

**Revolution in the stock exchange industry:
Two-sided platforms, battle for liquidity, and financial centres**

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Abstract

In 2000s regulation in the USA and subsequently in Europe responded to the needs of investors and traders, allowing them to take advantage of modern technology, and unleashing competition never before witnessed in the stock exchange industry, with a singular focus on liquidity. By 2010 new exchanges in the USA and Europe proved successful in the battle for liquidity. Essential to their success was the adoption of a simple and efficient business model of two-sided platforms, which contrasts with and threatens the model of diversification and vertical integration embraced by incumbent exchanges. The increased competition and network effects in the industry have been accompanied by its continued concentration in the New York City area in the USA, and emerging dominance of London in Europe, driven primarily by the value of proximity between exchanges and their major customers in terms of computers and human relations. While their iconic incumbent exchanges may suffer, revolution in the stock exchange industry benefits New York City and London as financial centres.

Keywords: stock exchanges, liquidity, networks, two-sided platforms, financial centres

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Introduction

In his book 'Capitals of Capital' Youssef Cassis states that stock exchanges set the pulse of financial centres (2006, 6). Out of the top 10 financial centres in the world according to the Global Financial Centre Index (Z/Yen 2010), only Geneva does not have stock exchange headquarters (although it has an office of the Swiss Exchange). In Canada, Brazil, and Australia, which witnessed domestic battles for financial centre primacy in the 20th century, winners – Toronto, São Paulo, and Sydney host the national stock exchange. This coincidence between financial centre and exchange location can be found also at the intra-urban level. The relocation of JSE Securities Exchange from downtown Johannesburg to Sandton in 2000, for example, marked the rise of Sandton as the city's new financial district. It is difficult to think of a single country, where the only or the main exchange is not located in the country's primary financial centre. While a financial centre can function without a stock exchange (think of Geneva, Boston or San Francisco), stock exchanges certainly contribute to financial centres in tangible (employment, infrastructure) and intangible ways (image, brand, reputation).

The last decade has shaken the stock exchange landscape, particularly in the USA and Europe. While the words of the former CEO of the New York Stock Exchange (NYSE) John Thain - "every country has a flag, an army, and an exchange" (Biglari 2007, 5) – were true to reality in 2000, ten years later we have international stock exchange groups such as the NYSE-Euronext, the London Stock Exchange Group (including Borsa Italiana), and the NASDAQ-OMX Group (with operations in at least 16 countries). All of them are self-listed and have diluted ownership structures, and feature state-controlled institutions from Dubai and Qatar among major investors. A special report of the Financial Times in 2007 entitled nomen omen 'World Financial Centres and Exchanges' hints at the fate of exchanges becoming divorced from the fate of financial centres. In the lead article John Authers (1) claims: "The on-going soap opera of consolidation matters greatly to shareholders of the exchanges involved. But it has little relevance for the balance of power between the world's financial centres".

In my view the stress on nationality in the debate on the relationship between exchanges and financial centres is misplaced. Financial centres, particularly in the 21st century, are about location rather than nationality. A stock exchange, like any company, may have a difficult to discern nationality, but its decision makers, employees, and hardware must be somewhere, and where they are is an integral part of corporate strategy. There is much more to geography than nationality. Confusing geography with nationality reminds me of the airline analogy, which I have heard many times interviewing experts at stock exchanges. It goes as follows. People and governments used to care about the nationality of airlines, but now they only care about cheap tickets and good service. Likewise they should and will stop caring about the nationality of exchanges. What the story does not mention is that competition among airlines (including an open market for their ownership) makes geography of airline industry more interesting than ever before, as companies can develop fewer but bigger airline hubs involving jobs, research & development, and attracting related services. Witness, for example, the development of aviation finance in Ireland. Nationality may

influence location (think of Ryan Air), but what matters more directly is competition and business strategy.

The objective of this paper is to investigate competition in the stock exchange industry and its relationship with the development of financial centres. Empirically, the emphasis is on Europe, particularly since the introduction of the Markets in Financial Instruments Directive (MiFID) in 2007. Comparisons will nevertheless be made between Europe and the USA, and some implications drawn at the global scale. The main source of material for the paper is previous work on the evolution of stock exchanges and markets (Mitchie 2006, Casey & Lannoo 2009) and data on equity trading from the Federation of European Stock Exchanges (FESE). In addition, the author has conducted tens of interviews with stock market experts in financial centres around Europe, which have helped to gain an insight into the practices of stock exchanges and related institutions.

The analysis takes the following steps. First, section 2 sketches the main forces that have transformed the stock exchange industry in the last quarter century, with particular focus on the last decade in Europe. Section 3 analyses the impact of these forces on the business models of new entrants and established players in the industry. It shows how the changes in the environment of exchanges have revolutionised the way these institutions conduct their business. Section 4 introduces the main actors on the European stock exchange stage and interprets the battle for liquidity between 2000 and 2010. The final part of the analysis in section 5 presents the footprint of the revolution in the stock exchange industry, interrogating the location of stock exchange operations for both new and established exchanges, as well as its relationship with financial centres. Section 6 concludes, drawing some implications for the global stock exchange industry and stock markets in general.

The central argument can be previewed as follows. In 2000s regulation in the USA and subsequently in Europe responded to the needs of investors and traders, allowing them to take advantage of modern technology, and unleashing competition never before witnessed in the stock exchange industry, with a singular focus on liquidity. By 2010 new exchanges in the USA and Europe proved successful in the battle for liquidity. Essential to their success was the adoption of a simple and efficient business model of two-sided platforms, which contrasts with and threatens the model of diversification and vertical integration embraced by incumbent exchanges. The increased competition and network effects in the industry have been accompanied by its continued concentration in the New York City area in the USA, and emerging dominance of London in Europe, driven primarily by the value of proximity between exchanges and their major customers in terms of computers and human relations. While the NYSE-Euronext and the LSE Group may suffer, revolution in the stock exchange industry benefits New York City and London as financial centres.

The winds and waves of change

This section provides a historical background and conceptual framework for the analysis of competition in the stock exchange industry, by identifying the winds and waves of change. The winds of change are the major forces operating on the stock exchange industry: technology, the nature of demand for stock exchange

services, and regulation. Waves are the major historical events, milestones in the history of the industry in Europe, starting with the Big Bang of 1986, which reformed the London Stock Exchange and precipitated a series of stock exchange deregulation in Europe; followed by the Investment Services Directive, in force since 1996, and replaced by the MiFID directive in 2007. There are many detailed accounts of change in the environment of stock exchanges (see e.g. Ferrarini 1998 or Casey & Lannoo 2009 for focus on regulation, and Lee 1998 on technology and governance). Compared to them this section is bound to look sketchy, nevertheless it is necessary to contextualise change in the exchange business model, competition for liquidity, and location.

Prior to mid 1980s European stock exchanges were mutual organisations owned by members trading on a physical trading floor (open outcry pit) and earning statutorily fixed commissions on executed orders sent to them by customers who, at least as far as retail trades are concerned, were obliged to send their orders to the stock exchange. This picture of stock exchanges functioning like national monopolies was in place at least since the Second World War, but was to change in 1986 with the financial reform referred to as the Big Bang in the UK. The core reforms involved the abolition of fixed fees and opening the membership of the London Stock Exchange to banks and investment firms, including the admission of foreign members (Mitchie 1999). The reform coincided with the replacement of the open outcry pit with screen-based electronic trading. What had the most direct impact on other stock exchanges in Europe in the aftermath of the reform in London was the Stock Exchange Automated Quotation-International (SEAQ-I), a computerised quote-driven trading system (modelled after the NASDAQ in the USA), which after 1986 attracted a substantial amount of trading in stocks from Continental Europe. The first to respond to this challenge was the Paris Bourse, which lost a significant amount of trading to SEAQ-I, and underwent a reform between 1986 and 1989. In early 1990s other exchanges followed, including Madrid, Milan, Brussels, Amsterdam and the German exchanges (Pagano 1998). The common themes in this wave of deregulation were the liberalisation of commissions, introduction of screen based trading, and broadening access to stock exchange membership. The reforms lowered the costs of trading, speeded up execution, made trades more transparent, and increased the liquidity of the market.

The next major reform came with the ISD in 1996, the main objective of which was to introduce an EU passport for investment services firms, whereby firms once authorised by their home country regulators could operate in any other Member State. A major implication was that authorised investment firms that wanted to become members of a foreign stock exchange, did not need to be physically present in the home country of that stock exchange. Stock exchanges had to accept remote members and provide them with trading screens. The ISD, however, did not introduce direct competition between stock exchanges, as it recognised existing stock exchanges as regulated markets and allowed Member States to maintain concentration rules, whereby national authorities could require that at least retail investor orders are executed only on the domestic regulated market (Ferrarini 1998). Thus the privileges of exchanges were maintained and competition between them was restricted.

This changed only in 2007 when MiFID came into force. The concentration rules were abolished, allowing regulated markets (incumbent exchanges) and investment firms to set up Multilateral Trading Facilities (MTFs), which can trade any equities that are eligible for trading on regulated markets. In addition, subject to trade transparency rules, investment firms can internalise retail investor orders in the capacity of systemic internalisers (with the investment firm as a counterparty to each trade). Stock exchanges lost their monopoly on trading, but also on market data, as trades taking place outside of regulated markets can be reported to an MTF or a specialised data vendor like Bloomberg or Reuters, and not necessarily to the incumbent exchange (Casey & Lannoo 2009, Davies 2008). Finally, MiFID requires investment firms to have a best execution policy - procedures to ensure that their customers' orders are sent to the trading venue that offers best execution (affected by a combination of stock price, speed, fraction of order executed, costs).

MiFID is the centrepiece of the Financial Services Action Plan initiated in the EU in 1999, following recognition that ISD was insufficient for the development of an integrated European capital market. Other directives most relevant to the stock market are the Prospectus Directive, Transparency Directive, and Market Abuse Directive. With the Prospectus Directive in force since 2005, once a company gets its prospectus authorised by the home country authority, its shares can be listed anywhere in Member States or traded unlisted on an MTF, without the latter needing to ask the issuer for permission. The Transparency and Market Abuse directives regulate the ongoing disclosure and reporting requirements of issuers.

A major wind of change, thus far silent in this account, is the nature of demand for stock exchange services. In terms of size over the last quarter century we have witnessed a growing demand from issuers, driven i.a. by privatisations of formerly state-owned companies; and from investors, driven mainly by the rise of private pension funds. In terms of structure investors' demand has been dominated by institutional investors, mainly pension, mutual, and insurance funds, as well as institutional traders, with hedge funds and investment banks in the lead. Large traders acting on behalf of institutional investors and on their own account demand speed and cheap execution much more effectively than retail (individual) investors ever could. Large institutional investors want to diversify their equity holdings internationally and are interested in quick and cheap buying and selling across national markets, treating the global or at least the European equity market as one world of investment opportunities. Over the last 25 years, this demand and way of viewing equity markets grew increasingly out of match with the European stock exchange infrastructure. Large investment funds and their brokers want to trade European stocks without the cost of being members of 10 to 20 different exchanges, each with its own rules for membership, trading, clearing and settlement.

The direction of the wind of change affecting the European exchange industry has been mostly eastwards, blowing from the USA, with the world's largest and most liquid stock market, and the seat of the largest institutional investors and investment firms. All waves of change in Europe have been affected by events in the USA, with NASDAQ and deregulation in the USA stimulating Big Bang (via the

pressure of the US investment banks present in the City of London); and the Regulation National Market System reform of 2005 in the USA inspiring MiFID, as the EU has considered the lack of an integrated European stock market as a major obstacle to lower cost of capital for European firms and better access to investment opportunities for investors. It should be noted that the fragmentation of European stock markets along national borders presented a major barrier to the expansion of US investors and intermediaries. The Sarbanes-Oxley Act of 2002, contributing to a wave of de-listings in the USA, restricted domestic revenue potential for the US exchanges and other stock market intermediaries, and became one of the motives for them decisively entering the battle for liquidity in Europe in mid 2000s. Likewise, the US investors and intermediaries are a major source of demand for European exchanges and intermediaries.

The impact of technology on the evolution of stock exchanges is closely related to the issues of demand as well as regulation. Prior to 1980s traders would meet on a physical trading floor and orders from their customers would be collected via telephone. Starting in mid 1980s open outcry pits were gradually replaced by computers displaying and matching orders, with traders sending their orders via computer networks from the dealing rooms of investment firms within the financial centre where the stock exchange was located. Themselves, traders would collect orders from their customers still mostly via telephone. In mid 1990s, with Internet and remote access, the connections between exchange order matching and display engines could extend across borders, and investors themselves could send their orders to trading firms via computer networks. Since the late 2000s, with the MiFID and best execution rules, traders and intermediaries need to be connected to multiple venues. A parallel innovation in this field has been the Financial Information eXchange (FIX) Protocol developed by investment banks and firms, which has standardised the format of trade-related messages, becoming a global language for the automated trading of financial instruments. The history of stock exchange technology is thus a story of increasing connectivity achieved through a network of physical infrastructure and rules.

2000s witnessed yet another technological revolution. As computing power and the speed of data transmission grows exponentially, an increasing part of trading is generated by trading firms writing and installing algorithms on computers which generate orders automatically. While in mid 1980s it was an achievement for SEAQ in London to execute up to 10 trades a second (Mitchie 1999), in 2010 computers can generate thousands of orders per second each, putting an enormous pressure on stock exchanges to process these huge numbers of transactions quickly. The fastest matching engines offer a round trip (from receiving an order to sending a message confirming its execution) measured in microseconds. As the speed of message transmission approaches the speed of light, there is demand from the trading firms to locate their order-generating computers as close as possible to the matching engines of exchanges, referred to as co-location services or proximity to liquidity. In stock trading, the notion that time is money has been taken to a new level.

In summary, I have tried to show that the exchange industry has been transformed over the last quarter century by forces that can be classified under

the broad headings of demand, technology and regulation. While regulation provides clear milestones in the history of stock exchanges, in a sense it has responded, arguably with considerable delay, to the demands of modern investors and intermediaries, allowing them to take advantage of available technologies. In Europe, changes in the exchange industry have been greatly affected by earlier changes in the US stock markets, channelled to large degree via the City of London. The USA as a continental size economy with the world's largest stock market has been influential as a major source of business for European exchange industry, and treated in many respects as a benchmark for European regulation. As I shall argue in the next section, these macro-changes in the environment of stock exchanges have had huge consequences for how stock exchanges formulate their strategies.

Revolution in the exchange business model

In this section I will explain how the changes in demand, technology and regulation have revolutionised the very business model of a stock exchange. The starting point of my argument is the increasing separation of trading from listing, services to traders from services to issuers, or more generally secondary from primary stock markets. This separation has created an opportunity for the emergence of a stock exchange business model focused exclusively on trading, which in Europe has materialised in the form of MTFs. Specifically, I will show that MTFs treat the secondary stock market as a two-sided network, with liquidity makers on one and liquidity takers on the other side, and consequently have developed their business as the provision of two-sided platforms. The concept of two-sided networks and platforms, inspired by network economics and business studies, will also allow me to compare the strategy of MTFs with the behaviour of incumbent exchanges, and draw implications about competition in the exchange industry.

The winds of change identified in the previous section are very useful in explaining the growing separation of trading from listing. In terms of demand, we have noted a shift to markets dominated by large, internationally oriented investors. These investors' interest in the number of listed companies in the US growing from say 7,000 to 7,050 or in bringing another small size issuer to the German stock market is minute compared to their interest in easy and cheap cross-border trading of large capitalisation stocks. Their interest in small capitalisation stocks is limited, because trade such involves high risk of adversely influencing price (liquidity risk). Alternatively, large investors would have to split their portfolio and attention into minute fractions. In the field of technology, algorithmic trading and ultra-speed connections reflect the fact that trading becomes more technology driven, while listing and other issuer services remain relationship-based. This enlarges the gulf between the two activities in terms of procedures and skill sets. Finally, regulation allows (and in some respects and contexts requires) issuers services to migrate from stock exchanges to regulatory authorities and companies other than stock exchanges (including rating agencies or media companies). The recent EU directives harmonise core procedures related to prospectus authorisation and issuer reporting, handing them over to regulatory authorities, and allow stock trading without listing by MTFs. The separation of issuer services from trading happens also at the level of

national regulation. In the UK, listing and delisting of stocks was transferred to the Financial Services Authority before the EU directives were in place (Macey & O'Hara 2002). As a result, the relationships with issuers matter less for the stock exchange business, and trading - the production of liquidity - becomes ever more critical and their *raison d'être*. In a sense, stock exchanges become more like derivatives exchanges, with few or none direct relationships with the issuers of traded securities.

In Europe, MTFs epitomise this shift to a singular emphasis on liquidity production, by treating the secondary stock market as a two-sided network and focus their business on providing two-sided platforms to service this market. It should come as no surprise that stock markets operate like networks. A trader/investor on a stock market benefits from the presence of other traders/investors. Buy/sell orders are attracted to the market where they can find the maximum number of other sell/buy orders. Liquidity attracts liquidity. Even in a physical sense, we have illustrated the development of trading as a network of connected traders, investors and exchanges. Secondary stock market however, is not any type of network - it is a two-sided network, with liquidity makers on one and liquidity takers on the other side. Liquidity makers are traders (institutional or individual) who send both sell and buy orders for the same stocks in order to make a profit on the difference (spread). As the spreads are typically small, the volume and speed of trading is paramount. Liquidity takers are investors (institutional and individual) who buy and sell stocks to build and rebuild their portfolios. The recognition of these two distinctive sides is key to the strategy and success of businesses providing platforms connecting the two sides.

Some of the most successful companies of the last 10-20 years have based their business model on two-sided networks. Web search engines like Google, for example, connect searchers and advertisers. Windows and Mac operating systems connect consumers with application developers. While concentrated in Information Technology (IT) and media, and very much enabled by the development of Internet, two-sided platforms are also present in more traditional sectors. Shopping malls, for example, are two-sided platforms connecting shoppers and retailers. A crucial feature of two-sided networks is the impossibility of identifying the cost and revenues side of business. A steel plant buys iron ore and sells steel to customers. A web search engine does not have a simple value chain; both searchers and advertisers are its customers. Analysing exchanges as two-sided networks is thus consistent with the recognition that they are being transformed from monopolistic public utilities to competitive financial companies with strong features of IT and media sectors.

The application of the concept of two-sided networks and platforms to stock exchanges is new. Eisenmann, Parker and Van Alstyne (2009) actually give stock trading as an example of one-sided networks, as they see stock traders selling and buying, thus playing double roles in the market. Evans and Schmalensee (2007), however, classify financial exchanges as two-sided platforms. Here I obviously side with the Evans and Schmalensee. My analysis of MTFs as two-sided platforms is inspired by the brilliant account of strategies for two-sided platforms in the Harvard Business Review by Eisenmann, Parker and Van

Alstyne (2006). To the best of my knowledge, this is the first paper that describes secondary stock markets as two-sided networks, and MTFs as two-sided platforms.

The basic logic of an exchange as a two-sided platform is that the more liquidity makers there are using a platform, the more attractive the platform is to liquidity takers and vice versa. In addition there are positive same-side effects. Liquidity makers benefit from the presence of other liquidity makers, and liquidity takers from the presence of other liquidity takers. The business of the platform provider is to offer the technology (with order matching engine in the centre) and rules (types of orders, rules for matching them, transparency). The distinction between the two-sides of the network is critical to pricing strategy. Here, the key to success is the decision on which side to subsidise and which to charge. Adobe Acrobat, for example, charges document producers (people who want to convert their documents into pdf have to buy Adobe Acrobat writer software), while document readers can download and use Adobe Acrobat reader software free of charge. Without the subsidy and revenue side defined in this way, the product would not work. The side that should be subsidised is one that is more sensitive to price and quality. In the exchange business, these are the liquidity makers rather than takers. Simplifying, ultimate investors have to invest their cash somewhere. Liquidity makers, mostly high frequency (HF) traders, make money on trading itself, and the speed and reliability of trading procedures affects the core of their business. As a reflection of this logic MTFs, while charging traders for connecting to the platform, actually pay money (give rebates) to liquidity providers and charge liquidity takers, retaining the difference. They recognise liquidity makers as those who post orders in the order book, and takers as those who use existing orders. Chi-X, a leading European MTF for example, uses the maker-taker fee structure, charging takers 0.3 bp and giving rebates of 0.2 bp to makers. Effectively, rebates to liquidity makers allow them to post sell and buy order with narrower spreads, improving the prices obtained by liquidity takers, and increasing the volume of transactions.

Next to pricing, the second major strategic issue for two-sided platforms is winner-take-all dynamics. Can the whole market eventually be served by a single platform? In secondary stock markets economies of scale related to positive network externalities are immense. There are no capacity constraints either. Technology is available for a single platform to serve the total volume of stock trading for the whole of Europe. There are however two major reasons why European (or US) market is unlikely to be served by a single platform. Liquidity demanded by traders and investors comes in different forms and shapes, which in turn stimulates demand for special features that may be difficult to satisfy by a single platform. The basic characteristics of a stock trade include stock price, cost of transaction (including clearing and settlement), speed, and discretion/transparency. Discretion is particularly important for large traders and investors who do not want their order to be seen by others. Such orders are often executed in dark pools of liquidity, where order book is invisible to traders. Firms running algorithmic trading care about speed, while retail traders and investors care most about the best available stock price and the cost of transaction. The second factor is the level of government intervention, which in

the exchange industry probably surpasses anything seen in the IT or media sectors, where two-sided platforms are common. The objective of regulation in both the USA and EU is to enhance competition for trading and exchange services. Concentration of trading on one platform or a set of platforms controlled by one company would be an anathema to regulators. In addition, best execution means that brokers channelling orders on behalf of their customers cannot simply connect to one platform (which they may have an incentive to do if they co-own the platform), sit back and watch other platforms lose business. They are obliged to ensure that they send orders to the platform offering best execution. Best execution may mean different things to different customers, and the right venue for it may change every day. As a consequence, it is difficult for platform providers to secure exclusive participation of big 'marquee' users in their platform.

How does the embrace of the logic of two-sided platforms by MTFs affect incumbent exchanges? In general, incumbent exchanges in Europe have over the last decade chosen the path of business diversification, covering issuer services, post-trade services, data and IT services, in addition to trading. Listing fees, representing the bulk of issuer services, have been a secure source of revenue, as European issuers rarely list their shares outside their home country. Thus, competition for listings is limited to listing of non-EU companies. However, as the activity on primary stock markets in the last decade has been low, listing revenues have stagnated, and their share in total revenues of stock exchanges has fallen from 18% in 1998 to 6% in 2008 (based on aggregate figures for all members of the World Federation of Exchanges). Some stock exchanges have extended their post-trade services to include clearing and settlement (e.g. the Deutsche Börse Group owning Clearstream). Trading services have been extended as well with mergers of stock exchanges with derivatives exchanges (LIFFE e.g. is a part of the NYSE-Euronext Group, and Eurex a part of the Deutsche Börse Group). In addition, some stock exchanges have opened their own MTFs, developed their IT operations specialising in trading technology (e.g. NASDAQ OMX Group) or purchased firms with expertise in this field (e.g. the recent acquisition of Millenium IT by the LSE Group).

In addition to vertical integration, stock exchanges have pursued a strategy of horizontal integration via cross-border mergers and acquisitions (M&A), leading to the creation of widely-held and self-listed international exchange groups, discussed in more detail in the following section. Hardly a month goes by without an M&A event in the exchange industry. With all the restructuring, and generally positive conditions in international financial markets, the 2000s have been a decade of financial success for stock exchanges, with revenues and profits multiplied. The Dow Jones Global Exchanges Index rose from 100 at the start of 2000 to 1,200 at the end of 2007. Revenues per employee in the exchange industry have been spectacular, much higher than for banks or insurance companies (Capaldo et al. 2008).

Notwithstanding the expansion and financial success of incumbent exchanges, the pure liquidity- focused two-sided platform model of MTFs poses a major new threat to them. MTFs are small and flexible organisations, which are both more IT-driven and closer to liquidity makers and takers than incumbent stock

exchanges. The former is reflected in incomparably higher speed of trading MTFs offer and the role of IT expertise in the biographies of their executives. The latter is underpinned by the fact that they are closely held by major liquidity takers and makers themselves. The ultimate arbiter of competition between incumbent exchanges and MTFs will be the battle for liquidity. Stock exchange groups, however diversified, will struggle if their share in trading falls substantially. When an exchange loses the majority of trading volume in a stock, the issuer may consider whether it is still the right primary market for it. Falling shares in trading would also put pressure on the exchange's ability to charge for trading data – MTFs give it away for free. Thus in 2010 it is possible to see the threat of the incumbent stock exchange model to crumble, like in a domino effect, where falling trading takes down with it other parts of the business. An option for incumbent exchanges may be to introduce the maker-taker fee model to their own trading activities. One problem with it is that as a result some large customers would have to pay more and could migrate to MTFs. Another problem is that it would make the prices of exchanges directly comparable to those of MTFs, leading to the ultimate challenge of whether the incumbents can beat MTFs at their own game, offering quicker and cheaper trading. Incumbent exchanges are unlikely to get rid of competition by taking over MTFs, as this would raise opposition from regulators as well as investment bank and traders. These strategies in the parlance of two-sided networks are called platform envelopment, whereby a big multi-platform provider takes over other successful platforms. Platform envelopment is unlikely to succeed in the exchange industry. MTFs are here to stay and threaten the model of the incumbents.

The battle for liquidity

Having explained the factors operating in the environment of stock exchanges, and generic changes they have undergone internally, the stage is set to introduce the major actors by name. Thus, this section presents the battle for liquidity in stock trading in the last decade in Europe, with references to situation in the USA. This will also give us an opportunity to provide examples of strategies pursued by both incumbent exchanges and MTFs. In the first part of the section, our attention will concentrate on the interpretation of data on the value of trading executed in the electronic order books of European stock trading venues, as presented in table 1.

To start with, let us introduce the trading venues that resulted from recent M&As of exchanges. Borsa Italiana merged with the London Stock Exchange in 2007, giving rise to the LSE Group. Trading migrated from Italy to the LSE trading platform in 2009. The Central and Eastern European Stock Exchange Group (CEESEG) is a holding company launched officially in 2009 with stock exchanges in Budapest, Ljubljana, Prague and Vienna as subsidiaries, with the management of the Vienna Stock Exchange at the steer. The latter is the controlling owner of stock exchanges in Ljubljana and Prague, and together with a consortium of Austrian banks controls the Budapest Stock Exchange. The NASDAQ OMX Nordic & Baltic includes stock exchanges in Stockholm, Copenhagen, Helsinki, Iceland, Vilnius, Riga, and Tallinn, and is part of the NASDAQ OMX Group, the product of the merger of OMX with the US-based NASDAQ in 2008. OMX dates back to early 2000s and itself was preceded by the Norex Alliance that started in 1990s. Joint

trading platform was introduced by OMX in 2004. The NYSE-Euronext is the product of the merger of Euronext with the NYSE in 2007. Euronext started with a merger of stock exchanges in Paris, Amsterdam, and Brussels in 2000, with Lisbon joining in 2002.

Before analysing trading values, let us consider briefly the pattern of the current stock exchange groupings. First, there is a regional element. This is obvious for the CEESEG. Here the strong position of Austrian banks in the financial markets of the Czech Republic, Hungary and Slovenia was instrumental in the creation of the group. Neither the Bratislava Stock Exchange nor the Warsaw Stock Exchange, however, has joined. Regional logic obviously also underpins the development of the NASDAQ OMX Nordic & Baltic, again with an important exception of Norway, which enjoys a vibrant corporate sector and community of domestic investors.

Compatibility of traditions, strategic objectives and expertise matters as well, as indicated by the shape of European and transatlantic mergers. The NASDAQ OMX Group is a marriage of markets specialising in relatively small firms and dynamic sectors, including IT and biotechnology. Nordic countries are prominent in these industries. Euronext markets of France, Netherlands, Belgium and Portugal are all in relatively centralised financial systems, with little significance of regional stock exchanges or regional banks (Verdier 2002). This may be one of the factors that facilitated the creation of Euronext as the very first successful international merger in the industry. Second, the economies of these countries are dominated by large companies, with telecommunications and utilities sectors in the lead (including energy and water companies, often formerly state owned), which makes their markets quite compatible with the focus of the NYSE. To be sure, simple generalisations must be avoided, as there is a lot of contingency in the history of M&As in the stock exchange industry. When the NOREX alliance was formed in 1998-99 Oslo Børs had just implemented a new trading system while Copenhagen urgently needed a new one. This was clearly an important reason for Copenhagen to join the Alliance, and for Oslo to stay out. NASDAQ attempted to buy the LSE in 2006, Deutsche Borse tried to merge with it a couple of times. Personalities and particular circumstances can matter as much as structural economic and business issues.

Moving to the analysis of trading values, we will focus on the share of each exchange in the total European trading value. To be sure, the total trading value fluctuated widely in the considered period (figure 1). It stagnated between 2000 and 2004, grew by 140% between 2004 and 2007, fell subsequently by 15% in 2008 and by nearly 40% in 2009. The first half of 2010 promised a recovery to the levels of trading from 2006. Another caveat is that the share of an exchange in the total European trading value cannot be interpreted strictly as a market share, since until 2008 trading was limited almost entirely to domestic companies (or companies domestic to one of the countries of an exchange group). In 2007 trading of non-domestic firms accounted only for 3% of the total European trading value. In other words, until 2008 the shares of exchanges in the European trading value express the relative size of their trading rather than market shares as such.

Euronext, the pioneer of stock exchange consolidation, entered the 21st century as by far the largest stock exchange in Europe, with Borsa Italiana (BIT), Deutsche Börse (DB) and the LSE in the second, and the Spanish Exchanges (Bolsas y Mercados Españoles - BME), Stockholm and Swiss exchanges in the third league. Between 2000 and 2007 the growth of trading on Euronext lagged behind the DB, and particularly the LSE. BIT grew at a slower pace as well. As a result, at the peak of the trading boom in 2007, DB and the LSE closed the gap to Euronext. BME became the fourth largest market. Figure for the SIX Swiss Exchange (SIX) in 2005 is very low due to the migration of trading in blue chip stocks to Virt-X, a London based subsidiary of the SIX, not included in the FESE data.

In 2008 the stage entered MTFs. Chi-X launched trading in March 2007, before MiFID came into force, as part of Instinet (headquartered in the USA and owned by the Japanese investment bank Nomura). BATS Europe, a subsidiary of BATS Global Markets (incorporated and headquartered in the USA), launched in 2008. Turquoise launched in 2007 by a consortium of investment banks (Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, Merrill Lynch, Morgan Stanley, UBS, with BNP Paribas and Société Générale joining later). In February 2008 it was taken over by the LSE Group. Burgundy launched in June 2009, set up by investment banks and firms from the Nordic countries. NYSE Euronext and NASDAQ OMX launched their own MTFs – NYSE Arca Europe and NASDAQ OMX Europe (known as NEURO), respectively. In July 2010 the trading from NEURO was migrating to Equiduct Systems, a London-based MTF, hitherto without significant trading activity.

Chi-X launched very successfully, becoming the 8th largest European exchange in the first year of operation. By 2010 it tripled its share in trading, becoming Europe's third largest exchange. BATS Europe captured approx. 4% of trading value, becoming number 8 in 2010, while Turquoise claimed the 9th spot. Together by June 2010, they controlled a quarter of European trading value, which is all the more remarkable given the general slump in stock market activity. Comparing the changes in trading values in the last 3 years, it is obvious that MTFs attracted trading from the LSE, Euronext, and to a lesser extent the DB.

It is only with the entrance of the MTFs that we can talk about real competition for market shares, as MTFs trade stocks traded on incumbent exchanges. All MTFs focus on the largest and most liquid stocks. In June 2010 Chi-X traded approx. 1,000 stocks from 15 countries (UK, Ireland, France, Germany, Netherlands, Belgium, Switzerland, Austria, Italy, Spain, Portugal, Norway, Sweden, Finland and Denmark), covering top stock market indices from each of these countries plus mid-cap indices for the largest markets. BATS Europe traded a similar number of stocks from exactly the same markets. Turquoise traded approx. 1,800 stocks from 17 countries (the same as Chi-X and BATS plus Hungary and the Czech Republic). The coverage is similar for NYSE Arca and NEURO. Burgundy in contrast, only trades stocks listed in Stockholm, Helsinki, Copenhagen, and Oslo. In short, in 2010 any of the top 1,000 European stocks could probably be traded on 6 venues: the home exchange (also referred to as

the primary market), Chi-X, BATS Europe, Turquoise, NEURO and NYSE Arca Europe.

Figure 2 presents the real market shares, defined as the share of different venues in the trading value of stocks according to their primary market (where they are listed; in almost all cases this is also the country where the issuer is headquartered). The figure shows the average share of each venue in the last five trading days of June 2010. Primary/home markets dominate, but the share of the three top MTFs is significant. The large share of category 'other markets' for Dublin, results from the fact that Irish stocks are traded mostly on the LSE; for Oslo there is a significant share of trading on NASDAQ OMX. Chi-X is ahead of BATS Europe in every single market.

The market share of MTFs differs greatly from one home market to another. Reasons for this variation can be traced to the familiar categories of demand, technology and regulation. The main customers of MTFs are institutional traders and investors, interested mainly in trading large cap, liquid stocks. These stocks are more prevalent in the UK, Netherlands, France and Switzerland than in Austria, Norway, Denmark or Italy. Finland is the home to the largest Nordic company – Nokia – which boosts the share of MTFs in the Finnish market. In terms of technology, trading on MTFs requires infrastructure that connects traders, investors, and their intermediaries to MTFs. This infrastructure, including Smart Order Routing (SOR), which automatically searches for the best trading venue for a given order and sends the order to this venue, is not yet available widely or evenly across Europe. Brokers and dealers are still to a large extent wired to incumbent exchanges. Although no data is available, based on my interviews I would speculate that the availability of infrastructure, including SOR, is particularly good in London, Amsterdam and Paris. Finally, with regard to regulation MiFID is de facto not yet fully implemented. In Spain, for example, because of complex clearing and settlement requirements, it is still difficult for traders to bypass BME when trading Spanish stocks.

As we saw in the preceding section, positive network externalities in the secondary stock markets shape the strategy of MTFs. The challenge for any new MTF is to gain a sizeable trading volume as quickly as possible, which will then attract more liquidity. For that reason the strategy is not to start with small stocks and small customers, learn, and then move on to large stocks and large customers. Rather they start with the largest stocks in the largest markets (the UK is number one in Europe in that respect). This strategy is related to the ownership structure of MTFs. Large traders are the main owners of MTFs and they can redirect their orders from incumbent exchanges to MTFs. MTFs can also reward their most active traders with ownership stakes to further induce them to move trading. Hengelbrock and Theissen (2009), for example, documented a positive correlation between the share of investment banks from the Turquoise consortium in the ownership of a company, and the share of trading in this company's stocks conducted on the Turquoise platform.

The competitive landscape in European stock trading in June 2010 can thus be summarised as follows. The fastest growing part is made of two large MTFs independent from incumbent exchanges. There are three major international

stock exchange groups: the LSE Group, NYSE-Euronext, and NASDAQ-OMX and three large stock exchange groups with a lesser international presence: the DB, SIX, and BME. The lower tier is made of a small regional stock exchange group CEESEG, Oslo Borse, a handful of independent exchanges in Central and Eastern Europe, and Burgundy – testing a unique strategy of developing a regional MTF. By comparison, in the US there are four stock exchanges: NYSE, NASDAQ, BATS, and Direct Edge, out of which the first three and largest are already present in Europe. To be sure, the data for trading analysed in this section is not complete. It does not include systemic internalisers, dark pools and OTC trades among investment banks and other traders. The estimates of FESE for 2010 imply that approximately 40% of trading in Europe is not included in the data used in this paper. Unfortunately details on these trading activities are unavailable. This large hole in available data, however, does not undermine the arguments of this paper. It just underscores the level of competition in the industry and the role of investment banks and other trading firms.

In summary, the battle for liquidity in Europe is intensifying, but arguably it is still in its infancy. While the fact that one can trade almost any of the large European stocks on as many as six different venues raises concerns about excessive fragmentation, in practice only two MTFs have significant market shares. These two, Chi-X and BATS-Europe, has thus far succeeded in the face of the adversity of general market conditions, stirring a revolution in European trading, and becoming probably too large to be swallowed by competitors. If the current trends continue, before the end of 2010, Chi-X may become the second largest European exchange, and the total market share of MTFs in trading value may exceed 30%.

A very geographical revolution

What is the geographical dimension of the recent transformation in the business model of stock exchanges? Where do MTFs - the new stars of the trading industry – operate from? How does the competitive landscape of the European stock trading industry relate to the geography of European financial centres? This section will address these questions and argue that the revolution we have witnessed in the stock exchange industry is a very geographical revolution. This is not because everyone, even a stock exchange or a stock trader, has to be somewhere, but because location really matters in the modern trading industry. It is an integral part of business strategy, affecting competition and its outcomes.

Let us first go back to table 1. It is relatively simple to assign incumbent stock exchanges to places, as their names usually indicate headquarter locations. To complete the picture BME is headquartered in Madrid, BIT in Milan (now a part of the LSE Group headquartered in London), DB in Frankfurt am Main, NASDAQ OMX Nordic in Stockholm, with the European headquarters of NYSE Euronext in Paris. The global headquarters of NYSE Euronext and NASDAQ OMX are in New York City. MTFs require more explanation, as their names do not contain names of cities or countries, though they often contain the word Europe. This is not surprising, given that typically they have a pan-European strategy. It would not serve their marketing well to be associated with a particular national market. Notwithstanding the somewhat anonymous and pan-European labels, the

geographic reality of MTFs is quite simple. Out of 6 MTFs with significant trading, the largest 4 are headquartered in London (and actually in the square mile of the City of London!). NYSE Arca Europe (a part of NYSE Euronext) and Burgundy are headquartered in Paris and Stockholm, respectively. In other words, London headquartered exchanges in 2010 controlled 44% of European stock trading activity.

Apart from headquarters we need to consider the location of matching engines on which trades are executed. The matching engines of the LSE Group, Chi-X, BATS, Turquoise, and NEURO, are all located in London or its vicinity, with the European trading of NYSE Euronext in the process of moving to a data centre in Basildon in 2010. This implies no less than 66% of European stock trading value executed on matching engines within 30 miles from the centre of London. If we consider that the bulk of systemic internalisation and OTC trading executed by investment banks also happens in London, the percentage of trading concentrated in London could be even higher than 66%. This is a level of dominance comparable to that in foreign exchange trading, where London also accounts for approx. two-thirds of the European total (Bank for International Settlements 2010). What are the reasons for such a high level of concentration of stock trading in London? Why MTFs in particular locate their decision-making and hardware in London, thus contributing to its dominance?

The foremost factor affecting the geographic concentration of the stock trading industry is the value of proximity, which takes two principal forms: proximity between exchange professionals and marquee customers, and that between the matching engines of exchanges and computers generating orders used by marquee customers. On the side of liquidity takers, the marquee customers of exchanges are institutional investors and investment banks. As a dominant headquarter location for the British financial institutions as well as the leading location for European institutions with international operations and American institutions with European operations, London is the decision making centre for the largest pool of money in Europe. On the liquidity making side, marquee customers are high frequency traders, operating as departments of investment banks or as independent specialised firms. The latter are mostly US-based firms (such as Getco, Tradebot and Infinium), for whom trading in London affords a familiar legal environment, as well as offers the neighbourhood of other US financial firms and a great pool of specialised labour for their offices. It should be added here that MTF employees and executives are mostly former traders and IT professionals. Thus, proximity between people facilitates interactions that helps marketing, product development and market surveillance of exchanges, and benefits them indirectly via access to a specialised labour pool (Wójcik, 2007).

Proximity between computers is important because of latency – the speed with which an order can reach the matching engine of the exchange, be executed, and the confirmation of its execution return to the computer from which it was sent. Latency is particularly important to high frequency traders, who use computer algorithms that constantly compare prices of tradable instruments, identify anomalies in relation to past statistical relationships between prices, and generate orders bidding for securities deemed underpriced and offering those deemed overpriced. For these orders to succeed every microsecond counts. It is

estimated that algorithmic trading accounts for approx. 60% of stock trading in the USA, and 30-40% in the UK. Chi-X, for example, is currently upgrading its system to handle 1 million messages per second. The Forbes magazine estimated that in 2008 high frequency traders in the USA made \$21bn in gross profits (Moyer & Lambert 2009).

The role of speed has led both MTFs and incumbent exchanges to offer co-location services, whereby trading firms can co-locate their computers with the matching engine of the exchange. Co-location takes place in data centres (big buildings full of compartments and racks filled with servers connected by ultra-high speed cables) usually run by independent data centre companies, from which exchanges lease space (matching engines themselves can be leased as well). There are different degrees of co-location. A computer can be in the same room as the matching engine, in the same building or in a separate data centre run by the same company as the data centre hosting the matching engine. Distance is critical, as the race for speed approaches its natural limit – the speed of light. Leading MTFs offer a round-trip time for an order of less than 250 microseconds. If the matching engine is in Stockholm, as is the case for Burgundy, the trip of light from and back to London takes approximately 10 milliseconds. Hence London-based traders who do not want to be at a disadvantage to Stockholm based ones need to co-locate their computers in Stockholm. When, after the merger with BIT, the LSE moved trading in Italian stocks to the matching engine in London, traders based in Italy suddenly lost advantage over those in London. Even if a customer does not use co-location services, proximity to the matching engine still helps the quick execution of trades. There are obviously advantages in putting matching engines close to each other. Customers can then cheaply connect with different exchanges, and exchanges have the option of re-routing orders they cannot fulfil themselves to other exchanges, thus attracting additional order flow.

The value of proximity between people and proximity between computers combined creates a virtuous circle of network externalities; whereby customers attract matching engines, matching engines attract more customers and more matching engines. This virtuous circle has clearly taken root in London. The main locations for data centres housing matching engines include Central London, Park Royal, Docklands, Slough and Basildon. London is by far the leading data centre location in Europe (serving all types of industries and firms beyond exchanges, see SAMI 2009), but the supply of data centres has to be seen as a beneficiary not the driver of the concentration of exchange industry in London. Frankfurt, Amsterdam and Paris offer high-quality data centres, and cheaper IT experts, but they have not succeeded in attracting new exchanges.

Regulation has also played a part in the concentration of trading industry in London. First of all, even before MiFID, the UK had no concentration rules, which allowed initiatives (led mostly by investment banks) to set up trading platforms trying to compete with the LSE. Chi-X and Turquoise may be the first successful movers, but were by no means the first that tried. Second, the UK authorities were among the fastest in Europe in implementing MiFID, conducting extensive consultation with industry. By contrast in Germany, for example, regulators offered little feedback or advice to firms on how to prepare for MiFID, and Spain

simply declared at the outset that it would not implement it on time (Casey & Lannoo 2009). By June 2010, there were 137 registered MTFs, out of which 71 were registered in the UK. Eventually, countries slow at implementation can do little to stop firms from other Member States from providing services within their territory, while their domestic firms are left incapable of doing the same (Lannoo 2007).

I do not have detailed data for the USA, but it is safe to say that geographic concentration of the exchange industry has also taken place across the Atlantic. The New York-headquartered NASDAQ took over exchanges in Boston and Philadelphia, while NYSE took over Archipelago (which earlier bought the Pacific Stock Exchange based in California). The only other full-status stock exchanges in the USA - BATS Exchange and Direct Edge - are headquartered in Kansas City and Jersey City respectively. NYSE, NASDAQ, BATS Exchange, and Direct Edge all have matching engines in the area of Jersey City in New Jersey (just across the Hudson River from Manhattan). BATS Exchange in Kansas City is located close to Tradebot, one of its marquee customers.

While the logic of co-location and proximity to marquee customers applies to incumbent exchanges as well as to MTFs, the strategy of business diversification, horizontal and vertical, practiced by some of the leading incumbent exchanges, has a specific footprint – one of extensive spatial network of operations. NASDAQ OMX is probably the best example, illustrated in table 2. With global headquarters in New York City and European headquarters in Stockholm, NASDAQ has offices, exchanges or subsidiaries in 29 locations, excluding the location of matching engines and disaster preparation facilities (precise information on which is not publicly available). The geographical spread of its offices reflects the significance of proximity to its trading technology users (other exchanges including Singapore Exchange, Tokyo Commodity Exchange, and Australian Exchange), and issuers (Beijing and Silicon Valley). Subsidiaries reflect diversification into new issuer services and media. To be sure, while MTFs focus solely on trading, they have emerging international structures as well. BATS Europe is a subsidiary of BATS Holding which owns BATS Exchange in the USA. Nomura - the controlling owner Chi-X Europe is also a 100% owner of Chi-X Global with a trading platform in Toronto, and Chi-X APAC with fledgling operations in Hong Kong, Tokyo and Singapore.

In summary, stock trading has become a much more competitive, technology driven and efficient industry, but it has not become people-less or dissolved in virtual space. People, hardware and physical infrastructure matter no less than ever before. With their sole focus on trading, MTFs employ staggeringly small numbers of people. With 40+ employees Chi-X is the third largest exchange in Europe, with 70+ employees BATS Exchange is the third largest in the USA. These figures are comparable to employment at the Malta and Cyprus stock exchanges respectively, while Deutsche Borse, for example, has approx. 3,000 employees, and NASDAQ OMX Nordic employs nearly 1,000. With their scope of activities much broader than that of MTFs, incumbent exchanges remain large financial institutions. In the USA between 1998 and 2006, employment in the exchange industry as a whole increased from approximately 7,000 to 9,000. The significance of the exchange industry, however, cannot be captured with

employment figures. Exchanges play a central part in the creation of a network connecting traders and investors. The geography of the exchange industry implies that this network has nodes in large financial centres.

Conclusions and implications

The objective of this paper was to investigate competition in the stock exchange industry and its relationship with the development of financial centres. It is an irony that while trading corporate ownership rights in a way epitomises capitalism, the institutional architecture of the stock exchange industry in Europe until recently - made of national monopolies operating like public utilities – could hardly be further from a model of free competitive markets. Over the last quarter century, but particularly in the last decade, the stock exchange industry has undergone a transformation at an accelerating rate. The paper has tried to document and interpret this transformation starting from a synthesis of changes in the environment of exchanges, explaining a revolution in their business model, analysing the battle for liquidity, and finishing by discussing its footprint in terms of location of exchange activities.

I have argued that changes in demand, technology and regulation transformed the exchanges, triggering the development of a networked structure of the exchange industry and unleashing economies of scale. These changes have brought to life new exchanges, which have focused solely on the production of liquidity, and have embraced the business model of two-sided platforms, while incumbent exchanges have pursued horizontal and vertical integration. While the expansion and financial success of the incumbent exchanges is a fact, new exchanges, gaining market shares at a spectacular rate, threaten the core business of the incumbents. The revolution in the exchange industry in Europe has fortified the position of London as the dominant European financial centre. New exchanges, the paragons of the revolution, operate out of the Square Mile of the City of London, and two-thirds of the value of European stock trades are executed on the matching engines located no further than 30 miles from the City. London is the central node of the European stock exchange network just as New York City has maintained an equivalent role in the USA. Exchange professionals and major liquidity makers and takers benefit from mutual interactions, while the matching engines of exchanges are attracted to the computers of major traders and vice versa.

The revolution in the exchange industry came from the USA, took hold of Europe but is yet to reach other parts of the world. Internationally the revolution seems to reinforce the New York City – London axis of global financial centres. The European headquarters of NYSE Euronext are in Paris, and NASDAQ OMX has promised to support Stockholm as a financial centre, but the European matching engines and major customers of both institutions are in London. There are first signs of consolidation of stock exchanges in Africa, where stock exchange in Johannesburg has ambitions to develop a pan-African stock exchange, and Asia, where NYSE Euronext is developing software to link exchanges and brokers in all ASEAN countries (with a pilot to link Kuala Lumpur and Bangkok in 2011). NASDAQ OMX has ownership links with the stock exchange in Dubai; NYSE

Euronext has links in Doha. New Exchanges such as Chi-X and BATS also have emerging intercontinental structures.

In the ongoing saga of M&As and the battle for liquidity, it is difficult to predict winners and losers in terms of particular stock exchange groups. In terms of their footprint, however, the trend seems less ambiguous. Even if the stock exchange revolution harms the LSE and the NYSE as its icons, it benefits New York City and London as financial centres. Notably, no offshore stock exchange centres have succeeded either in Europe or in North America, although some have tried (Young & Theys 1999). This is in contrast to the successes of offshore centres in some other parts of the financial sector, such as banking or fund management. To use a metaphor, the stock exchange industry is not divorcing financial centres, although in the process of integration it is concentrating on fewer spouses. It is not the first time we can witness a decline of stock exchange industry centres. Rio de Janeiro, Geneva, and Otago hosted the first stock exchange in Brazil, Switzerland and New Zealand respectively, but no longer have any.

Apart from financial centres, who are the major winners and losers of the stock exchange revolution? The winners are investment banks and firms that can capture a share of the booming trading activity stimulated by the revolution. Hopefully the winners are also investors for whom building and rebuilding their portfolios should become cheaper. The winners could also be issuers, benefiting from better access to stock markets and lower cost of capital. The benefits of the stock exchange revolution may however be uncertain for small and medium sized companies (SMEs). Nielsson (2009) for example shows that following the Euronext merger in early 2000s liquidity increased only for big capitalisation stocks. The merger seemed to have no impact on the liquidity of SMEs or the number of new listings. Witness that with the exception of Burgundy, no MTFs trade small capitalisation stocks. Perhaps the two-sided platform model, so successful with large capitalisation stocks, does not work for small caps? Or perhaps a subsidy is in order to develop a pan-European MTF for SMEs?

To be sure, with the revolution in the stock exchange industry in Europe still in its infancy, research thereon can hardly be conclusive. One of the interesting directions for future studies would be to analyse the impact of stock exchange M&As on financial centres through a series of case studies, for example comparing Paris with Brussels and Amsterdam or Stockholm with Helsinki and Copenhagen. How do their financial sectors adapt to the loss of certain stock exchange institutions and functions? How does it affect traders, investors and issuers in those centres? Engelen and Grote (2009) made the first foray in this direction indicating the slow decline of Amsterdam and Frankfurt as second-tier financial centres as a result of trading moving to London. Another pertinent question concerns the limits of international integration in the stock exchange industry. Given that algorithms do not distinguish between day and night, could there be one global trading platform for the world's largest stocks?

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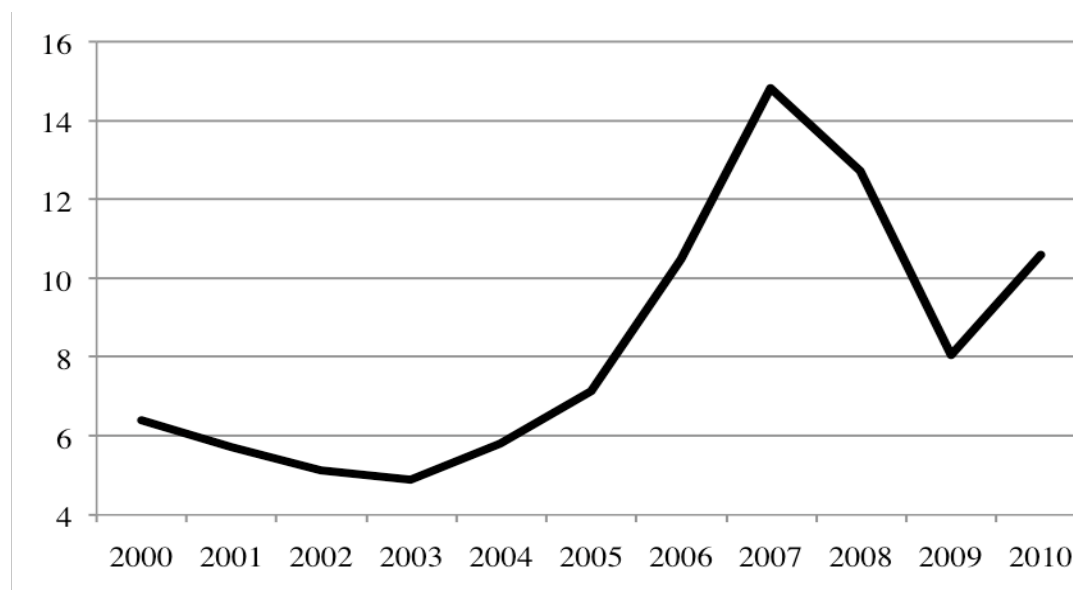
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Table 1. The percentage shares of exchanges in European trading

| | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | I-VI 2010 |
|---------------------------|-------|-------|-------|-------|------|------|-----------|
| Athens Exchange | 1.6 | 0.6 | 0.7 | 0.6 | 0.5 | 0.6 | 0.4 |
| BME (Spanish Exchanges) | 7.2 | 11.9 | 11.0 | 11.2 | 9.8 | 11.2 | 9.9 |
| Borsa Italiana | 15.2 | 13.4 | 11.0 | 10.6 | 8.1 | 8.4 | n/a |
| CEESEG | n/a | n/a | n/a | n/a | n/a | n/a | 0.8 |
| Deutsche Börse | 15.2 | 15.8 | 15.3 | 16.5 | 17.3 | 13.5 | 13.1 |
| London SE | 13.8 | 21.6 | 21.2 | 21.1 | 20.5 | 15.8 | 21.8 |
| Copenhagen SE | 0.5 | n/a | n/a | n/a | n/a | n/a | n/a |
| Helsinki SE | 2.4 | n/a | n/a | n/a | n/a | n/a | n/a |
| Stockholm SE | 6.2 | n/a | n/a | n/a | n/a | n/a | n/a |
| NASDAQ OMX Nordic&Baltic | n/a | 7.6 | 7.4 | 7.0 | 6.4 | 6.2 | 5.7 |
| NYSE Euronext | 27.8 | 25.0 | 22.8 | 22.2 | 20.5 | 17.2 | 15.9 |
| Oslo Børs | 0.7 | 2.0 | 2.4 | 2.2 | 2.2 | 2.0 | 2.0 |
| SIX Swiss Exchange | 8.7 | 0.7 | 6.6 | 6.8 | 7.5 | 6.6 | 6.0 |
| Warsaw SE | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 |
| Other incumbent exchanges | 0.6 | 1.0 | 1.3 | 1.3 | 1.2 | 1.0 | 0.1 |
| Total incumbent exchanges | 100.0 | 100.0 | 100.0 | 100.0 | 94.3 | 83.1 | 76.2 |
| BATS Europe | n/a | n/a | n/a | n/a | 0.0 | 2.3 | 4.6 |
| Burgundy | n/a | n/a | n/a | n/a | n/a | 0.1 | 0.2 |
| Chi-X | n/a | n/a | n/a | n/a | 5.2 | 10.7 | 15.6 |
| NASDAQ OMX Europe | n/a | n/a | n/a | n/a | 0.0 | 0.5 | 0.5 |
| NYSE Arca Europe | n/a | n/a | n/a | n/a | n/a | 0.0 | 0.2 |
| Turquoise | n/a | n/a | n/a | n/a | 0.5 | 3.3 | 2.7 |
| Total MTFs | n/a | n/a | n/a | n/a | 5.7 | 16.9 | 23.8 |

Source: Author's calculations based on data from the FESE

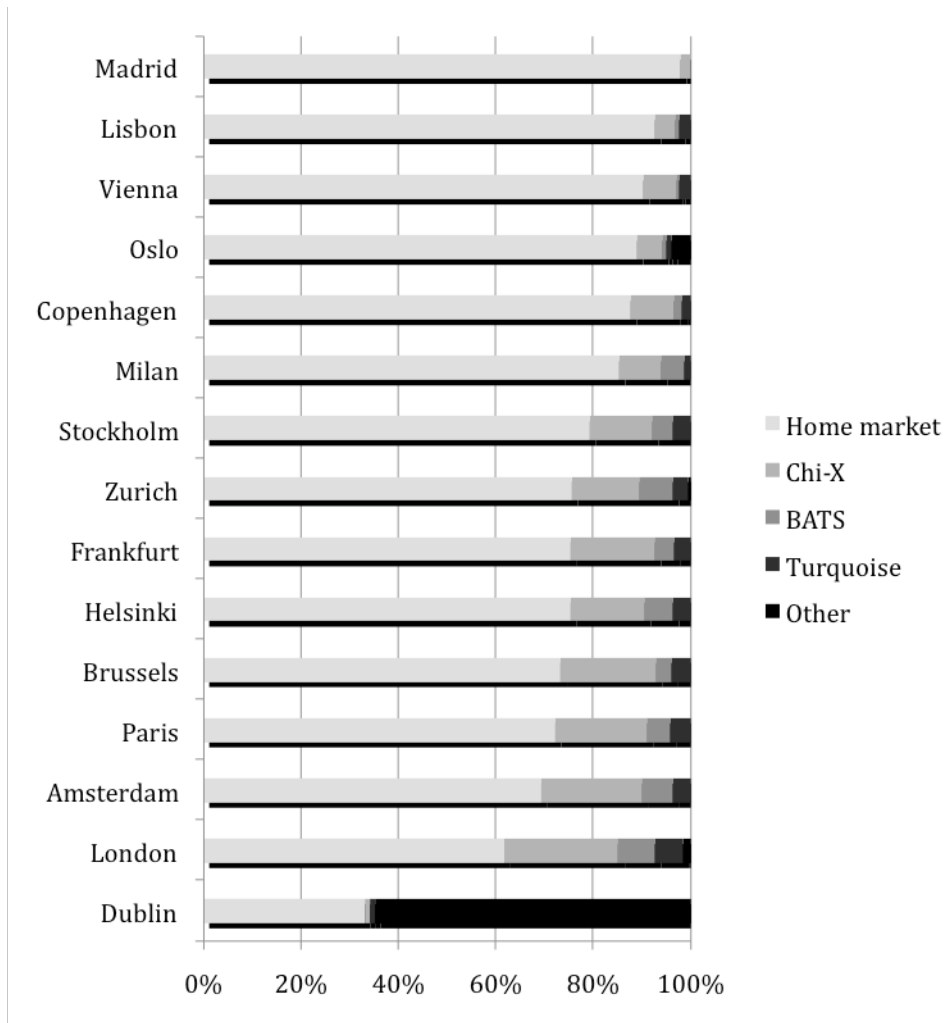
Figure 1. The value of stock trading on European exchanges



Note: The figure for 2010 is based on data for the first half of the year multiplied by 2.

Source: Author's calculations based on data from the FESE

Figure 2. The share of exchanges in the trading value of stocks according to the home market of the issuer



Source: Author's calculations based on data from BATS Europe for the last 5 days of June 2010

Table 2. The geographical newtork of NASDAQ OMX

| | Americas | Europe and Middle East | Asia Pacific |
|-------------------|--|--|--|
| HQs and Exchanges | New York, NY | Stockholm, Sweden | |
| Exchanges | Boston, MA Philadelphia, PA | Copenhagen, Denmark Helsinki, Finland Oslo, Norway Riga, Latvia Tallinn, Estonia Vilnius, Lithuania Reykjavik, Iceland Yerevan, Armenia Dubai, UAE | |
| Offices | Menlo Park, CA Chicago, IL Rockville, MD Washington DC Eugene, OR Calgary, Canada | London, UK Milan, Italy | Beijing, China Sydney, Australia Hong Kong, China Tokyo, Japan Singapore |
| Subsidiaries | Maynard, MA Spokane, WA Los Angeles, CA | | |

Note: Does not include the locations of matching engines and disaster preparedness facilities in the US.

Source: Author's compilation based on www.nasdaqomx.com