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Market fragmentation in Europe: assessment and prospects for market quality

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Market fragmentation in Europe: assessment and prospects for market quality

Carole Gresse, Professeur at Université Paris-Dauphine

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1. Introduction

There is an old common belief in economic theory that security markets are natural monopolies because the marginal cost of a trade decreases with the quantity of orders executed in a market. While this has long been true to a certain extent, technological progress has somehow changed this reality. The fixed costs and time necessary to launch a new market have considerably diminished and computer trading now allows cross-market trading strategies that connect to multiple trading venues as if they were a consolidated network of counterparties with several entries. Those new tools undermine the network externality argument. With the development of sophisticated trading technologies and the enforcement of pro-competition market regulations such as the Markets in Financial Instruments Directive (MiFID) in Europe or Reg NMS in the U.S., order flow fragmentation between rival trading platforms has rapidly increased in stock markets, and it is likely to remain substantial in the future, with potential effects on liquidity and price quality. On the one hand, competition between multiple trading venues generally reduces the cost of trading by preventing monopoly rents; on the other hand, the consolidation of orders in one trading venue may have positive externalities on liquidity and price stability.

In this context, the first objective of this driver review is to look back at the MiFID1[1] experience over the past four years and to understand the factors that drove multi-market trading so as to infer from recent developments the possible future trends in market fragmentation. The review focuses on questions such as to what extent and in which ways fragmentation has developed in Europe; which factors have fostered the observed fragmentation; and whether those factors are expected to play the same role in the future. Assuming that markets will remain substantially fragmented with computer trading, the second objective is to assess the expected impact of this order flow fragmentation on market quality in the next future based on existing empirical evidence. In particular, what can we learn from the MiFID1 experience about the relation between fragmentation and liquidity? How does fragmentation change the role of primary markets in the price discovery process? How are liquidity and price quality expected to change with order flow fragmentation?

The review is organized as follows: Section 2 provides an overview of market fragmentation in Europe since MiFID1; Section 3 reviews the factors fostering market fragmentation; Section 4 reports empirical evidence about how order flow fragmentation impacts liquidity and trade execution quality; Section 5 focuses on the consequences of market fragmentation for the price discovery process; Section 6 summarizes the prospects.

[1] MiFID1 refers to the first version of the directive implemented on 1 November 2007 as opposed to the upcoming revision (MiFID2).

2. Overview of market fragmentation in Europe since MiFID1

In Europe, the enforcement of MiFID on 1 November 2007 abolished the concentration rule[2] in all countries of the European Economic Area (EEA), and created a competitive environment for trading systems and services in which new trading systems were allowed to compete with incumbent exchanges. MiFID1 has recognized three types of order execution venues: Regulated Markets (RMs), Multilateral Trading Facilities (MTFs), and Systematic Internalizers (SIs). RMs and MTFs are multilateral trading systems with similar functionalities but they differ in that RMs have to be authorized by a competent authority. Both RMs and MTFs may organize primary listings, but securities with a primary listing on a MTF are not considered as regulated instruments. SIs are investment firms which, "on an organized, frequent and systematic basis," execute client orders outside a regulated market or an MTF, either on their principal accounts or against other clients' orders. Legally, a SI does not have to be designated by a regulated market, and an institution can be a SI for securities listed on different stock exchanges. Creating the legal status of SIs has institutionalized internalization. In counterpart, MiFID1 treats SIs as mini-exchanges and imposes pre-trade and post-trade transparency requirements on them. In addition, under the post-trade transparency rules introduced by MiFID1, all transactions in regulated financial instruments must be reported, even if carried out over-the-counter (OTC). Such disclosures do not have to be made to the regulated primary market; they may be made using proprietary resources or submitted to a MiFID-compliant trade reporting facility (TRF).

In brief, MiFID1 changed the European trading industry in three key ways:

- it liberalized competition between trading systems by breaking the monopolies of primary exchanges;
- it offered a regulatory framework for internalization;
- it extended post-trade transparency duties to OTC trades in regulated securities and allowed entities other than primary exchanges to report trades, which resulted in a fragmentation of the trade reporting activity.

As a result, competition in the industry has increased not only on the front side but also on the post-trading side, with the entry of new pan-European trading platforms and independent TRFs. This section sets out to provide an overview of those new entrants and to appraise the relative positions they have achieved so far.

[2] A provision in the 1993 Investment Services Directive (ISD) permitted (but did not mandate) individual member states to require orders from investors in that member state to be executed only in regulated markets. This provision was applied in France, Italy, and Spain.

2.1. New entrants in the market for markets

The most typical new entrants in the post-MiFID exchange industry are electronic order-driven trading systems, registered as MTFs, and designed to offer low-cost execution. New RMs and TRFs have been few to emerge and the number of broker-dealers registered as SIs has remained limited.[3]

2.1.1. RMs

The number of RMs has remained undeniably stable since MiFID introduction. The European Securities and Markets Authority (ESMA), formerly known as the Committee of European Securities Regulators (CESR), counted 93 RMs at the end of 2011 in comparison with 92 in 2007. Because most emerging trading systems do not provide listing services, very few chose to operate as RMs: the most remarkable are PLUS, a Londonish exchange whose activity has essentially concentrated on middle and small capitalizations UK equities,[4] and Equiduct, a London-based pan-European platform acquired by Börse Berlin in September 2007.

2.1.2. MTFs

Many MTFs have entered the European trading industry since MiFID1, some of them run by brokers, others by exchanges or by investment bank consortiums. Among the 146 MTFs listed by ESMA at the end of 2011, three of them deserve to be mentioned as prominent players: Chi-X, Turquoise, and BATS Europe in chronological order of opening. They adopted similar business models based on continuous order-driven trading, high-speed execution, low fees, and liquidity-rewarding rebates. They typically run both a lit and a dark order book. Their lit trading platforms are typical transparent order books while their dark platforms pertain to the category of dark pools described at Sub-section 2.1.4.

Chi-X was launched by broker Instinet in the third quarter of 2006. Live trading on Chi-X started for the DAX and the AEX components[5] on 30 March 2007. It was extended to the FTSE 100 stocks in August 2007 and to the CAC 40 index in October 2007.[6] It then rapidly operated for most European large and middle capitalization equities. Turquoise was created with a mutual structure in which the founding members were BNP-Paribas, Citi, Crédit Suisse, Deutsche Bank, Goldman Sachs, Merrill Lynch, Morgan Stanley, Société Générale, and UBS. It started

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[3] No more than 13 investment banks are declared as SIs (cf. http://mifiddatabase.cesr.eu/). This number has remained nearly unchanged since the implementation of MiFID1 and trades reported by SIs never reached significant volumes.

[4] PLUS organizes primary listings of small businesses and offers an execution venue for securities listed elsewhere in London and in continental Europe.

[5] The DAX is a blue chip stock market index consisting of the 30 major German companies trading on the Frankfurt Stock Exchange of Deutsche Börse. The AEX index is a stock market index composed of a maximum of 25 of the most actively traded stocks listed on Euronext Amsterdam.

[6] The FTSE 100 index is a stock index composed of the stocks of the 100 companies listed on the London Stock Exchange having the highest market capitalization. The CAC 40 index is the flagship French stock market index. It comprises the stocks of the forty largest companies listed on Euronext Paris.

trading five stocks each from Britain and Germany on 15 August 2008. On 29 August 2008, trading on the dark side was extended to nearly 1,300 securities across 13 markets, while trading on the lit order book was extended to about 300 equities. Live trading on BATS Europe, a subsidiary of U.S. exchange BATS, began on 31 October 2008. Ten large stocks of the London Stock Exchange (LSE) were initially traded. Trading on BATS Europe rapidly expanded to other UK stocks as well as to Euronext, German, Italian and Swiss stocks in November 2008 and to Nordic stocks in December 2008. BATS recently took over Chi-X in the course of 2011.

2.1.3. Trade Reporting Facilites (TRFs)

With MiFID1, trade reporting mechanisms have changed in two ways. First, any trade in a regulated instrument, even if executed over-the-counter (OTC), is to be reported as close to real-time as possible. Second, investment firms and MTFs are not obliged to report to the primary exchange. Instead, they may use proprietary resources to publish their trades themselves or use the services of MiFID-compliant trade reporting facility (TRF). The largest TRF that emerged in the landscape is Markit BOAT. Originally dubbed Project BOAT, BOAT was a consortium of more than 20 investment banks. It was then sold to firm Markit and renamed Markit BOAT. It will be referred to as BOAT hereafter. It receives the most significant volume executed out of self-reporting RMs and MTFs.

2.1.4. Dark pools

Dark pools are trading systems in which buy and sell orders are submitted anonymously and remain undisplayed to the public markets until execution. Dark pools can be classified in three categories (Zhu, 2012). A first category of dark pools passively match buyers and sellers at prices derived from transparent exchanges, such as the mid-quote of the best bid and offer on the primary exchange or a Volume-Weighed Average Price (VWAP). This category includes crossing networks such as ITG Posit, Chi-X Delta, BATS Europe Dark Pool, NYSE-Euronext SmartPool, or block-trading-interest alert systems such as Liquidnet or Pipeline. Crossing networks act as pure agent. They rely on lit venues to determine transaction prices and typically do not provide direct price discovery. They are registered as MTFs under MiFID1 and benefit from pre-trade transparency waivers for non-displayed orders. Block-trading-interest alert systems do not organize trade execution but inform their clients when potential counterparties are present in the market.

A second category of dark pools are continuous invisible limit order books that execute orders by price and time priority. Orders are executed inside the bid-ask spread but not necessarily at mid-quote. They are usually owned by broker-dealers as, for instance, Barclays LX, Citi Match, Credit Suisse CrossFinder, Deutsche Bank DBA, Goldman Sachs Sigma X, JP-Morgan JPM-X, Morgan Stanley MS Pool, or UBS PIN. They are not classified under MiFID: they operate as OTC trading venues and report executed trades to BOAT on a daily basis.

A third category of dark pools act as fast electronic inter-dealer brokers that immediately accept or reject incoming orders. Getco Excution Services, which exclusively accept orders from broker-dealers, enters this category. Contrary to the first category, dark pools of the second and third categories are not pure agents and may contain proprietary order flow. While implicit trading costs are null or very low in dark pools, their flipside is the low probability of execution they may result to offer. Therefore, they are particularly suited to traders who desire to move

large blocks of shares without the public investors ever-knowing, but are ready to bear non-execution costs.

2.2. Development and magnitude of market fragmentation in Europe as of 2007

Since 2007, the European stock exchange industry has been the setting of a dual-trend battle in which the entry of new competitors has alternated with concentration deals. On the one hand, alternative trading platforms have multiplied and diverted order flow from traditional exchanges, thus increasing the level of fragmentation/competition in the sector. On the other hand, in search for returns on scale, trading venues have entered a fight for market size by taking over other venues. The fragmentation trend significantly started with the entry of Chi-X in April 2007, and accelerated in fall 2008 with the successive openings of Turquoise, Nasdaq OMX Europe, and BATS Europe. The consolidation trend was already on in the early 2000s. It revived in 2007 with the merger of the London Stock Exchange (LSE) and Borsa Italiana and the merger of the New York Stock Exchange (NYSE) and Euronext. More recently, in 2011, BATS took over Chi-X. Table 1 lists the key events in this dual-trend competition.

Table 1. The development of the main European RMs, MTFs, and TRFs

Date	Event
22 September 2000	Amsterdam, Brussels and Paris exchanges merge, Euronext created
30 January 2002	Euronext group absorbs Lisbon exchange
September 2006	Nine investment banks create BOAT, a MiFID-compliant TRF
30 March 2007	Chi-X MTF begins trading in 5 Dutch stocks and 5 German stocks
4 April 2007	NYSE and Euronext merge, following announcement on 1 June 2006
12 April 2007	Chi-X extends trading to all DAX 30 constituents
13 April 2007	Chi-X extends trading to all AEX 25 constituents
29 June 2007	Chi-X begins trading in 11 FTSE 100 stocks
13 July 2007	Chi-X extends trading to all FTSE 100 stocks
28 September 2007	Chi-X begins trading in 19 CAC 40 stocks

Date	Event
8 et 22 October 2007	Chi-X extends trading to all other CAC 40 stocks
4 July 2008	Chi-X begins trading in Belgian stocks
21 August 2008	Chi-X extends trading to mid caps
2008 to today	Progressive expansion in universe of stocks traded on Chi-X
1st October 2007	LSE acquires Borsa Italiana
22 January 2008	Financial information provider Markit acquires BOAT TRF
22 September 2008	Pan-European platform Turquoise launched
1er October 2008	Pan-European platform Nasdaq OMX Europe launched
31 October 2008	BATS Europe launched as MTF for LSE, Euronext and Deutsche Börse stocks
2 February 2009	NYSE-Euronext lanches dark pool SmartPool in partnership with J.P. Morgan, HSBC, BNP Paribas
9 March 2009	NYSE-Euronext launches MTF NYSE Arca Europe
21 December 2009	Announcement that LSE is taking 60% stake in Turquoise, later reduced to 51%
2 November 2009	Deutsche Börse extends trading to pan-European equities with Xetra International Market
21 May 2010	Nasdaq OMX closed
18 February 2011	Agreement for the sale of Chi-X Europe to BATS

Date	Event
7 & 14 July 2011	NYSE-Euronext and Deutsche Börse receives approval for merger from shareholders but the deal was blocked by the European Commission in January 2012.

The market shares of new entrants started increasing at the end of 2008 and became substantial in the course of 2009 to exceed 20% of the lit trading in large equities, with three players standing out: Chi-X, Turquoise, and BATS Europe. Chi-X is the clear front-runner with its share in lit trading in European stocks reaching 19.85% over the last week of March 2012. BATS Europe and Turquoise follows with comparable market shares of respectively 3.95% and 4.69% over the same week. All other MTFs trade less than 1% of lit volumes.[7]

Figures 1, 2, and 3 report the distribution of trading volumes across various venues for respectively the CAC 40 index, the DAX index, and the FTSE 100 index, over four years from 2008 to 2011. In each figure, the left-side bar charts show the distribution of total trading volumes between four categories of venues: lit order books, regulated dark pools, SIs, and OTC venues. The right-side bar charts display the market shares of the first five venues in lit trading.

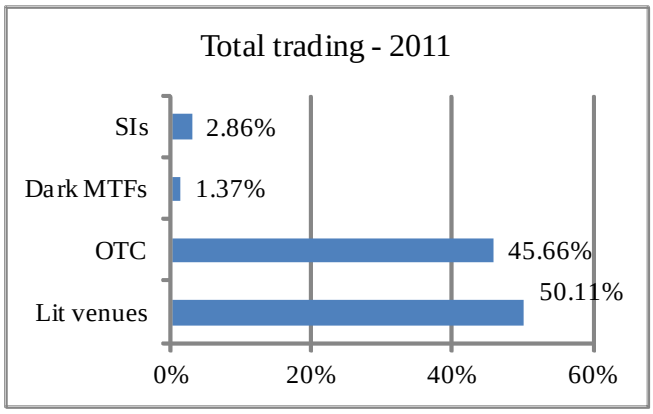
The right-side charts confirm that the fragmentation of lit order flow gradually increased from 2008 to 2011, as Chi-X, Turquoise, and BATS were wresting market shares away from traditional exchanges. Within four years, Euronext and Deutsche Börse lost approximately 22% of market share in their flagship-index stocks, while the LSE market share in FTSE 100 securities fell by almost 28%. In the meanwhile, Chi-X built a market share of more than 21% in French and German large capitalization stocks and of nearly 29% in UK large caps. BATS became the second-ranked MTF with market shares between 5% and 9%, closely followed by Turquoise with market shares between 5% and 7%.

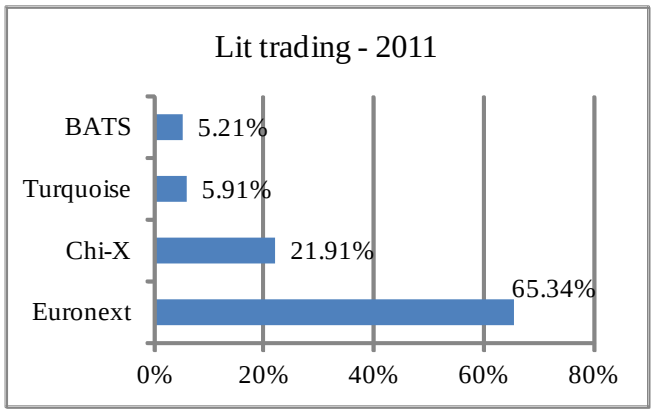
Most of the rise in fragmentation took place from mid-2008 to the end of 2009. The rapid success of new MTFs lied in their ability to offer services tailored for computer trading at low costs. Those services include high capacity, super-low latency, the ability to computerize complex decision processes, small tick sizes, and innovative orders. In addition, MTFs charge low fees and offers rebates on liquidity-providing orders.

In spite of this fierce rivalry, incumbent exchanges have kept the leadership in the order book trading of their locally-listed stocks, so that the average level of fragmentation has remained far lower than in the U.S. Largest traditional exchanges responded to their new rivals by cutting fees, improving latency, and introducing MTFs in the guise of pan-European lit order books or dark pools (cf. Table 1 for examples). Another reason for their ever-lasting leadership, coined by Menkveld (2011), might be the fragmentation of clearing services which does not allow multi-market traders to net their positions across venues and thus increases the cost of multi-market trading strategies.

[7] Source: http://fragmentation.fidessa.com/europe/.

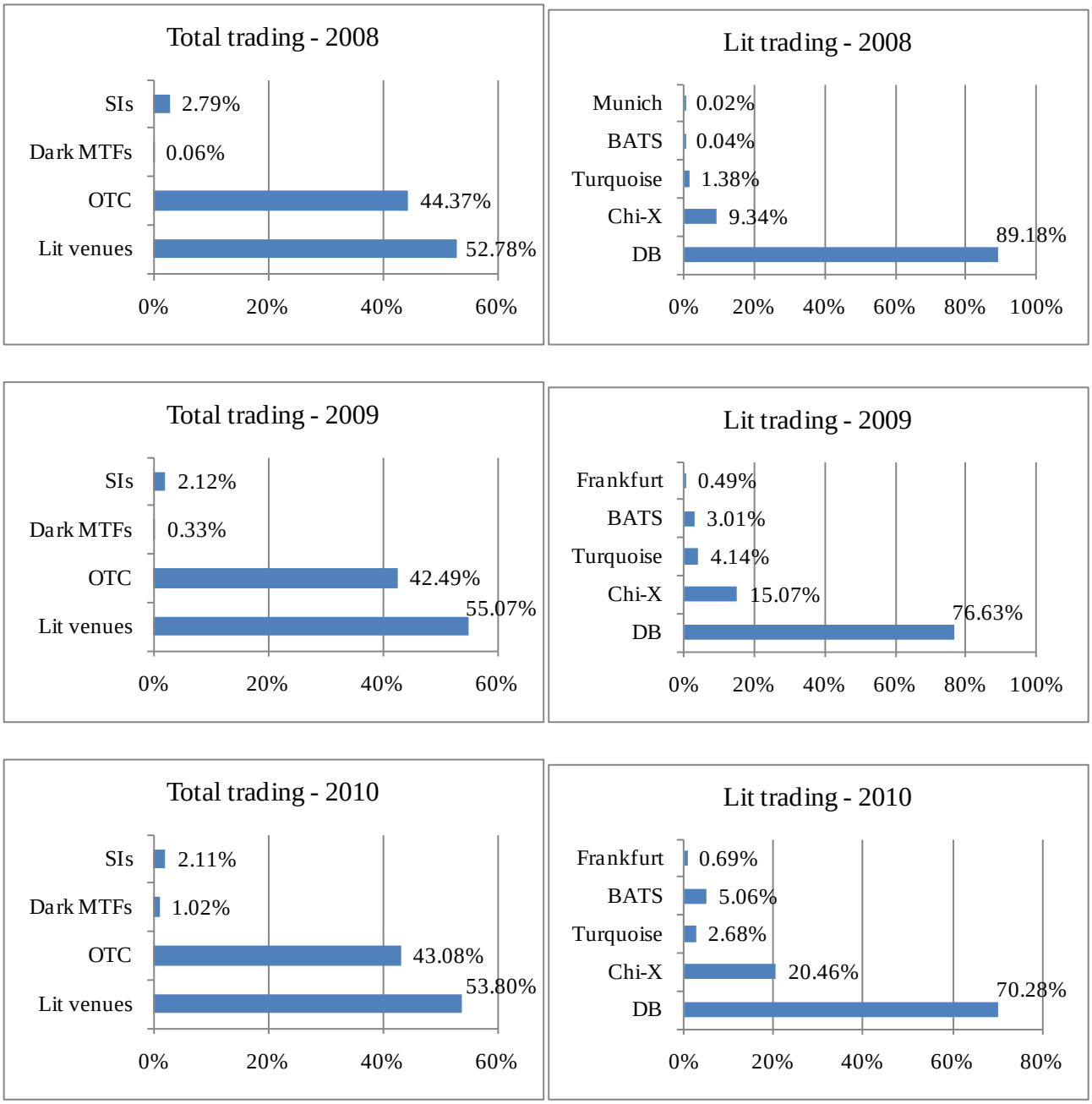
Figure 1. The distribution of trading volumes in CAC 40 stocks from 2008 to 2011

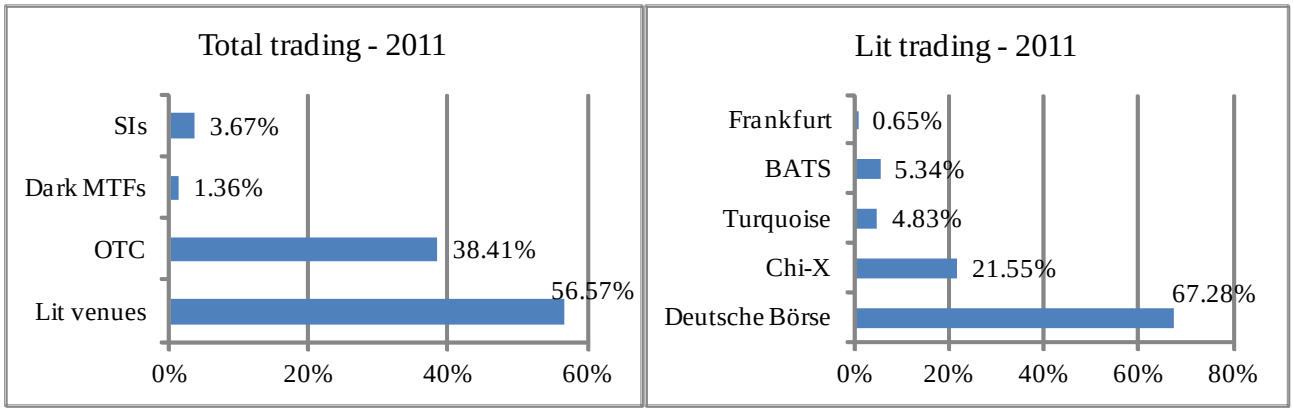




***Note*: Those bar charts are based on statistics extracted from www.fidessa.com. The 2008 period starts on May 1. The other three annual periods cover a full year from 1 January to 31 December.**

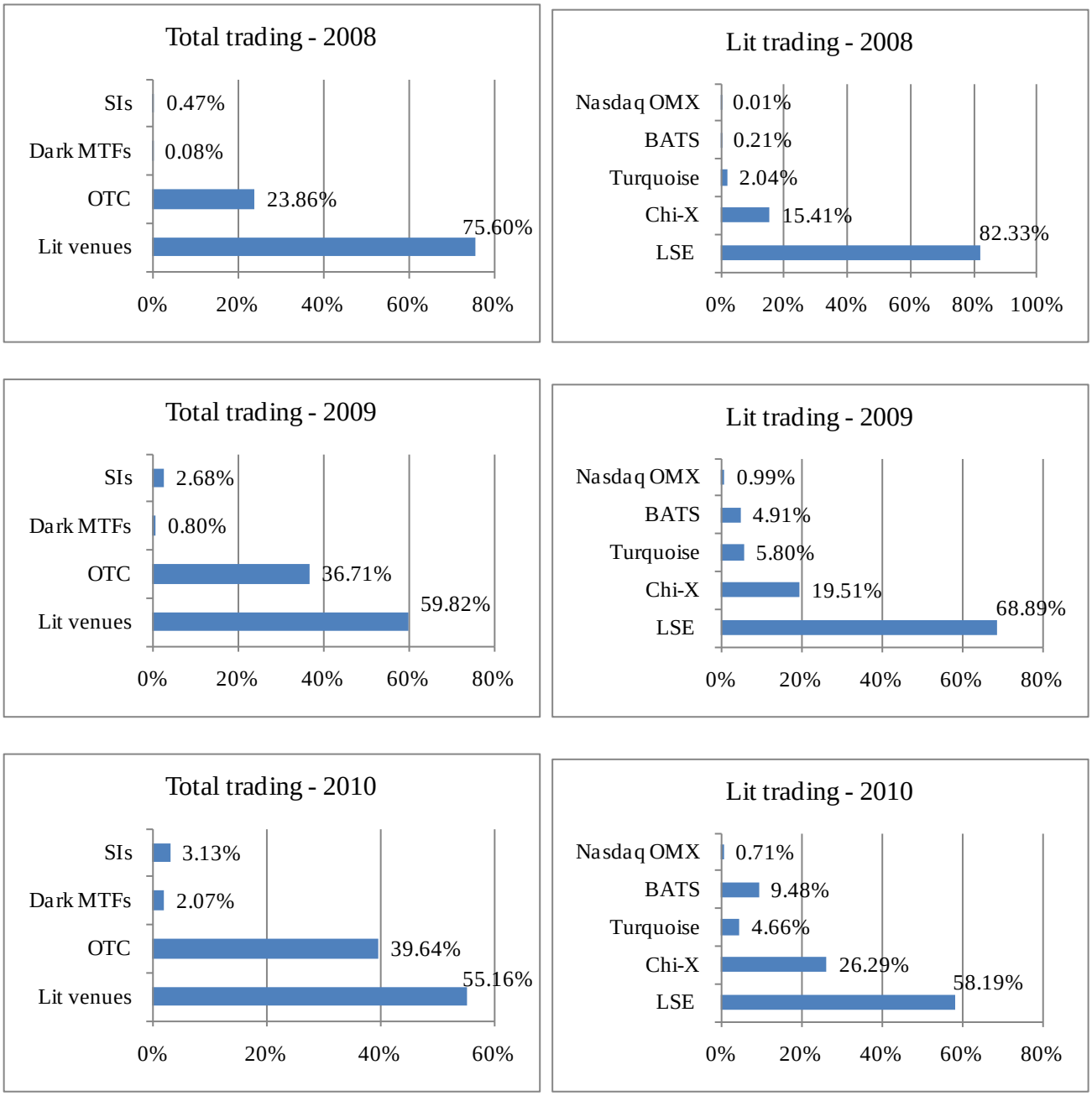
Figure 2. The distribution of trading volumes in DAX stocks from 2008 to 2011

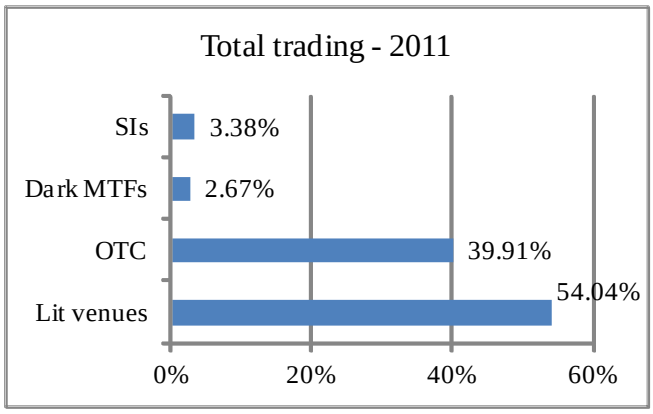


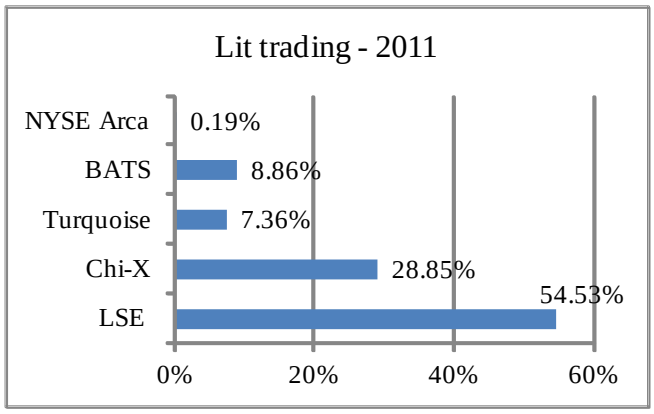


***Note*: Those bar charts are based on statistics extracted from www.fidessa.com. The 2008 period starts on May 1. The other three annual periods cover a full year from 1 January to 31 December.**

Figure 3. The distribution of trading volumes in FTSE 100 stocks from 2008 to 2011







***Note*: Those bar charts are based on statistics extracted from www.fidessa.com. The 2008 period starts on May 1. The other three annual periods cover a full year from 1 January to 31 December.**

The left-side bar charts of Figures 1, 2, and 3 reveal the weight of OTC trading and the thinness of regulated dark and internalized trading. Dark MTFs and SIs do not execute more than a few percent of the total trading volumes for any of the three indices. Crossing networks have gained trading volumes from 2008 to 2011 but their total market share has remained below 3% for the three indices considered, the largest dark pool being Chi-X Delta. According to Getco, dark pools represented 5% of the regulated trading volumes in Europe in 2010, the six largest pools of hidden liquidity being those of Chi-X, BATS, Turquoise, Liquidnet, Nomura, and Posit.[8] This is less than what is currently observed in the U.S. Estimates from Tabb Group and Rosenblatt Securities attribute 12% of U.S. equity trading volume to dark pools as of mid-2011.

In contrast, OTC trading is the second source of liquidity after lit trading. It fluctuates around 40% for German large caps, with a slight decrease from 2008 to 2011. For the other two indices, OTC trading significantly increased from 2008 to 2011, rising from 24% to 41% for the FTSE 100 and from 35% to 46% for the CAC 40. Those percentages encompass internalized dealer-to-customer trades and unregulated dark pool trades. No statistic exists about the relative share of each. Nevertheless, considering that the market size of unregulated dark pools is probably comparable to that of regulated crossing networks, we can conjecture that they do not account for more than a few percent of the OTC trading.

3. Factors fostering market fragmentation

Considering that market fragmentation appeared in Europe with MiFID would be misleading. Diverse forms of fragmentation had already emerged previously. In the 1990s, the SEAQ International, a quote-driven platform of the LSE, diverted a portion of the block-trading order flow in large Continental equities, until continental primary exchanges put their own block trading segments in place. In Germany, OTC trading was already developed before MiFID. In addition, the structure of German exchanges has long been fragmented between Deutsche Börse and regional exchanges. More interestingly, several post-MiFID alternative trading systems have their roots in pre-MiFID platforms: PLUS is born from a market formerly known as Ofex; Equiduct is a new form of Easdaq; crossing network POSIT already had a market share in UK middle capitalization stocks in the 2000s (cf. Gresse, 2006); and the pan-European order book of the Swiss exchange (SIX) was operating under the name of Virt-X which was a revival of former trading platform Tradepoint.

Indeed, the real change with MiFID is not the emergence of alternative trading systems but the degree of competition implied by their proliferation and growth in market share. While MiFID served as a catalyst for this rise in fragmentation by allowing free competition, its actual drivers are clientele effects and technology. Clientele effects and differences in trading needs expressed by final investors have driven past and present experiences of order flow fragmentation. Fragmentation generally arises when the primary market is unable to answer in an appropriate and timely fashion to every client need. Provided that entry costs to the market of markets are not prohibitive and that no regulatory barrier impedes free competition, new trading systems that answer the unsatisfied demand appear and succeed in attracting order

[8] This is consistent with estimations by the Federation of European Stock Exchanges (FESE).

flow. With respect to entry costs, technology has considerably lowered the cost of launching new trading systems. It has also provided innovative solutions catering for specific trading needs and it gave birth to a new trading clientele: algorithmic traders ("algos") and high frequency (HF) traders. MiFID has in turn set up a legal frame permitting what was technologically feasible.

3.1. Investor clientele effects

If the population of final investors was perfectly uniform, fragmentation could temporarily arise but would inevitably turn into the consolidation of the order flow, as the most liquid market would attract the whole order flow in the end. In practice, the needs of final investors are likely to differ according to trade size, impatience for execution, information quality, and information horizon. Institutional investors, block traders, retail investors, arbitragers, speculators, etc., are as many different clienteles which may appreciate trading systems with different designs. Those clientele effects offer the ground for multi-market trading to develop.

Large traders generally appreciate anonymity and immediacy. They may accept to pay higher fixed fees to obtain immediate execution on a great quantity of shares. This has made the success of the so-called upstairs markets and OTC trading. Alternatively, they may choose to implement sequential trading strategies by breaking initial parent order into series of small child orders, provided that they remain anonymous. This has favored the development of electronic order books guaranteeing anonymity.

To what extent investors are impatient to trade is another source of segmentation between investors. Liquidity traders with a long-term perspective or informed traders with long-lived information will accept to bear a non-execution risk to reduce their trading costs and market impact. Crossing networks or dark pools typically address the needs of that type of investors (Hendershott and Mendelson, 2000).

Technological progress gave birth to another clientele segment: HF traders. The SEC defines them as "professional traders acting as a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis". Many of them act as multi-venue market makers, providing liquidity in some markets and possibly unwinding inventories in others, so that HF trading is a direct determinant of fragmentation (Menkveld, 2011). Their specific needs are system reliability, execution speed, and low fees. Their trading strategies require highly reliable trading systems which can deal with great quantities of orders and process them very fast at low cost. This explains the flourishing of great-capacity and ultra-low-latency electronic trading platforms with low-fee liquidity-rewarding tariff models as those of Chi-X, BATS, and Turquoise.

3.2. Technological innovation

Technology has driven the increasing fragmentation of stock markets in several ways. First, technology has made the time and cost of building new electronic multilateral trading platforms extremely low. Second, it has empowered the buy-side by providing them with Direct Market Access (DMA) as well as other tools which enable them to exploit the total range of available trading services.

3.2.1. Enhanced connectivity and DMA

Most institutions are connected to several international marketplaces through DMA provided by their brokers, the number of those markets in connection depending on the size of the institution. Institutional investors' DMA is not a market membership but a transparent and real-time connection to the market provided by the broker acting as a gateway. Large buy-side institutions, that is proprietary trading desks and investment funds with more than one billion dollars under management, are generally connected to a great number of trading venues: primary exchanges, MTFs, and dark pools. Medium-size institutions have DMA to main trading venues only, and small ones usually restrict their connections to their local markets.

Continuous real-time connectivity between buy-side institutions, investment firms, exchanges, and alternative trading systems, is based on the use of a common standardized messaging protocol: the Financial Information eXchange (FIX) protocol. The FIX protocol is a series of messaging specifications developed through the collaboration of banks, broker-dealers, exchanges, institutional investors, and information technology providers, for the communication of trade-related information. This messaging standard was first conceived in 1992 as a bilateral communication framework for equity trading between Fidelity Investments and Salomon Brothers. It has then become the messaging standard used by most buy-side and sell-side firms for pre-trade, trade, and post-trade communication within equity markets. It is now expanding across the FX, fixed income, and derivative markets.

3.2.2. Other trading tools

In addition to allowing DMA, the FIX protocol also allows broker-dealers and investment firms to customize trading tools aiming to optimize execution conditions, such as sweep or pull technologies, Smart Order Routers (SORs), and Execution Management Services (EMSs).

Pull technologies connect to diverse institutions' Order Management Systems (OMSs) and scan their trading interests so as to pull orders that can be matched. Initiators of compatible orders are then alerted and have a limited time to respond and agree on a price.

SORs are algorithms that scan multiple trading venues, fraction, and distribute orders so as to optimize their price and probability of execution. When working orders, SORs may place resident orders, that is limit orders sitting in execution venues, or sweeping orders, which, if unexecuted on a venue, passes through to be allocated to another venue. Sweeping orders can be handled by sequential or simultaneous scanning. With sequential scanning, the system scans all possible trading venues in sequence with full order size, and finally routs orders in whole to the venue with the best liquidity. With simultaneous scanning, the SOR scans multiple venues simultaneously, split orders in smaller slices, and then reallocate unexecuted quantities to venues where liquidity has been identified.

EMSs are all-in-one broker-neutral trading systems designed to help investors pursue best execution by bringing them access to several liquidity sources and providing them with pre-trade liquidity analysis, automate execution strategies, and transaction cost analysis tools.

Those tools participate to fragmenting the order flow across multiple venues on the one hand, but also to re-aggregating the liquidity of those multiple venues into a single pool on the other hand. Clientele effects combined with a wider use of those tools should sustain market fragmentation in the near future. The market shares of MTFs may continue to grow, without however reaching the size of their peers in the U.S., unless the structure of the clearing

industry deeply changes. The lit order flow will concentrate on a handful of platforms, primary exchanges keeping the lead as far as they develop competitive trading mechanisms. Liquidity aggregators should play a major role in consolidating the overall marketplace.

4. Market fragmentation and liquidity

Considering that market fragmentation will remain substantial in the next ten years, its consequences for liquidity are a central issue. The impact of fragmentation on liquidity raised much debate immediately after MiFID1 enforcement. Some believed that heightened competition was pushing down transaction costs whereas others were convinced that increased fragmentation was widening spreads. Four years later, clearer conclusions may be drawn from academic research about how liquidity will change with market fragmentation in the future. The most common view in academia is that order flow fragmentation begets competition gains and promotes order execution quality (Huang, 2002; Stoll, 2003). Several studies conducted in the U.S. provide empirical evidence that bid-ask spreads narrowed after the opening of new markets (e.g. Battalio, 1997; Boehmer and Boehmer, 2003). O'Hara and Ye (2011) use SEC Rule 605 data provided by TAG Audit for U.S. stocks and analyze the cross-section of 150 Nasdaq-listed and 112 NYSE-listed equities. Their comparison of low and high fragmented stocks shows that fragmentation does not harm liquidity but, on the contrary, reduces effective spreads and increase execution speeds, the benefit being more pronounced for small stocks. Beneficial effects of fragmentation have also been found in Europe by Gresse (2006) for UK middle capitalization stocks, Degryse, de Jong, and van Kervel (2010, 2011) for Dutch stocks, and Gresse (2012) for UK and French stocks. The recent studies by De Jong et al. (2011) and Gresse (2012) find greater liquidity gains for large stocks than for small ones converse to what is observed in the U.S.

4.1. Pre-/Post-MiFID liquidity comparisons

Because MiFID1 widely abolished exchange monopolies inside the EEA, academic research has used its enforcement as an event of market fragmentation. Whereas Section 2 enlightens that some forms of market fragmentation did exist in European market before MiFID1, its implementation has undoubtedly served as a catalyst for the soaring of competition between marketplaces in the course of 2008 and 2009 as shown in Figure 1 of Section 2.2, and it can certainly be considered as a unique event of shifting from consolidated markets to fragmented markets within a relatively short period of time.

Following this view in a recent working paper (Gresse, 2012), I compare the liquidity of 51 LSE-listed stocks and 89 French Euronext-listed stocks before and after MiFID1. These stocks were chosen for belonging to the FTSE 100 index, the CAC 40 index, or the SBF 120 index[9] from 2007 to 2009 and for not pertaining to the financial sector. The trade and quote data were provided by Intelligent Financial Services (IFS) and cover the order flow of Euronext, the LSE, Deutsche Börse, Chi-X, Turquoise, Nasdaq OMX Europe, BATS Europe, PLUS, and the trade reports of BOAT. This allows me to examine not only the liquidity on the primary exchange, referred to as local liquidity, but also the aggregate liquidity of all active trading systems,

[9] The SBF 120 is a French stock market index based on the 120 most actively traded stocks listed on Euronext Paris. It includes the constituents of the CAC 40 index plus a selection of 80 additional stocks. I will use the SBF 120 acronym to designate those additional stocks in the remainder of the review.

referred to as global or consolidated liquidity. The former is relevant for local traders who can only connect to the primary exchange, while the latter is relevant for global traders who are connected to all trading venues or use SORs that enable them to distribute their orders across several marketplaces. Three metrics of local and global liquidity are considered: average quoted spreads,[10] average effective spreads,[11] and the average depth displayed at best quotes.[12]

The study confronts the pre-MiFID period of October 2007 to three post-MiFID one-month periods (January, June and September 2009) selected in order to avoid the 2008 subprime crisis and to correspond to different levels of fragmentation and volatility. Pre-MiFID period October 2007 comes just after the start-up of Chi-X but precedes the launch of Turquoise, Nasdaq OMX Europe, and BATS Europe. The three post-MiFID observation periods come after the launch of those three MTFs, but correspond to different levels of fragmentation and fundamental volatility measured by the standard deviation of daily returns of the CAC 40 and FTSE 100 indices. Fragmentation progressively increased from January to June 2009. Volatility was extreme in January, owing to the financial crisis. Volatility somewhat decreased by June 2009 but still exceeded the baseline level of October 2007. In September 2009, index volatility was almost comparable to pre-MiFID levels.

The comparison shows that global and local spreads narrowed between October 2007 and September 2009 for the three groups of stocks. The spreads of CAC 40 and SBF 120 stocks first widened in January 2009 as a consequence of the extreme rise in volatility, but they then steadily declined over the three months of 2009. The biggest decline in spreads from October 2007 to September 2009 was on the FTSE 100, for which the average consolidated quoted spread fell from 9.21 to 5.43 bps and the average local quoted spread fell from 9.21 to 7.07 bps. The spreads of SBF 120 mid caps narrowed less significantly than those of other stocks. Depth did not display such a favorable change over the same period. Between October 2007 and September 2009, average global depth was divided by 3.7 for FTSE 100 stocks, by 2.2 for CAC 40 stocks and 1.7 for the SBF 120. Although substantial, the reduction in depth was far smaller than the decline in average transaction size.

In order to check to what extent the decrease in spreads and depth observed between October 2007 and September 2009 was assignable to increased fragmentation, I conducted two multivariate analyses: (1) liquidity measures were regressed onto period dummies serving as proxies for the level of fragmentation after controlling for price volatility, trading volume, and price level; (2) liquidity metrics were regressed on a fragmentation index over the three post-

[10] The quoted spread is the difference between the highest bid price and the lowest ask price divided by their middle value. It represents the cost to pay to immediately buy and sell one unit of security in the market.

[11] The effective spread is a proxy for the implicit cost of a given transaction. It corresponds to the difference between the transaction price and the mid-quote prevailing at the time of the transaction, measured as a percentage of this mid-quote. It is doubled to make it comparable with the quoted spread.

[12] Best-limit depth is the sum of the quantities associated with the best bid and ask prices. It can be understood as the quantity of shares that can be instantaneously traded with no impact on quoted prices.

MiFID months with a methodology that addresses the co-determination between liquidity and fragmentation.[13]

The results of the first analysis indicate that global and local spreads decreased in the post-MiFID period with an increasing statistical and economic significance from January 2009 to September 2009. This spread improvement is most significant for FTSE 100 components and is nearly insignificant for SBF 120 mid-cap stocks. Those findings indicate that spread reductions related to the level of market competition as this market competition was weaker for the SBF 120 mid caps at all periods and continually increased from January to September 2009 for all indices. Depth decreased significantly but with very different patterns: in contrast with spreads, most of the fall in depth happened before January 2009 for all indices and its statistical significance is not weaker for French mid caps, suggesting that the reduction in depth most probably has other determinants than the reduction in spreads.

The results of the second analysis show that the liquidity of large caps improved with fragmentation, whatever the liquidity measure considered, with greater economic and greater significance for FTSE 100 securities than for CAC 40 ones. The liquidity of SBF 120 mid caps also improved with fragmentation but only in its price dimension, their depth being affected neither at the global cross-market level, nor locally in the primary market.

In the same spirit, Degryse et al. (2010) compare the liquidity of Dutch large equities composing the AEX index before and after MiFID1. Using the Thomson Reuters Tick History Data, they oppose the pre-MiFID period of September-October 2007 to the immediate post-MiFID period of November-December 2007 and two later periods, August 2008 and January 2009. They find that spreads of Dutch large stocks have worsened after MiFID1 but they acknowledge that the observed changes in liquidity are likely due to the financial crisis rather than fragmentation. More importantly, their event study shows that in their most fragmented observation period, that is January 2009, the order book of the primary exchange is more resilient as it reverts quicker to its normal level of liquidity after a liquidity shock created by aggressive orders.

4.2. The relation between fragmentation and liquidity in fragmented markets

Another way of looking at the impact of fragmentation on liquidity is to test how liquidity relates to fragmentation across time in a fragmented multi-market trading environment. I adopt this approach in Gresse (2012) with daily stock-by-stock observations of liquidity and fragmentation[14] for a sample of FTSE 100, CAC 40, and SBF 120 constituents from 1 September to 30 November 2009. The data, again provided by IFS, cover the same markets as the data used for the pre-/post-MiFID comparison of Sub-section 4.1. I find that liquidity measures are positively impacted by fragmentation. The only adverse effect is a reduction in the global and local depths of SBF 120 mid caps.

[13] For details about the methodology, refer to Gresse (2012).

[14] The methodology is a two-stage panel approach that addresses the co-determination of fragmentation and liquidity.

With the same type of approach, Degryse et al. (2011) evaluate the impact of fragmentation on the liquidity of 52 Dutch stocks over 1,022 trading days from 2006 to 2009. Using the Thomson Reuters Tick History data for seven lit trading venues[15] and the dark trades reported to BOAT, Euronext, Xetra, and Chi-X, they measure local and global liquidity with traditional measures of spreads and depth plus a measure of depth that incorporates not only the quantities available at the best quotes but also those available at further limit prices. They find that fragmentation in visible order books improves global liquidity but deteriorates the local liquidity of the primary market. Further, consistent with my result on French mid caps, they find that fragmentation in more beneficial to large caps than to mid caps.

4.3. Dark trading and liquidity

Dark trading designates trades for which the matched buying and selling interests are invisible from the market before execution. It covers trades executed in regulated dark pools, further referred to as crossing network trading, and OTC trades which includes trades of unregulated dark pools and dealer-to-customer OTC trades. Although SIs are submitted to pre-trade transparency duties, trades executed by SIs may also be considered as dark order flow. OTC trades combined with SI trades will be referred to as internalization.

Regarding the impact of dark trading on liquidity, the effects of crossing network trading and internalization should be distinguished. While crossing network trading is found to be associated with greater liquidity (Gresse, 2006, for UK mid caps in the early 2000s; Buti, Rindi, and Werner, 2011, for U.S. stocks in 2009), the effect of internalization is not so clear. In Gresse (2012), I examined the link between liquidity and internalization[16] for stocks of the FTSE 100, the CAC 40 and the SBF 120 indices. The pre-/post-MIFID comparison shows no significant impact of internalization for any of the three indices, except a weakly significant adverse effect on the global depth of SBF 120 mid caps. In the post-MiFID time series analysis, internalization is found to increase depth for the FTSE 100 and the SBF 120 indices, but at the expense of wider spreads. With their sample of Dutch stocks, Degryse et al. (2011) find that dark trading has a detrimental effect on liquidity. Weaver (2011) finds that internalization is related to spread widening for a sample of U.S. stocks in October 2010.

4.4. Trade-throughs in European stock markets

One keystone of MiFID is investor protection in fragmented markets. Among other provisions, MiFID1 introduced a best execution rule which, in contrast with RegNMS, its U.S. counterpart, does not restrict best execution definition to price but extend it to a range of factors such as costs, speed, the likelihood of execution and settlement (Davies, 2008; Petrella, 2009). As a consequence, trade-throughs – that is trades executed at prices worse than those posted elsewhere – are not prohibited and substantial rates of trade-throughs, although typically less that 10%, have been observed in European markets. Ende, Gomber, and Lutat (2009), by combining the order books of ten trading venues for Eurostoxx 50 stocks in December 2007 and January 2008, find a rate of full trade-throughs of 6.7% of and an additional rate of partial trade throughs of 6.5%. With their sample of 74 UK-listed stocks over 27 trading days from 20

[15] Euronext, Chi-X, Deutsche Börse, Turquoise, BATS Europe, Nasdaq OMX Europe, and SIX Swiss exchange.

[16] Internalized volumes were estimated by summing the trading volumes reported to BOAT and to the LSE trade reporting service.

April to 31 May 2008, Riordan et al. (2011) find 8.26% of trade-throughs on the LSE, 7.86% on Chi-X, 7.26% on BATS, and 5.42% on Turquoise. They provide evidence that those trade-throughs may result from investors valuing depth and execution speed instead of price, and that trade-throughs are more likely to be initiated by informed traders who value speed over costs.

5. Market fragmentation and price quality

In fragmented markets, the issue of the dissemination of information through trades and quotes becomes more complex. A relevant question for investors is whether order flow fragmentation implies price discovery fragmentation. This implicitly includes the question of which prices should they considered as the most informative. Another issue of interest is whether market fragmentation harms or improves price quality.

5.1. The location of price discovery in fragmented markets

A traditional belief is that primary markets organize price discovery and that competing MTFs freely exploit primary exchange prices to operate without significantly contributing to their formation. They would then act as satellite markets whose business cannot survive without the primary market being active. Some recent academic research by Riordan, Storkenmaier, and Wagener (2010) and Aitken, Harris, and Sennenbrebber (2010) strongly challenges this view by showing that the contribution of Chi-X to price discovery has exceeded that of the primary exchange for some large capitalization stocks since mid-2008.

Those two papers use the information share (IS) of Hasbrouck (1995) to measure the relative contribution of primary exchanges and most active MTFs to the price discovery process. The Hasbrouck's IS metric is based on the assumption that the efficient price is a common factor driving the prices of all markets in the long run. In the short run, price discrepancies may temporarily arise between competing systems. With arbitrage and information flow across venues, pricing errors vanishes and prices converge towards the common factor. Markets leading the price discovery process are those whose prices most contribute to the formation of the common factor. Hasbrouck (1995) represents the various markets' price series by a vector autoregressive model in which the common efficient component follows a random walk. He then decomposes price volatility so as to determine the IS of each market. The IS of a given market is the proportion of the variance of the innovations of the common factor that is attributable to this particular market.

Riordan et al. (2010) estimate the IS of the four largest trading venues – the LSE, Chi-X, BATS Europe and Turquoise – for 74 FTSE 100 stocks over 27 days from 20 April to 31 May 2009. Their trade and quote data were retrieved from the Thomson Reuters Tick History service. They find that, on that particular period, Chi-X contributed more to the quote-based price discovery process than the primary market but that trades on the LSE conveyed more private information than trades executed on MTFs. An alternative metric to the Hasbrouck's IS is the Common Factor Share (CFS) by Gonzalo and Granger (1995) which, in the same spirit, is the proportion of the common factor innovations assignable to a market. It differs from the IS in that the efficient price is assumed to also comprise a transitory component. Aitken, Harris, and Sennenbrebber (2010) estimate both the IS and the CFS metric for five large LSE-listed stocks from July 2007 to December 2008. They find that April 2008 was the changeover month when the LSE lost its leading role in price discovery to Chi-X. They attribute this change to a cut in Chi-X fees that might have led a proportion of informed order flow to migrate to Chi-X.

While not permitting any judgment on the effect of fragmentation on the quality of prices, those findings clearly indicate that in the future years, the quotes of primary markets will not necessary lead the price discovery process as in the past, and that the quotes of markets with smaller volume shares may take the lead. Moreover, the location of the most informative quotes may change rapidly according to changes in the relative competiveness of trading conditions. This enlightens the value of a real time trade and quote consolidated tape for investors.

5.2. The impact of fragmentation on price quality: A pre-/post-MiFID comparison

From a regulatory perspective, when several markets contribute to price discovery, the relevant question is whether this fragmentation deteriorates or improves price quality. To address this point, I compare price efficiency measures before and after MiFID. According to the Fama's weak-form efficiency, efficient prices follow a random walk and are not auto-correlated. The absence of price autocorrelation implies that the variance of long-term returns is proportional to the variance of short-term returns, the scale factor being the ratio of return horizons. Consequently, short-term/long-term return variance ratios can be used to assess price quality as first suggested by Lo and MacKinlay (1988). For example, with a high-quality price discovery process, the ratio of six times the 5-minute return variance divided by the 30-minute return variance should be close to one, and the absolute value of one minus this ratio should be close to zero. This absolute value, further referred to as a price inefficiency coefficient (PIC), is an inverse measure of price quality. Any increase in this coefficient indicates a deterioration of price quality. The deterioration may result from either a positive autocorrelation generated by delayed incorporation of information into prices (the variance ratio is then lower than one), or a negative autocorrelation due to noise or overreaction in price movements (the variance ratio is then greater than one).

Using the same samples and data as in Sub-section 4.1, I measure the changes in several PIC measures between the pre-MiFID period of October 2007 and the post-MiFID period of September 2009.[17] Three PIC measures are computed: the absolute value of one minus five times the one-minute/five-minute variance ratio of mid-quote returns, the absolute value of one minus six times the five-minute/30-minute variance ratio of mid-quote returns, and the absolute value of one minus 16 times the 30-minute/intraday variance ratio of mid-quote returns.[18] Those PICs are calculated on the local mid-quotes of primary exchanges and the cross-market mid-quotes resulting from the consolidation of all lit market best quotes. The PIC variations of stocks with highly fragmented order flow in September 2009 are compared with those of stocks with weakly fragmented order flow in a difference-in-differences approach. Results are reported in Tables 2, 3, and 4 for FTSE 100 stocks, CAC 40 stocks, and SBF 120 stocks respectively. They show that the PICs of high fragmented stocks do not change in a significantly different way as those of low fragmented stocks for any of the three stock indices. These findings do not provide any statistical evidence of a detrimental effect of lit order flow fragmentation on price quality as found by O'Hara and Ye (2011) for U.S. stocks. No significant beneficial effect is

[17] This post-MiFID period is chosen for having a level of fundamental volatility measured by index volatility comparable to that of October 2007.

[18] Returns are calculated in logarithm on mid-quotes from 8.15am to 16.15pm (UK time) in order to avoid open and close auctions. This intraday period encompasses sixteen 30-minute periods.

evidenced either for any stock category. This contrasts the finding of O'Hara and Ye (2011) that market fragmentation contributes to improving price efficiency for small stocks in the U.S.

Table 2. Pre-/post- MiFID comparison of price inefficiency coefficients of FTSE 100 non-financial stocks

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
1-minute/5-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.2277	0.4391	0.2113*	0.0631
	High fragmented stocks	0.2027	0.4007	0.1980	0.4089
	Difference in differences			-0.0134	0.9179
5-minute/30-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.1001	0.1464	0.0464**	0.0432
	High fragmented stocks	0.0818	0.0671	-0.0146	0.3597
	Difference in differences			-0.0610	0.1557
30-minute/intraday variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.3693	0.5333	0.1640	0.6713
	High fragmented stocks	0.3803	0.5805	0.2002	0.2433
	Difference in differences			0.0362	0.5308
1-minute/5-minute variance ratio of cross-market mid-	Low fragmented stocks	0.2277	0.1784	-0.0493*	0.0905

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
quote returns	High fragmented stocks	0.2027	0.1408	-0.0619	0.3504
	Difference in differences			-0.0126	0.6871
5-minute/30-minute variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.1001	0.1696	0.0696*	0.0804
	High fragmented stocks	0.0818	0.0816	-0.0002	0.4403
	Difference in differences			-0.0698	0.6066
30-minute/intraday variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.3693	0.4543	0.0850	0.9231
	High fragmented stocks	0.3803	0.3853	0.0050	0.5425
	Difference in differences			-0.0800	0.6598

This table reports the cross-sectional medians of six price inefficiency coefficients (PICs) in October 2007 and in September 2009, the variations in PIC median values between the two periods, the *p*-values associated with signed rank Wilcoxon tests testing the difference between the medians of the two periods, for two sub-groups of FTSE 100 non-financial stocks: 26 stocks with a high level of fragmentation in September 2009 (above median level) and 25 stocks with a low level of fragmentation in September 2009 (below median level). The table also reports the differences in the PIC median variations between high and low fragmented stocks and the *p*-values of signed rank Wilcoxon tests conducted on those differences. *, **, * indicate that the difference considered is significantly different from zero at the 10%, 5%, or 1% level respectively. No * means that the difference is not significantly different from zero.**

Table 3. Pre-/post- MiFID comparison of price inefficiency coefficients of CAC 40 non-financial stocks

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
1-minute/5-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.0738	0.0534	-0.0204	0.6677
	High fragmented stocks	0.0567	0.0422	-0.0145	0.4029
	Difference in differences			0.0059	0.6145
5-minute/30-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.0867	0.1375	0.0508	0.5633
	High fragmented stocks	0.0982	0.1014	0.0033	0.3256
	Difference in differences			-0.0476	0.5144
30-minute/intraday variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.1411	0.2042	0.0631	0.3256
	High fragmented stocks	0.3333	0.2717	-0.0616	0.9255
	Difference in differences			-0.1247	0.5633
1-minute/5-minute variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.4182	0.5869	0.1687	0.6145
	High fragmented	0.0916	0.2258	0.1341*	0.048

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
	stocks			*	5
	Difference in differences			-0.0346	0.2031
5-minute/30-minute variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.2396	0.3593	0.1198	0.1370
	High fragmented stocks	0.0864	0.3295	0.2431**	0.0113
	Difference in difference			0.1233	0.3629
30-minute/intraday variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.2309	0.5036	0.2727	0.0296
	High fragmented stocks	0.3668	0.4853	0.1185	0.2591
	Difference in differences			-0.1542	0.3080

This table reports the cross-sectional medians of six price inefficiency coefficients (PICs) in October 2007 and in September 2009, the variations in PIC median values between the two periods, the *p*-values associated with signed rank Wilcoxon tests testing the difference between the medians of the two periods, for two sub-groups of CAC 40 non-financial stocks: 16 stocks with a high level of fragmentation in September 2009 (above median level) and 16 stocks with a low level of fragmentation in September 2009 (below median level). The table also reports the differences in the PIC median variations between high and low fragmented stocks and the *p*-values of signed rank Wilcoxon tests conducted on those differences. *, **, * indicate that the difference considered is significantly different from zero at the 10%, 5%, or 1% level respectively. No * means that the difference is not significantly different from zero.**

Table 4. Pre-/post- MiFID comparison of price inefficiency coefficients of SBF 120 non-financial stocks

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
1-minute/5-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.0771	0.1631	0.0859***	0.0044
	High fragmented stocks	0.0925	0.1873	0.0948***	0.0013
	Difference in differences			0.0089	0.7090
5-minute/30-minute variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.1252	0.1242	-0.0010	0.9026
	High fragmented stocks	0.1561	0.1854	0.0293	0.2020
	Difference in differences			0.0303	0.3795
30-minute/intraday variance ratio of primary-exchange mid-quote returns	Low fragmented stocks	0.2739	0.2325	-0.0414	0.2878
	High fragmented stocks	0.3378	0.3515	0.0136	0.7452
	Difference in differences			0.0551	0.2859
1-minute/5-minute variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.0719	0.1468	0.0749***	0.0014
	High fragmented stocks	0.0941	0.2153	0.1213***	0.0027

Price inefficiency coefficient based on	Fragmentation group	Median value in October 2007	Median value in September 2009	Variation	*p*-value
	Difference in differences			0.0464	0.6060
5-minute/30-minute variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.1252	0.1453	0.0200	0.4302
	High fragmented stocks	0.1561	0.1894	0.0333	0.1330
	Difference in difference			0.0132	0.3967
30-minute/intraday variance ratio of cross-market mid-quote returns	Low fragmented stocks	0.2739	0.2583	-0.0157	0.5414
	High fragmented stocks	0.3378	0.3681	0.0302	0.3960
	Difference in differences			0.0459	0.2457

This table reports the cross-sectional medians of six price inefficiency coefficients (PICs) in October 2007 and in September 2009, the variations in PIC median values between the two periods, the *p*-values associated with signed rank Wilcoxon tests testing the difference between the medians of the two periods, for two sub-groups of SBF 120 non-financial stocks: 29 stocks with a high level of fragmentation in September 2009 (above median level) and 28 stocks with a low level of fragmentation in September 2009 (below median level). The table also reports the differences in the PIC median variations between high and low fragmented stocks and the *p*-values of signed rank Wilcoxon tests conducted on those differences. *, **, * indicate that the difference considered is significantly different from zero at the 10%, 5%, or 1% level respectively. No * means that the difference is not significantly different from zero.**

6. Concluding remarks and prospects

Four years after MiFID introduction, computer trading has fomented competition and complexity in the European exchange industry. A two-phase battle has taken place: the first phase has seen light and dark MTFs proliferate and divert order flow away from incumbent exchanges; the second phase has involved mergers of trading venues fighting for size and seeking profitability through returns on scale. As a result of this dual process, market fragmentation has considerably increased without however reaching the same level as in the U.S. The fragmentation of the lit order flow in large equities has constantly increased from 2008 to 2011, with most of the rise happening between the middle of 2008 and the end of 2009. Among the many emerging MTFs, only three have become significant players, namely Chi-X, BATS, and Turquoise. At present, their joint market share exceeds 30% of lit trading volumes, of which more than two thirds are attributable to Chi-X. The key factors of success in this competition for order flow have undeniably been low fees and technological performances, in response to the specific and growing demand of HF traders. In contrast with the growth of lit MTFs, regulated dark pools do not execute more than some 5% of the total trading volumes and they will probably not grow much more.

The increased fragmentation of the visible order flow does not harm liquidity. On the contrary, associated competition effects have contributed to reducing spreads for all categories of stocks and to increasing depth for large stocks. The larger spreads observed immediately after MiFID1 were the outcome of the 2008 subprime crisis but not a consequence of fragmentation, as shown by later statistics. The decrease in depth identified in the pre/post MiFID comparisons does not directly correlate with market fragmentation and seems to have other determinants, among which we could probably find HF trading.

Apart from those beneficial effects, two observations should receive further attention in European stock markets: significant trade-through rates are observed and fragmentation may adversely affect the depth of small stocks. These two observations are in contrast with U.S. stock markets where trade-throughs are prohibited and where market fragmentation benefits were found to be greater for small stocks than for large stocks.

Regarding price discovery, active MTFs significantly participate in the price discovery process and primary exchanges will not necessary be the major contributors for all stocks at all times. To the best of the current knowledge, this does not deteriorate price quality.

While neither the competition between lit trading venues nor crossing network trading harm market quality, the strong weight of OTC venues in total trading – over 35% – combined with the fragmentation of trade reporting are preoccupying. The actual share of unregulated dark pools versus that of dealer-to-customer trading in OTC volumes is unknown, so that the impact of each on market quality cannot be clearly appraised; yet some adverse effects of internalization on liquidity may be feared. Particular attention should be paid to this issue. Further, the quality of post-trade transparency may suffer from a lack of consistency in trade reporting. MiFID1 did not introduce any official consolidated trade and quote tape, so that the buy-side and the sell-side have to rely on data aggregators, as Bloomberg or Reuters, to obtain a global view on trade prices. Although data feed vendors provide those real-time services, they are not responsible for clearing and filtering the reported data, and no official body is in charge of investigating when trade reports are poorly done or delayed. MiFID2 is expected to fill those gaps.

The prospect for the next ten years is that the marketplace will remain segmented between several inter-connected venues, with technology still playing a central role. Due to profitability constraints, I do not expect the number of venues to grow but lit trading will more probably concentrate on a handful of platforms. SORs and liquidity aggregators should play a key role in reducing the probability of trade-throughs and in consolidating trading venues into an inter-connected marketplace with multiple access gates.

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