No. 2010/15

Trade-throughs in European Cross-traded Equities After Transaction Costs – Empirical Evidence for the EURO STOXX 50 –

Bartholomäus Ende and Marco Lutat

Center for Financial Studies
Goethe-Universität Frankfurt ■ House of Finance
Grüneburgplatz 1 ■ 60323 Frankfurt ■ Deutschland

Telefon: +49 (0)69 798-30050
Fax: +49 (0)69 798-30077
http://www.ifk-cfs.de ■ E-Mail: info@ifk-cfs.de

Center for Financial Studies

The *Center for Financial Studies* is a nonprofit research organization, supported by an association of more than 120 banks, insurance companies, industrial corporations and public institutions. Established in 1968 and closely affiliated with the University of Frankfurt, it provides a strong link between the financial community and academia.

The CFS Working Paper Series presents the result of scientific research on selected topics in the field of money, banking and finance. The authors were either participants in the Center´s Research Fellow Program or members of one of the Center´s Research Projects.

If you would like to know more about the *Center for Financial Studies*, please let us know of your interest.

Prof. Michalis Haliassos, Ph.D.   Prof. Dr. Jan Pieter Krahnen   Prof. Dr. Uwe Walz

Center for Financial Studies
Goethe-Universität ■ House of Finance
Grüneburgplatz 1 ■ 60323 Frankfurt am Main ■ Deutschland

Telefon: +49 (0)69 798-30050
Fax: +49 (0)69 798-30077
http://www.ifk-cfs.de ■ E-Mail: info@ifk-cfs.de

CFS Working Paper No. 2010/15

Trade-throughs in European Cross-traded Equities After Transaction Costs – Empirical Evidence for the EURO STOXX 50 –*

Bartholomäus Ende[1] and Marco Lutat[2]

June 2010

Abstract:
The new regulatory environment triggered by MiFID has resulted in a transformed competitive landscape and increased fragmentation among execution venues in Europe. One key component of MiFID is best execution, i.e. investment firms are obliged to achieve the best result for customer orders on a consistent basis. Specifically for retail transactions, the total consideration, i.e. price and explicit transaction costs, shall apply as a benchmark for the best result. In contrary to RegNMS, MiFID does not require to achieve the best result based on a real-time comparison of available prices. Therefore, after the introduction of MiFID the question on the extent of suboptimal order executions after transaction costs arises. Applying order book data for EURO STOXX 50 securities of ten European execution venues, this paper analyses suboptimal order executions including transaction costs by simulating an optimal Smart Order Routing engine. The results show that after explicit transaction costs, specifically cross-system settlement costs, still an economically relevant number of suboptimal order executions prevails. The developed methodology and parameters enable for assessing and future tracking of the efficiency of order execution in European equity markets and the effectiveness of regulatory measures both on the trading level, e.g. MiFID, or on the post-trading level, e.g. the Code of Conduct for Clearing and Settlement.

JEL Classification: G14, G15, G24

* The authors wish to thank the Capital Markets CRC Limited, 55 Harrington Street, The Rocks NSW 2000, Australia for the provision of data and the support of this research. Specifically we d like to thank Mr. Andreas Furche and Mr. Andreas Ruf for their support and insightful and fruitful input during the project.

1 Goethe-University Frankfurt, Chair of e-Finance, E-Finance Lab e.V., Grüneburgplatz 1, D-60323 Frankfurt/Main, Germany.
E-mail:ende@wiwi.uni-frankfurt.de

2 Goethe-University Frankfurt, Chair of e-Finance, E-Finance Lab e.V., Grüneburgplatz 1, D-60323 Frankfurt/Main, Germany.
E-mail lutat@wiwi.uni-frankfurt.de

1 Introduction

In fragmented markets the real-time investigation of order execution venues and the available executable order limits and quotes can improve execution results in agent and proprietary trading and finally portfolio performance.

In the US, market fragmentation between equity markets and the Electronic Communication Networks introduced in the late '90s triggered specific order routing concepts to assure best execution. The US Order Protection Rule does not allow a trading centre to execute an order at a price that is inferior to the price of a protected quotation, often representing an investor's limit order displayed by another trading centre, and thereby avoids trade-throughs. RegNMS modified the Order Protection Rule and introduced the concept of automated and manual markets whereby manual quotations are excluded from the set of quotations that are protected against trade-throughs (Securities and Exchange Commission 2005).

In Europe, equity trading was concentrated on the respective national stock exchange in various member states of the European Union (EU) until November 2007. As the successor of the 1993 Investment Services Directive (ISD), the Markets in Financial Instruments Directive (MiFID) has to be applied by regulated markets and investment firms from November 1st, 2007 (European Commission 2004). MiFID aims at establishing a single market and a homogenous regulatory regime for investment services across the European Economic Area and triggered important changes for European securities markets. Within the directive, best execution of investors' orders is a core component[3]. However, what 'best execution' means in MiFID practice, is largely determined by the relatively broad policy approach that MiFID calls for and the individual implementation of the best execution requirements by investment firms: The rule framework can be implemented as a static approach, i.e. based on historical data the investment firms' rule engine selects the execution venue that provides the best result on a consistent basis neglecting the current market situation and data when executing individual orders. Most investment firms apply this static best execution approach, i.e. stick to the MiFID minimum requirements (Gomber, Pujol and Wranik 2008). Technology is available, specifically Smart Order Routing systems, that enables to access multiple liquidity pools to identify the best destination by using proprietary

[3] MiFID requires investment firms to execute customer orders on terms most favourable to the client. The best execution obligation is detailed in Article 21(1) MiFID that requires investment firms to "*take all reasonable steps to obtain … the best possible result … taking into account price, costs, speed, likelihood of execution and settlement, size, nature or any other consideration relevant to the execution of the order.*"

algorithms that optimise order execution. They scan markets in real-time to determine the best bid and offer limits or quotes for a specific order, thereby achieving the best price. Figure 1 illustrates this process.

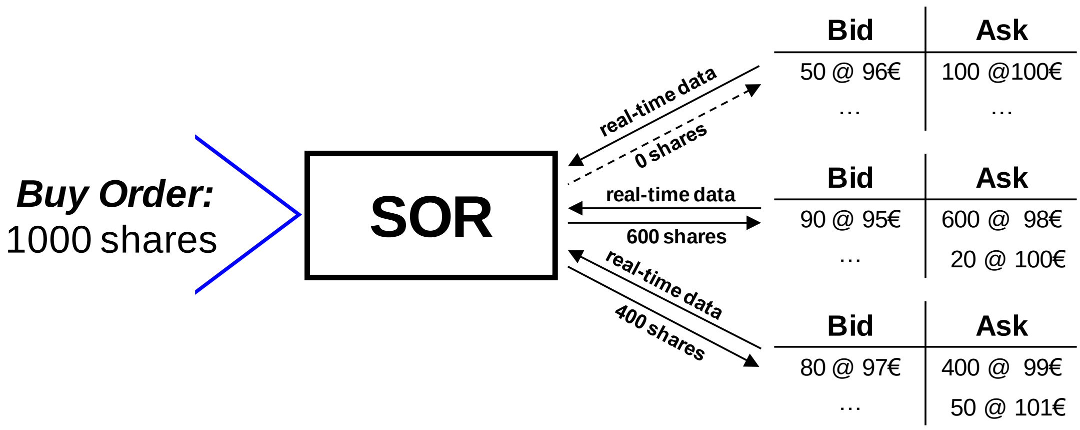

Figure 1 – Operating principle of a Smart Order Router (SOR)

The Smart Order Router – which is an implementation of best execution that exceeds the current MiFID minimum requirements – selects the appropriate execution venue on a dynamic basis, i.e. current market data feeds of information vendors are used by the rule framework. Such provisions support a dynamic allocation of the order to the execution venue offering the best conditions at the time of order entry including or excluding explicit transaction costs and/or other factors (e.g. the current technical latency of the venue). In order to achieve the best result in order execution on a real-time basis, i.e. price and explicit execution costs (the total consideration in MiFID terminology), two steps are required: First, at order arrival a routing system of an investment firm has to screen the respective execution venues for their order book situations, i.e. the execution price dimension. Second, the system has to incorporate a model that enables to calculate the total execution price of trades in different markets including applicable trading, clearing and settlement fees or even taxes, i.e. the explicit costs dimension (Domowitz 2002).

With an increasing focus on efficient order execution and technological sophistication of order routing concepts, one would expect suboptimal order executions, i.e. executions at a price that is worse than an executable price in a different market not to exist in Europe to a significant extent, at least on a net basis, i.e. after the inclusion of transaction costs.

To evaluate this hypothesis in this paper

- first, we analyse the existence of suboptimal order executions in ten European securities markets from a gross perspective, i.e. for every trade which occurs in a sample of EURO STOXX 50 equities in two weeks in late 2007 and early 2008, we seek better execution conditions (lower best asks for buy and higher best bids for sell orders) in a set of markets where a respective stock is traded simultaneously.
- Second, we include the explicit transaction costs component by assuming two different scenarios of cost structures in European cross-system trading and apply these cost structures to the gross results derived in the first step.

The applied methodology enables to assess and to track the efficiency of order execution in European equity markets. Furthermore, the results allow investors as well as investment firms assessing the value generation potential of Smart Order Routing systems on a net basis. As we analyse executions dated after November 1st, 2007, the results will enable regulators to assess the effectiveness of European best execution provisions after the applicability of MiFID and to evaluate the broad and flexible policy approach of MiFID relative to a strict trade through regime as applied by RegNMS. The comparison of the gross results and the net results furthermore provide insights on the impact of transaction costs, specifically costs in clearing and settlement, on order routing decisions. Also this comparison is an indication for the value generation potential of an integrated European market where the concept of cross-system settlement is redundant.

An important limitation concerning the transaction costs arise from the fact that the individual investment firms that are executing the respective trades are not included in public data sets and therefore beyond the authors' knowledge. Thus, based on publicly available information on trading and post trading costs from institutions along the securities trading value chain (exchanges, clearing houses and Central Securities Depositories), assumptions on costs structures for the order executing firms are derived and applied identically for all executed orders in two scenarios (one scenario with direct access to the respective infrastructures and therefore low costs and one high-cost scenario where intermediaries are assumed to provide the access to the market infrastructures).

The remainder of the paper is organised as follows: Section 2 reviews previous literature on cross market trading and execution quality. Section 3 elaborates on our instrument and marketplace choice, describes the dataset and explains the assumptions and adaptations necessary for the analysis of trade-throughs. Section 4 presents the assumptions for the applied transaction cost scenarios. Section 5 discusses our results. A conclusion and an outlook are provided in section 6.

2 Related literature

As our work tries to empirically assess the extent of suboptimal order executions in fragmented markets, our research is related to three specific streams in market microstructure, literature on (i) *cross market trading, (ii) international cross listings* and (iii) *execution quality*:

While most classic paradigms in theoretical market microstructure focus on centralised (securities) markets, modern equilibrium theory also addresses fragmented markets (e.g. Biais 1993). As market fragmentation is mainly a US phenomenon (O'Harra 2004) most literature on *cross market trading* deals with the American trading landscape. Although theory on cross market trading implies the emergence of one dominant market (Chowdhry and Nanda 1991), in the US and recently in Europe[4] a trend towards fragmentation has commenced. This raises the question on the impact of fragmentation on market quality. Theory implies that market fragmentation negatively affects liquidity provision, increases price volatility and leads to violations of price efficiency (Mendelson 1987, Madhavan 1995). The implications from empirical work are less clear: concerning Dow stocks that are traded on multiple US markets the results of the econometrical model by (Hasbrouck 1995) imply that the NYSE remains the predominant contributor to price discovery. Studies like (Cohen et al. 1985, Porter and Thatcher 1998) observe negative effects of fragmentation on market quality and (Amihud et al. 2003, Barclay and Hendershott 2004, Benett and Wei 2006) provide evidence that order consolidation improves liquidity provision and pricing efficiency. On the contrary, other studies like (Battalio 1997, Fong et al. 2001, Conrad et al. 2005) report no negative impact from fragmentation for the case of competing markets. (Foerster and Karolyi 1998) who analyse the effect of cross-listings of stocks from the Toronto Stock Exchange on US exchanges even report that trading cost in means of overall posted and effective spreads in the domestic market decrease. However, they observe the effect to be stronger for stocks that experience a significant shift of trading volume to the US exchange.

[4] For data on the current status of European equity market fragmentation (in terms of market share), refer e.g. to http://fragmentation.fidessa.com.

(Madhavan 1995) observes that some market participants – in particular large ones whose orders require multiple trades to be filled – prefer to trade in fragmented markets where trades are not disclosed. Other reasons for this phenomenon are stated by (Bessembinder and Kaufmann 1997). They conclude for the observations of (Blume and Goldstein 1997) that for most executions of NYSE listed stocks that take place off the NYSE the selected exchange posts worse quotes that this might be due practices like order preferencing and payments for order flow.

Concerning *international cross listings* academic literature is mostly centred on American Depository Receipts (ADRs). (Miller and Morey 1996) study intraday prices for ADRs at the NYSE and UK shares of Glaxo-Wellcome. As they find the price differences between those markets small during simultaneous trading they consider efficiency. Large fluctuations in deviations from theoretical parity over time are presented by (Froot and Dabora 1999), who examined the Anglo-American dual-listed company (DLC) Smithkline Beecham. They deny fundamental factors to be a reasonable explanation for their findings and rather cite issues related to currency risk, governance structures, legal contracts, liquidity, and taxation to be explanatory factors. Based on stocks listed at the Mexican Stock Exchange and their respective ADRs (Domowitz et al. 1998) highlight the importance of informational linkages. Their results show that in the case of freely available intermarket price information cross-listings positively affect market quality in terms of reduced spreads, more precise public information and increased liquidity in both markets. In contrary when intermarket price information is poor cross-listings weaken market quality as they reduce liquidity and increase volatility in the domestic market by a dispersion of informative order flow. (Bedi et al. 2003) and (de Jong et al. 2003) study the case of DLCs, which effectively represent mergers between companies that agree to combine their operations and cash flows and have common dividend structures while retaining separate shareholder registries and identities, e.g. Unilever N.V. and Unilever PLC. Each of these studies find large and systematic price parity deviations from their home market shares which they try to explain with tax, accounting, regulatory, governance and trading attributes. A few papers employ special intraday data for country-specific studies of relative price discovery in cross-listed and home-market shares. (Grammig et al. 2004) analyse this for DaimlerChrysler as a Global Registered Share (GRS), Deutsche Telekom and SAP (as ADRs) traded on Xetra in Germany and on the NYSE. They find that prices are largely determined in the home market rather than the foreign market. (Eun and Sabberwal 2003) support those findings for a sample of Canadian stocks. (Gagnon and Karolyi 2004) studied price deviations for nearly 600 pairs of cross-listed stocks from 39 countries and find deviations from the home market of 20 to 85 basis points.

With competing markets statistics on their *execution quality* become more and more important: First, they can highlight the attractiveness of those markets and help them gaining new order flow. Second they are required for the evaluation of regulatory environments, such as MiFID or Reg NMS. Accordingly, again a rich pool of literature for the US trading landscape exists. Typically execution quality is measured across trading venues by comparing trade prices with quotes from competing markets (e.g. Bessembinder and Kaufmann 1997 and 1997a, Battalio et al. 1998, Bessembinder 1999, Bacidore et al. 1999). Their common consent for retail sized orders is that the NYSE offers investors the most favourable prices. On the other hand a comparison of institutional investors' trading costs at the NYSE and the Nasdaq by (Chan and Lakonishok 1997) indicates that there are cost advantages for trades at the NYSE in large firms while Nasdaq provides better prices for smaller ones. Based on concerns by (Macey and O'Hara 1997) more recent literature argues that execution quality cannot be captured by the price dimension on its own. For instance (Battalio et al. 2003) compare the NYSE with Trimark Securities, a Nasdaq dealer. Their results outline that although the NYSE offers investors better prices, dimensions beyond the trade price like execution speed, depth improvement or order-flow payment look more favourable for Trimark. They conclude that if brokers pass parts of these payments to their investors, this would even lead to better net prices at Trimark. Aditionally, (Bacidore et al. 2003) highlight the importance of standardised methodologies to quantify execution quality as their results are sensitive to the employed calculation methodology. Finally, (Bakos et al. 1999) analysed the law of one price against the background of brokers' execution performance and commissions. They found relatively few price improvements, which are a measure of execution quality as they are sign for competitive pricing. The difference among brokers in obtaining price improvements was not statistically significant, but the brokers do exhibit statistically significant differences in total trading costs.

As the quality of order executions can vary heavily for different trading venues (Macey and O'Hara 1997), a reasonable selection of a venue for a particular order appears to be more important than ever for the US and findings from (Battalio et al. 2002) indicate that strategic routing of decisions for orders, e.g. via Smart Order Routing, could help to improve overall order execution quality.

Against the background of new technology driven opportunities in order handling (Ramistella 2006) observed that the demand for reasonable order routing solutions has intensified for investment firms. (Foucault and Menkveld 2008) analyse the implications of market fragmentation and the rate of price priority violations (i.e. an order was executed in a market providing an inferior price compared to a price available in a different market) of two trading venues for Dutch equities. From their findings they interpret trade-throughs as being due to a lack of automation of routing decisions.

The contribution of this paper to the existent literature is threefold: First, it examines suboptimal order executions in Europe rather than the US based on order book data rather than price data. Second, to the knowledge of the authors it is the first paper that empirically analyses execution performance including transactions costs after the MiFID introduction in Europe. Third, the presented results highlight the relevance of Smart Order Routing technology in the new European landscape.

3 Data, assumptions and methodology

To enable for an empirical analysis of suboptimal order executions, in the following we will first define the key term "trade-through", then describe the dataset, the data handling/cleaning operations as well as our hypotheses. Afterwards chapter 4 will elaborate on transaction costs in trading and post-trading and describe our different cost scenarios.

3.1 Identifying suboptimal order executions as trade-throughs

To identify suboptimal order executions, in the following we use the definition of trade-throughs according to (Schwartz and Francioni 2004) stated below.

Definition: Trade-Through

A trade-through in a particular stock is said to take place "*...when a transaction occurs at a price that is higher than the best posted offer or lower than the best posted bid and orders at these better prices are not included in the transaction*".

Figure 2 shows an example of a trade-through between two markets on a gross basis where – although market A shows a best offer of 86.44 € – the buy order is executed on market B at 86.50 € per share.

Market A:

Bid						Offer
Time	Quantity	Limit	Limit	Quantity	Time	
11:35	343	86.42	86.44	500	11:35	
…	…	…	86.50	100	11:35	
			…	…	…	

Market B:

11:36: Buy initiated execution 400 @ 86.50€

Trade-through of the better offer limit at market A.
This incurs the chance for a price improvement of 24€ (before costs).

Figure 2 – Example of a trade-through situation

Moreover, we label a situation where an order could be executed in a different market with its full order size at a better price (better bid or better offer limit) to be a *full trade-through*, whereas a situation in which only a part of an order could be executed in a different market at a better price (better bid or better offer limit) is classified as a *partial trade-through*[5].

To identify full and partial trade-throughs, for each order execution in our data set, we compare trade data (trade price and volume, trade direction and time stamp) of the market where the execution actually took place (e.g. market B in figure 2) with the order book situations in all other markets simultaneously at the time of this execution. A trade-through (full or partial) is found if at least one marketplace exists (e.g. market A in figure 2) where a strictly positive amount of savings could be realised. We pick the market with the highest potential overall savings for the trade.

3.2 Hypothesis and statistical testing

Assuming traders' rational behaviour in executing their orders and based on their responsibility to identify the best result for clients' orders, one should expect that the proportion of sub-optimally executed orders will not reach a significant level after considering explicit transaction costs, i.e. that the savings which could be realized by switching to a different market are smaller than the associated costs. For testing this hypothesis two variables are computed for each trade where a different market offers a price improvement (before costs):

[5] A partial trade-through might turn into a full trade-through when the complete order book data is available (also orders beyond the top of the book) to be included in the analysis. As our dataset includes merely the best bid and offer limits (top of the order book) we apply the partial trade-through concept.

1. Absolute amount of savings (Savings), defined as the maximum savings per trade if executed in a different market.

2. Relative price improvements (*PI*), defined as

$$PI = N_{adjust} \cdot \frac{\left|P_{better} - P_{trade}\right|}{P_{trade}}$$

$$with\ N_{adjust} = \begin{cases} \frac{N_{better}}{N_{trade}} & , if\ N_{better} < N_{trade} \\ 1 & , else \end{cases}$$

where N_{better} equals the quoted number of shares in the market offering a better price and N_{trade} is the actual trade's number of shares. P_{better} is the potential price in the market offering better conditions and P_{trade} the actual trade price. $N_{adjust} = 1$ reflects full trade-throughs, whereas $N_{adjust} < 1$ reflects partial trade-throughs.

Assuming that both test statistics have a *Student's t distribution* under the null hypothesis both variables' means will be tested for

$\mathbf{H_0}$: *mean* $\leq$ *switching costs* against $\mathbf{H_a}$: *mean* > *switching costs*.

Results will be checked against those from a Wilcoxon signed-rank test as the number of observations strongly varies among combinations of stock and marketplace.

3.3 Instrument and marketplace choice

The instrument choice is based on the constituents of the Dow Jones EURO STOXX 50 Index (as of October 2007) since those stocks represent the actively traded shares on multiple markets in Euro currency. The index covers 50 blue-chip stocks[6] from 12 Eurozone countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.[7] Table 1 provides the considered instruments.

INSERT TABLE 1 ABOUT HERE

[6] One EURO STOXX 50 instrument (ARCELORMITTAL) was not available in the data set, therefore the sample finally consists of 49 instruments of the index.
[7] For further information please refer to http://www.stoxx.com/indices/components.html?symbol=SX5E.

Concerning the execution venues in our sample, we included the European markets trading in Euro currency that feature a fully-electronic open central limit order book (CLOB) in the period under investigation.[8] Therefore, ten markets have been identified for this study: Bolsa de Madrid, Borsa Italiana Milan, Chi-X, four Euronext markets (Amsterdam, Brussels, Paris, and Lisbon), Helsinki Stock Exchange (NASDAQ OMX Helsinki), SWX Europe (formerly Virt-x) and Xetra (Deutsche Börse).

The trading mechanisms of these execution venues for liquid stocks apply continuous trading. Opening and closing prices are set via scheduled (time-triggered) call auction mechanisms[9]. To assure price continuity, additional volatility interruptions stop continuous trading in case of potential extreme price movements and trigger an unscheduled (event-triggered) auction. Except for Chi-X, all execution venues in our sample shift from continuous trading to a non-scheduled auction for a minimum of two minutes following a potential violation of price continuity.[10]

3.4 Description of the data set

Intraday trade and order book data for each stock and for each market are sourced from the archives of Reuters.[11] For the markets in our sample, this database contains each best bid/offer limit and trade price with respective volume and a date and time stamp with a granularity of one second assigned to it. The data set under investigation represents level 1 data, i.e. it does not include depth of order book information, consisting of orders positioned beyond the top of the book (level 2 data). Reuters trade and order book data do not contain an indication of trade direction, which must therefore be inferred. In the ten fully electronic markets these inferences are straightforward. All trades executed at the best offer are categorised as buy-initiated; all trades executed at the best bid quote are categorised as sell-initiated.[12] Total traded value and other aggregated activity figures for each stock were calculated from the Reuters trade and order book data.

[8] E.g. German exchanges like Stuttgart, Munich, Hannover and Hamburg or PLUS markets (http://www.plusmarketsgroup.com) in the UK have not been considered as their market models do not fully comply with these restrictions.

[9] While all other markets compute the opening price depending on their order book data in the opening and closing auctions, Chi-X opening and prices are established using the opening price of a stock's primary market.

[10] The Chi-X trading system does not accept orders leading to a violation of price continuity. For further information, please refer to the Chi-X website (www.chi-x.com).

[11] Reuters archives were made available by the Australian Capital Markets Cooperative Research Centre Limited (CMCRC).

[12] For further information on tick rules, please refer to (Ellis, Michaely and O'Hara, 2000).

Our sample consists of 20 trading days divided into two distinct sample periods with the first from December 10–21, 2007 and the second from January 7–18, 2008[13], i.e. after the applicability of MiFID. Altogether 8,010,905 executed trades representing an overall trading volume of € 262,314 million are included in the dataset.

3.5 Data handling and data cleaning

For the investigation, our dataset had to be cleaned and prepared in several dimensions. Trade and order book data lacking essential information (e.g. associated volume) were eliminated. In the case of order book data, the most recent valid limit orders featuring all information necessary for our analysis were considered for comparison of execution quality. Moreover, trades for which a trade direction could not unambiguously be determined were eliminated from the dataset. Regarding trade sizes no data cleaning measure were required.[14]

As trading hours among the ten electronic markets included in this study vary slightly, for a comparison of markets only the periods of simultaneous trading were taken as a basis. As we focus on continuous trading, auctions times were neglected and additionally, any order book or trading activity within two minutes around scheduled as well as non-scheduled auctions[15] were eliminated from our dataset. Table 2 presents the trading hours for continuous trading for each market. Table 3 presents the minimum duration of a non-scheduled auction for each execution venue in our sample. Altogether from a total of 9.163.780 trades, 12.58 percent of trades were eliminated.

INSERT TABLE 2 ABOUT HERE

INSERT TABLE 3 ABOUT HERE

As stated in section 3.4, our dataset contains time stamps for trades and quotes with a granularity of one second. With a quote change in a comparison market arriving within the second of a trade in the original market this new quote is considered available and thus

[13] Note that the Société Générale trading loss incident was publicly announced after the end of the second sample period and therefore no bias is to be expected from it.

[14] We checked our dataset for trades qualifying as large in scale compared with Normal Market Size (NMS), i.e. 500.000 Euro, as we would expect those trades to result from off-market transactions (CESR 2008). As the removal of these trades does not change our results we omitted this removal step within the reported ones.

[15] A non-scheduled auction (volatility interruption) for a stock was assumed whenever its best bid's and offer's limit price and volume were simultaneously set to zero followed by a period of at least two minutes with neither order book nor trading activity. For our investigations we filtered out all non-scheduled auctions that took place at the home market as it is the market where price discovery is expected to take place.

presents the most recent order book situation to this trade. With more than one quote change within the second of a trade occurrence at one market, the quote resulting in the least savings is taken as a basis for an execution performance comparison in order to retrieve a lower boundary for the possible price improvements.

4 Explicit transaction costs in order execution

Trading refers to the actual order submission/execution process and clearing ensures that all the prerequisites for the later settlement are in place so that at the conclusion of that process each market participant is aware of what its settlement obligations are vis-à-vis all its counterparties for the deals executed on a certain trade date (Stehm 1996). A Central Counterparty (CCP) adopts functions that enable a market to provide post trade anonymity, netting efficiency[16] and facilitation of risk management (Schwartz and Francioni 2004). Settlement is *"…the act of crediting and debiting the transferee's and transferor's accounts respectively, with the aim of completing a transaction in securities*" (CESAME Sub-Group on definitions 2005, p.12). Settlement represents the last act of the transfer process and takes place at Central Securities Depositories (CSDs). Once that transfer is legally binding, the securities transfer is considered as being final (Bank for International Settlements 1992).

Due to a relevant fragmentation in European post-trading infrastructures, it is expected that trading and clearing and specifically (cross-system) settlement costs are a key driver for suboptimal order executions in European equity markets. While the execution venues and respective clearing and settlement providers differ in their cost structures for domestic trading, the main driver of explicit costs when trading internationally are the cross-system settlement costs (in the following referred to as transfer costs)[17]. To exactly determine whether an individual execution is a trade-through on a net basis, one would need to identify the individual investment firm executing the trade and its individual (trade and post-trade) intermediaries'/service providers' fee levels. As the analysis is based on public data, information on the investment firm that executed a trade is not available. Therefore, we assume different scenarios of cost structures where in each scenario one specific level of

[16] Netting is the process of off-setting positions in cash and securities of opposite directions per security and market user. The netting efficiency is the ratio between the number of transactions falling off from settlement because of this netting procedure and the total number of transactions.

[17] Brokerage costs are not included in the analysis as it is assumed that the broker/investment firm is the decision point for order routing and consequently their cost structures are taken as the basis of the analysis.

costs is assumed consistently for all investment firms (in the following referred to as model user) in that scenario.

We consider explicit costs for trading, counterparty risk clearing and settlement services (Oxera 2007) by modeling the variable costs directly related to the execution of trades. Therefore, fix costs like all annual fees, one-off access fees, etc. are considered as being paid anyway and are not added as a cost component to an individual order.

The fees charged in the different trading platforms depend on various factors that drive the final total charge, e.g. because the fee schedules often are based on how much business a participant brought to the systems. Therefore, assumptions about the size of the model user are necessary in order to apply the fee schedules of the trading platforms and of providers of CCP clearing and settlement. Moreover, assumptions about how many *partial fills* apply to an order on average are required to allow a price comparison. Some service providers charge fees based on partial fills, others only on the orders sent to the respective service provider. For consistency reasons, the model user is assumed to reach an annual number of orders that enables to reach the highest discount levels in all of the markets which are analysed. In particular the markets of Italy and France require considerably high numbers of transactions in order to achieve the highest discount levels. The assumptions concerning partial fills and *price level hits per order* in connection with a certain *average €-value per order*, are based on numbers provided by Deutsche Börse in an exemplary cost calculation for Xetra (Deutsche Börse AG 2007, p.1). In that document, Deutsche Börse sets the number of partial fills and the number of price levels hit in a relation to the value of an order posted to its trading platform. This relation has been taken as being linear between the data points provided and used in order to derive the corresponding values for the assumed order size. Although there is no exact data about the *netting efficiency* achieved by the single European CCPs, Deutsche Börse in a quarterly balance statement published to achieve 90% (Deutsche Börse AG 2003, p.5). Therefore, a netting efficiency of 90% has been applied for all markets. Our assumptions can be found in Table 4.

INSERT TABLE 4 ABOUT HERE

As the number of partial executions and the average number of price level hits depends on the order size of individual orders, for our cost analysis orders with characteristics as given in Table 5 are applied.

INSERT TABLE 5 ABOUT HERE

Applying the above assumptions, the domestic costs per market are based on the respective institutions' publicly available fee schedules and presented in the following table. As the fees (non-linear) depend on the executed order sizes we derived typical and relevant[18] order sizes for the fee computation. In order to determine the costs for a particular trade-through of given order size, we interpolate these costs.

INSERT TABLE 6 ABOUT HERE

In cross-system trading, clearing and settlement, transaction costs depend on the channels used for access to the national CSDs. (Giovannini Group 2001) lists five different access routes for an international investment firm to a foreign CSD. Based on (Giovannini Group 2001), figure 3 shows these five different possibilities to access a foreign settlement system in Europe.

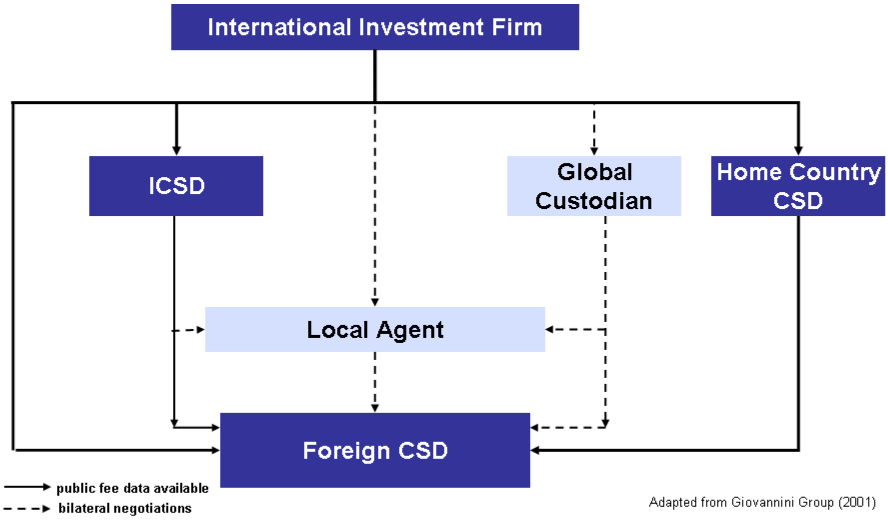

Figure 3 – Access alternatives to foreign settlement systems

[18] The figures concerning the sizes of the orders and related characteristics are derived from different sources. First the order sizes of 25,000, 45,000 and 100,000 Euros are the same as used in a study by the European Commission on the competition of securities trading and post-trading in Europe (European Commission, Competition DG 2006, p. 28). The order size of 7,500 Euros per order has been published as average retail order size by an association of German retail banks in the course of its MiFID best execution policy (Deutscher Sparkassen- und Giroverband e.V. 2007). The size of 200,000 Euros is considered an approximation for a wholesale order size as published by Clearstream Banking Luxembourg (Deutsche Börse Group 2002, p.19). Finally, the order sizes of one Euro and one million Euros are supposed to provide the lower and upper boundary for the costs.

In order to settle a transaction in a particular security, both counterparties must have access to systems where it is possible to deliver and receive the security in question. Thus, the distinctive feature of cross-system settlement is gaining access to a settlement system in another country and/or the interaction of different settlement systems.

The first option for a foreign investment firm to access the CSD in which a security is primarily listed, is direct (non-intermediated) access to that CSD. That means that the investment firm involves directly in domestic clearing and settlement, has own arrangements required in place and is holding a securities and cash account directly to the respective CSD and payment system.

The options two to five are options where the investment firm (or any international investor) uses the services of intermediaries to access the foreign settlement systems. Settlement via intermediaries includes settlement via International Central Security Depositories (ICSDs) (option two), via local agents (option three) or through a global custodian (option four). The fifth option makes use of CSD to CSD links. For our analysis, we apply option two as (i) for the services by local agents or a global custodian (options three and four) prices are mostly negotiated and not publicly available (Bank for International Settlements 1995) and (ii) with regard to option five, multiple initiatives in Europe try to enforce the use of CSD links as a less expensive alternative, but (as of end 2007/early 2008) they are only available between a limited number of CSDs and in this case mostly for a limited number of securities and so far seldom used (Kauko 2007). Furthermore, within our investigation we observed the costs of settlement via CSD links to lie in between the costs of scenario 1 and the costs of scenario 2. Thus, the CSD link approach would provide no additional information concerning the lower or higher boundaries of the cost ranges.

For the analysis, we compute the transaction costs for a model user both in one non-intermediated and one intermediated scenario. Thereby we aim to assure that we provide a lower and an upper boundary for the relevant transaction costs:

- Scenario 1 represents the first option of (Giovanni Group 2001), i.e. the model user has direct access to all facilities necessary along the transaction chain, i.e. trading, clearing and settlement facilities, in all European markets of our sample. It is assumed that the model user is a direct member of the trading platforms and clearing houses and that it holds securities accounts for settlement at the CSDs given in Table 7 and possesses cash accounts with the relevant central banks. Scenario 1 therefore represents the lower boundary regarding the variable explicit transaction costs for individual orders.

INSERT TABLE 7 ABOUT HERE

- In scenario 2, which will represent the upper cost boundary, cross-system settlements are conducted via ICSDs which charge an investment firm transfer fees (option two of Giovanni Group 2001). The respective transfer costs applied for our analysis have been derived from the publicly available fee schedules of Clearstream Banking Luxembourg and Euroclear Bank[19] (as of late 2007/early 2008) and are presented in table 8[20].

INSERT TABLE 8 ABOUT HERE

For the case of an investor involved in trading in two different countries our stylised model user set-up can be illustrated as in Figure 4 for the two scenarios.

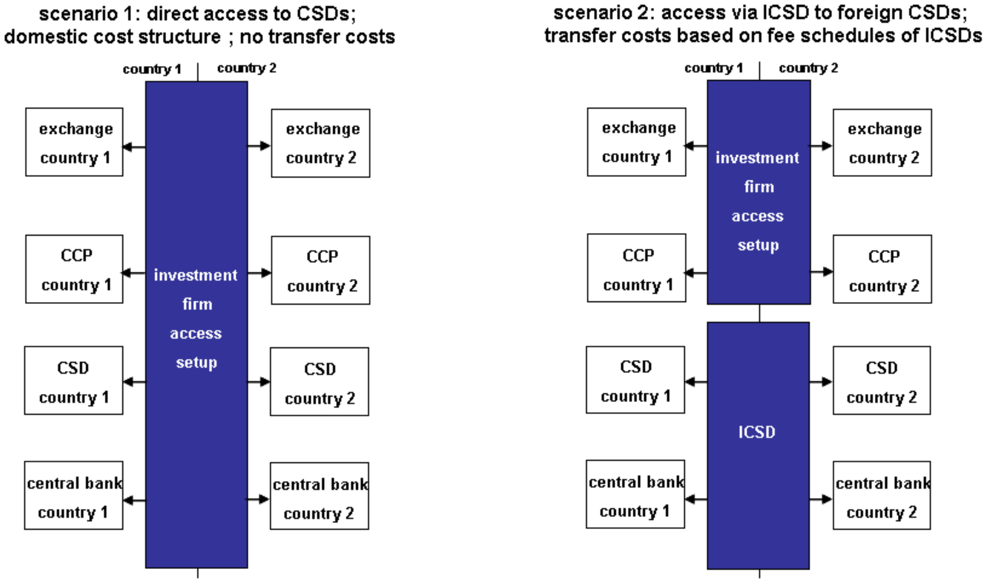

Figure 4 – Model user set-up for the case of the two scenarios

To evaluate whether a trade-through still holds after the inclusion of explicit costs, information about three cost variables is required:

- Total costs for trading, clearing and settlement in market A (from Table 6)

---

[19] As both Clearstream Banking Luxembourg and Euroclear Bank provide cross-system settlement services and their charges slightly differ, we consider the least expensive one for each trade in our sample.

[20] Since Chi-X trades are throughout settled in a security's domestic home CSD, transfer costs do not apply here.

- Total costs for trading, clearing and settlement in market B (from Table 6)
- Costs for the securities' transfer in scenario 2 (from Table 8)

In scenario 1 for a trade-through we consider a situation where it is possible to buy (sell) in market B at a more favourable price than buying on market A. However, with the costs for trading, clearing and settlement in both markets being different, these differences in costs need to be considered when executing a trade in one market instead of the other.

In scenario 2, the additional costs for the transfer of the equities bought or sold need to be included. It is assumed that the respective securities are kept in the CSD of the market where the securities could be bought (sold) causing costs for a delivery or receive instruction at the CSD where the security could be bought (sold) and a delivery or receive instruction at the ICSD, i.e. one external instruction to the respective market.

In section 5 we will first present the results for the gross perspective, i.e. without including explicit transaction costs, and afterwards for the non-intermediated scenario 1 and the intermediated scenario 2.

5. Results

Results for trade-throughs in the different scenarios will be presented as follows: First this section will deal with the findings on trade-throughs addressing summarising descriptive statistics. This will be followed by an illustrative in-depth analysis for an exemplary instrument with our results broken down into the gross perspective and the individual cost scenarios described in the previous section. Consequently, our test statistics for the relative and absolute savings will be presented.

Table 9 summarises the overall results from the gross perspective as well as the different cost scenarios. Without considering explicit costs from our total of 8,010,905 trades, 6.71% (absolute: 537,764) could have been executed at a better price with their full volumes (full trade-throughs), 6.45% (absolute: 516,797) at least with a part of their volumes (partial trade-throughs) with potential total savings of € 9.50 million, average savings per trade-through of 9.01 € and savings of 7.54 bps (0.36 bps) relative to total trade-through value (relative to total traded value). For the cost scenario 1, total savings increase compared to the no costs perspective as potential savings in explicit costs might add up on top of price improvements. This is the case whenever a market does not only offer a better execution price but is also less expensive in terms of transaction costs. With the explicit cost scenario 2 incurring explicit transaction costs (and particularly the costs for the securities transfer) those proportions obviously shrink, but still result to 1.41 % (absolute: 112,770) of full and 1.34 % (absolute: 107,483) of partial trade-throughs with potential total savings of € 5.9 million, average savings per trade-through of 26.83 € and savings of 10.17 bps (0.23 bps) relative to total trade-through value (relative to total traded value).

INSERT TABLE 9 ABOUT HERE

In the following tables these figures will be detailed for the individual EURO STOXX 50 securities. Table 10 provides the (gross) perspective without the inclusion of explicit trading costs. Generally, our findings exhibit a high level of heterogeneity among instruments regarding the trade-through characteristics with the minimum of full trade-through percentage at 0.16 and the maximum at 16.70 percent.

INSERT TABLE 10 ABOUT HERE

Table 11 describes the non-intermediated cost scenario 1, while table 12 presents the results for the intermediated ICSD cost scenario 2. For the later scenario absolute savings obviously decrease relative to those from the gross perspective, as potential savings are reduced and partly even absorbed by the accruing transfer costs. Not so for scenario 1, as transfer costs do not accrue and the difference in explicit trading costs between two markets potentially adds to savings if the market providing a price improvement also features lower domestic trading costs.

INSERT TABLES 11 & 12 HERE

TOTAL led the EURO STOXX 50 index in terms of market capitalisation as of December 31st, 2007 (STOXX Ltd. 2008). Therefore, in the following TOTAL will be taken as an example to explain our key figures for the gross perspective in table 13 and for the non-intermediated cost scenario 1 in table 14 as well as for the intermediated ICSD cost scenario 2 in table 15 respectively.

INSERT TABLES 13, 14 & 15 ABOUT HERE

Tables 13 to 15 feature the analysis results in the different cost scenarios for the individual execution venues. The "Overall" column summarises over all markets. The table's upper section gives an overview on the markets' activity for TOTAL applying characteristic figures which is obviously identical in the different scenarios. Trade activity varies heavily among market places with the second in number of trades (here: Chi-X) not even measuring up to one tenth of that of the primary exchange (here: Euronext Paris). This is a common observation for most stocks in our sample highlighting that the home markets principle (Schwartz and Francioni 2004) prevails up to the time of the analysis. The lower section introduces our findings on trade-throughs for each market with percentages and absolute figures on full and partial trade-throughs. For example in the gross perspective for TOTAL (table 13) 14.58 % or 42,815 out of the 293,729 trades which occurred in Euronext Paris could have been executed in its full size at a better price in (at least) one of the other markets. Potential accumulated savings over all trades are shown along with the absolute and relative average savings per trade-through [Avg. savings per trade-through and Savings/trade-through value respectively]. Finally, the savings are related to the total trade value for each market.

Table 16 presents the mean observed switching costs and *t*-statistics of TOTAL respectively for each market for the cost scenario 2. As described in section 3.2 we tested the relative price improvements [PI] and absolute savings [Savings] against those switching costs. Our findings are heterogeneous among stocks: Since this scenario incurs explicit costs for domestic transactions and securities transfer as described in section 4, the null hypotheses of no systematic relative price improvement and absolute savings cannot be statistically rejected for some stocks (e.g. TOTAL). On the other hand, for some stocks in our sample the null hypothesis of no systematic savings after transaction costs can be rejected, e.g. Table 17 presents our findings for AXA, where the null hypothesis of no systematic absolute savings can be rejected, as the potential savings from switching a trade to a different market significantly exceed the associated transaction costs.

INSERT TABLES 16 and 17 ABOUT HERE

Results show that investors could have realised significant savings on their trades across multiple instruments resulting from execution conditions superior to those in the actual execution venue even when considering different levels of explicit transaction costs.

6. Conclusions

After the introduction of MiFID, the European trading landscape moved from concentration rules to relevant market fragmentation and the best execution rules imposed by MiFID urge investment firms to achieve the best possible result for their customers. Nevertheless, MiFID applies a specific benchmark (price and explicit transaction) for order execution only for retail trades and does not enforce a strict trade-through regime like RegNMS. Against this background, the paper – based on a four week data set of EURO STOXX 50 securities consisting of 8 million executed trades with an overall value of € 262 billion – assesses the extent of suboptimal order executions after the introduction of MiFID both with and without considering explicit transaction costs by applying different cost scenarios. The analysis shows that there is a relevant and partly significant extent of suboptimal order executions where a different execution venue provides a better executable limit both in the gross and the net perspective: In the gross perspective, 6.71% of orders can be executed better in their full size (6.45% of orders partially) enabling for total savings of € 9.50 million within our sample period, i.e. 7.54 bps relative to total trade-through value and 0.36 bps relative to total traded value. Even in the cost scenario assuming explicit transaction costs which include the costs for the transfer of securities, 1.41 % of orders can be executed better in their full size (1.34 % of orders partially) enabling for total savings of € 5.90 million, i.e. 10.17 bps relative to total trade-through value and 0.23 bps relative to total traded value.

Given this evidence transaction costs alone as a form of market friction do not serve as an explanation for the existence of trade-throughs in Europe. Many investment firms seem to still apply established and pre-defined standard order routing mechanisms that are mostly targeting one market per security only (e.g. the national stock exchange or the "home market" of the respective security). (Gomber, Pujol and Wranik 2008) have revealed that for the case of German investment firms best execution implementation mostly relies on these standard routing mechanisms and only a very low rate of real time smart order routing solutions for could be found.

The developed methodology and parameters enable for assessing and future tracking of the efficiency of order execution in European equity markets and the effectiveness of regulatory measures both on the trading level, e.g. MiFID, or on the post-trading level, e.g. the Code of Conduct for Clearing and Settlement. As a future extension of the analysis, the inclusion of the order book depth of the respective markets (level 2 data) will allow to apply the concept of full trade-through to all the trades and to eliminate the partial trade-through approach.

References

Amihud, Y.; Lauterbach, B.; Mendelson, H. (2003): *The value of trading consolidation: evidence from the exercise of warrants*. Journal of Financial and Quantitative Analysis 38 (4), pp. 829–846.

Bacidore, J.; Ross, K.; Sofianos, G. (1999): *Quantifying best execution at the NYSE.* NYSE Working Paper 1999-05.

Bacidore, J.; Ross, K.; Sofianos, G (2003): *Quantifying market order execution quality at the New York stock exchange.* Journal of Financial Markets, 6 (3), pp. 281–307.

Bakos, Y.; Lucas, H.C.; Wonseok, O; Viswanathan, S.; Simon, G. and Weber, B. (1999): *Electronic Commerce in the Retail Brokerage Industry: Trading Costs of Internet Versus Full Service Firms*. Working Paper Series Stern #1S99-014.

Bank for International Settlements (1992): *Delivery Versus Payment in Securities Settlement Systems*, September, http://www.bis.org/publ/cpss06.pdf (last accessed: 11/10/2007).

Bank for International Settlements (1995): *Cross-Border Securities Settlements*, March, http://www.bis.org/publ/cpss12.pdf (last accessed: 01/07/2008).

Barclay, M.J.; Hendershott, T. (2004): *Liquidity externalities and adverse selection: evidence from trading after hours*. Journal of Finance 59, pp. 681–710.

Battalio, R.H. (1997): *Third market broker–dealer, cost competition or cream skimmers.* Journal of Finance 52, pp. 341–352.

Battalio, R.; Greene, J.; Jennings R. (1998): *Order Flow Distribution, Bid–Ask Spreads, and Liquidity Costs: Merrill Lynch's Decision to Cease Routinely Routing Orders to Regional Stock Exchanges.* Journal of Financial Intermediation, 7 (4), pp. 338–358.

Battalio, R.; Greene, J.; Hatch, B.; Jennings, R. (2002): *Does the Limit Order Routing Decision Matter?* The Review of Financial Studies, 15 (1), pp. 159–194.

Battalio, R; Hatch B., Robert J. (2003): *All else equal?: a multidimensional analysis of retail, market order execution quality*. Journal of Financial Markets, 6 (2), pp. 143–162.

Bedi, J.; Richards, A.; Tennant, P., (2003): *The characteristics and trading behavior of dual-listed companies.* Reserve Bank of Australia Working Paper.

Bennett, P.; Wei, L. (2006): *Market structure, fragmentation, and market quality.* Journal of Financial Markets, 9 (1), pp. 49–78.

Bessembinder, H. (1999): *Trade Execution Costs on NASDAQ and the NYSE: A Post-Reform Comparison.* The Journal of Financial and Quantitative Analysis, 34 (3), pp. 387–407.

Biais, B. (1993): *Price Formation and Equilibrium Liquidity in Fragmented and Centralized Markets.* Journal of Finance, Vol. 48(1), pp. 157-185.

Bessembinder, H.; Kaufman, H.M. (1997): *A cross-exchange comparison of execution costs and information flow for NYSE-listed stocks.* Journal of Financial Economics, 46 (3), pp. 293–319.

Bessembinder, H.; Kaufman, H.M. (1997a): *A Comparison of Trade Execution Costs for NYSE and NASDAQ-Listed Stocks.* The Journal of Financial and Quantitative Analysis, 32 (3), pp. 287–310.

Blume, M.; Goldstein, M. (1992): *Displayed and effective spreads by market.* Working paper, University of Pennsylvania Wharton School.

CESAME Sub-Group on definitions (2005): *Commission Services Working Document on Definitions of Post-Trading Activities*, October.

CESR (2008): *Shares admitted to trading on EU Regulated Markets*, http://mifiddatabase.cesr.eu/Index.aspx?sectionlinks_id=14&language=0&pageName=MiFIDLiquidSearch (last accessed: 06/25/2008).

Chan, L.K.C.; Lakonishok J. (1997): *Institutional Equity Trading Costs: NYSE versus Nasdaq.* The Journal of Finance, 52 (2), pp. 713–735.

Chowdhry, B.; Nanda V. (1991): *Multimarket Trading and Market Liquidity.* Review of Financial Studies, 4 (3), pp. 483–511.

Cohen, K.J.; Conroy, R.M.; Maier, S.F. (1985): *Order flow and quality of the market.* In: Amihud,Y., Ho, T., Schwartz, R. (Eds.), Market Making and the Changing Structure of the Securities Industry. Lexington Books.

Conrad, J.S.; Johnson, K.M.; Wahal, S. (2003): *Institutional trading and alternative trading systems.* Journal of Financial Economics, 70 (1), pp. 99–134.

De Jong, Abe; Rosenthal, L.; van Dijk, M. (2005): *The limits of arbitrage: Evidence from dual-listed companies.* November 2005, EFA 2004 Maastricht.

Deutsche Börse AG (2002): *Vision + Money - Smooth Integration, Consolidation of the European Exchange Infrastructure, July 2002.* http://www1.deutsche-boerse.com/INTERNET/EXCHANGE/zpd.nsf/PublikationenID/HAMN-5BQ9US/$FILE/v_m02_7.pdf?OpenElement (last accessed: 02/15/2008).

Deutsche Börse Group (2002): *Cross-Border Equity Trading, Clearing & Settlement in Europe, April 2002.* http://www1.deutsche-boerse.com/INTERNET/ EXCHANGE/zpd.nsf/PublikationenID/AKLS-58TMV6/$FILE/White-Paper_online_d.pdf?OpenElement (last accessed: 02/17/2008).

Deutsche Börse AG (2003): *Zwischenbericht Quartal 2/2003, August 2003.* http://deutsche-boerse.com/dbag/dispatch/de/binary/gdb_navigation/investor_relations/30_Reports_and_Figures/40_Interim_Reports/Content_Files/Interim_Reports/gdb_quartalsbericht_q2_2003.pdf (last accessed: 02/15/2008).

Deutsche Börse AG (2007): *Example calculations for cash equity transactions, July.* http://deutsche-boerse.com/dbag/dispatch/de/binary/gdb_content_pool/imported_files/public_files/10_downloads/45_clearing_members/Code_of_Conduct/20070628_Code_Example_Calculations_v2.2_final.pdf (last accessed: 02/15/2008).

Deutscher Sparkassen- und Giroverband e.V. (2007): Allgemeine Grundsätze der Auftragsausführung, First edition.

Domowitz, I.; Glen, J.; Madhavan, A. (1998): *International Cross-Listing and Order Flow Migration: Evidence from an Emerging Market.* Journal of Finance, 53 (6), pp. 2001–2027.

Domowitz, I. (2002): *Liquidity, transaction costs, and re-intermediation in electronic markets.* Journal of Financial Services Research, 22 (1&2): pp. 141–157.

Ellis, K.; Michaely, R.; O'Hara, M. (2000): *The accuracy of trade classification rules: evidence from NASDAQ.* Journal of Financial and Quantitative Analysis, 35, pp. 529–551.

Eun C.S.; Sabherwal S. (2003): *Cross-border listings and price discovery: Evidence from U.S.-listed Canadian stocks.* Journal of Finance, 58, pp. 549–575.

European Commission (2004): *Directive 2004/39/EC of the European Parliament and of the Council of 21 April 2004 on markets in financial instruments amending Council Directives 85/611/EEC and 93/6/EEC and Directive 2000/12/EC of the European Parliament and of the Council and repealing Council Directive 93/22/EEC*. Official Journal of the European Union, L 145/1.

European Commission, Competition DG, (2006): *Competition in EU securities trading and post-trading*. http://ec.europa.eu/comm/competition/antitrust/others/securities_trading.pdf (last accessed: 15.01.2008).

Froot, K.A.; Dabora, E.M. (1999): *How are stock prices affected by the location of trade?* Journal of Financial Economics, 53, pp. 189–216.

Foerster, S.R.; Karolyi, G.A. (1998): *Multimarket trading and liquidity: a transaction data analysis of Canada–US interlistings.* Journal of International Financial Markets, Institutions and Money, 8, (3-4), pp. 393–412.

Fong, K., Madhavan, A., Swan, P.L., (2001): *Why do markets fragment? a panel-data analysis of off-exchange trading.* Working Paper, University of Sydney.

Foucault, T.; Albert J.M. (2008): *Competition for Order Flow and Smart Order Routing Systems.* Journal of Finance 63, 119-158.

Gagnon, L.J.; Karolyi, G.A. (2004): *Multi-market trading and arbitrage* (June 17, 2004), Dice Center No. 2004-9.

Giovannini Group (2001): *Cross-Border Clearing and Settlement Arrangements in the European Union*. November, http://ec.europa.eu/internal_market/financial-markets/docs/clearing/first_giovannini_report_en.pdf (last accessed: 08/11/2007).

Gomber, P., Pujol, G. and Wranik, A. (2008): *The Implementation of European Best Execution Obligations - An Analysis for the German Market.* FinanceCom 2008, Paris, France.

Grammig, J.; Melvin, M.; Schlag, C. (2005): *Internationally cross-listed stock prices during overlapping trading hours: Price discovery and Exchange rate effects.* Journal of Empirical Finance, 12 (1), pp. 139-164.

Hasbrouck, J. (1995): One Security, Many Markets: Determining the Contributions to Price Discovery. The Journal of Finance, Vol. 50, No. 4 (Sep., 1995), pp. 1175-1199.

Kauko, K. (2007): *Interlinking securities settlement systems: A strategic commitment?* Journal of Banking & Finance, 31, pp. 2962–2977.

Macey, J.; O'Hara, M. (1997): *The law and economics of best execution.* Journal of Financial Intermediation, 6, pp. 188–223.

Madhavan, A. (1995): *Consolidation, fragmentation, and the disclosure of trading information.* Review of Financial Studies, 8, pp. 579–603.

Mendelson, H. (1987): *Consolidation, Fragmentation, and Market Performance.* Journal of Financial and Quantitative Analysis, 22 (2), pp. 189-207.

Miller, D.P.; Morey, M.R. (1996): *The intraday pricing behavior of internationally dually listed securities.* Journal of Financial Markets, Institutions & Money, 6, pp. 77–87.

O'Hara, M. (2004): *Searching for a new center: U.S. securities markets in transition.* Economic Review, Federal Reserve Bank of Atlanta, issue Q 4, pp. 37–52.

Oxera (2007): *Methodology for monitoring prices, costs and volumes of trading and post-trading activities*. July, http://ec.europa.eu/internal_market/financial markets/docs/clearing/oxera_study_en.pdf (last accessed: 01/15/2008).

Porter, D.C.; Thatcher, J.G. (1998): *Fragmentation, competition, and limit orders: new evidence from interday spreads.* Quarterly Review of Economics and Finance 38 (1), pp. 111–128.

Ramistella, A. (2006): *Crossing Networks: Bringing Back Large Block Trades to Instituional Trading.* Tech. rep., Tower Group Inc.

Schwartz, Robert A.; Francioni, R. (2004): *Equity markets in action: The fundamentals of liquidity, market structure & trading*. Wiley, Hoboken, N.J.

Securities and Exchange Commission (2005): *Regulation NMS 06/2005*.

Stehm, J. (1996): Clearance *and Settlement Systems for Securities - Critical Design Choices in Emerging Market Economics.* World Bank Discussion Papers.

STOXX Ltd. (2008): *Composition Lists of the Blue-chip Indices.* http://www.stoxx.com/data/composition_list/bluechip.html#, retrieved 9/24/08.

Appendix

Table 1 – Euro Stoxx Instruments (Name, ISIN) analysed in this study

AEGON, NL0000303709	IBERDROLA, ES0144580Y14
AIR LIQUIDE, FR0000120073	ING GROEP, NL0000303600
ALCATEL LUCENT, FR0000130007	INTESA SANPAOLO, IT0000072618
ALLIANZ, DE0008404005	L'OREAL, FR0000120321
ASSICURAZIONI GENERALI, IT0000062072	LVMH MOET HENNESSY, FR0000121014
AXA, FR0000120628	MUENCHENER RUECK, DE0008430026
BANCO SANTANDER, ES0113900J37	NOKIA, FI0009000681
BASF, DE0005151005	PHILIPS ELECTRONICS, NL0000009538
BAYER, DE0005752000	RENAULT, FR0000131906
BCO BILBAO VIZCAYA ARGENT, ES0113211835	REPSOL YPF, ES0173516115
BNP PARIBAS, FR0000131104	RWE, DE0007037129
CARREFOUR SUPERMARCHE, FR0000120172	SAINT GOBAIN, FR0000125007
CREDIT AGRICOLE, FR0000045072	SANOFI-AVENTIS, FR0000120578
DAIMLER AG, DE0007100000	SAP, DE0007164600
DEUTSCHE BANK, DE0005140008	SCHNEIDER ELECTRIC, FR0000121972
DEUTSCHE BOERSE, DE0005810055	SIEMENS, DE0007236101
DEUTSCHE TELEKOM, DE0005557508	SUEZ, FR0000120529
E.ON, DE0007614406	TELECOM ITALIA, IT0003497168
ENEL, IT0003128367	TELEFONICA, ES0178430E18
ENI, IT0003132476	TOTAL, FR0000120271
FORTIS, BE0003801181	UNICREDITO ITALIANO, IT0000064854
FRANCE TELECOM, FR0000133308	UNILEVER NV, NL0000009355
GROUPE DANONE, FR0000120644	VINCI, FR0000125486
GROUPE SOCIETE GENERALE, FR0000130809	VIVENDI UNIVERSAL, FR0000127771
	VOLKSWAGEN, DE0007664005

Table 2 – Trading hours for continuous trading

Stock Exchange	Trading hours for continuous trading (CET)			
	Begin	End	Begin	End
Xetra DAX	09:00	13:00	13:02	17:30
Xetra Stoxx	09:04	13:10	13:12	17:30
Euronext (all)	09:00	-	-	17:30
Borsa Italiana Milan	09:05	-	-	17:25
Bolsa de Madrid	09:00	-	-	17:30
SWX Europe	09:00	-	-	17:20
Chi-X	09:00	-	-	17:30
Helsinki Stock	09:00	-	-	17:20

Table 3 – Minimum duration of non-scheduled auctions

Stock Exchange	Minimum duration of non-scheduled auctions (in minutes)
Xetra	2 (plus random end)
Euronext (all)	2
Borsa Italiana Milan	12
Bolsa de Madrid	5 (plus 30-second random end)
SWX Europe	5
Chi-X	n/a
Helsinki Stock	Determined individually

Table 4 – Assumptions regarding the model user

Annual number of orders	7,501,250
Avg. €-value per order	45,000
Partial fills per order	2.05
Price level hits per order	2.01
Netting efficiency	90.00%

Table 5 – Model user order size assumptions

Orders with €-value	Avg. number of partial executions	Avg. number of price level hits
7,500	1.00	1.00
25,000	1.50	1.50
45,000	2.05	2.01
100,000	2.50	2.13
200,000	3.40	2.35

Table 6 – Domestic transaction costs per market for respective order sizes

Market / Order size	1 €	7,500 €	25,000 €	45,000 €	100,000 €	200,000 €	1,000,000 €
Xetra	1.15 €	1.15 €	2.01 €	3.27 €	6.74 €	13.04 €	24.16 €
EN Amsterdam	1.47 €	1.47 €	2.67 €	3.79 €	4.90 €	6.92 €	8.14 €
EN Paris	1.47 €	1.47 €	2.67 €	3.79 €	4.90 €	6.92 €	8.14 €
Bolsa de Madrid	1.14 €	5.78 €	8.40 €	10.90 €	15.20 €	16.90 €	16.90 €
Borsa Italiana	0.34 €	0.36 €	0.53 €	0.70 €	0.75 €	0.86 €	0.86 €
Helsinki Stock Exchange	1.05 €	1.35 €	2.04 €	2.83 €	5.01 €	8.97 €	11.05 €
Chi-X	0.47 €	0.73 €	1.35 €	2.05 €	3.88 €	7.20 €	30.81 €
SWX Europe	0.95 €	1.32 €	2.35 €	3.53 €	6.72 €	12.51 €	38.95 €
EN Brussels	1.47 €	1.47 €	2.67 €	3.79 €	4.90 €	6.92 €	8.14 €
EN Lisbon	1.47 €	1.47 €	2.67 €	3.79 €	4.90 €	6.92 €	8.14 €

Table 7 – Trading, clearing and settlement facilities with direct access by the model user

Trading platforms	Clearing houses	CSDs
Bolsas y Mercados Españoles	CC&G	Clearstream Banking Frankfurt
Borsa Italiana	EMCF	Euroclear France
Chi-X	Eurex Clearing	Iberclear
Deutsche Börse Xetra	Iberclear	Monte Titoli
Euronext Amsterdam	LCH. Clearnet Ltd.	NCSD
Euronext Brussels	LCH. Clearnet S.A.	SegaInterSettle
Euronext Lisbon	NCSD	
Euronext Paris	SIS x-clear	
OMX Helsinki		
SWX Europe		

Table 8 – ICSD transfer costs among the respective exchanges (€)

Source (row) / Destination (column)	Xetra	EN Brussels	EN Paris	Borsa Italiana	SWX Europe	EN Amsterdam	EN Lisbon	Helsinki Stock Exchange	Chi-X	Bolsa de Madrid
Xetra	n/a	7.36	7.36	25.00	21.95	7.36	31.40	27.35	n/a	29.63
EN Brussels	6.56	n/a	7.36	25.00	21.95	7.36	31.40	27.35	n/a	29.63
EN Paris	6.56	7.36	n/a	25.00	21.95	7.36	31.40	27.35	n/a	29.63
Borsa Italiana	6.56	7.36	7.36	n/a	21.95	7.36	31.40	27.35	n/a	29.63
SWX Europe	6.56	7.36	7.36	25.00	n/a	7.36	31.40	27.35	n/a	29.63
EN Amsterdam	6.56	7.36	7.36	25.00	21.95	n/a	31.40	27.35	n/a	29.63
EN Lisbon	6.56	7.36	7.36	25.00	21.95	7.36	n/a	27.35	n/a	29.63
Helsinki Stock Exchange	6.56	7.36	7.36	25.00	21.95	7.36	31.40	n/a	n/a	29.63
Chi-X	6.56	7.36	7.36	25.00	21.95	7.36	31.40	27.35	n/a	29.63
Bolsa de Madrid	6.56	7.36	7.36	25.00	21.95	7.36	31.40	27.35	n/a	n/a

Table 9 – Descriptive statistics of trade-throughs for all instruments

All instruments	No costs	Scenario 1	Scenario 2
Number of trades		8,010,905	
Value [€ mn]		262,313.9	
Value per trade [€]		32,745	
% full trade through	6.71	6.60	1.41
% partial trade through	6.45	5.30	1.34
Savings [€]	9,502,869	9,709,864	5,908,346
Avg. savings per trade through [€]	9.01	10.21	26.83
Savings / trade through value [bps]	7.54	7.80	10.17
Savings / trade value [bps]	0.36	0.37	0.23

Table 10 – Summary statistics trade-throughs for all instruments (gross perspective)

Instrument	Number of trades	Value [€ mn]	Value per trade [€]	% full trade through	% partial trade through	Savings [€]	Avg. savings per trade through [€]	Savings / trade through value [bps]	Savings / trade value [bps]
AEGON	125,881	2,397.4	19,045	14.30	6.24	287,978	11.14	9.72	1.20
AIR LIQUIDE	137,656	1,960.0	14,238	5.21	3.68	18,804	1.54	2.35	0.10
ALCATEL LUCENT	117,490	1,730.5	14,729	8.05	6.90	113,667	6.47	14.20	0.66
ALLIANZ	190,387	8,673.0	45,555	13.29	14.34	272,392	5.18	3.50	0.31
ASSICURAZIONI GENERALI	112,315	2,984.2	26,570	0.21	0.11	3,099	8.80	5.64	0.01
AXA	208,272	5,143.0	24,694	11.61	9.73	881,357	19.83	18.71	1.71
BASF	131,899	5,487.2	41,602	7.43	8.24	84,518	4.09	2.81	0.15
BAYER	135,287	5,912.6	43,704	6.19	8.47	112,074	5.65	4.16	0.19
BCO BILBAO VIZCAYA ARGENT	137,718	6,415.8	46,587	0.56	0.94	20,345	9.82	10.24	0.03
BCO SANTANDER	165,497	11,024.8	66,616	11.88	22.17	2,034,860	36.11	32.59	1.85
BNP PARIBAS	297,256	6,746.5	22,696	16.70	12.86	337,179	3.84	3.86	0.50
CARREFOUR SUPERMARCHE	132,166	2,726.3	20,628	4.07	3.91	22,275	2.11	2.72	0.08
CREDIT AGRICOLE	144,184	2,074.5	14,388	3.73	4.66	29,979	2.48	5.59	0.14
DAIMLER	173,898	8,531.9	49,063	5.94	10.72	170,043	5.87	4.97	0.20
DEUTSCHE BANK	189,235	8,416.7	44,478	11.56	14.13	226,700	4.66	3.20	0.27
DEUTSCHE BOERSE	96,267	3,532.2	36,691	1.06	2.97	14,754	3.80	4.51	0.04
DEUTSCHE TELEKOM	103,617	7,702.1	74,332	9.10	7.13	141,996	8.44	5.09	0.18
E.ON	172,070	8,778.9	51,019	8.24	13.48	466,167	12.47	8.38	0.53
ENEL	133,043	4,158.2	31,254	1.95	1.61	207,925	43.90	54.79	0.50
ENI	171,544	5,969.3	34,798	0.73	0.56	20,379	9.17	6.36	0.03
FORTIS	230,052	5,672.3	24,656	16.51	7.92	488,988	8.70	6.25	0.86
FRANCE TELECOM	210,668	5,190.2	24,637	6.16	4.55	121,109	5.36	5.43	0.23
GRP DANONE	170,115	3,192.2	18,765	0.39	0.31	21,806	18.28	19.59	0.07
GRP SOCIETE GENERALE	246,933	6,323.9	25,610	2.01	1.57	161,869	18.32	14.31	0.26
IBERDROLA	98,281	4,285.8	43,608	0.16	0.39	8,396	15.49	25.67	0.02
ING GROEP	183,835	5,913.2	32,166	3.83	1.76	224,677	21.85	10.60	0.38
INTESA SANPAOLO	119,681	4,805.5	40,153	0.49	0.17	20,275	25.66	11.56	0.04
L'OREAL	137,517	2,327.6	16,926	3.72	4.35	27,480	2.48	4.30	0.12
LVMH MOET HENNESSY	150,690	2,710.5	17,987	3.73	4.44	26,264	2.13	3.60	0.10
MUENCHENER RUECK	120,327	4,607.9	38,295	9.58	8.82	88,364	3.99	2.64	0.19
NOKIA	179,301	9,235.7	51,509	2.39	3.11	167,993	17.05	10.57	0.18
PHILIPS ELECTRONICS	202,630	5,368.0	26,492	11.32	6.29	286,566	8.03	5.73	0.53
RENAULT	171,747	3,104.4	18,075	3.75	4.68	38,316	2.65	4.46	0.12
REPSOL YPF	95,611	2,631.3	27,521	0.30	1.05	57,300	44.38	118.40	0.22
RWE	132,587	5,712.3	43,083	5.00	8.56	75,185	4.18	3.99	0.13
SAINT GOBAIN	158,017	2,521.0	15,954	5.25	5.83	73,193	4.18	7.47	0.29
SANOFI-AVENTIS	209,655	6,004.3	28,639	6.10	5.22	95,685	4.03	3.46	0.16
SAP	118,283	4,972.4	42,038	4.81	6.23	115,952	8.88	6.51	0.23
SCHNEIDER ELECTRIC	147,489	2,321.4	15,739	3.84	4.99	24,692	1.90	3.78	0.11
SIEMENS	190,914	10,639.8	55,731	7.43	11.92	478,100	12.94	8.29	0.45
SUEZ	194,471	4,723.2	24,287	8.00	7.06	146,770	5.01	5.14	0.31
TELECOM ITALIA	100,334	3,790.0	37,774	0.60	0.80	16,924	12.08	12.75	0.04
TELEFONICA	171,690	8,535.1	49,712	4.14	8.27	109,178	5.12	7.19	0.13
TOTAL	320,685	10,773.7	33,596	14.24	10.40	514,131	6.50	4.22	0.48
UNICREDITO ITALIANO	215,043	11,573.4	53,819	1.29	0.85	110,155	23.98	13.14	0.10
UNILEVER NV	184,066	4,809.7	26,130	10.33	5.03	260,660	9.22	5.92	0.54
VINCI	193,968	2,890.0	14,899	5.46	3.90	122,639	6.75	12.18	0.42
VIVENDI	162,783	3,092.6	18,998	4.87	5.32	67,594	4.08	5.21	0.22
VOLKSWAGEN	117,850	4,221.5	35,821	9.02	9.03	86,120	4.05	2.97	0.20
ALL INSTRUMENTS	8,010,905	262,313.9	32,745	6.71	6.45	9,502,869	9.01	7.54	0.36

Table 11 – Summary statistics trade-throughs for all instruments (cost scenario 1)

Instrument	Number of Trades	Value [€ mn]	Avg. value per trade [€]	% full trade through	% partial trade through	Savings [€]	Avg. savings per trade through [€]	Savings / trade through value [bps]	Savings / trade value [bps]
AEGON	125,881	2,397.4	19,045	14.16	5.88	297,277	11.79	10.05	1.24
AIR LIQUIDE	137,656	1,960.0	14,238	5.17	2.24	23,684	2.32	3.16	0.12
ALCATEL LUCENT	117,490	1,730.5	14,729	8.00	6.13	118,108	7.12	14.80	0.68
ALLIANZ	190,387	8,673.0	45,555	12.74	11.43	278,923	6.06	3.58	0.32
ASSICURAZIONI GENERALI	112,315	2,984.2	26,570	0.17	0.10	2,898	9.57	5.34	0.01
AXA	208,272	5,143.0	24,694	11.41	8.82	887,923	21.07	18.87	1.73
BCO SANTANDER	165,497	11,024.8	66,616	11.42	21.96	2,060,041	37.28	33.00	1.87
BASF	131,899	5,487.2	41,602	7.30	6.96	87,109	4.63	2.95	0.16
BAYER	135,287	5,912.6	43,704	6.12	7.45	114,547	6.24	4.29	0.19
BCO BILBAO VIZCAYA ARGENT	137,718	6,415.8	46,587	0.55	0.92	23,214	11.48	11.72	0.04
BNP PARIBAS	297,256	6,746.5	22,696	16.30	10.63	370,445	4.63	4.32	0.55
CARREFOUR SUPERMARCHE	132,166	2,726.3	20,628	4.04	2.22	25,576	3.09	3.24	0.09
CREDIT AGRICOLE	144,184	2,074.5	14,388	3.72	3.13	32,253	3.27	6.22	0.16
DAIMLER AG	173,898	8,531.9	49,063	5.81	7.66	172,350	7.36	5.16	0.20
DEUTSCHE BANK	189,235	8,416.7	44,478	11.22	13.16	233,366	5.06	3.32	0.28
DEUTSCHE BOERSE	96,267	3,532.2	36,691	1.05	1.67	14,543	5.57	4.62	0.04
DEUTSCHE TELEKOM	103,617	7,702.1	74,332	8.91	5.43	146,336	9.85	5.26	0.19
E.ON	172,070	8,778.9	51,019	8.04	11.96	466,985	13.57	8.52	0.53
ENEL	133,043	4,158.2	31,254	1.71	1.19	203,547	52.80	54.69	0.49
ENI	171,544	5,969.3	34,798	0.64	0.37	18,450	10.68	5.87	0.03
FORTIS	230,052	5,672.3	24,656	16.37	6.88	493,020	9.22	6.32	0.87
FRANCE TELECOM	210,668	5,190.2	24,637	6.10	3.80	120,681	5.78	5.46	0.23
GROUPE DANONE	170,115	3,192.2	18,765	0.39	0.31	21,462	18.03	19.31	0.07
GROUPE SOCIETE GENERALE	246,933	6,323.9	25,610	1.99	1.31	165,841	20.37	14.72	0.26
IBERDROLA	98,281	4,285.8	43,608	0.16	0.34	8,330	16.66	25.81	0.02
ING GROEP	183,835	5,913.2	32,166	3.80	1.32	228,921	24.29	10.83	0.39
INTESA SANPAOLO	119,681	4,805.5	40,153	0.46	0.17	19,107	25.44	10.90	0.04
L'OREAL	137,517	2,327.6	16,926	3.67	2.61	29,483	3.41	5.28	0.13
LVMH MOET HENNESSY	150,690	2,710.5	17,987	3.68	3.07	28,813	2.83	4.32	0.11
MUENCHENER RUECK	120,327	4,607.9	38,295	9.38	7.58	94,664	4.64	2.88	0.21
NOKIA	179,301	9,235.7	51,509	2.34	2.51	169,307	19.47	10.72	0.18
PHILIPS ELECTRONICS	202,630	5,368.0	26,492	11.19	5.65	302,295	8.86	6.07	0.56
RENAULT	171,747	3,104.4	18,075	3.70	2.81	41,227	3.69	5.32	0.13
REPSOL YPF	95,611	2,631.3	27,521	0.30	0.89	57,602	50.44	122.22	0.22
RWE	132,587	5,712.3	43,083	4.87	6.22	76,021	5.17	4.22	0.13
SAINT GOBAIN	158,017	2,521.0	15,954	5.21	4.25	75,026	5.02	8.17	0.30
SANOFI-AVENTIS	209,655	6,004.3	28,639	6.04	3.76	103,549	5.04	3.82	0.17
SAP	118,283	4,972.4	42,038	4.75	5.05	116,913	10.08	6.62	0.24
SCHNEIDER ELECTRIC	147,489	2,321.4	15,739	3.76	3.08	26,252	2.60	4.45	0.11
SIEMENS	190,914	10,639.8	55,731	7.31	10.17	479,086	14.36	8.40	0.45
SUEZ	194,471	4,723.2	24,287	7.96	4.59	145,004	5.94	5.22	0.31
TELECOM ITALIA	100,334	3,790.0	37,774	0.50	0.67	15,566	13.29	11.79	0.04
TELEFONICA	171,690	8,535.1	49,712	3.59	6.16	112,267	6.71	7.46	0.13
TOTAL	320,685	10,773.7	33,596	14.05	9.26	533,651	7.14	4.41	0.50
UNICREDITO ITALIANO	215,043	11,573.4	53,819	1.17	0.71	105,221	26.03	12.59	0.09
UNILEVER NV	184,066	4,809.7	26,130	10.25	4.36	272,291	10.12	6.21	0.57
VINCI	193,968	2,890.0	14,899	5.42	2.94	128,389	7.92	13.07	0.44
VIVENDI	162,783	3,092.6	18,998	4.81	3.69	72,510	5.24	5.72	0.23
VOLKSWAGEN	117,850	4,221.5	35,821	8.84	7.30	89,792	4.72	3.18	0.21
ALL INSTRUMENTS	8,010,905	262,313.9	32,745	6.58	5.29	9,709,864	10.21	7.80	0.37

Table 12 – Summary statistics trade-throughs for all instruments (cost scenario 2)

Instrument	Number of trades	Value [€ mn]	Value per trade [€]	% full trade through	% partial trade through	Savings [€]	Avg. savings per trade through [€]	Savings / trade through value [bps]	Savings / trade value [bps]
AEGON	125,881	2,397.4	19,045	4.98	2.99	174,743	17.42	8.22	0.73
AIR LIQUIDE	137,656	1,960.0	14,238	0.23	0.15	4,745	9.02	5.20	0.02
ALCATEL LUCENT	117,490	1,730.5	14,729	2.02	1.67	54,345	12.51	9.62	0.31
ALLIANZ	190,387	8,673.0	45,555	2.12	2.28	147,903	17.65	5.16	0.17
ASSICURAZIONI GENERALI	112,315	2,984.2	26,570	0.03	0.00	491	14.89	2.78	0.00
AXA	208,272	5,143.0	24,694	3.15	4.63	694,500	42.88	27.41	1.35
BASF	131,899	5,487.2	41,602	1.02	1.23	39,492	13.28	4.15	0.07
BAYER	135,287	5,912.6	43,704	1.17	1.76	59,301	14.95	5.79	0.10
BCO BILBAO VIZCAYA ARGENT	137,718	6,415.8	46,587	0.05	0.06	4,418	30.47	8.67	0.01
BCO SANTANDER	165,497	11,024.8	66,616	3.42	4.23	1,270,991	100.39	28.52	1.15
BNP PARIBAS	297,256	6,746.5	22,696	2.24	1.85	337,179	27.75	13.13	0.50
CARREFOUR SUPERMARCHE	132,166	2,726.3	20,628	0.28	0.23	5,691	8.46	4.24	0.02
CREDIT AGRICOLE	144,184	2,074.5	14,388	0.27	0.37	6,757	7.33	6.50	0.03
DAIMLER	173,898	8,531.9	49,063	1.34	1.79	100,490	18.48	6.73	0.12
DEUTSCHE BANK	189,235	8,416.7	44,478	1.69	2.70	93,240	11.25	4.14	0.11
DEUTSCHE BOERSE	96,267	3,532.2	36,691	0.24	0.27	7,395	15.09	5.98	0.02
DEUTSCHE TELEKOM	103,617	7,702.1	74,332	2.63	2.14	94,644	19.18	3.94	0.12
E.ON	172,070	8,778.9	51,019	1.91	5.67	341,883	26.22	14.09	0.39
ENEL	133,043	4,158.2	31,254	0.65	0.30	167,364	132.41	76.70	0.40
ENI	171,544	5,969.3	34,798	0.09	0.02	7,013	36.52	5.61	0.01
FORTIS	230,052	5,672.3	24,656	5.67	2.37	254,053	13.73	4.66	0.45
FRANCE TELECOM	210,668	5,190.2	24,637	1.10	0.83	60,512	14.87	6.08	0.12
GRP DANONE	170,115	3,192.2	18,765	0.18	0.20	14,976	22.97	19.59	0.05
GRP SOCIETE GENERALE	246,933	6,323.9	25,610	0.81	0.50	129,124	40.03	15.93	0.20
IBERDROLA	98,281	4,285.8	43,608	0.04	0.02	5,482	89.86	39.22	0.01
ING GROEP	183,835	5,913.2	32,166	2.31	0.81	174,931	30.53	9.21	0.30
INTESA SANPAOLO	119,681	4,805.5	40,153	0.21	0.02	10,510	38.92	7.30	0.02
L'OREAL	137,517	2,327.6	16,926	0.29	0.25	12,136	16.31	13.30	0.05
LVMH MOET HENNESSY	150,690	2,710.5	17,987	0.26	0.24	8,637	11.58	6.65	0.03
MUENCHENER RUECK	120,327	4,607.9	38,295	1.30	1.25	40,490	13.20	4.28	0.09
NOKIA	179,301	9,235.7	51,509	0.53	0.31	89,960	59.85	9.65	0.10
PHILIPS ELECTRONICS	202,630	5,368.0	26,492	2.74	1.88	161,579	17.27	6.54	0.30
RENAULT	171,747	3,104.4	18,075	0.31	0.43	16,703	13.25	10.92	0.05
REPSOL YPF	95,611	2,631.3	27,521	0.04	0.34	43,215	118.40	452.46	0.16
RWE	132,587	5,712.3	43,083	0.67	1.26	40,056	15.65	7.53	0.07
SAINT GOBAIN	158,017	2,521.0	15,954	0.56	0.97	33,764	14.02	15.43	0.13
SANOFI-AVENTIS	209,655	6,004.3	28,639	0.89	0.62	40,238	12.71	4.53	0.07
SAP	118,283	4,972.4	42,038	1.47	1.93	72,698	18.10	7.05	0.15
SCHNEIDER ELECTRIC	147,489	2,321.4	15,739	0.28	0.23	6,288	8.24	6.46	0.03
SIEMENS	190,914	10,639.8	55,731	2.60	4.11	350,163	27.35	10.10	0.33
SUEZ	194,471	4,723.2	24,287	1.43	0.84	70,545	16.03	5.65	0.15
TELECOM ITALIA	100,334	3,790.0	37,774	0.09	0.02	6,885	59.87	8.93	0.02
TELEFONICA	171,690	8,535.1	49,712	0.31	0.16	25,750	31.79	5.49	0.03
TOTAL	320,685	10,773.7	33,596	2.85	2.41	252,965	14.99	5.02	0.23
UNICREDITO ITALIANO	215,043	11,573.4	53,819	0.30	0.12	63,467	70.68	11.21	0.05
UNILEVER NV	184,066	4,809.7	26,130	2.90	1.39	154,989	19.62	6.32	0.32
VINCI	193,968	2,890.0	14,899	0.53	0.77	82,962	32.90	35.53	0.29
VIVENDI	162,783	3,092.6	18,998	0.81	0.66	28,666	11.97	5.89	0.09
VOLKSWAGEN	117,850	4,221.5	35,821	0.94	1.11	44,017	18.19	6.82	0.10
ALL INSTRUMENTS	8,010,905	262,313.9	32,745	1.41	1.34	5,908,346	26.83	10.17	0.23

Table 13 – Results for TOTAL from the gross perspective

	Euronext FR	Chi-X	Euronext BR	Milan	SWX Europe	Overall
Number of trades	293,729	26,263	465	210	18	**320,685**
Volume [shares]	183,140,456	8,060,835	85,240	30,682	211,050	**191,528,263**
Value [€]	10,299,568,394	455,750,908	4,787,262	1,715,115	11,859,899	**10,773,681,578**
Avg. volume per trade [shares]	624	307	183	146	11,725	**597.2**
Avg. value per trade [€]	35,065	17,353	10,295	8,167	658,883	**33,595.8**
Percentage full trade through	14.58	9.52	53.98	53.33	5.56	**14.24**
Percentage partial trade through	10.88	5.24	4.95	1.90	5.56	**10.40**
Number of trade throughs	74,778	3,875	274	116	2	**79,045**
Full	42,815	2,499	251	112	1	**45,678**
Partial	31,963	1,376	23	4	1	**33,367**
Savings [€]	493,219	16,679	3,360	542	331	**514,131**
Avg. savings per trade through [€]	6.60	4.30	12.26	4.67	165.64	**6.50**
Savings / trade through value [bps]	4.23	3.33	12.73	8.28	51.19	**4.22**
Savings / trade value [bps]	0.48	0.37	7.02	3.16	0.28	**0.48**

Table 14 – Results for TOTAL in cost scenario 1

	Euronext FR	Chi-X	Euronext BR	Milan	SWX Europe	Overall
Number of trades	293,729	26,263	465	210	18	**320,685**
Volume [shares]	183,140,456	8,060,835	85,240	30,682	211,050	**191,528,263**
Value [€]	10,299,568,394	455,750,908	4,787,262	1,715,115	11,859,899	**10,773,681,578**
Avg. volume per trade [shares]	624	307	183	146	11,725	**597.2**
Avg. value per trade [€]	35,065	17,353	10,295	8,167	658,883	**33,595.8**
Percentage full trade through	14.51	8.06	53.76	35.24	5.56	**14.05**
Percentage partial trade through	9.82	3.16	4.52	0.95	5.56	**9.26**
Number of trade throughs	71,465	2,946	271	76	2	**74,760**
Full	42,608	2,116	250	74	1	**45,049**
Partial	28,857	830	21	2	1	**29,711**
Savings [€]	516,314	13,114	3,429	464	330	**533,651**
Avg. savings per trade through [€]	7.22	4.45	12.65	6.10	165.20	**7.14**
Savings / trade through value [bps]	4.45	2.78	13.05	7.66	51.05	**4.41**
Savings / trade value [bps]	0.50	0.29	7.16	2.70	0.28	**0.50**

Table 15 – Results for TOTAL in cost scenario 2

	Euronext FR	Chi-X	Euronext BR	Milan	SWX Europe	Overall
Number of trades	293,729	26,263	465	210	18	**320,685**
Volume [shares]	183,140,456	8,060,835	85,240	30,682	211,050	**191,528,263**
Value [€]	10,299,568,394	455,750,908	4,787,262	1,715,115	11,859,899	**10,773,681,578**
Avg. volume per trade [shares]	623.5	306.9	183.3	146.1	11,725.0	**597.2**
Avg. value per trade [€]	35,064.9	17,353.3	10,295.2	8,167.2	658,883.3	**33,595.8**
Percentage full trade through	2.98	1.07	20.43	1.90	0.00	**2.85**
Percentage partial trade through	2.58	0.61	1.94	0.48	5.56	**2.41**
Number of trade throughs	16,324	440	104	5	1	**16,874**
Full	8,752	280	95	4	0	**9,131**
Partial	7,572	160	9	1	1	**7,743**
Savings [€]	245,661	4,728	2,243	45	287	**252,965**
Avg. savings per trade through [€]	15.05	10.75	21.57	8.99	287.34	**14.99**
Savings / trade through value [bps]	5.01	4.45	12.17	2.67	51.08	**5.02**
Savings / trade value [bps]	0.24	0.10	4.69	0.26	0.24	**0.23**

Table 16 – Test results for TOTAL in cost scenario 2

TOTAL		Euronext FR	Chi-x	Euronext BR	Milan	SWX Europe
	# obs.	74778	3875	274	116	2
PI (bps) Ho: Mean PI < Mean Costs, Ha: Mean PI > Mean Costs	Mean Costs	17.4354	17.3304	37.8679	642.9350	13.0634
	t-value	-790.0000	-270.0000	-36.9296	-1100.0000	-0.0292
Savings (€) Ho: Mean Savings < Mean Costs, Ha: Mean Savings > Mean Costs	Mean Costs	7.0837	8.4424	7.117703***	25.9103	22.3854
	t-value	-9.9816	-34.1718	2.9928	-28.9709	0.9923

Table 17 – Test results for AXA in cost scenario 2

AXA		Euronext FR	Chi-X	Euronext NL	Milan	SWX Europe
	# obs.	41725	2432	11	266	3
PI (bps) Ho: Mean PI < Mean Costs, Ha: Mean PI > Mean Costs	Mean Costs	30.3804	63.8241	502.4863	659.7641	18.6915
	t-value	-57.0684	-30.3345	-19.0531	-250.0000	1.3282
Savings (€) Ho: Mean Savings < Mean Costs, Ha: Mean Savings > Mean Costs	Mean Costs	7.16531***	8.329631***	7.106193**	26.1118	22.4315
	t-value	39.6281	10.5609	1.8687	-19.9199	1.0213

CFS Working Paper Series:

No.	Author(s)	Title
2010/14	**Terrence Hendershott** **Albert J. Menkveld**	Price Pressures
2010/13	**Sarah Draus**	Does Inter-Market Competition Lead to Less Regulation?
2010/12	**Kai-Oliver Maurer** **Carsten Schäfer**	Analysis of Binary Trading Patterns in Xetra
2010/11	**Annamaria Lusardi** **Olivia S. Mitchell**	How Ordinary Consumers Make Complex Economic Decisions: Financial Literacy and Retirement Readiness
2010/10	**Annamaria Lusardi** **Daniel Schneider** **Peter Tufano**	The Economic Crisis and Medical Care Usage
2010/09	**Annamaria Lusardi** **Olivia S. Mitchell** **Vilsa Curto**	Financial Literacy among the Young: Evidence and Implications for Consumer Polic
2010/08	**Volker Wieland** **Maik Wolters**	The Diversity of Forecasts from Macroeconomic Models of the U.S. Economy
2010/07	**Antje Brunner** **Jan Pieter Krahnen**	Hold-Up in Multiple Banking: Evidence from SME Lending
2010/06	**Roman Kräussl** **André Lucas** **David R. Rijsbergen,** **Pieter Jelle van der Sluis** **Evert B. Vrugt**	Washington Meets Wall Street: A Closer Examination of the Presidential Cycle Puzzle