$$PES_t = 100 \times \frac{ES_t}{(Bid_t + Ask_t)/2} \tag{4}$$

Based on quotes alone, we add measures of transaction costs for trades executed under the conditions displayed on Reuters:

Quoted Spread. Implicit transaction cost that a trader would pay when buying at the displayed ask price and directly selling at the quoted bid price:

$$QS_t = (Ask_t - Bid_t) \tag{5}$$

Proportional Quoted Spread. Quoted spread expressed as a percentage of the quote mid-point.

$$PQS_t = \frac{QS_t}{(Bid_t + Ask_t)/2} \tag{6}$$

Our measures are subsequently aggregated (averaged) over fixed-length intervals. The direction of the trade recorded by e-MID allows us to investigate potential asymmetries based upon the aggressor. We therefore duplicate our measures, where relevant, on the basis of the sign of the transaction, that is, buy or sell. First, equally-weighted averages, in which an equal weight is assigned to every record, are applied to create equally-weighted average trade durations (EWTD), market spreads (EWMS), deviation of prices from the EONIA (EWDPE), half traded spreads for buy (EWTS.b) and sell orders (EWTS.s), proportional half traded spreads (EWPTS.b and EWPTS.s), effective spreads (EWES), proportional effective spreads (EWPES), quoted spreads (EWQS) and proportional quoted spreads (EWPQS). Second, we use size-weighted averages, in which the weight of a trade is defined by the quantity exchanged in the transaction, and compute size-weighted average half traded spreads for buy (SWTS.b) and sell (SWTS.s) transactions, proportional half traded spreads (SWPTS.b and SWPTS.s), effective spreads (SWES) and proportional effective spreads (SWPES). Additionally, we enlarge our set of market activity measures with the average quantity per trade (EWQTY), the total quantity traded over the interval (SUMQTY) and the number of trades over the

interval (NBTRD). Again, we distinguish between buy and sell orders.[17]

Finally, we compute a measure of realised volatility, based on intraday 5-minute squared returns (Andersen and Bollerslev 1998):

Realised Volatility. Sum of 5-minutes squared returns over interval i:

$$RVOLA_i = \sum_{t=1}^{T} r_{i,t}^2 \tag{7}$$

where $t = 1, ..., T$ denotes the t^{th} 5-minute subinterval within interval i and $r_{i,t}^2 = (p_{i,t} - p_{i,t-1})^2$ is the t^{th} squared return within interval i, with $p_{i,t}$ being the interest rate at which the last transaction of 5-minute subinterval t was executed.[18]

Descriptive statistics for the daily measures are presented in Table 1. Interestingly, the daily quantity exchanged through sell orders is almost three times higher than the quantity traded via buy orders. Turning to the number of buy trades versus sell trades provides further evidence that the electronic platform is primarily used with the aim of disposing of excessive liquidity, therefore providing, or selling, liquidity in the market. On average a trade is executed every 73 seconds on the electronic platform, even though some days appear more active, with a transaction recorded every 40 seconds, while others are very slow, with a trade every 3 minutes. Transacting through the platform implies an average market spread of 6 to 7 bps. The bid/ask spread displayed on Reuters screens averages 7 bps, meaning that the implicit cost for transacting in the overnight market is close to 7 bps. However, turning to the average effective spread, that is, the effective transaction cost incurred on the platform, the average cost appears to be much lower. The effective spread is indeed less than 1 bps which could be explained

[17] SUMQTY represents the total volume traded over a specific interval while SUMQTY.b (SUMQTY.s) is the total volume traded through buy (sell) orders. Similarly, EWQTY is the average quantity per trade over the interval whereas EWQTY.b (EWQTY.s) is the average quantity traded through buy (sell) orders. Both volumes and average trade sizes are expressed in millions of EUR. Finally, NBTRD is the number of trades executed over a specific interval and, similar to the above measures, NBTRD.b (NBTRD.s) is the number of buy (sell) trades over the interval.

[18] When a price for a financial asset is observable, the standard formula for the intraday return is $r_{i,t} = (p_{i,t} - p_{i,t-1})$, with $p_{i,t}$ being the (log) price of the asset with the given maturity at time t. However, in the special case of the overnight maturity, the corresponding interest rate could be associated with the (log) price of a (short maturity) zero-coupon bond, explaining the adjustment made in this paper to calculate the realised volatility compared with the standard formula for asset prices presented in Andersen and Bollerslev (1998).

by the bargaining power of traders using the platform. A trader might indeed contact its preferred counterparty and negotiate price improvements with respect to the quotes displayed on Reuters. Traded half-spreads on buy trades are on average positive, implying that buy trades occur above the mid-quote displayed on Reuters screens. However, traded half-spreads on sell trades are on average negative, albeit very tight, implying that sell trades are also executed above the Reuters mid-quote.

Pairwise correlations reported in Tables 2 and 3 give more insight into the behaviour of our variables. First, the quantity exchanged is negatively correlated with realised volatility while a positive correlation links volatility and market activity, measured by the number of transactions, and all spread measures. As expected, it is thus more costly to trade under stress: the quoted and effective spreads are positively related to volatility. Second, volume is negatively related to transaction costs. Finally, the number of trades and transaction costs seem to move in the same direction.

3.3 Review of the literature

Although the literature provides theoretical and empirical insight into the operation of the interbank market for funds in general, and the overnight money market in particular, the focus is largely on the federal funds market in the United States.

Eagle (1995) and Bartolini, Bertola and Prati (2001) identify predictable interday patterns characterised by an increase in volatility around the end of the maintenance period. Griffiths and Winters (1995) provide similar evidence of seasonal volatility patterns arising at the turn of the maintenance period or on days preceding a market close. The authors also support the findings of Spindt and Hoffmeister (1988) of an increase in volatility at the end of the trading day. Before them, Ho and Saunders (1985) introduce a model of the demand for funds in which the expected level of excess reserves and the degree of risk aversion condition a bank's demand. This, according to the authors, explains the different behaviour of large (liquidity-absorbing) versus small (liquidity-providing) banks.

Turning to intraday data reinforces the evidence of predictable patterns: Van-

Hoose (1991) or Cyree and Winters (2001), among others, lend support to the presence of regular intraday patterns in the US market for funds. Bartolini, Gudell, Hilton and Schwarz (2005) conduct a thorough examination of the intraday patterns of market activity in the federal funds market and provide evidence of predictable patterns in the market. They notably show that market activity is essentially U-shaped over a typical trading day while remaining broadly stable over the maintenance period. Their results similarly point to increased volatility at the end of the trading day, associated with lower rates. Finally, their analysis of settlement versus non-settlement days or days based on payment flows does not yield conclusive evidence of statistically different intraday dynamics.

Several studies thus model and empirically test the management of liquidity by banks over the reserve maintenance period or within a typical day. More specifically, the interaction between liquidity management and the behaviour of the overnight market is extensively examined. In a number of theoretical models, the risk aversion of banks (VanHoose (1991) or Ratti (1980), among others), rational expectations (Eagle 1995) or the impact of information and noncontinuous trading (Cyree and Winters 2001) support the empirical patterns.

If the literature provides extensive evidence of a rejection of the martingale hypothesis for the federal funds market, with a major focus on interest rates and volatility[19], similar analysis for European markets is however more limited. The gain of interest for this type of analysis in Europe has been renewed and reinforced with the introduction of the euro for which the then-prevailing 12 money markets in the European countries sharing the European single currency have merged into a single vast market. In addition, the evidence reported in Prati, Bartolini and Bertola (2003) suggests that the market for funds in the euro area shares some similar patterns with the federal funds market: both markets are indeed found to be significantly impacted by institutional and calendar effects.

The limited number of studies focusing on the overnight segment of the euro area money market arguably results from its over-the-counter (OTC) nature, for which data is not easily available. Several studies indeed almost exclusively rely

[19]Some authors, e.g., Bartolini et al. (2001) or Cyree and Winters (2001), additionally identify regular patterns in volumes or trading activity. These aspects do however benefit from much less attention.

on daily EONIA data or quotations posted on wire services such as Reuters or Bloomberg. The availability of detailed data on the transactions executed through the e-MID platform however opens the way for extensive microstructure examinations. In the literature, a number of studies examines the operation of the platform and the trading behaviour of banks. Precup, Iori and Gabbi (2005) and Iori et al. (2008) apply methods of statistical mechanics of complex networks to investigate the Italian segment of the overnight market. The size of credit institutions influences their management of liquidity and the structure of the connections between banks has evolved over the period from January 1999 to December 2002, with banks with a high degree of network more likely to be connected to banks with a low degree (Precup et al. 2005). In the same vein, the results in Iori et al. (2008) suggest that the banking network in the Italian overnight market is fairly random, and preferencing rather limited. The authors also find little evidence of participating banks able to exploit short-term profit opportunities by borrowing from some and lending to others over the course of a single day. An analysis of common factors in trading behaviour in the Italian overnight market over the period 1999-2002 points to the emergence of groups of banks with similar trading strategies (communities) at the end of the reserve maintenance period (Iori, Renò, De Masi and Caldarelli 2007).

The electronic platform additionally provides insight into the intraday operation of the market. Assuming that banks are risk averse, Angelini (2000) derives theoretical conditions according to which the percentage of trades performed earlier in the trading day is expected to be larger on days when interest rate volatility increases. Empirical tests based on hourly data for the Italian interbank market over the period 1993-1996 confirm these theoretical predictions. An examination of similar data for various European countries over the period 1999-2000 shows that, except in Italy, market activity intensifies on specific days (especially on Tuesdays where repo auctions by the ECB take place and on Thursdays corresponding to Governing Council meetings) and that a quick and efficient reallocation of funds follows the auction (Hartmann, Manna and Manzanares 2001). On the basis of e-MID data for the period 1999-2004, Angelini and Vacca (2004) test the martingale hypothesis in the overnight market and the related assumption that the

interest rate sensitivity of banks' demand for funds should be infinite. Consistent with Angelini (2002), they find little evidence of the martingale hypothesis, rejecting in particular the hypothesis of an infinite elasticity of the demand for reserves. The authors additionally show that banks facing borrowing constraints in the interbank market tend to be less interest rate sensitive, while higher risk seems to be associated with lower interest rate reactivity. Similarly, Barucci, Impenna and Renò (2004) provide evidence against the martingale hypothesis for the period from 4 January 1999 to 31 August 2001, notably at the end of the reserve maintenance period and on specific calendar days (e.g., at the end of a month) where the overnight interest rate exhibits predictable patterns. Their results also suggest that interest rate announcements by the ECB tend to increase volatility and volumes in the market. Palombini (2003) shows that trading volumes are more impacted by institutional factors, hence explaining that the volatility of the overnight interest rate is weakly influenced by trading volume in the Italian interbank market over the period 2000-2002. Finally, Baglioni and Monticini (2006) investigate the intraday patterns of the overnight rate using tick data from e-MID from 2 January 2003 to 31 December 2004. From the observed intraday patterns, it appears that the hourly interest rate is a function of the intraday term structure of the overnight rate, supporting the absence of arbitrage opportunities.

With regular patterns identified in the interday and intraday behaviour of interest rates and volatility, the overnight money market is thus subject to seasonal patterns similar to stock or derivatives markets. In such markets, interday seasonality in returns (Lakonishok and Smidt 1988), market activity (Lakonishok and Maberly 1990), volumes, volatility or spreads (Foster and Viswanathan 1990) is indeed extensively documented. The martingale hypothesis is similarly rejected within days with evidence of predictable intraday patterns in returns (Wood, McInish and Ord 1985), volumes (Jain and Joh 1988, Admati and Pfleiderer 1988, Foster and Viswanathan 1993) or spreads (McInish and Wood 1992, Chan, Christie and Schultz 1995, Chan, Chung and Johnson 1995).

This paper does however add to the existing literature by investigating seasonality in an extensive set of market activity and liquidity variables. In addition, our analysis assesses the influence of the operational framework or specific calendar

effects on the behaviour of our measures. Finally, we examine the impact of the implementation in March 2004 of structural changes to the operational framework or of a more frequent occurrence of fine-tuning operations (FTOs) since October 2004 on the interday and intraday dynamics of this market.

4 Microstructure analysis

In this section, we examine the dynamics of the electronic segment of the overnight money market on the basis of our proxies for market quality and liquidity constructed from pre- and post-trade information. The objective of our analysis is essentially twofold. First, we compare the actual trading dynamics of this segment with the theoretical behaviour expected from market microstructure theory or with empirical patterns highlighted in earlier studies. Second, we examine the statistical significance of the observed patterns and the presence of breaks over the sample. Our analysis starts with an investigation of the interday dynamics. Then, the presence and stability of regular intraday patterns are analysed.

Given the strong connection between the design of the Eurosystem's operational framework and the behaviour of banks on the overnight money market, we condition our analysis on four subsamples. Sample 1 covers the period from 4 September 2000 to 9 March 2004 and is representative of the former design of the operational framework. Structural changes to the operational framework became effective on 10 March 2004. The subsample from 10 March 2004 to 3 May 2007 (hereafter Sample 2) accordingly covers the period of the current operational framework. Finally, within this latter subperiod, we further distinguish (i) the period from 10 March 2004 to 11 October 2004 (Sample 2a) with almost no fine-tuning operations (FTOs) at the end of the maintenance period and (ii) the period from 12 October 2004 to 3 May 2007 (Sample 2b) characterised by a more frequent occurrence of FTOs.[20]

[20] Note that only one FTO occurred in the period between 10 March and 11 October 2004, whereas 24 FTOs took place in the second subsample (including 9 liquidity-providing and 15 liquidity-absorbing operations).

4.1 The methodology

A robust analysis of the dynamics of our microstructure proxies for trading activity and market liquidity is provided by parametric and nonparametric methods. Both types of tests indeed appear complementary to ascertain the robustness of our conclusions (Hamilton 1996). On the one hand, given the averaging mechanism to fulfil reserve requirements, the volatility of market variables is generally confined to the end of the RMPs when minimum reserve constraints become binding. Over the last days of the period, credit institutions therefore tend to be more sensitive to liquidity shocks. Ordinary least squares (OLS) estimations might consequently be misleading with strong significance caused by few outliers in periods of relative stability. Although this issue is attenuated with tick data (contrary to the daily frequency used in Andrews (1991)), it nevertheless appears necessary to check the robustness of OLS estimates with additional nonparametric tests. On the other hand, OLS regressions allow us to specify models conditioned upon specific variables expected to be the source of regular interday or intraday patterns.

Based on heteroskedastic and autocorrelation consistent (HAC) estimators (Andrews 1991), our parametric tests boil down to estimating the following static univariate equation:

$$X_t = \mathbf{D}_\mathbf{t}'\beta + \varepsilon_t \tag{8}$$

where X_t denotes the microstructure proxy and $\mathbf{D_t}$ is a set of dummy variables capturing its expected interday or intraday dynamics (with the corresponding estimated coefficients in β). The significance of the observed patterns is then examined by means of Wald tests.

Regular patterns are expected to be caused by the rules contained in the Eurosystem's operational framework or 'calendar effects'. The Eurosystem's operational framework, which defines the implementation of the monetary policy, is indeed expected to influence the behaviour of our proxies on specific days. More precisely, in this paper, we examine the influence of (i) MRO allotment days, (ii)

last days of the RMP[21], (iii) the very last open day of the period, (iv) the week before the holding of a press conference, and (v) the day of the press conference[22]. Calendar effects such as the end of a month, a quarter or a year additionally represent days on which banks usually need more liquidity to absorb specific movements and are thus more sensitive to liquidity shocks. From a market microstructure perspective, the proportion of utilitarian traders is expected to increase significantly on such days, leading to a larger number of transactions being executed. At the same time, peaks in market volatility should point to an increase in information asymmetry which would give rise to wider bid/ask spreads quoted by banks taking part in the operation of the overnight money market.

To assess the robustness of the conclusions provided by our Wald tests, eleven nonparametric tests of mean, median and variance equality are additionally conducted. The null hypothesis of mean equality is examined in a series of t-tests and ANOVA F-statistics. Wilcoxon-Mann-Whitney, Chi-square, Kruskal-Wallis and van der Waerden tests of median equality are additionally performed. Finally, variance equality is assessed by means of F-, Siegel-Tukey, Barlett, Levene and Brown-Forsythe tests.[23]

4.2 Interday patterns[24]

4.2.1 Empirical interday patterns

In this section, the presence of predictable interday patterns is examined. Figures 1 to 7 illustrate the behaviour of our measures of market activity and liquidity over a stylised reserve maintenance period. The horizontal axis denotes the number of

[21] The last days are defined as the days between the last main refinancing operation (MRO) allotment and the last day of the RMP.

[22] Press conference days are the days on which the Governing Council of the ECB meets to decide upon the level of the key policy interest rates.

[23] For more details on the tests used and performed in EViews, see Sheskin (1997) for the median equality tests (for the Chi-square test, see also Conover (1980)). For the variance equality tests, see Conover, Johnson and Johnson (1981) for a general description; see also Sheskin (1997) (for the Siegel-Tukey test) and Levene (1960) (for the Levene test).

[24] For space reasons, the results from the nonparametric tests are mainly presented since they are largely similar to the parametric Wald tests based on OLS regressions. Only different results or other relations tested in the OLS framework are discussed. For similar reasons, we do not report the results of the t-tests for mean equality or the F-test for variance equality. Those results remain however available upon request.

days before the end of the period (occurring on day 0).[25] Main refinancing operation (MRO) allotments are denoted by a vertical line, that is, MRO allotments take place 3, 8, 13 and 18 days before the end of our sytlised period before 10 March 2004, and 5, 10 and 15 days before the end of the stylised period after 10 March 2004. In addition, after 10 March 2004, the last day of the period is (almost always) an allotment day. Figures 3 to 5 compare the evolution of traded volumes, average trade sizes and number of transactions between buy and sell trades.

Against the background of the design of the Eurosystem's operational framework, market activity is expected to intensify towards the end of the RMP when utilitarian trading becomes more pronounced. Facilitated by the averaging mechanism, the underlying intuition is that banks trading in the overnight market to eventually fulfil their own reserve requirements at the end of the RMP should face two types of liquidity shocks: idiosyncratic (individual) and aggregate shocks (impacting the aggregate level of liquidity in the overnight market). While banks observe their own shocks in real time, they are less able to assess the magnitude of the aggregate shocks, if any, supported by other banks. Both types of shocks however raise market uncertainty about the evolution of liquidity conditions, especially at the end of the RMP when reserve requirements become binding.[26] We accordingly expect market activity to be more pronounced towards the end of the RMP, with increased volatility in trade parameters. This intuition, developed in the theoretical models of Pérez Quirós and Rodríguez Mendizábal (2006) and Gaspar, Pérez Quirós and Rodríguez Mendizábal (2008), is supported by empirical evidence in the Eurosystem (see, e.g., Angelini (2000) or Bartolini and Prati (2003)). In this context, we check whether trading dynamics on e-MID confirm earlier studies.

As reported in Figures 1 to 5, market activity indeed intensifies over the RMP,

[25]Note that we only consider the days for which at least 15 observations are available. This partly leads us to consider only 5 days between MROs as a longer period between 2 consecutive MROs is unusual and therefore not representative of the actual pattern. For similar reasons, the last days period before 10 March 2004 (after 10 March 2004) is built upon the last 3 (5) days of the period.

[26]At the beginning of the RMP, these shocks can be easily absorbed by currents accounts of banks held at central banks on account of the averaging mechanism for reserves requirements. Note also that in case of noncompliance with the requirements, banks are subject to a significant payment according to the criteria described in ECB (2005a).

with notably the number of trades and the realised volatility of the overnight interest rate reaching a peak on the last day of the period. The total volume exchanged nevertheless decreases on the last day. The imbalance between buy and sell orders decreases markedly over the last days. As expected, the duration between trades declines significantly over the last days, as the uncertainty of banks to end the RMP in a balanced position increases. The market spread follows a similar path with a decrease towards the end of the period. It is also during the last days that the deviation of e-MID transaction prices from the actual EONIA increases. Such empirical patterns are consistent with theoretical predictions and remain valid across our subsamples.

In active markets characterised by a significant increase in the proportion of utilitarian traders, liquidity appears to deteriorate, with larger transaction costs paid by participating banks against the background of lower total volume. Spreads also appear to increase when realised volatility is higher. We conjecture that, consistent with the literature, information asymmetry increases at the turn of the period, which results in wider spreads posted by market participants. Figure 6 exhibits the evolution of our liquidity measures over our stylised RMP. Quoted (i.e., EWQS and EWPQS) and effective (i.e., EWES, EWPES, SWES and SWPES) spreads appear to increase towards the end of the RMP. Although those spreads exhibit little variation until the last MRO allotment of the period, transacting on the last days of the period eventually becomes more costly, with the last open day of the period being the most expensive day. Apart from a greater stability of effective spreads during the non-last days, no significant change is observed after 10 March 2004 (Figure 7). This analysis extends to traded spreads. However, after the implementation of the changes to the operational framework, traded spreads for buy and sell orders evolve in opposite directions on non-last days, before starting a common increase over the last days of the RMP. Over non-last days, traded spreads for buy orders broadly follow an inverted U-shaped path, while traded spreads for sell orders exhibit a regular U-shaped pattern. This picture is not affected by the frequency of FTOs.

Market liquidity additionally deteriorates on Tuesdays, that is, on allotment days, as well as before the weekend, where quoted, effective and traded spreads

increase. A similar pattern is observed on non-last and last days of the RMP, although, as already discussed, our spread measures widen over the last days.

4.2.2 Statistical tests of observed interday patterns

Market activity. Over the period from 4 September 2000 to 10 March 2004, that is, Sample 1, our tests confirm that the Eurosystem's operational framework and the occurrence of specific calendar days significantly impact the behaviour of market activity. A summary of the significance of the patterns in our proxies for market activity is presented in Table 6.

Table 10 reports the test statistics for equality between last and non-last days. The equality between the last open day of a period and the other days is additionally examined in Table 14. Market activity peaks around the end of the reserve maintenance period: the number of transactions (NBTRD) and realised volatility (RVOLA) are significantly higher while the exchanged quantities (SUMQTY and EWQTY) or the duration between trades (EWTD) significantly decrease. In addition, the imbalance between buy and sell trades (IMBAL) significantly decreases during the last days. Similarly, a significantly reduced market spread (EWMS) is observed around the end of the period.

The evidence presented in Table 12 suggests that market activity is however not affected by MRO allotments. Weak evidence nevertheless points to a slight increase in total volumes (SUMQTY) or realised volatility (RVOLA) on such days. By contrast, market activity remains stable in the neighbourhood of a press conference (see Tables 16 and 18).

Calendar effects are examined in Tables 20 and 22 where evidence suggests that market activity differs significantly at the end of a month or a quarter. In particular, the results from our nonparametric tests confirm that the number of trades (NBTRD) is significantly higher on such days with significantly lower average quantities per trade (EWQTY). The average market spread (EWMS) widens at the end of a month or a quarter. Finally, we note that market activity fluctuates over a typical week, notably with the number of trades (NBTRD) increasing significantly before the weekend.

Our findings thus confirm that banks tend to be more sensitive to liquidity developments on specific days either because they face larger payments or because the minimum reserve constraints eventually become binding. The increased number of transactions executed on such days and the lower duration between trades also confirm that utilitarian trading intensifies as banks become more sensitive to liquidity shocks. The stronger reactiveness of banks to liquidity shocks on such days also results in inflated realised volatility suggesting an increase in information asymmetry.

Although the above analysis is broadly confirmed in Sample 2, the implementation of structural changes to the operational framework brings slightly different conclusions. First, evidence reported in Table 13 suggests that MRO allotments now affect market activity with a significant increase in the number of transactions (NBTRD) and realised volatility (RVOLA), while the average quantity per trade (EWQTY) and the average duration between trades (EWTD) are significantly reduced. We conjecture that, in Sample 2, MRO allotments tend to raise the proportion of utilitarian traders in the market.

Second, the interday dynamics over the last days (Table 11) or on the last day (Table 15) remain broadly unchanged in Sample 2. Trading volume remains stable over the period, with the exception of the last day where it significantly drops at the time when the imbalance between buy and sell trades becomes less pronounced.

Third, the total volume exchanged through the electronic platform (SUMQTY) now significantly drops on specific calendar days such as the end of a month (Table 21) or a quarter (Table 23) while the number of transactions (NBTRD) does not appear significantly different on such days.

Fourth, the pattern of trade duration over the RMP remains broadly unchanged with a lower duration on days where the reactiveness of banks is higher.

Market liquidity. The examination of our spread-based liquidity proxies lends additional support to the above analysis. A summary of the statistical significance of the seasonality in our measures of market liquidity is provided in Table 9. As reported in Tables 10 and 14, before 10 March 2004 (i.e., Sample

1), all spread measures significantly increase over the last days of the RMP. More specifically, our liquidity proxies are significantly larger on the last open day of the RMP than on any other day of the period. We thus conclude that it is significantly more costly to trade during the last days, with the last open day of the period being the most expensive day of the RMP.

We observe that MRO allotments do not influence the magnitude of our liquidity measures (Table 12). This result is consistent with the observation that market activity is not different on allotment days than on the other days of the period. Therefore, transacting in the overnight money market on allotment days is not more costly than trading on the other days of the period.

Finally, apart from mixed evidence regarding the quoted spread (the proportional quoted spread decreases while the quoted spread increases), we find no evidence of a change in liquidity conditions in anticipation of a press conference (Table 16) nor on the day of the conference (Table 18).

The results presented in Table 20 suggest that the end of a month does not clearly alter market liquidity: only the quoted spread (EWQS) and the effective spreads (EWES, EWPES but also SWES and SWPES) significantly increase. A separate examination of traded spreads for buy and sell orders does not suggest the presence of significant differences at the turn of a month: buy and sell orders are thus subject to similar transaction costs on the last day of a month than on any other day. However, as reported in Table 22, all but one liquidity measure (the traded spread for buy orders) are significantly larger at the end of a quarter.

A comparison of weekdays shows that liquidity remains stable over a typical week except during the last days where it fluctuates more between days (EWQS, EWES, EWPES and SWES reject the test of mean equality at the 5% level).

After 10 March 2004 (i.e., Sample 2), liquidity conditions are significantly altered on allotment days where the magnitude of almost all our measures significantly increase (Table 13). Only the size-weighted (proportional) traded spreads for sell orders (i.e., SWTS.s and SWPTS.s) are unaffected by the increased activity observed on allotment days. While, as before the introduction of the current operational framework, market liquidity remains unchanged before a press conference

(Table 17), evidence now suggests that a larger cost is paid by banks transacting on the day of the press conference (Table 19). The changing market conditions at the end of the RMP may partially explain the observed higher costs. Additionally, no significant change in liquidity occurs at the end of the month (Table 21) while only the EWQS and traded spreads for buy orders (EWTS.b and SWTS.b) remain significantly higher at the end of a quarter after the implementation of the current operational framework (Table 23). Finally, we note the increased instability of liquidity between days of a typical week in Sample 2. Apart from mixed evidence on the relative stability of traded spreads for sell orders between days, almost all measures reject the null hypothesis of equality between days of a week over non-last or last days.

These developments thus confirm that market participants fully benefit from the averaging mechanism for reserve fulfilment as they appear more active towards the end of the RMP. From this particular perspective, trading dynamics on e-MID is similar to other financial markets. As a robustness check, we adjust our measures of total volume (SUMQTY), average trade size (EWQTY), number of trades (NBTRD) and trade imbalance (IMBAL) for the presence of a time trend in the exchanged quantities (increasing trend) and number of transactions (decreasing trend). The above conclusions are reinforced. The only noticeable difference is observed in the neighbourhood of a press conference in Sample 1 where the quantities and the number of transactions become subject to significant pressure.

Changes to the operational framework and more frequent FTOs. The equality of the distribution of our proxies before and after 10 March 2004 is additionally examined in Table 24 and the impact of more frequent fine-tuning operations (FTOs) is presented in Table 25, with the associated test statistics reported in Table 26.[27] The main conclusions are summarised as follows.

First, our results suggest that the changes introduced to the Eurosystem's operational framework led to an improvement in market activity in overnight segments such as e-MID. Between Samples 1 and 2, the total volume exchanged through the e-MID platform (SUMQTY) has significantly increased. Although

[27] The test statistics for SUMQTY, EWQTY, NBTRD and IMBAL presented in Tables 24 and 26 are corrected for the significant time trend observed in the quantities and number of trades executed on the e-MID platform over the corresponding period.

the null hypothesis of an equal number of trades (NBTRD) executed daily on the platform before and after 10 March 2004 cannot be rejected, the average quantity per trade (EWQTY) has significantly increased with the introduction of the current operational framework. More frequent fine-tuning operations have not altered the daily total quantity traded nor the number of trades: both distributions remain unchanged between Samples 2a and 2b. Weak evidence however suggests that the average quantity per trade increases with a more frequent occurrence of FTOs. Additionally, the imbalance between buy and sell trades (IMBAL) does not vary over time.

Second, the realised volatility (RVOLA) of the overnight interest rate on e-MID significantly decreases after 10 March 2004, from a level of 0.087 in Sample 1 to 0.052 in Sample 2. More frequent FTOs do not however further reduce the daily volatility in the market: as reported in Table 26, our nonparametric tests fail to reject the null hypothesis of mean equality between Samples 2a and 2b. As suggested by the test statistics for mean and variance equality, the reactiveness of the overnight interest rate has increased with the occurrence of more frequent FTOs. As regards Samples 2a and 2b, both results in terms of mean and variance equality are interesting as differences with previous results in the literature could be explained by the nature of the underlying asset used to estimate the realised volatility measure (see Section 3). We conjecture that the increased reactiveness under a regime of more frequent FTOs is linked to nonlinearities in the overnight interest rate as a function of liquidity. The nonlinearity of this function would imply that, around the mid-point of the standing facility corridor (i.e., the minimum bid rate), the curve is less elastic than closer to the standing facility rates. In that case, even subdued departures from an equilibrium level for liquidity may involve sharper fluctuations of market interest rates around the minimum bid rate, hence increasing the volatility of the overnight interest rate.

Third, the duration between trades increases over time, with an average of 66.57 seconds in Sample 1 rising to 79.16 seconds in Sample 2. This tendency continues in Sample 2 where a trade is executed every 74.39 seconds in Sample 2a against 80.26 seconds on average in Sample 2b. We conjecture that the longer duration does not necessarily reflect weaker activity on the e-MID platform but

is the result of a larger average quantity per trade. Finally, the observed market spread (EWMS) of 6 bps does not significantly change over time.

Spread-based liquidity measures provide further evidence of improved liquidity conditions under the current operational framework. While quoted spreads averaged 8.47 bps before 10 March 2004, they now fluctuate around the significantly lower level of 5.53 bps. In addition, market liquidity has continued to improve with the introduction of more frequent fine-tuning operations (FTOs). A comparison of liquidity proxies before and after 12 October 2004 provides evidence of significantly reduced quoted spreads (EWQS and EWPQS) under the period of more frequent FTOs. After 12 October 2004, size-weighted effective spreads reject the null hypothesis of equality while equally-weighted effective spreads do not. Although average transaction costs (EWES and EWPES) remain unchanged with a more frequent occurrence of FTOs, price improvements are nevertheless stronger for large orders than for small orders in Sample 2b.

Overall, the introduction of structural changes to the Eurosystem's operational framework has thus improved the quality of the overnight money market, with a significantly higher market activity associated with significantly lower transaction costs.

4.3 Intraday patterns

4.3.1 Empirical intraday patterns

Intraday examinations of the overnight money market are particularly relevant given the very short maturity of this segment. Whereas daily observations of the overnight market might suggest high stability of parameters such as interest rates or volumes in the long run, intraday analyses could nevertheless reveal strong market dynamics hidden behind the daily averages. It thus appears particularly interesting to check whether the earlier findings for the Italian segment of the overnight market or for other market structures also extend to the whole euro area overnight market.

The behaviour of our proxies for market activity and liquidity over a stylised

trading day is presented in Figures 8 to 14. The Figures make use of 30-minute averages to derive the intraday pattern of our measures. The relative intraday behaviour of buy and sell transactions is additionally illustrated in Figures 10 to 12.

Figures 8 to 12 show that the total volume exchanged is broadly U-shaped over the trading day, with market activity recording a trough at lunchtime. The average transaction size is nevertheless slightly higher on average at this time of day. When activity resumes in the afternoon, the number of transactions rises whereas the size of each trade tends to be smaller. This behaviour of more sequential trades, consistent with an increasing volatility over the day, likely reflects the increased uncertainty faced by market participants regarding price developments and the availability of liquidity in the afternoon as liquidity appears to diminish. We also note that the imbalance between buy and sell trades is more pronounced in the morning. This imbalance reduces significantly in the early afternoon and almost disappears when the market closes. The market spread and the deviation of e-MID transaction prices from the EONIA decrease almost linearly throughout the day. However, e-MID transaction prices appear higher than the EONIA in the morning and lower than the EONIA for the rest of the trading day. Again, these general patterns do not differ considerably from one sample to another.

In spite of its specific features, the overnight money market thus exhibits intraday dynamics similar to other market structures. U-shaped volumes are indeed consistent with their intraday pattern on the NYSE (Jain and Joh 1988) or on Nasdaq (Chan, Christie and Schultz 1995) and the negative relation between the total volume exchanged and the volatility of the market highlighted in our Figures is also in line with the findings for the NYSE in Foster and Viswanathan (1993).

The intraday dynamics of market liquidity before 10 March 2004 is illustrated in Figure 13. Although the magnitude of quoted spreads does not vary much over a typical trading day, our other liquidity proxies confirm that the timing of the decision to trade determines the cost effectively paid on the transaction. Although quoted spreads vary over the day, their range remains narrow (no more than 0.7 bps for EWQS). Effective spreads (EWES and SWPES) follow a J-pattern over the day, with a decrease in the morning from the opening level and a subsequent

increase until the end of the day. Transacting at the end of the day yields the largest effective costs of the day, consistent with the fact that banks transact more near the close of trading when their information regarding their reserve needs is more exhaustive. Turning to traded spreads for buy (EWTS.b and SWPTS.b) and sell (EWTS.s and SWPTS.s) trades shows that the cost of buy trades decreases almost linearly throughout the day (before increasing near the close of trading) while the cost paid on sell transactions increases.

The observed deterioration of liquidity as market activity intensifies and the J-pattern of transaction costs (approximated by our effective spreads) over a stylised trading day is consistent with the findings in McInish and Wood (1992) where the authors investigate the dynamics of spreads quoted on the NYSE. In the overnight money market, the intraday behaviour of market liquidity thus closely replicates its dynamics under other market structures.

As shown in Figure 14, the implementation of the current operational framework on 10 March 2004 has not altered the behaviour of quoted spreads, which remain broadly stable over the day. The most noticeable difference is arguably the fact that quoted spreads now more closely follow the expected U-shaped pattern over the trading day (see, e.g., Chan, Chung and Johnson (1995)). In Sample 2, the positive relation between quoted spreads and volumes, consistent with the findings in Foster and Viswanathan (1993), additionally becomes more obvious. The J-pattern in effective spreads still persists with however much lower spreads on average: effective transaction costs have thus decreased since 10 March 2004. Finally, although we observe a lower cost paid by liquidity-providing banks, that is, banks transacting with sell orders, the behaviour of traded spreads for buy orders is now much more unstable, with larger spreads being paid and a noticeable decrease near the close of trading.

Our initial analysis thus provides evidence of strong and persistent intraday patterns arising from the behaviour of banks in their quest for liquidity as well as from the operation of the market. Trading indeed appears to take place more heavily around both ends of the the trading day, and less activity is observed in the middle of the day as banks either have already balanced their liquidity positions or are waiting for more complete information about their liquidity needs for the

day.

4.3.2 Statistical tests of observed intraday patterns

The investigation of the statistical significance of the observed intraday patterns leads us to conduct two series of tests. First, we test the null hypotheses of mean, median and variance equality between 30-minute intraday intervals on specific days, that is, we check the empirical validity of these null hypotheses (i) on all days, (ii) on all allotment days, (iii) on the last allotment days of the RMP, (iv) on all allotment days excluding the last allotment of the RMP, (v) on the last open days of the RMP, (vi) on non-last days, (vii) on press conference days and finally, (viii) on non-press conference days. Similar tests of equality between a morning (08:30:00–12:00:00), a mid-day (12:00:01–15:00:00) and an afternoon (15:00:01–18:00:00) session are additionally performed.[28]

Second, we investigate the equality of individual intraday intervals between days, with a particular focus on (i) last allotment days and other allotments days, (ii) the last days or (iii) the last open day of the RMP and the other days of the period, and finally, (iv) the press conference days and the other days. The purpose of this second series of tests is therefore to check the null hypotheses of mean, median and variance equality of our proxies for market activity and liquidity over the same intraday interval, but across specific days.

We additionally adjust our data to isolate the intraday pattern caused by the behaviour of participating banks from the dynamics resulting from a purely mechanical operation of the market. Our proxies are accordingly standardised by the observed mean and standard deviation of the corresponding interval. The deseasonalised measure $X^D_{t,i}$ corresponding to the observed measure $X_{t,i}$ recorded on day $t = 1, ..., T$ over interval i is defined as:

$$X^D_{t,i} = \frac{X_{t,i} - \overline{X_i}}{s_i} \tag{9}$$

where $\overline{X_i}$ is the sample mean of $X_{t,i}$ for intraday interval i and s_i is the sample

[28] For space reasons, we essentially comment the results for the null hypothesis of mean equality, as the median and variance equality tests roughly provide similar conclusions.

standard deviation of $X_{t,i}$ for interval i. Subsequent test statistics are computed on the basis of the standardised measures.

Market activity. Our tests of intraday market activity are reported in Tables 27 (before 10 March 2004) and 28 (after 10 March 2004). The evidence reported in the Tables confirms the presence of significant intraday patterns in market activity in both samples, in line with earlier results in the literature (see, for instance, Barucci et al. (2004) or Palombini (2003)). With the exception of the market spread (EWMS) and volatility (RVOLA), the null hypothesis that the mean value of our measures of market activity is equal between the morning, the midday and the afternoon sessions is indeed strongly rejected in all cases (i.e., in Samples 1 and 2, but also in Samples 2a and 2b). This result is further confirmed by our tests based on 30-minute intervals.

A similar picture is provided by an analysis focusing on specific days. Only the market spread (EWMS) and realised volatility (RVOLA) fail to reject the null of equality between intraday intervals while the average quantity per trade (EWQTY), the total volume (SUMQTY), the number of trades (NBTRD), the imbalance between buy and sell trades (IMBAL), and the average duration between trades (EWTD) significantly differ from one intraday interval to another over allotment days, press conference days or the last days of the RMP. We conjecture that the intraday pattern is reinforced on days when market activity intensifies. This conclusion remains broadly valid across all subsamples. Consistent with the nature of the changes made to the operational framework, all market activity measures exhibit a flat pattern on press conference days after 10 March 2004: the null of mean equality between intervals is indeed never rejected on such days. Market activity additionally appears more stable over regular allotment days. Evidence however suggests that the role played by the last MRO allotment of the period has changed in Sample 2, with a rejection of the null of equality for the total volume (SUMQTY) and the average trade size (EWQTY).

Market liquidity. Turning to our liquidity proxies in Tables 29 (Sample 1) and 30 (Sample 2) brings somewhat different conclusions. If the equality of average transaction costs (quoted and traded spreads) over a typical day is also rejected whatever the length of the intraday intervals (i.e., 3 hours or 30 minutes),

effective spreads exhibit greater stability over the day, as the null hypothesis is never rejected in Sample 1. On allotment days, the intraday pattern of our liquidity measures flattens: only the traded spreads for sell transactions reject the null of mean equality. This turns out to be due to the specific behaviour of those spreads on non-last allotment days while the null is never rejected on the last allotment day of the RMP. On last days, no significant difference is observed between quoted spreads (i.e., EWQS and EWPQS) over the day. The null hypothesis of mean equality is however rejected by the other liquidity measures. This holds true on the last open day of the RMP. On last days, traded spreads for buy orders (i.e., EWTS.b, SWTS.b, EWPTS.b and SWPTS.b) exhibit a quasi-linearly decreasing pattern over the day while traded spreads for sell orders (EWTS.s, SWTS.s, EWPTS.s and SWPTS.s) exhibit a quasi-linearly increasing pattern. Finally, market liquidity is flat on press conference days (the null is again never rejected). The implementation of the current operational framework has not significantly altered the intraday dynamics of market liquidity in the overnight market. Only last days (and to a lesser extent, last open days of the RMP) exhibit changing liquidity conditions: quoted spreads are now much more unstable over the day, while mixed evidence suggests that traded spreads converge to greater stability on those days. Our results additionally suggest that the period before 12 October 2004 acts as a transition period between Samples 1 and 2b.

We next examine the stability (i.e., equality) of the patterns across days.[29]

MRO allotment days. On the basis of 30-minute intervals, we first compare the intraday dynamics between last and non-last MRO allotment days. From 4 September 2000 to 9 March 2004 (i.e., Sample 1), the 30-minute average quantity per trade (EWQTY) exchanged through the platform or the trade imbalance (IMBAL) do not appear statistically different between the 2 groups of allotments. This result holds true for the total volume (SUMQTY) and the number of trades (NBTRD), with the sole exception of the sub-interval from 11:00:01 to 11:30:00 during which the total quantity traded (number of trades) is lower (higher) on last allotment days compared with non-last allotment days. Similarly, the null of equality is never rejected for realised volatility (RVOLA), market spread (EWMS)

[29] Due to the space constraints, we do not report the values for the tests statistics. The results remain available upon request.

and trade duration (EWTD). By contrast, in Sample 2, the null of mean equality is rejected for specific intraday intervals, which demonstrates the increased importance of the last MRO allotment. The average quantity per trade (EWQTY) significantly changes on last allotment days over the intervals from 10:30:01 to 11:30:00 and from 16:30:01 to 17:30:00 due to different total quantities exchanged over these intervals.

In Sample 1, quoted spreads (EWQS), and to a lesser extent, effective spreads (EWES), significantly widen on last allotment days around the announcement of the outcome of the MRO allotment. Over the rest of the day, there is no significant difference between last and non-last allotment days. Proportional quoted spreads (EWPQS) nevertheless fail to confirm this analysis which demonstrates that around MRO announcements banks might indeed quote wider absolute spreads but those spreads remain proportional to the interest rate prevailing in the market. No major difference in traded spreads is observed between last and non-last allotments over the morning and early afternoon. These spreads nevertheless flatten more during the afternoon on last allotment days than on the other allotment days. After 10 March 2004, the announcement of MRO results no longer alters quoted or effective spreads. Significant differences only appear at both ends of the trading day, when market activity is weaker. With more frequent FTOs, evidence suggests that traded spreads for buy orders vary slightly around the announcement of the outcome of the last MRO of the period.

Last days. Second, the stability of the intraday trading dynamics between last and non-last days is assessed. The hypothesis of mean equality is strongly rejected for mean quantity, market spread, realised volatility and trade duration in Samples 1 and 2. The average quantity per trade (EWQTY) significantly drops on last days in almost all 30-minute intraday intervals in Sample 1 (and in most intraday intervals in Sample 2). A closer look at the data suggests that the lower quantity per trade essentially comes from liquidity providers less willing (or able) to provide liquidity when reserve requirements become binding and when the uncertainty about future liquidity increases. This finding is also consistent with the increase in utilitarian trading observed at the turn of the period. The number of trades (NBTRD) increases on last days in both samples whereas the total quantity

traded (SUMQTY) remains broadly unchanged. Similarly, in Samples 1 and 2, intraday realised volatility (RVOLA) is significantly larger over the last days than over the other days of the RMP whereas the duration between trades (EWTD) and the market spread (EWMS) are significantly lower. Whereas utilitarian trading increases when reserve requirements eventually become binding, market participants also tend to spread their liquidity needs in a larger number of transactions as uncertainty increases, in line with the assumption of risk aversion (notably in terms of interest rate uncertainty) developed in Angelini (2000). With more frequent FTOs, the decrease in the average quantity per trade is mostly confined to the end of the trading day. Additional tests conducted between the last day of the period and the other days support this analysis.

An examination of our proxies for market liquidity between last and non-last days confirms the impact of increased uncertainty associated with information asymmetry on transaction costs at the turn of the period. In Sample 1, quoted spreads (EWQS and EWPQS) significantly widen for every 30-minute interval on the last days of the period, consistent with the increased uncertainty expected around the end of the period. Similarly, larger effective transaction costs, approximated by the effective spreads, are paid by banks transacting on the last days of the period. The timing of operation does not appear to impact effective transaction costs as higher effective spreads are observed throughout the trading day. Although 30-minute proportional traded spreads for buy orders are significantly wider on last days, evidence suggests that 30-minute traded spreads for sell orders are significantly tighter over the morning before becoming significantly wider for most of the afternoon. Liquidity absorbers therefore incur higher costs on last days, whatever their timing of operation, while liquidity providers have an opportunity to transact at lower costs during the morning before facing increased transaction costs over most of the afternoon. In Sample 2, the intraday behaviour of our liquidity measures becomes more homogenous as all measures are now significantly higher for most 30-minute intervals on the last days of the period. Further tests of the intraday behaviour on the last open day of the reserve maintenance period bring similar conclusions. The picture is broadly equivalent between Samples 2a and 2b.

Press conference days. We finally assess the influence of a press conference on the intraday dynamics of the overnight segment. In Sample 1, the null hypothesis of mean equality between press conference days and the other days is rejected for the majority of our market activity variables on the specific intraday intervals corresponding to the timing of the policy announcement or the beginning of the press conference. Trading patterns are therefore altered by the holding of the Governing Council meeting due to the uncertainty surrounding the future path of the key ECB interest rates. Market activity generally decreases over the intervals from 13:30:01 to 14:30:00 on press conference days with significantly lower average quantities (EWQTY) and volumes (SUMQTY) compared with the other days. By contrast, the number of trades (NBTRD) and realised volatility (RVOLA) are significantly higher reflecting the uncertainty surrounding policy decisions. This increased uncertainty also results in a larger trade imbalance (IMBAL). Only the market spread (EWMS) remains unaffected by the holding of the conference. In Sample 2, the null hypothesis of mean equality is however never rejected. Consistent with the nature of the changes, after the implementation of the current operational framework, intraday market dynamics is thus unaffected by the conference. A separate examination of Samples 2a and 2b confirms this analysis.

Spread-based liquidity measures support the finding that the overnight market is impacted by the higher level of uncertainty surrounding press conferences in Sample 1. We conjecture that uncertainty increases the adverse selection component of the spreads. Before 10 March 2004, mixed evidence suggests that quoted spreads are significantly wider at the time of the press conference. However, in the neighbourhood of a press conference, effective spreads do not significantly deviate from the levels observed on the other days. This finding is further confirmed by the traded spreads that fail to provide conclusive evidence of significant deviations caused by the conference. In Sample 2, quoted spreads do not suffer any change due to a press conference. However, after 12 October 2004, effective spreads significantly widen in anticipation of the press conference and this higher level is maintained until the end of the conference. Traded spreads for buy orders significantly tighten around a press conference, while wider traded spreads for sell

orders are observed over most of the trading day. This latter picture is not altered under a regime of more frequent FTOs. Liquidity is thus bought at a lower cost during the press conference but sold at a larger cost over most of the trading day.

5 Concluding remarks

In this paper, we use parametric and nonparametric methods to examine the behaviour of trading activity and market liquidity in the overnight segment of the euro area money market. We first look for evidence of the presence of interday seasonality in the market and assess the statistical significance of the observed regular patterns. In line with theoretical predictions, market activity intensifies when banks exhibit greater sensitivity to liquidity shocks. Market activity peaks on specific days such as the last days of the reserve maintenance period, of which the last day of the period is the most active day, but also at the end of a month or a quarter. Our analysis points out that the rules for the implementation of the monetary policy contained in the Eurosystem's operational framework and the occurrence of specific calendar days alter the proportion of utilitarian traders in the overnight money market. The larger number of trades, the lower average quantities traded, the slightly lower volumes associated with changing market spreads, the higher realised volatility and the lower duration between consecutive transactions indeed demonstrate that utilitarian trading becomes more pronounced. Larger spreads are accordingly observed on last days, with the last open day being the most expensive day of the maintenance period, or at the end of a quarter. Market liquidity therefore deteriorates under the influence of increased uncertainty and information asymmetry between market participants. Liquidity is flat over weekdays, except over the last days where it becomes much more unstable. The introduction of the current operational framework on 10 March 2004 has not radically altered the observed patterns. Market activity has nevertheless improved in Sample 2, coupled with a significantly lower level of volatility while transaction costs have become increasingly unstable between the days of a typical week. A more frequent occurrence of fine-tuning operations (FTOs) has increased the reactiveness of the overnight money market while allowing market liquidity to improve (evidence is

reported of a significant drop of average quoted spreads between Samples 1 and 2, but also, between Samples 2a and 2b).

Second, we examine the statistical significance of regular intraday patterns in the market. We apply similar parametric and nonparametric methods to check the empirical validity of the null hypotheses of equality of our proxies between intraday intervals on specific days. Consistent with Barucci et al. (2004) or Palombini (2003), we find strong evidence supporting the presence of intraday patterns in the activity and liquidity of the market. In spite of its specific features, the intraday dynamics of the overnight money market remains very similar to what is traditionally observed in other market structures (e.g., NYSE or Nasdaq). Market activity fluctuates throughout the day on allotment days, on press conference days and on the last days of a maintenance period. We conjecture that on such days, credit institutions are faced with increased pressure for finding liquidity in the overnight market. Liquidity exhibits similar intraday patterns, with quoted and traded spreads rejecting the null of equality over the day. Although liquidity appears flat over allotment or press conference days, it exhibits greater intraday instability at the turn of the period where effective and traded spreads fluctuate over the day. More frequent FTOs have not altered the existing liquidity conditions: only intraday quoted spreads become more volatile over the last days. Unlike the patterns observed for the other specific days, the intensified market dynamics observed on press conference days (with higher realised volatility and lower volume) does not result in a deterioration of liquidity (i.e., larger transaction costs).

Finally, we examine the stability of the intraday patterns across days. A comparison of market activity and liquidity between last and non-last allotment days suggests that intraday market activity changes between these allotments with lower volumes and less transactions executed on the day of the last MRO allotment of the period. Intraday realised volatility, market spread, trade imbalance and trade duration do not appear significantly different between the two allotments. Market liquidity, on the other hand, deteriorates around the announcement of the outcome of the last MRO of the period. This effect does however disappear after 10 March 2004. We next compare the intraday trading dynamics between

last and non-last days. The increased uncertainty expected around the end of the maintenance period results in significantly lower average quantities traded, more transactions and a higher realised volatility, in line with the assumption of risk aversion for participating banks developed in Angelini (2000). Liquidity deteriorates on last days, with inflated quoted spreads, meaning that larger transaction costs are paid by credit institutions transacting near the end of the period. This result holds true on the last open day of the period. Again, the implementation of the current operational framework has not radically altered the existing liquidity conditions. The examination of the impact of the holding of a press conference on our market activity and liquidity proxies concludes our analysis. Market activity decreases at the time of the conference, with however more trades being executed. Realised volatility similarly increases which highlights the higher level of uncertainty surrounding the press conference. Consistent with the segmentation implied by the current design of the Eurosystem's operational framework, this effect completely vanishes after 10 March 2004. Significantly wider quoted spreads at the time of the conference in Sample 1 denote a deterioration of liquidity conditions. Nevertheless, effective and traded spreads do not confirm this analysis, meaning that, although larger spreads are indeed quoted by banks, effective transaction costs do not deviate from their usual levels. In Sample 2, the situation is reversed, quoted spreads remain stable while evidence suggests that larger costs are indeed paid by credit institutions transacting around the conference, supported by a significant increase in the effective spreads.

In summary, the interday and intraday patterns of trading activity and market liquidity tend to support the expected relations between liquidity provision and uncertainty in the market on specific days or on specific intraday intervals when banks become more sensitive to unexpected shocks. In particular, liquidity decreases, transacting becomes more costly and volatility increases during these periods. The system however continues to operate effectively with limited price impact. As the electronic platform is only one of the channels competing for the provision of liquidity, the observed market dynamics could however simply reflect a consistent use of all possible channels by market participants, possibly switching channels depending on market conditions.

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Table 1: Descriptive Statistics for Aggregate Measures of Market Activity and Liquidity – Full Sample

Aggregate Measures of Market Activity							
Variable	Sub-Sample	Mean	Median	Std Dev.	Max	Min	Obs.
SUMQTY	Buy & Sell	16,734.55	15,884.36	4,850.34	40,764.50	4,015.40	1,703
SUMQTY.b	Buy	4,466.30	4,264.35	1,665.65	14,500.00	530.00	1,703
SUMQTY.s	Sell	12,268.26	11,464.05	4,526.30	38,325.00	3,485.40	1,703
EWQTY	Buy & Sell	38.0502	36.2107	13.9291	93.7115	12.6278	1,703
EWQTY.b	Buy	35.1889	32.1043	14.7067	118.8525	12.1327	1,703
EWQTY.s	Sell	39.0758	36.6904	14.9933	103.5811	11.1766	1,703
NBTRD	Buy & Sell	458.45	453.00	80.42	818.00	148.00	1,703
NBTRD.b	Buy	136.78	129.00	51.45	441.00	19.00	1,703
NBTRD.s	Sell	321.67	319.00	58.18	575.00	110.00	1,703
RVOLA	Buy & Sell	0.0706	0.0088	0.2717	4.2191	0.0012	1,703
EWTD	Buy & Sell	72.5390	70.8980	14.7520	197.8364	40.8595	1,703
EWMS	Buy & Sell	0.0631	0.0598	0.1258	0.9929	-0.6946	1,703
EWDPE	Buy & Sell	-0.0062	-0.0046	0.0191	0.2019	-0.2241	1,703
IMBAL	Buy & Sell	-7,801.96	-7,134.19	4,795.59	6,421.89	-35,885.50	1,703

Aggregate Measures of Market Liquidity							
Variable	Sub-Sample	Mean	Median	Std Dev.	Max	Min	Obs.
EWQS	Buy & Sell	0.0702	0.0726	0.0223	0.1709	0.0216	1,637
EWPQS	Buy & Sell	2.6042	2.5644	0.9736	8.8040	0.6508	1,637
EWES	Buy & Sell	0.0061	0.0024	0.0221	0.2640	-0.1483	1,637
SWES	Buy & Sell	0.0024	0.0003	0.0180	0.2422	-0.1465	1,637
EWPES	Buy & Sell	0.1967	0.0883	0.7563	9.0669	-4.3791	1,637
SWPES	Buy & Sell	0.0716	0.0092	0.5731	7.0127	-2.6117	1,637
EWTS.b	Buy	0.0145	0.0119	0.0213	0.2464	-0.1536	1,637
SWTS.b	Buy	0.0141	0.0120	0.0193	0.2520	-0.1428	1,637
EWTS.s	Sell	-0.0018	-0.0034	0.0208	0.2372	-0.1771	1,637
SWTS.s	Sell	-0.0037	-0.0045	0.0159	0.2084	-0.1416	1,637
EWPTS.b	Buy	0.5600	0.4464	0.8522	13.2696	-4.4288	1,637
SWPTS.b	Buy	0.5332	0.4479	0.6624	8.1349	-4.1284	1,637
EWPTS.s	Sell	-0.0901	-0.1269	0.6948	6.8706	-5.6551	1,637
SWPTS.s	Sell	-0.1495	-0.1732	0.4973	6.0331	-3.0504	1,637

SUMQTY is the total volume exchanged over a day, SUMQTY.b (SUMQTY.s) is the total volume exchange through buy (sell) orders over a day. EWQTY is the average volume per trade, EWQTY.b (EWQTY.s) is the average volume per buy (sell) trade. NBTRD is the total number of trades over a day, NBTRD.b (NBTRD.s) is the total number of buy (sell) trades over a day. RVOLA is our realised volatility measure. EWTD is the average duration (time) between two consecutive trades. EWMS is the average market spread per trade. EWDPE is the average deviation of the transaction price from the EONIA of the corresponding day. IMBAL is an indicator of the imbalance between buy and sell orders. SUMQTY, SUMQTY.b, SUMQTY.s, EWQTY, EWQTY.s, EWQTY.s and IMBAL are expressed in millions of EUR. EW(P)QS is the equally-weighted average (proportional) quoted spread. EW(P)ES is the equally-weighted average (proportional) effective spread. SW(P)ES is the size-weighted average (proportional) effective spread. EW(P)TS.b is the equally-weighted average (proportional) traded spread for buy trades and EW(P)TS.s is the equally-weighted average (proportional) traded spread for sell trades. SW(P)TS.b is the size-weighted average (proportional) traded spread for buy trades and SW(P)TS.s is the size-weighted (proportional) traded spread for sell trades.

Table 2: Pairwise Correlations for Aggregate Measures of Market Activity and Liquidity – Full Sample

	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	EWQS	EWPQS	EWES
EWQTY	0.8762									
NBTRD	-0.2321	-0.6338								
RVOLA	-0.1079	-0.2009	0.3394							
EWTD	0.1145	0.5487	-0.9029	-0.2232						
EWMS	-0.0289	-0.0175	0.0193	0.0223	0.0313					
EWDPE	0.1078	0.1693	-0.2152	-0.2211	0.1676	0.0443				
EWQS	-0.5436	-0.6876	0.5856	0.3832	-0.4488	0.1227	-0.2423			
EWPQS	-0.1363	-0.2461	0.2302	0.3090	-0.2207	-0.1464	-0.1294	0.5819		
EWES	-0.1718	-0.2710	0.3763	0.5865	-0.2885	0.0352	-0.5961	0.3850	0.1869	
SWES	-0.1340	-0.2079	0.2946	0.4302	-0.2323	-0.0035	-0.5720	0.2723	0.1553	0.8999
EWPES	-0.1500	-0.2451	0.3223	0.5576	-0.2493	-0.0101	-0.5976	0.3514	0.2479	0.9293
SWPES	-0.1482	-0.2184	0.2687	0.4367	-0.2080	-0.0030	-0.5595	0.2851	0.1954	0.8680
EWTS.b	-0.0711	-0.0757	0.0623	0.2396	-0.0172	0.0969	0.6024	0.1642	0.1193	-0.2609
SWTS.b	-0.0926	-0.1126	0.1121	0.2697	-0.0531	0.1692	0.5269	0.2217	0.1130	-0.2001
EWTS.s	-0.0686	-0.1434	0.2548	0.3893	-0.1952	-0.0415	-0.7750	0.1961	0.1074	0.8301
SWTS.s	-0.0168	-0.0637	0.1567	0.2336	-0.1280	-0.1108	-0.6875	0.0804	0.0692	0.7275
EWPTS.b	0.0223	-0.0020	0.0385	0.3017	-0.0168	-0.1064	0.5087	0.0923	0.3198	-0.2324
SWPTS.b	0.0191	-0.0198	0.0741	0.3114	-0.0428	-0.0286	0.4956	0.1379	0.3249	-0.2154
EWPTS.s	-0.1002	-0.1665	0.2360	0.3448	-0.1799	0.0152	-0.7572	0.2159	0.0592	0.8049
SWPTS.s	-0.0768	-0.1176	0.1667	0.2291	-0.1281	-0.0326	-0.6827	0.1331	0.0001	0.7358

Table 3: Pairwise Correlations for Aggregate Measures of Market Activity and Liquidity – Full Sample *(continued)*

	SWES	EWPES	SWPES	EWTS.b	SWTS.b	EWTS.s	SWTS.s	EWPTS.b	SWPTS.b	EWPTS.s
EWQTY										
NBTRD										
RVOLA										
EWTD										
EWMS										
EWDPE										
EWQS										
EWPQS										
EWES										
SWES										
EWPES	0.8067									
SWPES	0.9392	0.8880								
EWTS.b	-0.3659	-0.2474	-0.3206							
SWTS.b	-0.3135	-0.1938	-0.2605	0.9383						
EWTS.s	0.8209	0.7822	0.7783	-0.6773	-0.6037					
SWTS.s	0.8279	0.6683	0.7694	-0.7155	-0.6941	0.9386				
EWPTS.b	-0.2656	-0.2208	-0.2562	0.8633	0.7378	-0.5386	-0.5246			
SWPTS.b	-0.2543	-0.2068	-0.2331	0.8657	0.8771	-0.5350	-0.5739	0.9079		
EWPTS.s	0.7408	0.8560	0.7956	-0.6338	-0.5378	0.9295	0.8386	-0.6198	-0.5849	
SWPTS.s	0.7833	0.7569	0.8212	-0.6689	-0.6248	0.8982	0.9294	-0.6082	-0.6368	0.9300

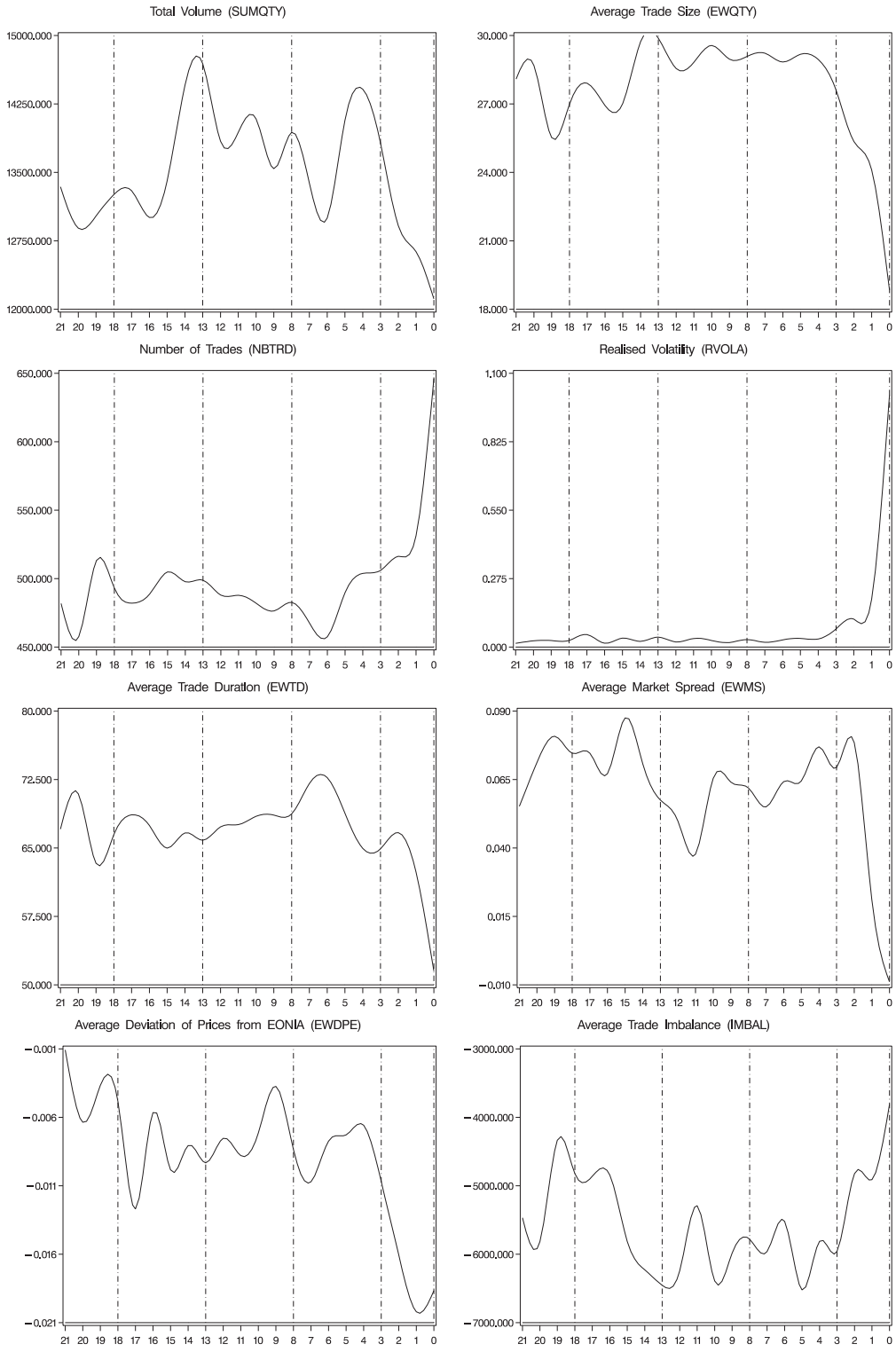

Figure 1: Interday Patterns for Aggregate Measures of Market Activity – Before 10 March 2004 (Sample 1). The vertical dashed lines denote the MRO allotment days.

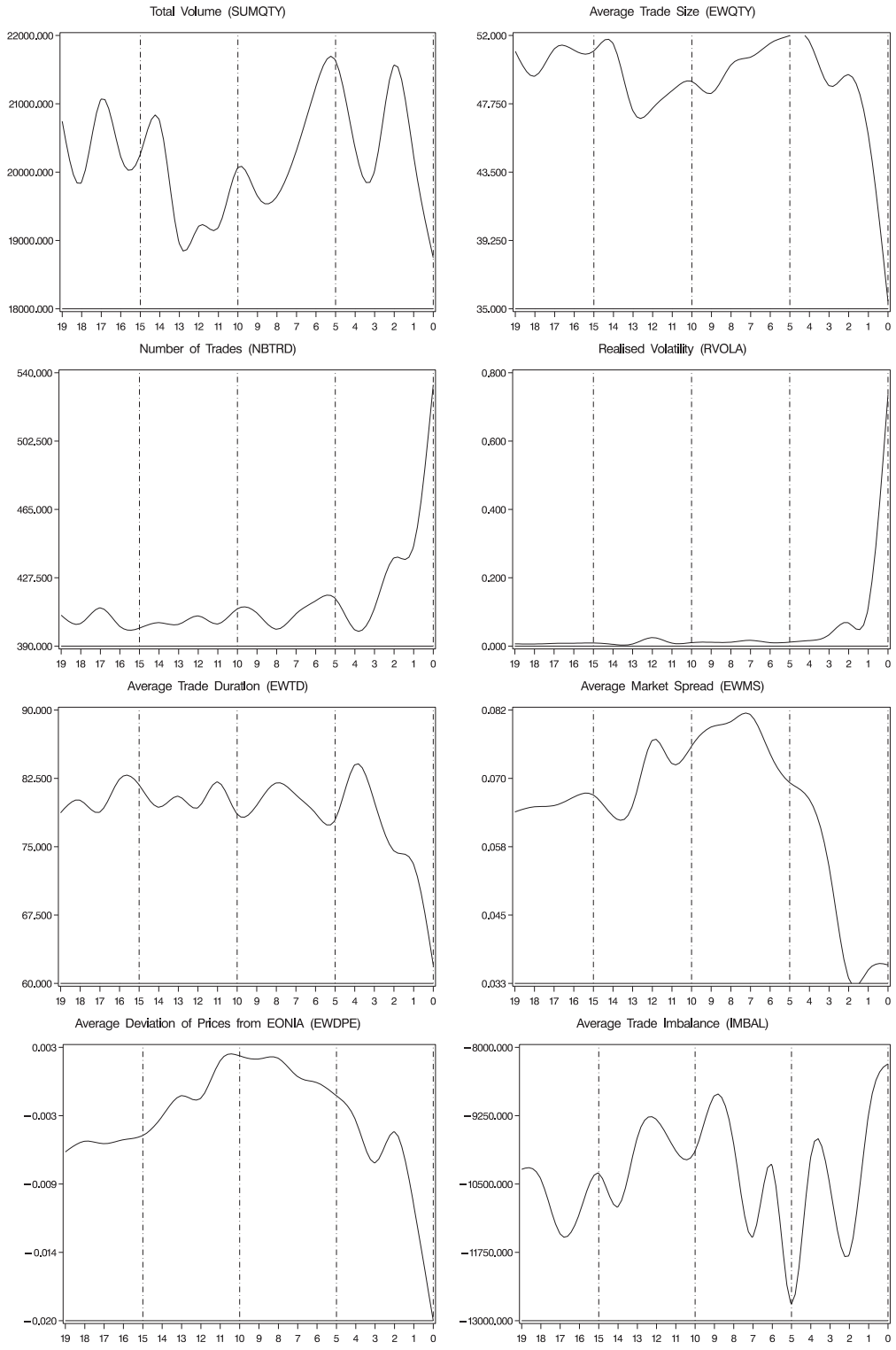

Figure 2: Interday Patterns for Aggregate Measures of Market Activity – After 10 March 2004 (Sample 2). The vertical dashed lines denote the MRO allotment days.

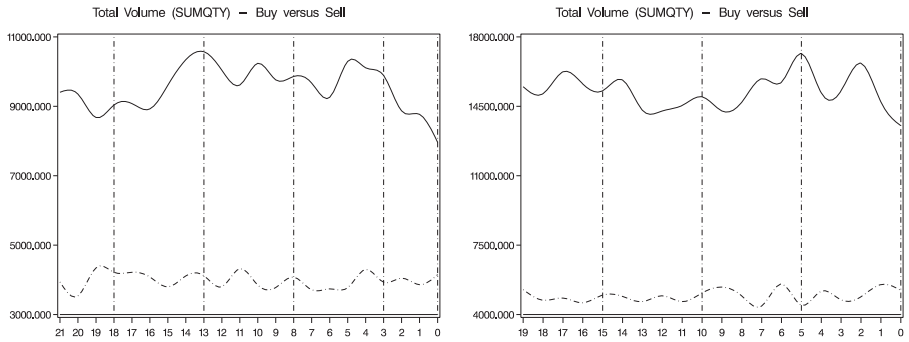

Figure 3: Interday Patterns for Total Volume of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the volume of sell (buy) trades over a typical RMP. The vertical dashed lines denote the MRO allotment days.

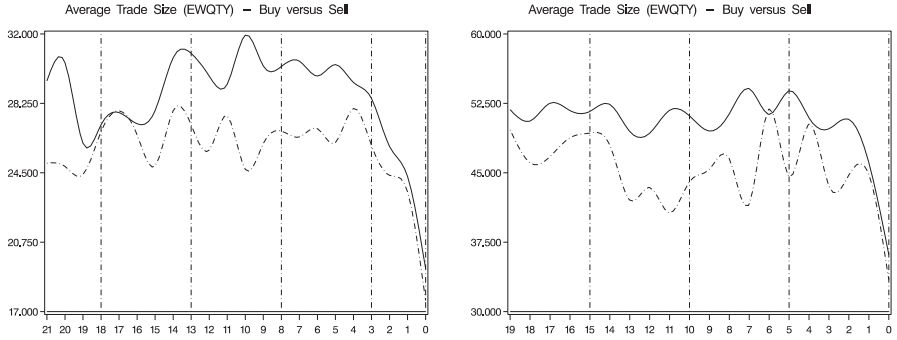

Figure 4: Interday Patterns for Average Size of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the average size of sell (buy) trades over a typical RMP. The vertical dashed lines denote the MRO allotment days.

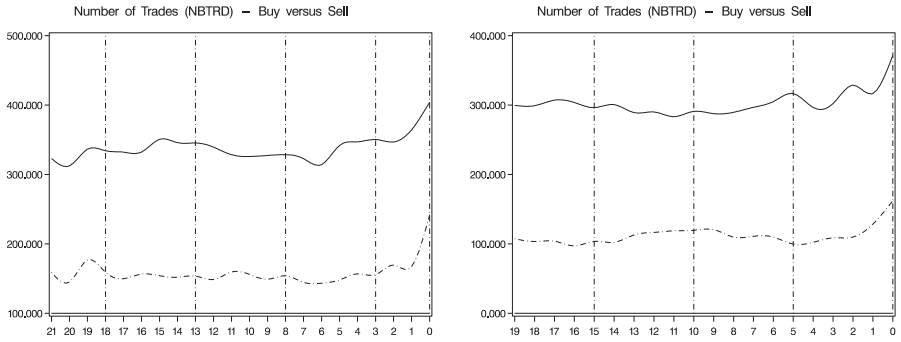

Figure 5: Interday Patterns for the Number of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the number of sell (buy) trades over a typical RMP. The vertical dashed lines denote the MRO allotment days.

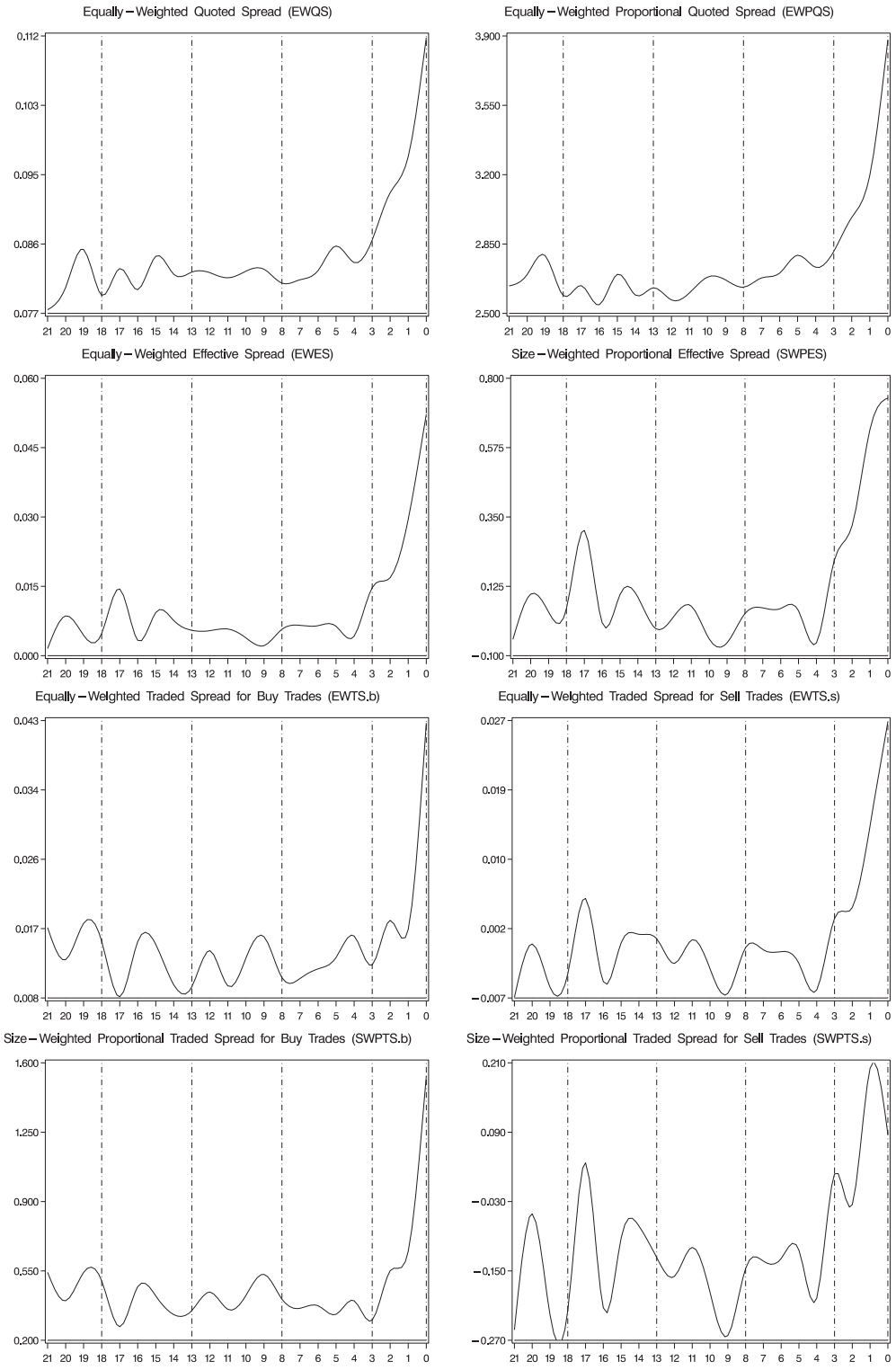

Figure 6: Interday Patterns for Aggregate Measures of Market Liquidity – Before 10 March 2004 (Sample 1). The vertical dashed lines denote the MRO allotment days.

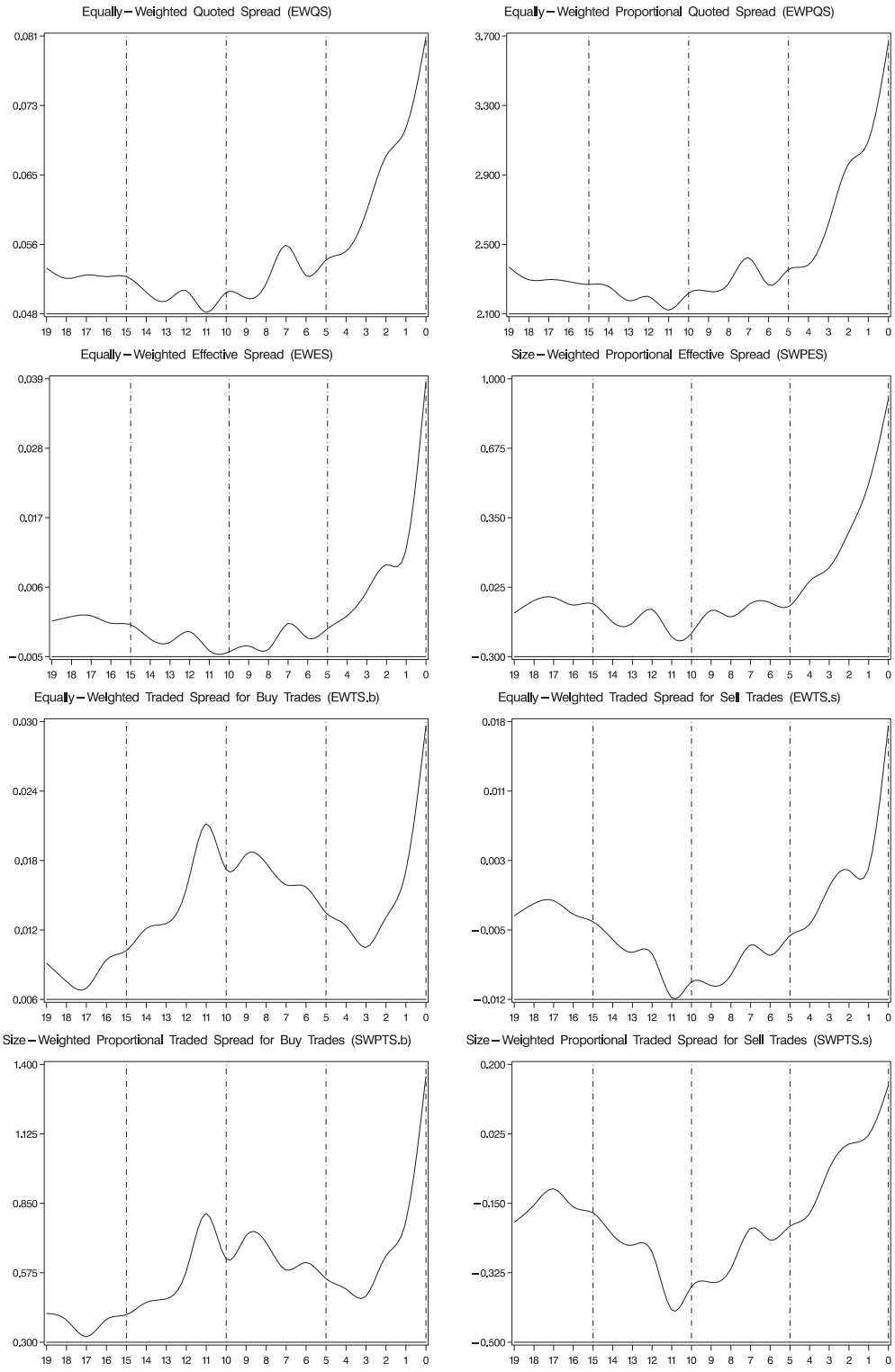

Figure 7: Interday Patterns for Aggregate Measures of Market Liquidity – After 10 March 2004 (Sample 2). The vertical dashed lines denote the MRO allotment days.

Table 4: Mean, Median, and Variance Values for Aggregate Measures of Market Activity – Before 10 March 2004 (Sample 1)

	Conditional Mean Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Mean	13,566.14	27.7207	498.7564	0.0873	66.5652	0.0612	-0.0090	-5,524.010
Allotment Days	13,888.17	27.9322	504.4946	0.1219	65.5966	0.0769	-0.0083	-5,591.571
Last Days	12,762.13	23.3703	559.8258	0.4060	60.3764	0.0240	-0.0175	-4,739.827
Last Day of RMP	12,202.33	19.0320	644.8333	0.9913	51.5000	-0.0080	-0.0172	-3,688.095
5 Days before Press Conference	13,473.63	27.5128	498.2683	0.0782	66.5649	0.0686	-0.0089	-5,744.527
Day of Press Conference	13,209.60	26.8883	497.2241	0.0914	66.0205	0.0351	-0.0135	-5,051.052
End of Month	13,078.73	25.5961	520.7143	0.1081	63.1448	0.1534	-0.0204	-5,131.194
End of Quarter	12,416.86	21.8155	574.7857	0.2606	57.0507	0.2558	-0.0362	-4,719.866
End of Year	13,248.76	21.7138	621.5000	0.6846	52.9804	0.4202	-0.0999	-5,151.545

	Conditional Median Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Median	13,309.30	26.6886	497.0000	0.0103	65.0159	0.0456	-0.0074	-5,419.340
Allotment Days	13,604.50	27.0023	502.5000	0.0104	64.5239	0.0473	-0.0076	-5,429.800
Last Days	12,424.90	22.4120	557.0000	0.1313	58.9835	0.0085	-0.0164	-4,829.300
Last Day of RMP	11,632.28	18.1095	642.5000	0.6787	50.6461	0.0284	-0.0099	-3,010.350
5 Days before Press Conference	13,186.21	26.2144	497.0000	0.0105	64.8540	0.0472	-0.0082	-5,655.850
Day of Press Conference	13,086.30	26.0580	490.0000	0.0118	66.2607	0.0291	-0.0095	-4,786.325
End of Month	12,578.78	23.8867	516.0000	0.0295	62.2678	0.1042	-0.0144	-5,021.480
End of Quarter	12,190.00	21.6162	575.5000	0.1036	57.7254	0.2373	-0.0225	-4,393.645
End of Year	13,126.50	21.9944	638.0000	0.6808	52.1935	0.4250	-0.0736	-5,264.715

	Conditional Standard Deviation Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Standard Deviation	2,689.535	6.4259	76.5992	0.3159	12.9576	0.1615	0.0231	3,029.576
Allotment Days	2,893.451	6.5467	73.4368	0.4920	9.8390	0.1646	0.0206	3,221.227
Last Days	2,627.537	5.8691	96.5578	0.7071	14.8201	0.3260	0.0389	3,728.046
Last Day of RMP	2,782.958	4.3102	69.4754	1.0029	5.6414	0.3886	0.0586	3,938.409
5 Days before Press Conference	2,855.818	6.7838	72.2495	0.3274	11.6220	0.1484	0.0187	3,076.133
Day of Press Conference	2,447.361	5.8689	57.6192	0.3199	6.9631	0.1413	0.0183	2,867.827
End of Month	2,337.356	6.0808	71.2222	0.2190	8.1475	0.1215	0.0377	2,077.793
End of Quarter	1,258.225	2.8915	64.6912	0.3350	5.3149	0.1602	0.0611	2,080.581
End of Year	2,086.841	4.8880	87.5233	0.3640	4.1144	0.1359	0.0860	2,379.165

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. SUMQTY, EWQTY and IMBAL are expressed in millions of EUR.

Table 5: Mean, Median, and Variance Values for Aggregate Measures of Market Activity – After 10 March 2004 (Sample 2)

	Conditional Mean Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Mean	20,244.12	49.4920	413.8032	0.0521	79.1560	0.0652	-0.0032	-10,325.18
Allotment Days	20,241.21	47.4428	436.2744	0.1735	75.6374	0.0630	-0.0056	-10,430.09
Last Days	20,181.15	46.1604	445.9945	0.1951	74.5263	0.0449	-0.0090	-9,944.813
Last Day of RMP	18,747.25	35.4661	533.4054	0.7352	62.0355	0.0363	-0.0200	-8,305.026
5 Days before Press Conference	20,712.80	50.7577	410.9297	0.0208	79.9639	0.0702	-0.0023	-10,766.54
Day of Press Conference	20,128.09	48.8363	412.6486	0.0370	79.7586	0.0568	-0.0065	-10,031.33
End of Month	18,095.63	43.0706	420.3947	0.0435	77.7207	0.1025	-0.0038	-9,129.851
End of Quarter	16,014.90	36.6212	435.8462	0.0833	74.2806	0.1341	-0.0038	-8,686.056
End of Year	14,917.45	33.4995	439.0000	0.2091	72.8890	0.1633	-0.0242	-7,758.100

	Conditional Median Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Median	19,871.70	48.0644	414.5000	0.0068	77.3693	0.0710	-0.0028	-9,879.900
Allotment Days	19,724.34	47.3459	424.5000	0.0076	75.0957	0.0692	-0.0032	-10,081.33
Last Days	19,736.35	44.9128	440.0000	0.0307	72.5261	0.0461	-0.0050	-9,660.470
Last Day of RMP	18,519.98	34.5684	530.0000	0.5742	60.8544	0.0140	-0.0181	-8,098.340
5 Days before Press Conference	20,646.20	49.2986	419.0000	0.0089	76.9639	0.0699	-0.0017	-10,774.30
Day of Press Conference	19,899.31	47.5653	416.0000	0.0095	77.9561	0.0560	-0.0047	-8,367.590
End of Month	17,932.05	43.5431	425.5000	0.0150	76.9029	0.0940	-0.0037	-9,598.140
End of Quarter	16,089.29	35.6778	431.0000	0.0562	72.7919	0.1388	-0.0046	-7,766.750
End of Year	16,089.29	33.4497	481.0000	0.2403	67.5125	0.1776	-0.0107	-8,885.890

	Conditional Standard Deviation Values							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Standard Deviation	4,258.843	10.6790	57.8026	0.2109	13.7681	0.0668	0.0125	5,119.168
Allotment Days	3,998.263	11.0806	71.0103	0.4329	11.7864	0.1140	0.0193	5,195.921
Last Days	4,324.830	11.0577	70.0219	0.4112	15.3160	0.1283	0.0220	6,140.872
Last Day of RMP	3,161.127	6.7849	53.3065	0.6547	5.9521	0.2349	0.0356	4,848.590
5 Days before Press Conference	4,593.425	10.4449	56.1217	0.0455	14.9933	0.0433	0.0096	6,037.219
Day of Press Conference	4,857.551	9.7442	53.0661	0.0791	14.4324	0.0696	0.0142	6,421.696
End of Month	3,868.852	7.6876	53.3598	0.0726	10.8040	0.0417	0.0118	3,569.191
End of Quarter	3,029.736	5.4402	45.3502	0.0975	7.0181	0.0423	0.0180	3,184.903
End of Year	4,501.562	3.8355	90.6201	0.1411	13.0819	0.0441	0.0251	3,868.481

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. SUMQTY, EWQTY and IMBAL are expressed in millions of EUR.

Table 6: Summary Significance of Mean Equality for Aggregate Measures of Market Activity

	Before 10 March 2004 (Sample 1)							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Mean	13,566.14	27.7207	498.7564	0.0873	66.5652	0.0612	−0.0090	−5,524.010
Allotment Days	+	=	=	+	=	=	=	=
Last Days	− − −	− − −	+ + +	+ + +	− − −	− − −	− − −	+ + +
Last Day of RMP	− − −	− − −	+ + +	+ + +	− − −	− − −	−−	+ + +
5 Days before Press Conference	=	=	=	=	=	=	=	=
Day of Press Conference	=	=	=	=	=	=	=	=
End of Month	=	−−	+	=	−	+ + +	− − −	=
End of Quarter	=	− − −	+ + +	++	− − −	+ + +	− − −	=

	After 10 March 2004 (Sample 2)							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Overall Mean	20,244.12	49.4920	413.8032	0.0521	79.1560	0.0652	−0.0032	−10,325.18
Allotment Days	=	− − −	+ + +	+ + +	− − −	=	− − −	=
Last Days	=	− − −	+ + +	+ + +	− − −	− − −	− − −	=
Last Day of RMP	−−	− − −	+ + +	+ + +	− − −	− − −	− − −	++
5 Days before Press Conference	+	+	=	−−	=	=	=	=
Day of Press Conference	=	=	=	=	=	=	−	=
End of Month	− − −	− − −	=	=	=	+ + +	=	=
End of Quarter	− − −	− − −	=	=	=	+ + +	=	=

+ + +, ++ and + denote a significant increase in the measure on the corresponding day at the 1%, 5% and 10% levels, respectively. Similarly, − − −, −− and − denote a significant decrease in the measure at the 1%, 5% and 10%, respectively. Finally, = denotes no significant change in the measure.

Table 7: Mean, Median, and Variance Values for Aggregate Measures of Market Liquidity – Before 10 March 2004 (Sample 1)

	Conditional Mean Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Mean	0.0847	2.7858	0.0100	0.1297	0.0147	0.0004	0.4836	-0.1068
Allotment Days	0.0839	2.7360	0.0110	0.1328	0.0149	0.0010	0.4953	-0.1145
Last Days	0.0989	3.3846	0.0300	0.5387	0.0237	0.0138	0.8477	0.0902
Last Day of RMP	0.1112	3.8984	0.0513	0.7309	0.0420	0.0262	1.5051	0.0867
5 Days before Press Conference	0.0862	2.5683	0.0097	0.1143	0.0150	0.0001	0.4387	-0.0972
Day of Press Conference	0.0870	2.6238	0.0116	0.1511	0.0097	0.0053	0.3244	-0.0093
End of Month	0.0917	2.8793	0.0182	0.3740	0.0133	0.0065	0.3730	0.0903
End of Quarter	0.1112	3.3830	0.0416	0.9107	0.0125	0.0234	0.2655	0.5245
End of Year	0.1445	4.1991	0.1067	2.3281	-0.0280	0.0854	-1.0602	2.0894

	Conditional Median Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Median	0.0822	2.6367	0.0045	0.0411	0.0116	-0.0023	0.3987	-0.1549
Allotment Days	0.0819	2.6406	0.0043	0.0311	0.0111	-0.0026	0.3961	-0.1718
Last Days	0.0915	3.0218	0.0185	0.4268	0.0148	0.0072	0.4223	0.0948
Last Day of RMP	0.1098	3.3914	0.0411	0.6987	0.0271	0.0226	0.9459	0.1859
5 Days before Press Conference	0.0825	2.4979	0.0045	0.0374	0.0121	-0.0024	0.3757	-0.1426
Day of Press Conference	0.0832	2.5243	0.0080	0.1560	0.0106	0.0007	0.3106	-0.0870
End of Month	0.0849	2.5879	0.0051	0.1540	0.0170	-0.0030	0.4584	-0.1502
End of Quarter	0.0985	3.0645	0.0284	0.5092	0.0240	-0.0041	0.7719	-0.0213
End of Year	0.1454	4.0727	0.0606	0.9917	-0.0166	0.0555	-0.5116	1.2220

	Conditional Standard Deviation Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Standard Deviation	0.0161	0.8746	0.0270	0.6369	0.0265	0.0265	0.7691	0.5979
Allotment Days	0.0163	0.8570	0.0269	0.6321	0.0301	0.0277	0.8238	0.5845
Last Days	0.0216	1.2667	0.0475	1.0222	0.0444	0.0442	1.5053	1.0072
Last Day of RMP	0.0199	1.5559	0.0613	1.3139	0.0655	0.0645	2.1904	1.4481
5 Days before Press Conference	0.0180	0.7386	0.0249	0.5407	0.0244	0.0246	0.5344	0.4798
Day of Press Conference	0.0164	0.8016	0.0268	0.4528	0.0184	0.0316	0.4126	0.5000
End of Month	0.0211	0.8537	0.0451	1.1755	0.0353	0.0433	0.9194	1.1048
End of Quarter	0.0269	1.0320	0.0717	1.9141	0.0577	0.0699	1.5604	1.8104
End of Year	0.0183	1.0489	0.1053	3.1395	0.0957	0.1061	2.3337	2.7823

Note that, to preserve space, we do not report mean, median and standard deviation values for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those results remain available upon request.

Table 8: Mean, Median, and Variance Values for Aggregate Measures of Market Liquidity – After 10 March 2004 (Sample 2)

	Conditional Mean Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Mean	0.0553	2.4155	0.0020	0.0112	0.0144	-0.0040	0.5848	-0.1939
Allotment Days	0.0584	2.5678	0.0076	0.1249	0.0171	-0.0008	0.7144	-0.1549
Last Days	0.0669	2.9512	0.0137	0.3788	0.0166	0.0037	0.7547	-0.0115
Last Day of RMP	0.0808	3.6613	0.0386	0.9059	0.0296	0.0176	1.3536	0.1471
5 Days before Press Conference	0.0561	2.4330	0.0014	0.0219	0.0135	-0.0040	0.5512	-0.1695
Day of Press Conference	0.0614	2.6798	0.0072	0.1797	0.0100	0.0014	0.4599	-0.0310
End of Month	0.0605	2.5765	0.0039	0.0924	0.0174	-0.0044	0.7084	-0.1748
End of Quarter	0.0676	2.8014	0.0084	0.2332	0.0232	-0.0036	0.8427	-0.1075
End of Year	0.0762	2.9892	0.0263	0.7188	0.0257	0.0096	0.7507	0.2110

	Conditional Median Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Median	0.0549	2.4511	0.0000	-0.0232	0.0123	-0.0047	0.4866	-0.1862
Allotment Days	0.0554	2.5091	0.0011	0.0015	0.0130	-0.0034	0.5114	-0.1414
Last Days	0.0662	3.0286	0.0073	0.2386	0.0130	0.0008	0.5959	-0.0390
Last Day of RMP	0.0801	3.7274	0.0309	0.7214	0.0222	0.0135	0.9486	0.1737
5 Days before Press Conference	0.0551	2.5398	0.0012	0.0022	0.0126	-0.0045	0.4865	-0.1746
Day of Press Conference	0.0634	2.7806	0.0051	0.1726	0.0112	-0.0009	0.4406	-0.0513
End of Month	0.0598	2.6811	0.0029	0.0064	0.0174	-0.0045	0.6632	-0.1859
End of Quarter	0.0676	3.1569	0.0045	0.1143	0.0275	-0.0074	0.8240	-0.1859
End of Year	0.0750	3.4774	0.0292	0.8993	0.0327	0.0073	1.1987	0.2532

	Conditional Standard Deviation Values							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Standard Deviation	0.0175	1.0341	0.0144	0.4916	0.0139	0.0119	0.5250	0.3595
Allotment Days	0.0194	1.1771	0.0224	0.6802	0.0204	0.0167	0.7825	0.4658
Last Days	0.0172	1.1637	0.0228	0.7405	0.0209	0.0173	0.8161	0.4980
Last Day of RMP	0.0169	1.3925	0.0287	0.9978	0.0367	0.0245	1.3382	0.7835
5 Days before Press Conference	0.0141	0.8690	0.0112	0.3983	0.0101	0.0099	0.3582	0.3004
Day of Press Conference	0.0157	0.9686	0.0176	0.5631	0.0111	0.0139	0.3770	0.3774
End of Month	0.0126	0.8025	0.0103	0.3814	0.0102	0.0078	0.3940	0.2622
End of Quarter	0.0107	0.8260	0.0131	0.4580	0.0130	0.0094	0.4633	0.2486
End of Year	0.0093	0.9975	0.0133	0.5375	0.0217	0.0039	0.7896	0.0788

Note that, to preserve space, we do not report mean, median and standard deviation values for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those results remain available upon request.

Table 9: Summary Significance of Mean Equality for Aggregate Measures of Market Liquidity

	Before 10 March 2004 (Sample 1)							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Mean	0.0847	2.7858	0.0100	0.1297	0.0147	0.0004	0.4836	−0.1068
Allotment Days	=	=	=	=	=	=	=	=
Last Days	+++	+++	+++	+++	+++	+++	+++	+++
Last Day of RMP	+++	+++	+++	+++	+++	+++	+++	++
5 Days before Press Conference	+	−−−	=	=	=	=	=	=
Day of Press Conference	=	=	=	=	=	=	=	=
End of Month	+++	=	++	++	=	=	=	++
End of Quarter	+++	++	+++	+++	=	+++	=	+++

	After 10 March 2004 (Sample 2)							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Overall Mean	0.0553	2.4155	0.0020	0.0112	0.0144	−0.0040	0.5848	−0.1939
Allotment Days	+++	++	+++	+++	+++	+++	+++	=
Last Days	+++	+++	+++	+++	++	+++	+++	+++
Last Day of RMP	+++	+++	+++	+++	+++	+++	+++	+++
5 Days before Press Conference	=	=	=	=	=	=	=	=
Day of Press Conference	++	=	++	++	−−	+++	=	+++
End of Month	+	=	=	=	=	=	=	=
End of Quarter	+++	=	=	=	++	=	+	=

+ + +, ++ and + denote a significant increase in the measure on the corresponding day at the 1%, 5% and 10% levels, respectively. Similarly, − − −, −− and − denote a significant decrease in the measure. Finally, = denotes no significant change in the measure.

Table 10: Mean, Median, and Variance Equality Tests for Last Days – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	14.039^{***}	77.000^{***}	110.468^{***}	191.003^{***}	36.733^{***}	8.270^{***}	21.447^{***}	10.484^{***}
Median Tests								
Wilcoxon-Mann-Whitney	3.914^{***}	8.635^{***}	8.633^{***}	13.877^{***}	8.295^{***}	5.274^{***}	4.416^{***}	2.950^{***}
Median Chi-Square	12.733^{***}	33.999^{***}	38.882^{***}	111.765^{***}	31.834^{***}	11.423^{***}	10.184^{***}	2.927^{*}
Kruskal-Wallis	15.319^{***}	74.566^{***}	74.525^{***}	192.564^{***}	68.815^{***}	27.816^{***}	19.505^{***}	8.703^{***}
van der Waerden	14.700^{***}	92.705^{***}	93.144^{***}	206.936^{***}	85.564^{***}	34.832^{***}	18.558^{***}	10.726^{***}
Variance Tests								
Siegel-Tukey	0.915	4.789^{***}	7.434^{***}	9.863^{***}	6.526^{***}	10.537^{***}	9.202^{***}	4.227^{***}
Bartlett	0.078	0.728	34.365^{***}	$1,329.419^{***}$	8.399^{***}	396.350^{***}	161.823^{***}	17.063^{***}
Levene	0.455	0.720	31.212^{***}	348.566^{***}	1.404	176.397^{***}	106.061^{***}	20.084^{***}
Brown-Forsythe	0.536	0.462	31.047^{***}	168.701^{***}	1.399	176.180^{***}	105.787^{***}	20.035^{***}

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	129.252^{***}	73.532^{***}	87.701^{***}	64.018^{***}	16.940^{***}	38.739^{***}	33.602^{***}	15.937^{***}
Median Tests								
Wilcoxon-Mann-Whitney	9.087^{***}	6.054^{***}	8.252^{***}	7.806^{***}	1.541	5.887^{***}	1.619	5.176^{***}
Median Chi-Square	48.474^{***}	16.031^{***}	50.820^{***}	40.292^{***}	2.146	28.848^{***}	0.467	22.897^{***}
Kruskal-Wallis	82.573^{***}	36.657^{***}	68.097^{***}	60.930^{***}	2.377	34.658^{***}	2.621	26.792^{***}
van der Waerden	89.784^{***}	49.471^{***}	64.182^{***}	58.602^{***}	3.473^{*}	32.655^{***}	5.648^{**}	22.773^{***}
Variance Tests								
Siegel-Tukey	3.761^{***}	1.840^{*}	8.660^{***}	7.491^{***}	6.761^{***}	7.113^{***}	5.774^{***}	6.863^{***}
Bartlett	56.209^{***}	75.616^{***}	231.680^{***}	132.950^{***}	145.186^{***}	151.837^{***}	340.237^{***}	148.663^{***}
Levene	68.138^{***}	55.880^{***}	134.020^{***}	79.873^{***}	76.642^{***}	87.883^{***}	117.610^{***}	63.507^{***}
Brown-Forsythe	48.027^{***}	43.158^{***}	109.532^{***}	73.194^{***}	61.919^{***}	75.202^{***}	77.513^{***}	63.603^{***}

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 11: Mean, Median, and Variance Equality Tests for Last Days – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	0.052	23.674***	80.617***	125.657***	27.634***	22.576***	54.500***	1.307
Median Tests								
Wilcoxon-Mann-Whitney	0.192	4.730***	8.183***	13.441***	7.553***	5.499***	4.988***	0.776
Median Chi-Square	0.177	11.875***	39.738***	104.988***	26.287***	16.962***	7.693***	0.064
Kruskal-Wallis	0.037	22.377***	66.960***	180.662***	57.048***	30.242***	24.879***	0.602
van der Waerden	0.066	30.537***	77.324***	189.890***	67.387***	31.377***	31.112***	2.375
Variance Tests								
Siegel-Tukey	0.814	3.732***	3.891***	9.439***	4.155***	11.200***	7.653***	4.516***
Bartlett	0.104	1.173	35.751***	2,503.269***	8.124***	798.280***	465.312***	19.265***
Levene	0.282	2.109	19.590***	356.976***	1.374	177.481***	143.255***	20.190***
Brown-Forsythe	0.233	2.342	18.881***	119.449***	1.383	177.356***	113.771***	20.229***

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	119.761***	68.993***	193.613***	158.601***	6.040**	113.844***	25.590***	65.925***
Median Tests								
Wilcoxon-Mann-Whitney	9.749***	7.257***	10.437***	10.176***	0.914	7.847***	2.760***	7.087***
Median Chi-Square	61.513***	18.573***	56.348***	53.850***	0.603	28.294***	2.101	24.827***
Kruskal-Wallis	95.040***	52.672***	108.940***	103.546***	0.836	61.574***	7.618***	50.231***
van der Waerden	103.037***	64.999***	122.112***	115.065***	0.332	76.498***	9.219***	58.685***
Variance Tests								
Siegel-Tukey	2.758***	3.520***	7.667***	7.919***	5.825***	6.516***	4.043***	5.452***
Bartlett	1.426	14.230***	404.281***	252.098***	143.249***	170.191***	190.628***	102.043***
Levene	0.957	12.053***	174.425***	100.695***	52.664***	87.494***	51.436***	29.114***
Brown-Forsythe	0.931	11.959***	127.149***	83.090***	46.080***	71.370***	40.372***	28.405***

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 12: Mean, Median, and Variance Equality Tests for MRO Allotment Days – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	3.329*	0.251	1.300	2.776*	1.295	2.194	0.210	0.115
Median Tests								
Wilcoxon-Mann-Whitney	1.544	0.549	0.702	0.459	0.550	1.181	0.106	0.139
Median Chi-Square	2.267	1.381	1.381	0.000	3.250*	0.461	0.022	0.022
Kruskal-Wallis	2.384	0.301	0.492	0.211	0.302	1.396	0.011	0.019
van der Waerden	2.718*	0.385	0.709	0.018	0.376	2.132	0.037	0.087
Variance Tests								
Siegel-Tukey	1.066	0.977	0.410	0.208	0.771	1.169	0.495	1.181
Bartlett	2.748*	0.155	0.777	163.749***	27.146***	0.182	5.351**	1.812
Levene	2.389	0.060	0.429	10.697***	1.622	0.000	0.313	1.714
Brown-Forsythe	2.282	0.100	0.436	2.801*	1.576	0.245	0.234	1.600

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	0.445	0.702	0.299	0.005	0.026	0.126	0.050	0.036
Median Tests								
Wilcoxon-Mann-Whitney	0.831	0.557	0.288	0.255	0.693	0.214	0.396	0.235
Median Chi-Square	0.673	0.117	0.732	0.117	0.029	0.732	0.000	0.117
Kruskal-Wallis	0.691	0.310	0.083	0.065	0.480	0.046	0.157	0.055
van der Waerden	0.855	0.457	0.000	0.010	0.336	0.124	0.118	0.033
Variance Tests								
Siegel-Tukey	0.603	1.597	0.077	0.331	0.396	0.525	0.202	0.237
Bartlett	0.067	0.176	0.002	0.028	7.665***	0.854	2.144	0.227
Levene	0.009	2.844*	0.309	0.007	0.043	0.235	0.078	0.014
Brown-Forsythe	0.026	1.958	0.026	0.022	0.004	0.097	0.054	0.022

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 13: Mean, Median, and Variance Equality Tests for MRO Allotment Days – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	0.000	7.639***	32.304***	74.452***	13.649***	0.240	7.691***	0.086
Median Tests								
Wilcoxon-Mann-Whitney	0.112	2.387**	3.916***	2.994***	3.833***	0.373	1.260	0.369
Median Chi-Square	0.275	1.499	5.998**	3.314*	8.844***	0.765	0.275	0.765
Kruskal-Wallis	0.013	5.697**	15.340***	8.967***	14.692***	0.139	1.587	0.137
van der Waerden	0.011	9.418***	24.801***	15.423***	22.110***	0.360	2.179	0.073
Variance Tests								
Siegel-Tukey	1.813*	2.143**	3.290***	2.933***	3.203***	2.085**	2.711***	0.168
Bartlett	1.558	0.715	26.571***	1,306.095***	7.733***	250.851***	137.285***	0.085
Levene	2.439	0.894	23.336***	286.426***	0.267	20.007***	29.429***	0.005
Brown-Forsythe	2.602	1.350	20.630***	74.501***	0.531	19.475***	24.395***	0.001

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	6.674***	4.453**	31.968***	11.078***	8.185***	15.568***	12.657***	2.409
Median Tests								
Wilcoxon-Mann-Whitney	1.864*	1.416	2.298**	1.517	1.485	2.065**	1.830*	0.931
Median Chi-Square	0.079	0.399	1.342	2.278	1.779	2.278	1.779	2.838*
Kruskal-Wallis	3.476*	2.004	5.282**	2.301	2.206	4.264**	3.349*	0.867
van der Waerden	5.377**	3.704*	10.843***	4.248**	3.011*	6.529**	5.729**	0.874
Variance Tests								
Siegel-Tukey	1.012	0.586	1.407	1.282	0.085	0.786	0.608	0.862
Bartlett	5.156**	8.091***	163.083***	66.302***	101.604***	74.411***	112.649***	36.955***
Levene	4.002**	3.669*	63.157***	15.437***	16.179***	18.967***	15.244***	4.508**
Brown-Forsythe	3.571*	3.716*	29.501***	11.060***	10.680***	14.787***	7.777***	4.467**

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 14: Mean, Median, and Variance Equality Tests for the Last Day of the RMP – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	11.464***	88.450***	195.052***	604.405***	63.751***	8.156***	5.634**	16.463***
Median Tests								
Wilcoxon-Mann-Whitney	3.719***	8.666***	9.963***	10.425***	9.717***	1.193	0.603	3.797***
Median Chi-Square	8.052***	25.506***	44.167***	44.167***	39.877***	0.095	0.000	4.929**
Kruskal-Wallis	13.833***	75.103***	99.262***	108.686***	94.425***	1.423	0.363	14.416***
van der Waerden	14.352***	114.833***	140.406***	156.393***	133.200***	4.655**	0.426	16.487***
Variance Tests								
Siegel-Tukey	3.088***	6.255***	8.434***	9.361***	8.007***	7.150***	7.793***	3.471***
Bartlett	0.140	8.352***	0.000	1,106.450***	33.064***	152.139***	182.463***	7.730***
Levene	0.206	4.478**	0.812	526.957***	2.649	117.289***	160.693***	8.580***
Brown-Forsythe	0.046	4.137**	0.818	395.049***	2.319	112.706***	156.867***	7.027***

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	127.582***	71.846***	107.967***	38.084***	45.811***	40.798***	78.934***	4.300**
Median Tests								
Wilcoxon-Mann-Whitney	8.367***	5.426***	6.268***	4.689***	2.836***	3.521***	3.354***	1.919*
Median Chi-Square	33.128***	22.622***	19.609***	11.862***	4.546**	9.710***	6.052**	2.179
Kruskal-Wallis	70.017***	29.447***	39.296***	21.988***	8.046***	12.401***	11.250***	3.682*
van der Waerden	77.654***	41.576***	44.892***	22.834***	11.625***	15.218***	17.952***	3.044*
Variance Tests								
Siegel-Tukey	5.961***	2.006**	7.720***	7.010***	6.283***	6.673***	5.936***	6.848***
Bartlett	7.854***	51.005***	140.659***	85.651***	166.945***	157.170***	289.828***	142.961***
Levene	11.892***	46.155***	102.922***	66.748***	131.140***	129.937***	189.927***	102.434***
Brown-Forsythe	11.569***	32.029***	93.577***	65.452***	112.313***	128.045***	136.874***	98.300***

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 15: Mean, Median, and Variance Equality Tests for the Last Day of the RMP – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	4.813**	72.845***	208.751***	819.367***	64.687***	7.327***	76.132***	6.076**
Median Tests								
Wilcoxon-Mann-Whitney	2.235**	8.163***	9.676***	10.014***	9.409***	2.856***	4.350***	2.104**
Median Chi-Square	4.787**	38.776***	38.776***	39.161***	38.776***	3.427*	6.373**	1.388
Kruskal-Wallis	4.995**	66.648***	93.623***	100.297***	88.532***	8.160***	18.928***	4.429**
van der Waerden	4.584**	91.002***	141.155***	150.767***	130.437***	11.205***	26.127***	6.595**
Variance Tests								
Siegel-Tukey	0.329	5.549***	8.572***	9.249***	8.039***	7.245***	7.643***	1.010
Bartlett	5.335**	9.584***	0.086	1,397.543***	29.157***	495.244***	269.221***	0.188
Levene	2.930*	4.766**	0.217	1,236.819***	3.759*	205.690***	196.247***	0.001
Brown-Forsythe	2.900*	3.941**	0.222	863.753***	3.220*	190.461***	194.365***	0.002

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	92.452***	60.462***	367.890***	152.807***	49.745***	150.959***	92.717***	36.452***
Median Tests								
Wilcoxon-Mann-Whitney	7.619***	5.669***	9.255***	7.664***	3.301***	6.651***	4.650***	4.272***
Median Chi-Square	30.940***	10.278***	30.940***	27.309***	6.414**	15.048***	8.233***	8.233***
Kruskal-Wallis	58.060***	32.146***	85.662***	58.736***	10.897***	44.244***	21.624***	18.251***
van der Waerden	74.652***	47.801***	122.577***	76.878***	12.254***	65.801***	31.554***	22.433***
Variance Tests								
Siegel-Tukey	4.727***	4.143***	7.894***	6.701***	5.442***	6.936***	4.080***	6.277***
Bartlett	0.024	10.802***	132.945***	96.985***	201.396***	101.655***	192.953***	99.168***
Levene	0.260	9.385***	98.640***	55.504***	140.820***	80.199***	125.527***	38.206***
Brown-Forsythe	0.247	8.955***	68.250***	44.181***	113.343***	73.704***	76.601***	37.346***

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 16: Mean, Median, and Variance Equality Tests for the 5 Days before a Press Conference – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	0.500	0.442	0.017	0.348	0.000	0.886	0.001	2.241
Median Tests								
Wilcoxon-Mann-Whitney	1.161	1.456	0.457	0.039	0.180	0.863	0.444	1.683*
Median Chi-Square	0.229	4.219**	0.229	0.009	0.037	0.657	1.427	3.651*
Kruskal-Wallis	1.347	2.121	0.209	0.002	0.033	0.745	0.197	2.834*
van der Waerden	0.972	0.765	0.019	0.000	0.008	0.901	0.064	2.542
Variance Tests								
Siegel-Tukey	0.466	1.382	1.969**	1.307	1.533	1.286	1.339	0.078
Bartlett	3.248*	2.624	2.719*	1.101	8.804***	5.469**	29.066***	0.218
Levene	1.167	0.002	2.132	0.883	0.384	0.032	0.764	0.054
Brown-Forsythe	1.062	0.131	2.154	0.358	0.425	0.147	0.608	0.060

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	3.607*	23.993***	0.053	0.220	0.060	0.030	1.293	0.096
Median Tests								
Wilcoxon-Mann-Whitney	1.249	4.750***	0.337	0.497	0.302	0.442	0.936	0.720
Median Chi-Square	0.119	11.825***	0.022	0.201	1.095	0.089	1.095	0.201
Kruskal-Wallis	1.562	22.569***	0.114	0.247	0.091	0.195	0.877	0.518
van der Waerden	2.664	24.519***	0.322	0.234	0.189	0.293	0.606	0.452
Variance Tests								
Siegel-Tukey	0.153	1.498	1.157	1.009	0.155	1.162	0.811	0.017
Bartlett	11.315***	15.156***	4.280**	16.763***	4.831**	3.837*	68.061***	28.606***
Levene	3.144*	4.319**	0.040	0.362	0.000	0.050	4.139**	2.010
Brown-Forsythe	1.543	2.564	0.000	0.267	0.005	0.028	3.666*	1.824

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 17: Mean, Median, and Variance Equality Tests for the 5 Days before a Press Conference – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	2.913*	3.381*	0.593	5.283**	0.826	1.299	1.173	1.785
Median Tests								
Wilcoxon-Mann-Whitney	1.996**	2.024**	0.834	3.109***	0.208	1.103	1.269	1.254
Median Chi-Square	4.382**	3.709*	5.896**	8.064***	0.344	0.063	2.531	3.709*
Kruskal-Wallis	3.984**	4.096**	0.696	9.666***	0.044	1.217	1.611	1.573
van der Waerden	2.622	4.480**	0.000	5.135**	0.180	1.980	1.565	1.001
Variance Tests								
Siegel-Tukey	0.136	0.989	1.191	0.083	0.756	1.381	0.781	3.649***
Bartlett	3.057*	0.199	0.409	407.962***	3.792*	60.853***	26.264***	15.792***
Levene	0.507	0.506	0.545	20.697***	0.475	1.848	1.380	12.947***
Brown-Forsythe	0.599	0.413	1.024	5.570**	0.093	1.406	1.357	13.238***

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	0.608	0.069	0.493	0.114	0.951	0.001	0.984	1.109
Median Tests								
Wilcoxon-Mann-Whitney	1.279	1.011	0.422	1.270	0.264	0.014	0.426	1.153
Median Chi-Square	0.367	2.085	2.597	0.367	0.073	0.073	0.004	0.598
Kruskal-Wallis	1.637	1.023	0.178	1.614	0.070	0.000	0.182	1.330
van der Waerden	1.350	0.815	0.020	1.301	0.015	0.031	0.010	1.722
Variance Tests								
Siegel-Tukey	3.811***	2.232**	0.924	0.621	1.141	1.040	1.992**	0.273
Bartlett	17.513***	12.233***	23.646***	17.309***	36.704***	14.100***	49.306***	12.885***
Levene	15.125***	6.567**	4.280**	0.893	4.588**	2.914*	6.581**	1.752
Brown-Forsythe	15.243***	7.019***	2.860*	0.790	3.355*	2.806*	5.080**	1.737

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 18: Mean, Median, and Variance Equality Tests for Press Conference Days – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	1.090	1.041	0.025	0.010	0.109	1.622	2.341	1.512
Median Tests								
Wilcoxon-Mann-Whitney	1.080	1.004	0.358	1.555	0.552	2.285**	2.205**	1.266
Median Chi-Square	0.285	1.820	0.069	0.305	1.199	3.580*	4.681**	2.684
Kruskal-Wallis	1.166	1.009	0.128	2.420	0.305	5.223**	4.864**	1.604
van der Waerden	1.126	0.803	0.095	2.408	0.216	4.903**	4.633**	1.444
Variance Tests								
Siegel-Tukey	0.275	1.425	1.396	0.532	1.917*	1.913*	0.697	0.824
Bartlett	1.004	0.930	8.052***	0.018	31.071***	1.958	5.590**	0.346
Levene	0.636	1.979	2.933*	0.003	3.208*	0.021	0.001	1.007
Brown-Forsythe	0.529	1.896	3.025*	0.007	2.762*	0.067	0.012	1.096

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	1.214	1.944	0.195	0.064	1.987	1.930	2.429	1.505
Median Tests								
Wilcoxon-Mann-Whitney	1.160	1.386	1.157	1.133	1.180	1.169	2.151**	1.727*
Median Chi-Square	0.197	0.504	4.533**	1.632	0.987	0.504	7.274***	0.987
Kruskal-Wallis	1.347	1.923	1.339	1.285	1.393	1.367	4.627**	2.984*
van der Waerden	1.642	2.257	0.692	0.779	1.490	1.543	3.547*	2.799*
Variance Tests								
Siegel-Tukey	0.169	0.564	1.014	0.210	0.173	0.583	1.748*	0.404
Bartlett	0.024	0.775	0.007	10.144***	11.257***	4.042**	28.329***	3.091*
Levene	0.267	0.193	0.061	0.790	1.126	0.136	3.507*	0.129
Brown-Forsythe	0.114	0.118	0.001	0.560	0.855	0.058	3.150*	0.210

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 19: Mean, Median, and Variance Equality Tests for Press Conference Days – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	0.029	0.146	0.015	0.198	0.074	0.617	2.745*	0.128
Median Tests								
Wilcoxon-Mann-Whitney	0.021	0.224	0.176	1.756*	0.230	1.952*	2.057**	0.803
Median Chi-Square	0.028	0.255	0.028	2.389	0.255	3.427*	2.294	0.708
Kruskal-Wallis	0.000	0.050	0.031	3.086*	0.053	3.812*	4.234**	0.646
van der Waerden	0.100	0.066	0.013	1.529	0.078	2.648	4.079**	0.504
Variance Tests								
Siegel-Tukey	0.021	0.302	0.867	1.898*	0.563	2.363**	0.439	2.734***
Bartlett	1.413	0.593	0.521	39.955***	0.167	0.130	1.257	4.545**
Levene	0.220	0.396	0.607	1.292	0.080	2.146	0.470	5.701**
Brown-Forsythe	0.223	0.347	0.645	0.220	0.072	2.239	0.224	4.176**

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	4.785**	2.539	5.057**	4.576**	3.869**	8.103***	2.199	8.030***
Median Tests								
Wilcoxon-Mann-Whitney	2.433**	1.956*	3.003***	2.813***	1.773*	2.653***	1.070	2.876***
Median Chi-Square	2.318	2.318	8.233***	6.414**	0.695	4.822**	1.370	4.822**
Kruskal-Wallis	5.922**	3.828*	9.017***	7.916***	3.146*	7.043***	1.146	8.275***
van der Waerden	5.242**	3.470*	7.286***	6.497**	5.161***	7.999***	2.597	9.499***
Variance Tests								
Siegel-Tukey	0.318	0.697	1.921*	2.429**	0.669	1.320	0.380	1.726*
Bartlett	0.801	0.296	3.798*	1.578	3.130*	2.041	6.510**	0.217
Levene	0.420	0.029	1.091	1.107	0.061	0.965	0.546	0.268
Brown-Forsythe	0.523	0.035	1.031	1.144	0.022	0.667	0.355	0.258

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 20: Mean, Median, and Variance Equality Tests for the Last Open Day of the Month – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	1.448	4.838**	3.632*	0.190	3.078*	14.567***	11.002***	0.741
Median Tests								
Wilcoxon-Mann-Whitney	1.396	2.689***	1.958*	6.013***	2.252**	7.487***	2.643***	0.988
Median Chi-Square	2.475	4.864**	3.626*	36.163***	4.864**	44.167***	2.475	1.618
Kruskal-Wallis	1.948	7.234***	3.835*	36.160***	5.074**	56.061***	6.990***	0.977
van der Waerden	1.335	5.948**	3.570*	27.968***	4.236**	48.565***	8.148***	0.706
Variance Tests								
Siegel-Tukey	1.270	0.972	0.598	1.341	1.046	3.484***	2.482**	2.180**
Bartlett	1.515	0.231	0.412	8.951***	13.441***	5.401**	31.572***	9.411***
Levene	2.603	0.331	0.000	0.005	0.685	0.336	6.928***	6.421**
Brown-Forsythe	2.769*	0.418	0.004	0.041	0.649	0.003	4.838**	6.456**

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	7.950***	0.480	3.884**	6.225**	0.108	2.215	0.870	4.586**
Median Tests								
Wilcoxon-Mann-Whitney	2.489**	0.695	1.077	1.418	1.069	0.050	0.850	0.705
Median Chi-Square	3.842**	0.105	0.420	0.420	0.945	0.105	0.420	0.000
Kruskal-Wallis	6.198**	0.484	1.161	2.011	1.143	0.003	0.723	0.498
van der Waerden	7.683***	0.739	1.270	2.717*	0.546	0.127	0.179	0.921
Variance Tests								
Siegel-Tukey	0.161	0.418	1.805*	2.031**	2.095**	1.743*	1.363	1.582
Bartlett	7.474***	0.048	33.356***	52.353***	8.185***	29.845***	2.961*	52.368***
Levene	3.527*	0.013	7.332***	6.468**	2.708	5.454**	0.863	7.585***
Brown-Forsythe	1.486	0.008	4.751**	4.693**	2.817*	3.371*	0.930	5.377**

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 21: Mean, Median, and Variance Equality Tests for the Last Open Day of the Month – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	10.215***	14.595***	0.506	0.067	0.425	12.579***	0.107	2.139
Median Tests								
Wilcoxon-Mann-Whitney	2.886***	3.724***	1.248	5.314***	0.847	5.379***	0.682	1.222
Median Chi-Square	3.946**	2.736*	6.052**	25.090***	0.105	15.969***	0.432	0.000
Kruskal-Wallis	8.332***	13.870***	1.558	28.238***	0.718	28.940***	0.465	1.493
van der Waerden	11.068***	15.687***	0.822	22.048***	0.536	30.641***	0.363	1.692
Variance Tests								
Siegel-Tukey	1.046	0.479	1.108	0.979	0.682	3.803***	1.289	0.516
Bartlett	0.588	6.280**	0.466	46.624***	3.838*	12.244***	0.244	7.733***
Levene	0.149	2.096	0.000	1.038	0.051	0.035	0.109	2.285
Brown-Forsythe	0.136	1.650	0.013	0.182	0.025	0.029	0.110	2.074

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	3.552*	0.940	0.649	1.058	1.879	0.034	2.155	0.109
Median Tests								
Wilcoxon-Mann-Whitney	2.340**	1.355	2.194**	1.373	2.233**	0.183	2.645***	0.505
Median Chi-Square	6.414**	1.407	3.457*	1.407	2.318	0.031	6.414**	0.031
Kruskal-Wallis	5.477**	1.838	4.816**	1.885	4.989**	0.034	7.000***	0.255
van der Waerden	4.397**	1.523	3.532*	2.075	4.837**	0.016	5.449**	0.252
Variance Tests								
Siegel-Tukey	1.928*	0.987	0.438	0.477	0.529	0.563	0.091	1.044
Bartlett	6.488**	4.033**	6.664***	4.034**	5.676**	9.919***	5.030**	6.016**
Levene	6.185**	2.674	0.645	0.224	0.244	1.521	0.472	1.465
Brown-Forsythe	6.198**	2.866*	0.474	0.248	0.142	1.475	0.288	1.551

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 22: Mean, Median, and Variance Equality Tests for the Last Open Day of the Quarter – Before 10 March 2004 (Sample 1)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	2.602	12.161***	14.219***	4.296**	7.726***	21.106***	20.177***	1.002
Median Tests								
Wilcoxon-Mann-Whitney	1.893*	4.018***	3.837***	4.795***	4.074***	5.308***	2.027**	1.162
Median Chi-Square	7.234***	10.422***	7.279***	14.254***	10.422***	14.254***	1.152	1.170
Kruskal-Wallis	3.585*	16.145***	14.725***	23.002***	16.601***	28.177***	4.112**	1.352
van der Waerden	2.261	14.788***	15.083***	21.549***	15.475***	29.921***	6.413**	1.089
Variance Tests								
Siegel-Tukey	1.216	1.607	1.720*	3.063***	2.237**	4.086***	3.177***	0.490
Bartlett	9.395***	10.068***	0.603	0.098	12.033***	0.000	56.897***	2.855*
Levene	7.653***	7.086***	0.312	2.434	1.782	2.202	26.802***	1.668
Brown-Forsythe	7.731***	6.151**	0.312	2.499	1.687	2.203	21.622***	1.674

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	37.246***	6.197**	18.510***	20.320***	0.084	10.095***	1.062	14.965***
Median Tests								
Wilcoxon-Mann-Whitney	4.367***	2.284**	2.085**	2.321**	1.591	0.499	1.399	1.280
Median Chi-Square	9.509***	1.954	1.954	1.954	1.954	0.078	1.954	0.703
Kruskal-Wallis	19.077***	5.218**	4.351**	5.389**	2.533	0.250	1.960	1.640
van der Waerden	23.894***	6.177**	5.868**	6.984***	1.287	1.174	0.522	2.837*
Variance Tests								
Siegel-Tukey	3.146***	0.029	4.110***	3.000***	3.096***	2.559**	3.041***	2.091**
Bartlett	10.120***	0.759	52.999***	76.600***	26.631***	51.189***	20.728***	77.535***
Levene	12.767***	1.400	19.383***	20.988***	13.266***	23.792***	12.319***	31.804***
Brown-Forsythe	9.637***	1.101	14.886***	16.395***	10.083***	14.820***	7.387***	20.871***

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 23: Mean, Median, and Variance Equality Tests for the Last Open Day of the Quarter – After 10 March 2004 (Sample 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	13.194***	19.625***	1.910	0.287	1.649	14.249***	0.028	1.339
Median Tests								
Wilcoxon-Mann-Whitney	3.696***	4.734***	1.849*	4.418***	1.591	4.754***	0.254	1.258
Median Chi-Square	6.310**	9.432***	6.727***	13.311***	1.942	9.488***	0.076	0.711
Kruskal-Wallis	13.667***	22.415***	3.421*	19.527***	2.534	22.609***	0.065	1.583
van der Waerden	15.953***	25.377***	2.586	17.136***	2.305	27.762***	0.002	1.237
Variance Tests								
Siegel-Tukey	1.338	3.264***	0.254	2.544**	0.214	4.030***	2.218**	0.579
Bartlett	2.120	6.926***	1.183	8.910***	7.140***	3.600*	4.043**	3.927**
Levene	1.964	3.944**	0.502	0.030	0.964	0.000	2.531	1.959
Brown-Forsythe	1.890	3.529*	0.549	0.048	0.892	0.001	2.463	2.049

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	6.664***	1.842	2.584	2.700	5.315**	0.016	3.198*	0.762
Median Tests								
Wilcoxon-Mann-Whitney	2.945***	1.665*	2.087**	1.846*	2.680***	0.011	2.580***	0.958
Median Chi-Square	9.489***	0.711	1.967	1.967	3.849**	0.076	3.849**	0.081
Kruskal-Wallis	8.677***	2.776*	4.360**	3.411*	7.188***	0.000	6.662***	0.919
van der Waerden	7.177***	2.468	4.483**	3.726*	7.399***	0.044	5.380**	1.086
Variance Tests								
Siegel-Tukey	0.254	0.265	0.502	0.314	2.558**	0.392	1.888*	0.703
Bartlett	4.208**	1.028	0.175	0.110	0.101	1.125	0.333	2.545
Levene	3.725*	0.458	0.156	0.206	0.392	0.027	0.030	0.313
Brown-Forsythe	3.725*	0.674	0.122	0.049	0.307	0.075	0.051	0.654

IMBAL is an indicator of the imbalance between the total volume of buy trades versus sell trades. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 24: Mean, Median, and Variance Equality Tests before and after 10 March 2004 (Samples 1 and 2)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	15.382^{***}	18.586^{***}	0.706	7.180^{***}	377.811^{***}	0.435	40.002^{***}	0.185
Median Tests								
Wilcoxon-Mann-Whitney	2.878^{***}	3.160^{***}	0.318	12.645^{***}	24.444^{***}	8.639^{***}	10.619^{***}	0.996
Median Chi-Square	4.249^{**}	7.511^{***}	0.431	109.390^{***}	508.047^{***}	129.471^{***}	110.355^{***}	2.484
Kruskal-Wallis	8.284^{***}	9.988^{***}	0.101	159.904^{***}	597.507^{***}	74.630^{***}	112.765^{***}	0.992
van der Waerden	9.157^{***}	10.532^{***}	0.260	169.664^{***}	525.554^{***}	46.168^{***}	85.784^{***}	0.227
Variance Tests								
Siegel-Tukey	11.652^{***}	12.267^{***}	6.052^{***}	9.473^{***}	1.219	6.934^{***}	9.573^{***}	7.569^{***}
Bartlett	263.322^{***}	308.734^{***}	66.744^{***}	132.971^{***}	3.126^{*}	574.302^{***}	293.066^{***}	161.306^{***}
Levene	191.415^{***}	209.426^{***}	33.684^{***}	15.794^{***}	2.522	64.552^{***}	61.296^{***}	94.479^{***}
Brown-Forsythe	187.831^{***}	207.404^{***}	33.257^{***}	6.021^{**}	2.181	57.712^{***}	58.670^{***}	90.748^{***}

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	$1,252.529^{***}$	61.345^{***}	55.689^{***}	17.653^{***}	0.074	18.489^{***}	9.587^{***}	12.644^{***}
Median Tests								
Wilcoxon-Mann-Whitney	28.749^{***}	7.220^{***}	10.400^{***}	4.845^{***}	1.298	4.943^{***}	5.359^{***}	3.221^{***}
Median Chi-Square	724.733^{***}	16.641^{***}	83.216^{***}	12.152^{***}	2.742^{*}	16.641^{***}	19.576^{***}	4.417^{**}
Kruskal-Wallis	826.523^{***}	52.136^{***}	108.151^{***}	23.477^{***}	1.684	24.434^{***}	28.717^{***}	10.374^{***}
van der Waerden	734.909^{***}	70.442^{***}	93.638^{***}	23.525^{***}	2.459	20.640^{***}	30.442^{***}	12.290^{***}
Variance Tests								
Siegel-Tukey	5.485^{***}	7.118^{***}	0.976	0.764	5.549^{***}	6.068^{***}	1.878^{*}	2.917^{***}
Bartlett	5.337^{**}	22.864^{***}	302.715^{***}	53.974^{***}	317.905^{***}	468.041^{***}	115.759^{***}	201.651^{***}
Levene	29.849^{***}	31.674^{***}	48.406^{***}	8.047^{***}	44.702^{***}	64.868^{***}	7.538^{***}	27.144^{***}
Brown-Forsythe	34.287^{***}	34.829^{***}	30.876^{***}	6.317^{**}	40.330^{***}	59.244^{***}	7.320^{***}	25.430^{***}

For the computation of the test statistics for SUMQTY, EWQTY, NBTRD and IMBAL, the corresponding measures are first adjusted to account for the presence of a significant time trend. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 25: Mean, Median, and Variance Values – After 10 March 2004 with and without FTOs (Samples 2a and 2b)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean								
Overall	20,244.12	49.4920	413.8032	0.0521	79.1560	0.0652	-0.0032	-10,325.18
No FTOs	19,203.12	44.0668	438.6711	0.0675	74.3950	0.0481	-0.0051	-7,780.51
Frequent FTOs	20,485.33	50.7490	408.0412	0.0485	80.2591	0.0692	-0.0027	-10,914.79
Median								
Overall	19,871.70	48.0644	414.500	0.0068	77.3693	0.0710	-0.0028	-9,879.90
No FTOs	18,979.18	43.9090	433.000	0.0076	73.6684	0.0353	-0.0039	-7,737.43
Frequent FTOs	20,208.91	48.9688	410.000	0.0066	78.1908	0.0758	-0.0025	-10,468.71
Standard Deviation								
Overall	4,258.843	10.6790	57.8026	0.2109	13.7681	0.0668	0.0125	5,119.17
No FTOs	3,576.348	7.7911	54.0575	0.2361	9.1378	0.1003	0.0146	4,232.03
Frequent FTOs	4,369.035	10.8673	57.1494	0.2047	14.4161	0.0557	0.0120	5,129.08

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean								
Overall	0.0553	2.4155	0.0020	0.0112	0.0144	-0.0040	0.5848	-0.1939
No FTOs	0.0661	3.2404	0.0036	0.0901	0.0126	-0.0028	0.6662	-0.2321
Frequent FTOs	0.0527	2.2229	0.0016	-0.0072	0.0148	-0.0043	0.5658	-0.1850
Median								
Overall	0.0549	2.4511	0.0000	-0.0232	0.0123	-0.0047	0.4866	-0.1862
No FTOs	0.0633	3.1382	0.0018	0.0121	0.0105	-0.0034	0.5581	-0.2279
Frequent FTOs	0.0533	2.2849	-0.0007	-0.0315	0.0129	-0.0050	0.4727	-0.1776
Standard Deviation								
Overall	0.0175	1.0341	0.0144	0.4916	0.0139	0.0119	0.5250	0.3595
No FTOs	0.0178	0.8746	0.0140	0.5119	0.0128	0.0118	0.6080	0.3510
Frequent FTOs	0.0164	0.9723	0.0144	0.4853	0.0141	0.0119	0.5022	0.3611

'No FTOs' refers to the period before 12 October 2004. 'Frequent FTOs' refers to the period after 12 October 2004 when fine-tuning operations (FTOs) became more frequent. SUMQTY, EWQTY and IMBAL are expressed in millions of EUR.

Table 26: Mean, Median, and Variance Equality Tests before and after 12 October 2004 (Samples 2a and 2b)

	Aggregate Measures of Market Activity							
	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
Mean Test								
ANOVA F-Statistic	1.685	3.521*	0.148	1.010	22.997***	12.536***	4.411**	1.232
Median Tests								
Wilcoxon-Mann-Whitney	1.488	2.855***	1.151	3.191***	5.937***	11.783***	1.964**	1.533
Median Chi-Square	0.810	5.478**	0.810	4.965**	23.629***	116.688***	1.588	2.074
Kruskal-Wallis	2.215	8.155***	1.325	10.183***	35.252***	138.838***	3.857**	2.349
van der Waerden	2.544	5.566**	0.978	11.934***	35.034***	96.572***	3.977**	1.743
Variance Tests								
Siegel-Tukey	0.384	2.514**	0.090	6.088***	0.534	7.728***	1.690*	0.284
Bartlett	5.634**	10.596***	0.173	5.285**	41.786***	104.978***	10.814***	1.954
Levene	1.189	7.330***	0.083	3.645*	4.932**	3.734*	1.447	0.599
Brown-Forsythe	1.193	6.958***	0.106	0.838	4.117**	1.653	1.158	0.552

	Aggregate Measures of Market Liquidity							
	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
Mean Test								
ANOVA F-Statistic	78.381***	139.972***	2.319	4.851**	3.026*	2.085	4.527**	2.123
Median Tests								
Wilcoxon-Mann-Whitney	7.559***	10.678***	2.645***	2.301**	2.302**	1.631	2.280**	1.800*
Median Chi-Square	17.313***	68.969***	7.396***	1.634	5.406**	4.748**	4.748**	3.185*
Kruskal-Wallis	57.137***	114.027***	6.998***	5.295**	5.302**	2.660	5.197**	3.240*
van der Waerden	66.735***	114.159***	6.157**	5.973**	4.257**	2.359	5.786**	2.524
Variance Tests								
Siegel-Tukey	0.864	0.800	2.374**	0.446	0.892	0.994	1.594	0.145
Bartlett	1.492	2.622	0.206	0.712	2.022	0.039	9.645***	0.196
Levene	0.991	6.550**	0.688	0.630	1.609	0.047	0.313	0.019
Brown-Forsythe	0.787	6.680***	0.719	0.311	1.690	0.044	0.094	0.019

For the computation of the test statistics for SUMQTY, EWQTY, NBTRD and IMBAL, the corresponding measures are first adjusted to account for the presence of a significant time trend. Note that, to preserve space, we do not report test statistics for EWPES, EWPTS.b, EWPTS.s, SWES, SWTS.b and SWTS.s. Those statistics remain available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

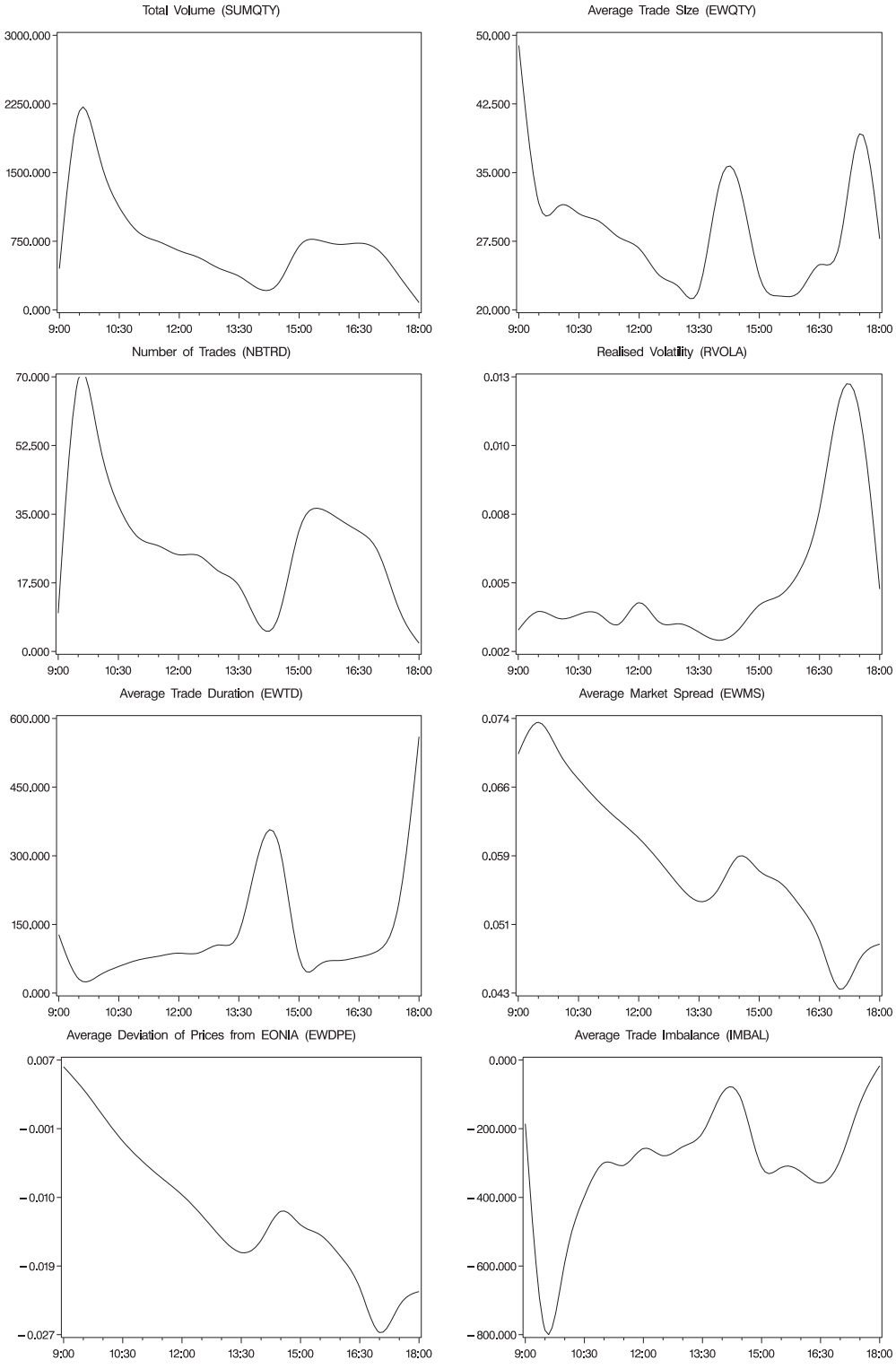

Figure 8: Intraday Patterns for Aggregate Measures of Market Activity – Before 10 March 2004 (Sample 1)

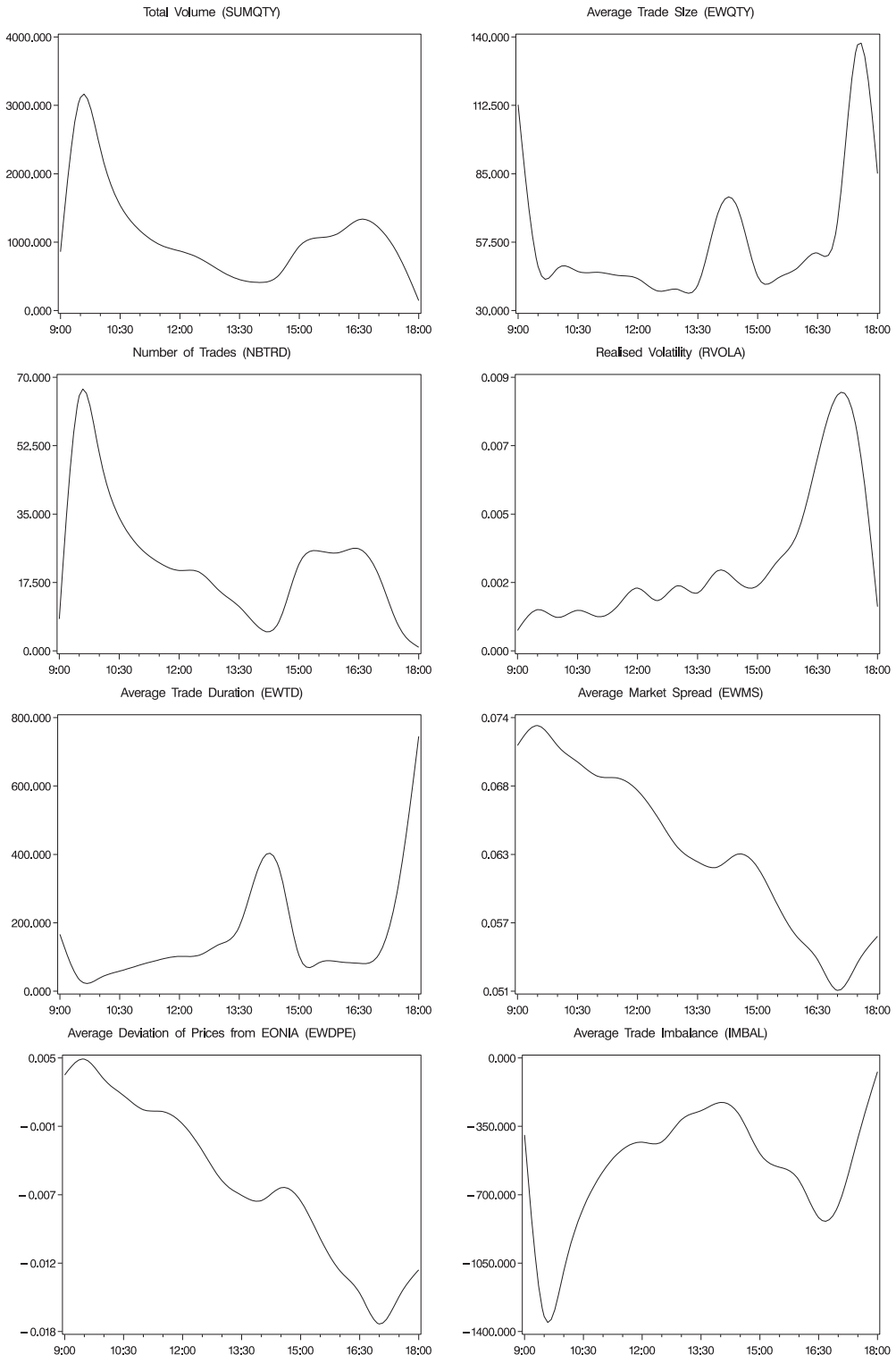

Figure 9: Intraday Patterns for Aggregate Measures of Market Activity – After 10 March 2004 (Sample 2)

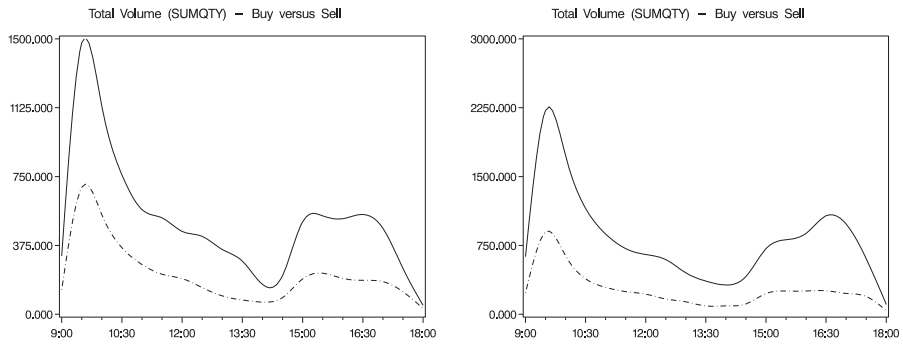

Figure 10: Intraday Patterns for the Total Volume of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the total volume of sell (buy) trades over a typical day.

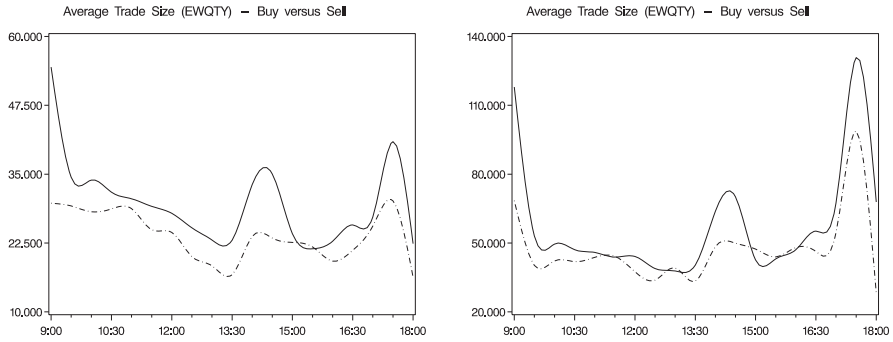

Figure 11: Intraday Patterns for the Average Size of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the average size of sell (buy) trades over a typical day.

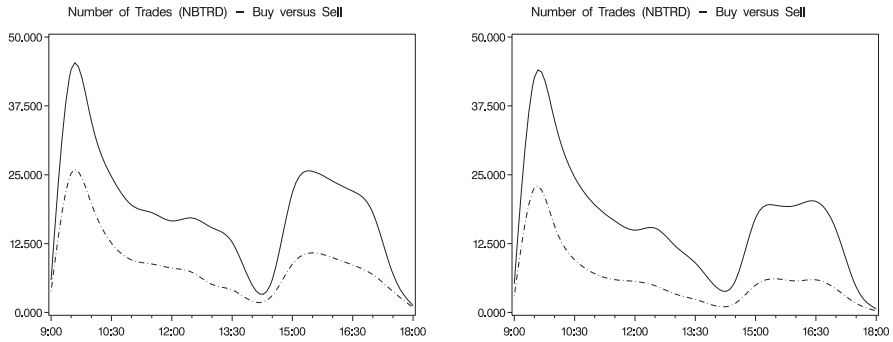

Figure 12: Intraday Patterns for the Number of Buy and Sell Trades – Before (Left) and After (Right) 10 March 2004. The solid (dashed) line plots the evolution of the number of sell (buy) trades over a typical day.

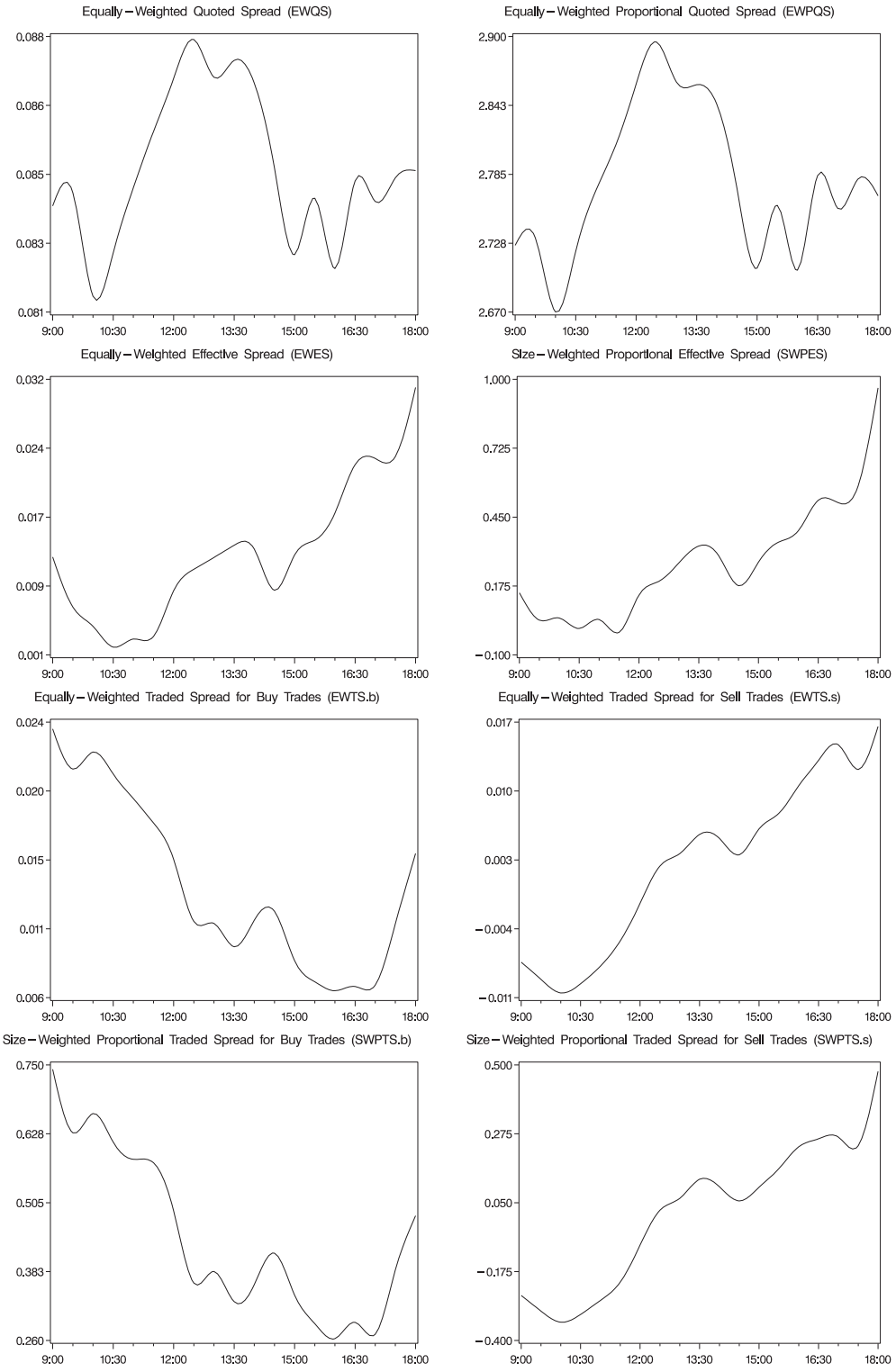

Figure 13: Intraday Patterns for Aggregate Measures of Market Liquidity – Before 10 March 2004 (Sample 1)

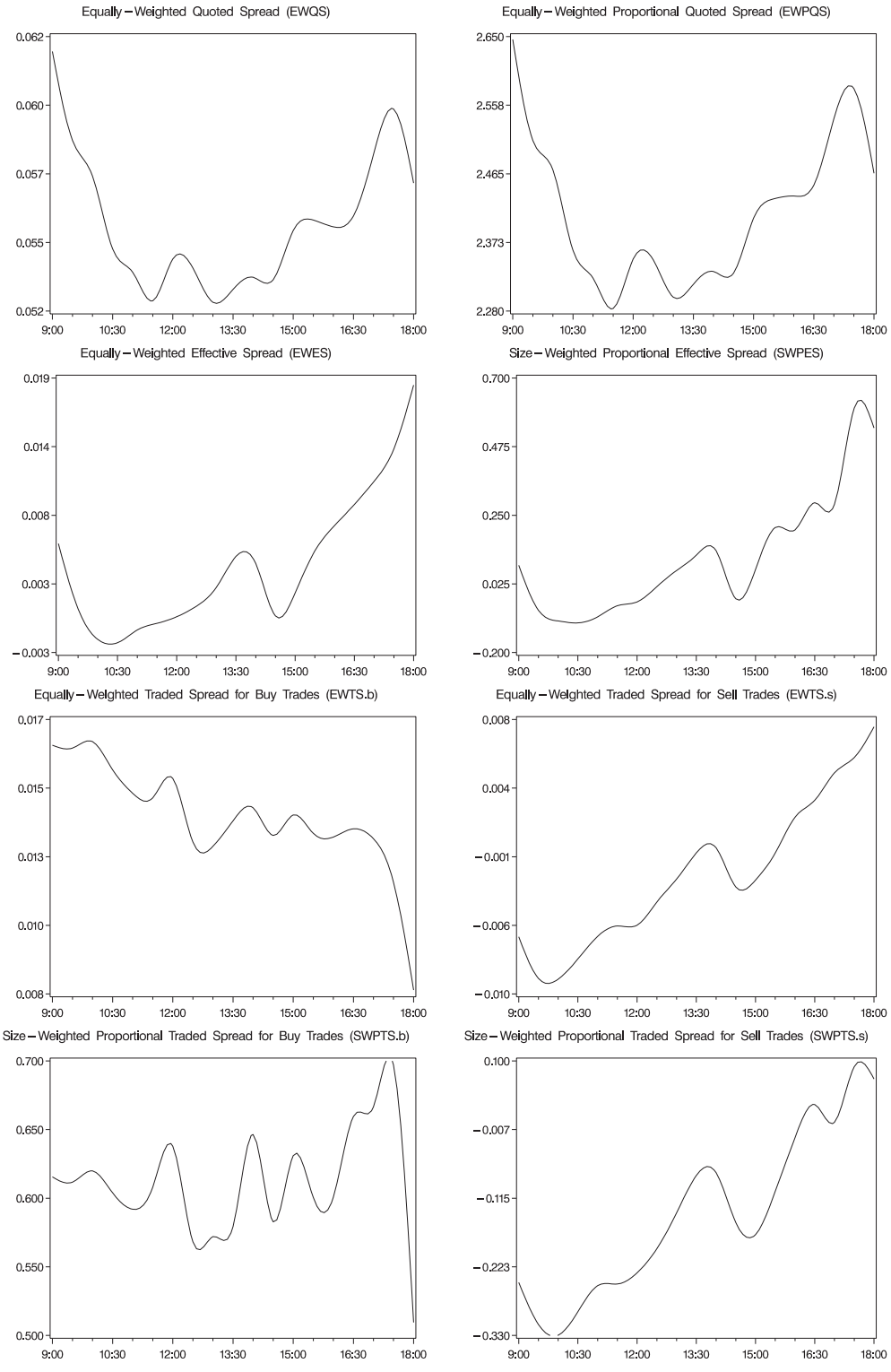

Figure 14: Intraday Patterns for Aggregate Measures of Market Liquidity – After 10 March 2004 (Sample 2)

Table 27: Mean, Median, and Variance Equality Tests of Intraday Market Activity – Before 10 March 2004 (Sample 1)

	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
	3 Intraday Intervals							
ANOVA F-Statistic	46.878***	63.767***	38.520***	2.777	10.757***	0.098	4.385***	31.954***
Kruskal-Wallis	90.039***	180.468***	89.287***	106.125***	142.695***	134.051***	274.057***	63.717***
Brown-Forsythe	44.953***	127.828***	0.918	2.466	49.224***	5.318***	6.529***	44.145***
	30-minute Intervals							
ANOVA F-Statistic	18.469***	14.015***	8.377***	0.519	5.211***	0.047	1.304	8.707***
Kruskal-Wallis	808.749***	314.823***	219.871***	4245.297***	826.634***	146.500***	321.619***	264.486***
Brown-Forsythe	23.840***	16.131***	0.524	1.348	19.215***	0.659	1.085	26.852***
	Allotment Days							
ANOVA F-Statistic	5.112***	7.599***	4.781***	0.354	2.445***	0.099***	0.580	4.257***
Kruskal-Wallis	177.747***	102.911***	85.784***	958.922***	266.216***	40.770***	88.964***	88.443***
Brown-Forsythe	7.122***	8.528***	1.646**	0.650	6.971***	0.203	0.313	10.082***
	Non-Last Allotment Days							
ANOVA F-Statistic	3.940***	4.636***	3.000***	0.442	1.706**	0.087	0.254	3.197***
Kruskal-Wallis	135.541***	72.605***	55.404***	799.500***	186.755***	38.623***	80.768	73.897***
Brown-Forsythe	5.392***	5.762***	1.364	0.579	7.112***	0.187	0.093	6.646***
	Last Allotment Days							
ANOVA F-Statistic	3.822***	1.407	3.181***	1.211	1.249	0.073	1.181	1.421
Kruskal-Wallis	38.281***	46.928***	49.870***	176.827***	100.127***	6.686	33.891**	23.596
Brown-Forsythe	4.355***	2.230***	1.266	1.164	1.474*	0.036	0.723	4.193***
	Last Days							
ANOVA F-Statistic	1.948**	8.673***	6.778***	0.924	1.686**	0.148	2.437***	1.690**
Kruskal-Wallis	51.430***	240.609***	138.285***	21.519	152.459***	1.220	33.282**	66.920***
Brown-Forsythe	4.605***	7.461***	1.808***	1.033	3.417***	0.141	0.606	8.295***
	Last Open Day of a Period							
ANOVA F-Statistic	1.252	10.980***	10.538***	1.193	3.425***	0.184	1.342*	2.030***
Kruskal-Wallis	44.780***	240.386***	157.284***	42.395***	129.844***	20.969	3.153	51.652***
Brown-Forsythe	1.541*	3.780***	1.156	1.008	9.531***	0.486	0.865	2.648***
	Press Conference Days							
ANOVA F-Statistic	3.632***	3.484***	5.493***	0.692	3.563***	0.758	4.054***	2.956***
Kruskal-Wallis	64.419***	86.083***	66.213***	240.414***	116.101***	26.847*	109.014***	55.395***
Brown-Forsythe	1.359*	2.789***	4.775***	0.718	6.490***	0.146	0.613	1.792**

Note that, to preserve space, we do not report similar tests for equality on non-last days, non-last open days of RMPs or days without press conferences. The results are available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 28: Mean, Median, and Variance Equality Tests of Intraday Market Activity – After 10 March 2004 (Sample 2)

	SUMQTY	EWQTY	NBTRD	RVOLA	EWTD	EWMS	EWDPE	IMBAL
	3 Intraday Intervals							
ANOVA F-Statistic	20.465***	19.078***	80.079***	6.620	15.825***	0.349***	9.646***	15.142***
Kruskal-Wallis	85.439***	100.473***	156.975***	33.051***	55.341***	148.944***	1334.089***	57.619***
Brown-Forsythe	5.436***	0.747***	83.085***	1.898**	92.791***	0.264	1.913	5.679***
	30-minute Intervals							
ANOVA F-Statistic	6.088***	5.481***	17.511***	1.239	7.808***	0.263	2.838	4.115***
Kruskal-Wallis	227.367***	303.079***	310.322***	5873.049***	193.593***	186.601***	1664.573***	125.128***
Brown-Forsythe	2.318***	0.860	18.521***	1.898**	44.711***	0.090	0.440***	5.036***
	Allotment Days							
ANOVA F-Statistic	1.204	0.643	3.683***	1.435*	2.446***	0.910	3.315***	0.651
Kruskal-Wallis	30.840**	18.529	68.169***	766.377***	66.129***	8.809	104.854***	16.380
Brown-Forsythe	1.170	1.303	2.986***	1.626**	13.020***	1.110	0.457	1.846**
	Non-Last Allotment Days							
ANOVA F-Statistic	0.720	0.621	3.212***	1.543*	2.162***	0.935	3.372	0.517
Kruskal-Wallis	25.515	20.816	54.950***	475.521***	55.703***	7.653	84.255***	11.829
Brown-Forsythe	0.832	0.914	3.069***	1.661**	10.033***	1.251	0.456	1.431
	Last Allotment Days							
ANOVA F-Statistic	1.933**	1.535*	1.657**	6.779***	1.514*	0.157	0.691	0.943
Kruskal-Wallis	37.003***	36.938***	28.393*	340.169***	28.691**	3.015	30.716**	23.260
Brown-Forsythe	1.347	1.252	1.503*	1.796**	3.762***	0.610	0.515	1.119
	Last Days							
ANOVA F-Statistic	3.658***	2.560***	4.135***	1.785**	1.829**	0.608	3.098***	2.396***
Kruskal-Wallis	79.344***	59.410***	71.967***	206.613***	60.691***	3.393	18.072	50.087***
Brown-Forsythe	2.062***	1.706**	3.312***	2.039***	12.789***	1.346	0.421	3.394***
	Last Open Day of a Period							
ANOVA F-Statistic	1.038	2.918***	7.564***	1.947**	2.093***	1.307	4.895***	0.897
Kruskal-Wallis	21.779	65.132***	120.818***	87.230***	76.398***	21.029	72.057***	16.321
Brown-Forsythe	1.144	2.073***	1.737**	1.614**	5.433	2.010***	0.665	1.255
	Press Conference Days							
ANOVA F-Statistic	1.202	0.779	1.008	0.511	0.799	0.141	1.139	0.956
Kruskal-Wallis	23.032	24.733	18.962	180.027***	18.716	9.277	74.862***	17.029
Brown-Forsythe	0.904	0.944	0.941	0.704	2.918	0.116	0.166	0.860

Note that, to preserve space, we do not report similar tests for equality on non-last days, non-last open days of RMPs or days without press conferences. The results are available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 29: Mean, Median, and Variance Equality Tests of Intraday Market Liquidity – Before 10 March 2004 (Sample 1)

	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
	3 Intraday Intervals							
ANOVA F-Statistic	11.216***	12.375***	0.770	0.613	20.807***	14.560***	13.085***	11.796***
Kruskal-Wallis	40.128***	42.389***	64.798	38.064	0.138	23.749***	0.838	12.503***
Brown-Forsythe	13.594***	11.061***	21.690	72.190	12.637***	32.426***	53.840***	43.028***
	30-minute Intervals							
ANOVA F-Statistic	2.296***	3.634***	0.433	0.772	2.989***	2.104***	2.102***	1.910**
Kruskal-Wallis	86.792***	107.914***	104.937***	195.595***	27.370*	42.465***	42.606***	29.139**
Brown-Forsythe	3.285***	1.790**	3.790***	8.070***	3.091***	5.258***	9.755***	8.566**
	Allotment Days							
ANOVA F-Statistic	0.906	1.063	0.936	1.196	1.353	2.086***	1.016	2.056***
Kruskal-Wallis	21.242	30.763**	25.138	29.305**	13.051	14.030	16.937	20.621
Brown-Forsythe	0.621	0.524	1.708**	2.914***	0.973	0.980	1.850**	1.422
	Non-Last Allotment Days							
ANOVA F-Statistic	0.876	0.738	0.934	0.794	0.882	1.610**	0.773	1.369
Kruskal-Wallis	21.446	24.974	21.162	28.808*	12.528	9.529	12.024	12.342
Brown-Forsythe	0.638	0.465	1.334	1.963***	0.668	0.608	1.409	0.993
	Last Allotment Days							
ANOVA F-Statistic	0.578	0.741	0.952	1.187	1.236	0.935	1.251	1.278
Kruskal-Wallis	14.408	12.303	36.051***	30.614**	20.576	27.417*	22.666	32.921**
Brown-Forsythe	0.326	0.652	0.762	1.115	0.728	0.610	1.185	1.094
	Last Days							
ANOVA F-Statistic	0.314	0.329	3.318***	2.312***	4.528***	8.264***	2.722***	6.858***
Kruskal-Wallis	9.553	8.211	58.255***	48.195***	67.063***	95.439***	53.510***	92.000***
Brown-Forsythe	1.332	0.505	0.818	1.216	0.552***	0.671	1.541*	1.010
	Last Open Day of a Period							
ANOVA F-Statistic	0.593	0.380	2.890***	1.682**	3.479***	7.782***	2.233***	5.283***
Kruskal-Wallis	11.356	5.844	56.436***	36.860***	55.504***	116.373***	52.495***	91.989***
Brown-Forsythe	1.148	0.652	1.262	1.445	0.678	1.834**	1.024	1.545*
	Press Conference Days							
ANOVA F-Statistic	0.418	0.461	0.770	0.685	1.308	0.702	1.242	0.708
Kruskal-Wallis	11.990	9.867	17.215	17.814	14.164	9.055	16.044	10.499
Brown-Forsythe	0.710	0.439	0.490	1.176	0.448	0.377	1.676**	0.901

Note that, to preserve space, we do not report similar tests for equality on non-last days, non-last open days of RMPs or days without press conferences. The results are available upon request. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 30: Mean, Median, and Variance Equality Tests of Intraday Market Liquidity – After 10 March 2004 (Sample 2)

	EWQS	EWPQS	EWES	SWPES	EWTS.b	EWTS.s	SWPTS.b	SWPTS.s
				3 Intraday Intervals				
ANOVA F-Statistic	11.858***	9.336***	2.258	0.678	51.673***	52.495***	16.510***	19.411***
Kruskal-Wallis	14.766***	19.408***	121.329***	39.501***	386.066***	500.317***	140.963***	218.351***
Brown-Forsythe	14.414***	0.910	12.679***	35.742***	8.843***	32.526***	14.420***	45.096***
				30-minute Intervals				
ANOVA F-Statistic	2.441***	2.744***	1.892	0.948	7.287***	7.428***	2.443***	3.074***
Kruskal-Wallis	36.477***	57.444***	141.823	169.213***	439.058***	581.434***	179.539***	241.692***
Brown-Forsythe	2.626***	0.498	5.482***	5.911***	1.815**	5.845***	3.646***	7.410***
				Allotment Days				
ANOVA F-Statistic	1.169	0.930	1.593*	1.115	1.819**	1.458*	1.005	0.703
Kruskal-Wallis	13.261	10.354	31.687**	17.065	87.840***	62.295***	45.143***	40.870***
Brown-Forsythe	1.530*	0.491	1.918**	0.763	1.639**	1.038	0.781	0.501
				Non-Last Allotment Days				
ANOVA F-Statistic	0.972	0.820	1.884**	2.099***	1.591*	1.853**	0.939	0.824
Kruskal-Wallis	11.400	9.236	23.371	20.900	70.619***	43.050***	41.722***	34.078**
Brown-Forsythe	1.382	0.621	2.143***	1.818**	1.826**	1.517*	0.949	0.655
				Last Allotment Days				
ANOVA F-Statistic	0.592	0.332	1.023	1.136	1.877**	2.431***	1.593*	1.303
Kruskal-Wallis	9.129	5.452	25.046	24.082	40.310***	50.938***	23.824	23.719
Brown-Forsythe	1.342	0.884	1.512*	2.009***	1.569*	2.464***	2.402***	2.330***
				Last Days				
ANOVA F-Statistic	3.168***	1.894**	3.096***	1.814**	0.988	1.666**	0.668	1.385
Kruskal-Wallis	51.618***	29.277**	42.280***	26.512*	35.623***	26.456*	18.880	18.933
Brown-Forsythe	1.422	0.533	2.097***	0.580	1.681**	1.129	0.919	0.783
				Last Open Day of a Period				
ANOVA F-Statistic	2.832***	1.625**	3.664***	2.242***	0.928	3.855***	0.721	1.565*
Kruskal-Wallis	49.737***	17.130	15.205***	52.759***	23.224	84.767***	21.685	43.207***
Brown-Forsythe	0.659	1.105	2.393***	1.094	2.726***	2.082***	1.444	1.297
				Press Conference Days				
ANOVA F-Statistic	0.646	0.433	0.845	0.680	1.206	1.002	0.879	0.846
Kruskal-Wallis	7.751	7.336	14.500	10.188	36.374***	38.081***	23.201	21.745
Brown-Forsythe	0.894	0.578	0.855	1.072	0.897	1.173	1.057	1.219

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