

Stock exchange merger and liquidity: The case of Euronext[☆]

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Abstract

The paper empirically investigates the effects of the Euronext stock exchange merger on listed firms, i.e. the merger of stock exchanges in Amsterdam, Brussels, Lisbon and Paris. Specifically, it examines how exchange consolidation has affected stock liquidity and how the effect varies with firm type, i.e. what types of firms benefit the most in terms of stock liquidity and other financial outcomes. The results show asymmetric liquidity gains from the stock exchange merger, where the positive effects are concentrated among big firms and firms with foreign sales. There is not a significant increase in stock liquidity of small or medium sized firms, nor of firms that only operate domestically. Beyond the significant size and foreign exposure effects (i.e. big firms and firms with foreign sales gain), the analysis finds no systematic pattern in the distribution of merger benefits across industries or listing locations. The merger is associated with an increase in Euronext's market share, where the

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increase is drawn from the London Stock Exchange. There is however no evidence of Euronext enhancing its competitive stand in terms of attracting new firm listings.

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1. Introduction

The business environment of stock exchanges has changed considerably in the last decade. The typical government or member owned, national stock exchanges have largely been replaced by for-profit, publicly listed exchanges.² These transformed stock exchanges increasingly operate at an international level, offering world-wide menus rather than merely serving a national appetite. The transition has been accompanied by an immense increase in international stock exchange integration and co-operation. For example, stock exchanges have established strong operational ties with the usage of joint trading systems and the harmonization of regulations. Interestingly, this increased level of integration has recently taken a new turn as stock exchanges have sought partners to create fully merged identities. The most noteworthy merger activities include the Euronext merger, the OMX merger, the NYSE-Euronext merger, the NASDAQ-OMX merger and the merger between the London Stock Exchange and Borsa Italiana.³

The impacts of such stock exchange mergers are largely unknown. There are many aspects of interest in such an analysis, both economic and regulatory issues which affect investors, firms, financial intermediaries and the overall economy. Thus, any profound study of the effects of stock exchange merger is bound to be selective and incomplete in its coverage. This paper narrows the focus by examining how consolidation of exchanges has affected the market liquidity of traded stocks. In particular, have all firms gained from merger in terms of stock liquidity? Or are the gains perhaps asymmetrically distributed? If so, which types of firms have benefited the most from stock exchange merger? Does it depend on firm size, industry, location or any other characteristics? These are the key questions that the paper sets out to answer. This is done by empirically investigating the effects of the Euronext stock exchange merger on listed firms, i.e. the merger of the stock exchanges of Amsterdam, Brussels, Lisbon and Paris. Also, in addition to such a firm heterogeneity analysis, the paper also attempts to measure the competitive effects on neighboring markets, such as the effect on relative market shares of European exchanges.

The main motivation for studying liquidity is that it ultimately affects the cost of capital. For example, if trading volume of a particular stock is low, then the stock is harder to sell (e.g. in bear markets) and the bid-ask spread is typically high. This makes the stock less desirable, which is reflected in price. [Amihud and Mendelson \(1986\)](#) estimate that the most illiquid stocks could gain 50% in value if, all else equal, liquidity would be raised to the

²In 1998, 38% of exchanges in the World Federation of Stock Exchanges were for-profit. In 2006 this figure was up to 75% ([World Federation of Exchanges, 2007](#)).

³Euronext is the merged stock exchange of former national exchanges of Belgium, France, Netherlands and Portugal. OMX owns and operates 7 exchanges based in the Nordic and Baltic countries. Borsa Italiana is the main Italian exchange and is located in Milan.

level of the most liquid stocks. Brennan and Subrahmanyam (1996) and Datar, Naik, and Radcliffe (1998) also find that stock returns are a decreasing function of various measures of liquidity—such as turnover, which is the primary liquidity measure used in this paper (see further Section 3). Liquidity is therefore of concern to both firms and the stock exchanges that serve them.⁴

The purpose of the study is to shed light on not only whether the Euronext stock exchange merger has been beneficial to firms in general, but also how the gains may be distributed among different types of firms. Answering how liquidity has changed—and for which firms—is a valuable contribution to evaluating possible motives for a stock exchange merger and whether such a cross-border merger is advisable. A further motivation is to provide evidence on how a stock exchange merger may influence the competitive market environment, i.e. whether it proves to be an effective means of competition. In particular, it is of interest to explore whether merged exchanges attract market shares (share of trading) from other exchanges as a result of the merger—and if so, from which competing exchanges the additional order flow has been drawn. Such competitive effects have largely been left unexplored in Europe.

Empirical work directly related to stock exchange mergers is naturally limited in scope as there are still only a handful of realized mergers to be analyzed. Previous studies have therefore mostly been restricted to theoretical analyses (Santos and Scheinkman, 2001; Di Noia, 2001) or estimation of cost functions of stock exchanges (Malkamäki, 1999; Schmiedel, 2001; Schmiedel, Malkamäki, and Tarkka, 2002). On the empirical side, there are only a few papers that relate to this paper in terms of liquidity and stock exchange structure. First, Jain (2003) examines 51 stock exchanges to pinpoint which institutional features are associated with higher liquidity. He finds that hybrid systems and pure electronic limit order books have better liquidity outcomes than e.g. pure dealer systems.⁵ Second, in a more directly related paper, Arnold, Hersch, Mulherin, and Netter (1999) analyze the effect of three US regional stock exchange mergers on liquidity and market share of exchanges. They find that merged stock exchanges provide narrower bid-ask spreads and attract market share from other exchanges. Their paper provides no firm heterogeneity analysis, but it applies the same econometric framework as used here for analyzing competitive effects of merger. Third, a noteworthy study by Padilla and Pagano (2005) analyses the effects of harmonization of clearing systems in the Euronext exchanges and finds that liquidity among the largest 100 stocks rose substantially.

Our study offers several significant improvements and extensions to the literature. In particular, the analysis is not restricted to a sub sample of firms. The paper introduces a comprehensive dataset including all firms listed on the four Euronext exchanges in 1996–2006. Having the whole population of firms offers a more complete picture of merger effects than studies limited to analyzing only a fraction of firms, typically the largest and most liquid ones. The data richness also makes it possible to examine the potential

⁴For example, Aggarwal (2002) argues that the ability to generate trading volume will be a key factor in determining stock exchanges' future success, since transaction revenue is likely to become the most important source of income. It should, however, be noted that more frequent trading may not be in the interest of investors (Barber and Odean, 2000), even though firms benefit from more trading activity.

⁵A limit order market is a market where orders (which specify direction, quantity and acceptable price of trade) are compared to orders already held in the system (the book) and execution of trade takes place if there is a match between buy and sell orders. A dealer system is a market where an intermediary (the dealer) acts as a counterparty for the trades of his customer. A hybrid system is a combination of these two market systems.

heterogeneous outcomes of listed firms, which has not been viable in former studies with a non-random sub sample of firms. The heterogeneity analysis offers insight to the distributional effects of mergers, i.e. which types of firms benefit from merger depending on characteristics such as firm size, industry, foreign exposure and location. The paper also examines four key merger events, i.e. it focuses not only on clearing system unification (the four key merger events are outlined in Section 3). This provides a more detailed and comprehensive analysis of the effects of stock exchange merger, since such a merger is typically a lengthy process. The staggered introduction of merger events across the four participating stock exchanges further improves the econometric methodology (i.e. extending time-dimensional event studies into a difference-in-difference estimation). The paper also estimates the competitive effects of the Euronext merger on other European stock markets. Such a competitive analysis, i.e. the effect of stock exchange integration on non-merging markets, has not previously been carried out with European data.

The results indicate that the gains from the Euronext stock exchange merger have been unevenly allocated. The increase in liquidity is concentrated among big firms and firms with foreign exposure (e.g. with foreign sales). A plausible explanation is that these firms are more visible and familiar to new foreign investors that enter the market following the merger. This explanation is consistent with the result that there is no significant increase in stock liquidity of small or medium sized firms, nor of firms that only operate domestically. Beyond the significant size and foreign exposure effects (big firms and firms with foreign sales gain), further analysis shows that there is no systematic pattern found across industries or listing locations. The results are robust to various data definitions and model specifications. The key conclusions are also consistent across three different dimensions of liquidity, i.e. amount of trading, cost of trading and market depth. Finally, the analysis of the competitive effects of the merger indicates that trading activity has drifted from the London exchange to Europe's mainland exchanges, where Euronext's market share has risen by 2.18% (in terms of value of volume). There is however no evidence of Euronext enhancing its competitive stand in terms of attracting new firm listings.

To fix ideas, the paper proceeds by presenting several competing hypotheses on the potential effects of stock exchange merger on liquidity. Section 3 describes the Euronext merger process and the data. The estimation methodology is introduced in Section 4 and empirical results follow in Section 5. Section 6 concludes.

2. Hypotheses on merger effects

There is a vast theoretical literature which examines the effects of market integration, e.g. monopoly, on various market outcomes. But this literature is limited to the theory of the firm; much less work exists on integration of financial intermediaries that serve those firms. Also, several theoretical models exist that deal with investment and security *holding* (ownership). But few theoretical models predict *trading* decisions after market consolidation. However, several arguments and hypotheses can nonetheless be presented that predict liquidity outcomes following a stock exchange merger. It is then up to empirics to shed light on which of these competing hypotheses hold true.

There are several reasons why firms may gain in terms of stock liquidity following a stock exchange merger. First, the market may become broader, in the sense that there are more market participants trading in listed firms. In other words, each individual firm faces

a bigger pool of potential investors. Second, the market may deepen, meaning that larger quantities are available at a price marginally above and below the prevailing market price. This makes the market more liquid in the sense that large, individual trades are less likely to drive price movements. Third, there are various cost channels through which liquidity may increase after stock exchange merger. These include lower information and indirect (non-monetary) transactions costs, such as ease of transaction due to unification of trading and clearing systems. A stock exchange merger may also lower direct transactions costs, thereby inducing higher trading volume. This may especially be important in Europe where transaction costs are far higher than in the US. For example, clearing and settlement costs for European transactions are 9 times higher than for US transactions, and the costs of cross-border transactions in Europe can be as much as 46 times higher than in the US (London Stock Exchange, 2001). These kind of pricing schedules are very likely to affect trading volume, with volume finding shelter where prices are low. The European Commission predicts that 2–5 billion Euros spent on trading, clearing and settlement can be saved by consolidating exchange infrastructure within Europe (Economist, 2006c). In short, lower transactions costs due to stock exchange mergers are likely to lead to increased trading volume.

There are fewer convincing arguments of why firms may in general experience lower stock liquidity after stock exchange merger. The main concern is potential monopolistic behavior by the newly merged exchange. For example, the Economist (2006a) reported that “[m]ore than a few investment bankers were furious ... when Euronext announced that it was returning 1 billion Euros to shareholders, without cutting trading fees”, despite Euronext’s objective of “offering participants increased liquidity and lower transactions costs” (Euronext, 2007). On the other hand, it can also be argued that there is still active competition in the current European system, e.g. through competition from quasi-exchanges, like automated trading systems or electronic communication networks. Also, although fees may not have decreased after the Euronext merger, they have remained fairly stable. This study takes no stand on the potential monopolistic effects of the Euronext merger, other than analyzing changes in market shares and examining whether Euronext has attracted volume from other European exchanges.

Given these arguments it may seem likely that liquidity should increase following a stock exchange merger. However, the liquidity benefits may still be asymmetrically allocated among firms. To investigate whether this is the case, the paper examines how potential liquidity gains differ depending on firm’s characteristics, such as firm size, foreign exposure, industry or listing location. Liquidity is primarily measured by turnover, where turnover is defined as number of shares traded in a particular firm relative to the number of outstanding shares (see further Section 3). Two further liquidity dimensions are explored in Section 5.3, i.e. cost and market depth dimensions which are captured by bid-ask spreads and the Amivest ratio, respectively.

2.1. Foreign exposure

The Euronext cross-border merger increased the potential investor base, i.e. stocks listed on individual national stock exchanges became more accessible to foreign investors. But the trading pattern of these foreign investors is potentially concentrated on certain types of stocks. In particular, firms with high visibility outside their domestic market may receive more interest from foreign traders. For example, firms which operate abroad

or offer their products outside their home market may enjoy higher visibility to foreign investors, who in turn may be more inclined to trade in those companies. Also, investors may prefer trading in stocks of recognizable, household brands since it may involve lower information and indirect transaction costs. Therefore, firms that have foreign sales or foreign assets in the market into which they are merging, may be better known to foreign investors and enjoy more visibility, resulting in relatively higher post-merger trading. Hence, this supports the idea that turnover increases relatively more for firms *with* foreign exposure.

However, higher visibility of firms with foreign exposure could also imply that those firms will fare relatively worse. If firms are household names outside their home market, it may imply that foreign investors are already trading relatively more in those firms, compared to the less known firms. Thus the merger may not have a sizeable effect on trading volume in recognizable firms which foreign investors are already tracking. In contrast, the merger should primarily benefit firms that experience the relatively highest increase in visibility to foreign investors. The firms that gain the relatively most visibility experience a greater boost in attention than firms that are already well known to foreign investors. The firms that investors were not familiar with previous to the merger are likely to be those without foreign exposure (foreign sales or assets), which are therefore the ones that should experience the greatest fall in indirect transaction costs and the relatively highest increase in trading volume. In other words, turnover may therefore increase relatively more for firms *without* foreign exposure.

These two competing hypotheses on the merger effects are conditional on whether foreign investors already trade a lot in well-known firms before the merger. To make the hypotheses more direct for the case of the Euronext merger it would be informative to look at data on the level of foreign trading before the merger. Unfortunately, trading data identifying the nationality of investors is non-existent, but instead two suggestive measures of the pre-merger foreign trading activity are presented. First, cross-listing data can provide hints about which firms foreigners already trade in. For example, if a group of Dutch firms is cross-listed in Brussels before the merger, Belgian investors may already be trading relatively more in those firms compared to other Dutch firms. Since cross-listed firms are typically large, international firms, a high number of cross-listed firms suggests that big firms with foreign exposure gain relatively less from the merger than small, domestic firms. The number of cross-listed firms at the outset of the merger is reported in Table 1. The table shows that Dutch and French firms tend to be most often cross-listed in other Euronext exchanges prior to the merger. However, taking into account the total number of firms of each nationality, the ratio of cross-listed firms is by far the highest for Dutch firms. More specifically, 11% of all Dutch firms are cross-listed, which indicates that a substantial fraction of well-known, international Dutch firms are cross-listed before the merger. In terms of the hypotheses presented, this would intuitively *suggest* that relatively lower turnover benefits may be observed for Dutch firms with foreign exposure, compared to similar firms from other Euronext countries—which is to be empirically and statistically analyzed in Section 5.2.

A second suggestive indicator—of whether foreign investors already trade in well known international firms before the merger—is aggregate foreign ownership data. Table 1 shows the fraction of shares in the Euronext countries that are owned by foreign investors at the outset of the merger. For comparison, the western European average at this time was

Table 1

Cross-listed firms and foreign ownership

The figures show number of cross-listed firms in the local exchanges of Euronext at the outset of the merger. The column showing total number of firms cross-listed is obtained by taking into account multiple cross-lists. For example, the total number of cross-listed Dutch firms is 20 (not $17 + 13 = 30$) since 10 Dutch firms cross-list in both Brussels and Paris. Also shown is the fraction of shares owned by foreigners pre- and post-merger in the four Euronext countries (ownership data for Netherlands is not available in the second half of the sample period). The data is obtained from Euronext Statistics, the Worldscope database and the Federation of European Securities Exchanges.

	Amsterdam	Brussels	Lisbon	Paris	Total	Fraction of firms (%)
Dutch firms cross-listed in ...	—	17	0	13	20	11
Belgian firms cross-listed in ...	6	—	0	4	8	4
Portuguese firms cross-listed in ...	0	0	—	1	1	1
French firms cross-listed in ...	8	15	0	—	17	2
Fraction of ... equity held by foreign investors.	...Dutch	...Belgian	...Portug.	...French		
Pre-merger (%)	67.0	30.4	24.9	38.1		
Post-merger (%)	—	53.2	39.7	39.5		

approximately 31% (FESE, 2002). Thus, foreign ownership of Belgian, French and Portuguese shares is not very far from the European average. The fraction of foreign ownership in Dutch equities is, however, a staggering 67%. This again suggests that foreigners are already trading relatively more in Dutch equities at the outset of the merger, which may limit their merger benefits. Table 1 also shows that the level of foreign ownership increased in the merger period (no post-merger ownership data exists for Netherlands). However, it should be emphasized that these figures are only compiled and reported *annually* at the country level, so any observed increase in foreign ownership cannot be attributed to the merger (too few observations also exist for any hypothesis testing). Thus, any conclusive statements about potential merger effects are restricted to the statistical analysis of trading data, which is presented in Section 5.

The indicative evidence of foreign trading presented in Table 1 is consistent with the fact that the Amsterdam exchange has long been characterized by large firms that are internationally recognized. Pagano and Steil (1996, pp. 19–20), who summarize European equity trading in the 1990s, underline this by stating that: “The Dutch equity market is ... highly dependent on trading in about 25 international stocks of Dutch origin (representing 85% of Amsterdam volume) which are actively traded around the world.” They go on to add: “Foreign investors generate roughly two-thirds of trading volume in Dutch equities—very high by European standards.” Thus, as the Euronext exchanges merge, the level of foreign trading in Dutch equities—in particular in large, international firms—may increase relatively less compared to other Euronext equities, since foreigners were already quite active in the Dutch market before the merger (to be statistically examined in Section 5.2).

Finally, to complete the discussion on foreign exposure, it cannot be theoretically ruled out that foreign exposure is irrelevant for realized merger benefits. What investors really trade on might only be financially relevant information, such as profits per share, dividend

payments and expected future prospects.⁶ Foreign sales (or foreign assets) may therefore have no say in determining post-merger turnover increase.

2.2. Size

The argument that firms with foreign exposure may enjoy higher visibility to foreign investors—thereby leading to relatively higher post-merger liquidity—can also be applied to big firms. That is, people may be more familiar with big, salient firms and therefore be more inclined to trade in those. Big firms are typically also better covered by analysts and therefore expected to feature lower informational asymmetries. Thus, stock exchange merger might primarily affect trading in big firms. Also, smaller firms may become relatively tiny once the markets have merged. In other words, they may be likelier to disappear in the crowd and as a result get less attention from investors than before. This reasoning implies that it may be better to be a small firm on a small market, than a tiny firm on a big market. Finally, even if visibility of small firms increases, it may not matter to big and influential investors (such as hedge funds or pension funds) since they often trade primarily in the biggest companies anyway. These arguments support that turnover increases relatively more for *big* firms.⁷

Imitating the arguments presented for foreign exposure, it might also be that foreign investors are already trading relatively more in big firms. Therefore the primary increase in trading volume should occur among small firms. Furthermore, big domestic firms need no longer be relatively big on the newly merged market. Therefore traders' attention may shift away from those firms to the ones that are still big on an international scale. In other words, it may be better to be a relatively big firm on a small market, than relatively small on a big market. For example, a big firm that qualifies for inclusion in the domestic market index may not qualify for a big-cap market index on the merged market. Therefore investors may now devote less attention to it as they shift their focus to the new market index. In contrast, a small firm, which did not qualify for the domestic market index in the first place, is not adversely affected to the same extent. Furthermore, smaller firms may also benefit indirectly as they are likelier to become international takeover targets once markets have merged. For these reasons, bigger firms may experience a relatively lower increase (or greater decrease) in trading volume than smaller firms. Equivalently, turnover may increase relatively more for *small* firms.

Lastly, a case can also be made for size not mattering for trading decisions. This is intuitively appealing if firms of different size categories are otherwise the same. Thus, it cannot be theoretically ruled out that potential merger effects are unrelated to firm size.

2.3. Location

Location data of this study is restricted to the primary exchange of each firm. The study therefore examines heterogeneous outcomes of firms listed in Amsterdam, Brussels, Lisbon

⁶It should, however, be noted that these variables intuitively relate to security *holdings*, not necessarily trading volume.

⁷In the stock market liberalization literature, [Dahlquist and Robertsson \(2004\)](#) find that foreign investors seem to prefer large and well-known firms, and thus these firms realize the largest reduction in capital costs.

and Paris. It is hard to predict which firms across these exchanges should gain the most liquidity. But there are nonetheless some general arguments that can be presented.

First, the market with the relatively biggest increase in its potential investor base can be expected to enjoy the highest relative increase in liquidity. Here Lisbon or Brussels (country population 10 mill.) listed firms should thus gain relatively most whereas the increase in Paris's investor base (country population 60 mill.) is relatively small and thus should have a more limited effect. Second, if the merger breaks down on restrictions and red-tape, the market with the strictest pre-merger regulations and the least favorable business environment might enjoy a relatively greater rise in the trading volume. In particular, the market where foreign access was relatively cumbersome prior to the merger (e.g. through fees or restrictive regulations) might experience a relatively larger rise in the number of market participants and trading volume. In sum, turnover may increase relatively more for firms listed in exchanges that originally are small and more regulated (restrictive).

In contrast, investors may also escape markets which historically have provided a relatively unfavorable trading environment. In other words, firms listed on the most attractive exchange before the merger may be the firms which attract the highest share of foreign trading. Also, there may be a flight to liquidity in the sense that trading may now concentrate on one market, i.e. the one which enjoyed the highest pre-merger liquidity. This is consistent with Pagano (1989) and Chowdhry and Nanda (1991), who present a theory of clustering of trading volume in markets, i.e. they argue that if transaction costs are limited, then liquidity will concentrate on a few markets. Furthermore, Portes and Rey (2005) demonstrate that the key determinant of asset flow is market size (measured as equity market capitalization). Therefore one can argue that trading may concentrate on the biggest market among Euronext's exchanges, namely Paris. This supports that turnover increases relatively more for firms listed in exchanges that originally are large, liquid and less regulated or restrictive.

Lastly, it has been established that investors are generally infected by home bias. This means that investors prefer investing domestically and thereby forego potentially large gains from international diversification. Moreover, investors may prefer investing in their home market to support domestic businesses, e.g. in order to keep profits (and taxes thereof) within their own country. Thus, although stock exchange mergers may facilitate cross-border transactions, e.g. by alleviating asymmetric information, it may not be enough to significantly induce cross-border transactions. Thus, post-merger turnover across exchanges may be unchanged from the pre-merger level.

3. Data and background information

On March 20, 2000, it was announced that the exchanges of Amsterdam, Brussels and Paris planned to merge. The chairman and chief executive of the new exchange emphasized that: "It is not a link. It is not an alliance. It's a merger, a full merger." (*Associated Press Financial News*, 2000). The steps towards unification were laid out, along with the many aims and objectives of the merger. The numerous declared goals of the merger typically took the form of general statements, covering a wide range of improvements for investors, exchange members, listed firms, shareholders and European capital markets as a whole. For example, Euronext's first annual report claimed that the new exchange was to "be leading in terms of quality of service, efficiency and innovation", "create a fair and orderly

market for investors, brokers and issuers”, “decrease fragmentation in European markets” and “facilitate capital market growth” (Euronext Annual Report, 2000, pp. 5–9). Some of the less cloudy objectives included cutting costs to all market participants, attracting more (foreign) listings, offering a wider selection of investment products and deepening liquidity pools. Any of these stated motives for merger are likely to contribute—either directly or indirectly—to higher trading turnover of stocks. The purpose of this study is to examine if the new exchange was successful in obtaining this particular objective—and if the potential liquidity benefits proved to be evenly allocated among listed firms.

Given the various motives for merger, a short note on potential endogeneity issues between merger events (events are to be discussed in detail below) and turnover is in order. First, with regards to reverse causality, it seems counter-intuitive that increased turnover may have caused the merger to take place. That is, if turnover was already increasing it should not encourage a merger (Fig. 1 also shows that turnover does not increase in the years leading up to the merger). It is rather the case that low or non-changing initial turnover causes the merger events to occur, but this does not impose any statistical problems. It merely induces a selection issue in the sense that these particular exchanges may have decided to merge because of relatively low turnover, implying that the results cannot be generalized to other stock exchange mergers. This, however, raises no problems for the statistical analysis, i.e. the regression coefficients still capture whether merger events are associated with liquidity improvements.

Second, there may in principle be a third factor causing both liquidity improvements and merger events to occur, leading to spurious correlation between the two variables. For example, an improvement in many of the merger motivating factors outlined above could directly or indirectly increase turnover. However, an improvement in these factors cannot simultaneously be causing the merger events to occur, which thereby eliminates concerns of spurious correlation. More specifically, it was not an improvement in any of the merger motivating factors that ignited the merger, but rather the lack thereof. In other words, by definition it has to be the case that any significant improvements in merger motivating factors do not occur prior to the merger events, since the motive of the merger is to get these non-changing variables on the move. If these variables were already improving before the merger, there would be no reason to merge in the first place. In addition, in the case of the Euronext merger, the timing of the merger events was predetermined at the outset of the merger and the Euronext exchange did not depart from this schedule. Therefore the merger schedule is not affected by outside elements such as changes in market conditions or in merger motivating factors. For these reasons, even though variation in a third factor may cause turnover to increase, it will not simultaneously be driving merger events and thereby induce spurious correlation.

The widespread goals of the merger were to be reached by integrating listing, trading, data dissemination, regulation, information services, clearing procedures and various other aspects of the industry. Therefore the stock exchange merger can be viewed as a series of different events that unify the participating exchanges. The study identifies the main steps taken towards exchange consolidation and estimates if these steps are associated with an increase in liquidity. The first concrete step towards consolidation was taken in September 2000 when the exchanges of Amsterdam, Brussels and Paris formally merged into the first pan-European exchange, named Euronext. Two years later the Lisbon exchange also merged into Euronext. This first step meant that members of each local exchange automatically became members of the other exchanges as well, which gave members access

to the entire trading platform. For example, a member (broker) of the Paris exchange had direct access to the Brussels exchange, and vice versa. Other important steps of the merger process soon followed, i.e. events that further integrated and unified the markets. The second key event was the unification of the trading platform, which involved introducing the same technical system (NSC) that made cross-border trading easier as the markets became accessible by both local and remote members through any of the four gateways. A single set of trading rules was also introduced as the order books were consolidated, which unified the trading structure of the four exchanges. Third, Euronext introduced a common clearing platform (Clearing 21), which meant that the whole clearing framework became harmonized. Therefore the users of the trading platform would not need to deal with separate clearing systems and thus this event further helped to integrate the markets. Lastly, in 2005 all shares listed on the four local exchanges were moved to a single, regulated market, named the Eurolist. This is a single list which encompasses all Euronext's regulated national markets, with stocks classified in alphabetical order (not geographical). The list was introduced to increase simplicity and transparency on the consolidated market.

The dates of these events in the merger process of Euronext are listed in Table 2. Although various other important steps were taken towards unification of the national stock exchanges (see further discussion below), these are the ones identified as being the principal integration events. Thus, these 4 mergers events—occurring at different dates for the 4 national exchanges—will be utilized in the empirical merger analysis that follows.

Other changes took place during the merger period that changed the architectural structure of individual exchanges. However, the merger did not bring about many such fundamental changes since the individual exchanges had very similar market characteristics (e.g. trading mechanism) before the merger, which the consolidated exchange maintained. A summary of the architectural structure is provided in Table 3.

In early 2000, at the outset of the merger, all of the four individual exchanges were structured as hybrid markets with limit order book emphasis (Swan and Westerholm, 2003). All the exchanges had at this time already introduced an order driven, electronic, continuous market. In other words, an order processing system routed all orders to the central limit order book, where orders were matched for automatic execution. All local exchanges supplemented this electronic system with pre-assigned market makers that provided additional liquidity for low capitalization stocks. Thus the main features of the trading systems of each local exchange were very compatible at the time of the merger. Therefore, as the trading system was harmonized, it required limited adjustments by individual exchanges. The consolidated exchange maintained the hybrid market structure.⁸

This pre-merger comparability in exchange structure makes the estimation of merger effects less arduous. For example, Swan and Westerholm (2003) show that different forms

⁸The Brussels exchange introduced their NTS trading system in 1996, which replaced the similar CATS system that originally was introduced in 1989 (Degryse, 1999). Paris upgraded their trading system in 1994 to NSC from their previous version named CAC, which also was closely patterned after the CATS system (Pagano, Röell, Danthine, and Schaefer, 1990). The Paris trading structure also resembled closely the Amsterdam structure (Pagano, Röell, Danthine, and Schaefer, 1990), for example the Amsterdam trading system—introduced in 1994 and named TSA—was similar to the Paris one (Pagano and Steil, 1996). The Lisbon system (LIST, introduced in 1999) also exhibited the same features of an automatic order-driven system (see e.g. *The Handbook of World Stock, Derivative and Commodity Exchanges*, 1998–2005). With the Euronext merger, all stocks migrated to the already existing Paris trading system (NSC).

Table 2

Dates of merger events

The table shows the dates of the key events in the Euronext merger process. First, members of each local exchange became members of all four exchanges; second, the trading platforms were unified; third, the clearing framework become harmonized and fourth, all stocks migrated to a single (non-geographical) list, the Eurolist. *Source:* Euronext annual reports and news announcements on Euronext's website.

	Members' access to all Euronext securities	Trading system (NSC)	Clearing system (Clearing 21)	Eurolist
Amsterdam	Sept. 2000	Oct. 2001	Oct. 2002	Apr. 2005
Brussels	Sept. 2000	May 2001	Mar. 2002	Apr. 2005
Lisbon	Sept. 2002	Nov. 2003	Nov. 2003	Apr. 2005
Paris	Sept. 2000	Already in place	Jan. 2001	Feb. 2005

of market structures—such as dealer markets, electronic order book markets or hybrid markets—lead to different liquidity outcomes. Since the consolidated Euronext exchange maintained the fundamental market structure of the participating exchanges, the estimated merger effect will not be influenced by such a structural change. Instead the main implication of the trading systems unification is first and foremost to make cross-border trading easier as all markets become accessible through any of the four local gateways (which is the trading system consolidation effect we seek to estimate). As a second example, Jain (2005) provides empirical evidence that the introduction of automatic electronic trading tends to enhance liquidity of stock markets. Since all of the four local Euronext exchanges had already undergone this change prior to the merger, this does not contaminate the estimates of the merger effect. Any improvement in liquidity due to this technical innovation should already have been realized before the merger takes place. Finally, Swan and Westerholm (2006) use data from 33 major stock exchanges to show how transparency-enhancing market design affects trading volume. Using data from March 2000 to October 2001, the time at which the Euronext merger was being initiated, they rank stock exchanges in terms of best practice, i.e. in terms of the architectural design that promotes predicted trading volume the most. Their results are reproduced for the Euronext exchanges in Table 3, where an architectural score of 1.0 represents the architectural design that promotes traded value the most (best practice). The exchanges of Brussels (0.299), Paris (0.291) and Amsterdam (0.255) score very similarly to each other in terms of best practice (ranking 6–8 out of 10 peer exchanges), implying that transparency characteristics are very similar across these exchanges. Therefore, asymmetric liquidity improvements should not be realized across exchanges due to different transparency enhancements of the order books, in particular since the merged Euronext market structure builds on the architectural features of the individual exchanges.⁹

⁹In particular, it builds on the French market model as all stocks migrate to the French NSC trading platform. The French market structure resembles closely the pre-merger Amsterdam and Brussels structure (Pagano, Röell, Danthine, and Schaefer, 1990; Pagano and Steil, 1996). More detailed information on transparency can be found in e.g. Demarchi and Foucault (2000), Venkataraman (2001), Euronext Cash Markets Trading Manual (2007) and The Handbook of World Stock, Derivative and Commodity Exchanges (1998–2005). The Swan and Westerholm (2006) study neatly sums up these details and gives an overall view of the comparability of the transparency features in the individual Euronext exchanges. To supplement the scores reported in Table 3, the scores of other peer exchanges are: Tokyo (0.838), Switzerland (0.728), New York (0.475), NASDAQ (0.410), Milan (0.305), Frankfurt (0.139) and London (0.099).

Table 3

Pre- and post-merger market architecture and characteristics

The architectural score of transparency-enhancing features is obtained from Swan and Westerholm (2006). The measure represents how an exchange scores in terms of transparency-enhancing features, i.e. how successful the architectural design of the exchange is in promoting trading volume (score of 1.0 representing best practice). For comparison, the score of peer exchanges is: Tokyo (0.838), Switzerland (0.728), New York (0.475), Nasdaq (0.410), Milan (0.305), Frankfurt (0.139) and London (0.099). Tick sizes are reported in Euros and vary with the price of shares. The Euronext exchange has no historical information available on the pre-merger tick sizes in Brussels. The tick size in Paris prior to January 1999 was given in French Franc (1 Euro = 6.56 FRF). *Source*: Demarchi and Foucault (2000), Pagano and Steil (1996), Degryse (1999), Venkataraman (2001), Aggarwal (2002), Swan and Westerholm (2003, 2006), Pagano et al. (1990), Bourghelle and Declercq (2002), The Handbook of World Stock, Derivative and Commodity Exchanges (various years), Euronext Cash Markets Trading Manuals (various years), Euronext Annual Reports (various years), the official websites of Euronext, Euronext.liffe and World Federation of Exchanges and direct correspondence with the local stock exchanges.

	Amsterdam	Brussels	Paris	Lisbon	Euronext
<i>Panel A</i>					
Trading system	Hybrid market with limit order book emphasis. System name: TSA.	Hybrid market with limit order book emphasis. System name: NTS	Hybrid market with limit order book emphasis. System name: NSC.	Hybrid market with limit order book emphasis. System name: NSC.	Hybrid market with limit order book emphasis. System name: LIST.
Architectural score of transparency-enhancing features	0.255 (ranked 6 out of 10)	0.299 (ranked 8 out of 10)	0.291 (ranked 7 out of 10)		The harmonized Euronext market structure builds on the features of the individual exchanges (e.g. all stocks migrate to the NSC system).
Ownership of exchange	Demutualized in 1997.	Demutualized once it became part of Euronext in 2000.	Paris Bourse proposed demutualization in 2000, prior to Euronext merger announcements. It was carried out in conjunction with the merger.	Fully owned by Euronext N.V. in 2001 (one year prior to the first key merger event for Lisbon, i.e. the member access event in 2002).	Demutualized in 2000. Owned by Euronext N.V., which is a Dutch holding company founded in July 2001, 2 months prior to its merger with the exchanges of Amsterdam, Brussels and Paris.

Table 3 (continued)

	Amsterdam	Brussels	Paris	Lisbon	Euronext			
Tick size :	Change in Jan. 2003		Change in January 1999		Change in June 2002	Change in January 2007		
	$P < 1$	0.01 0.01	$P < 5$	0.01F 0.01	$P < 50$	0.01 0.01	$P < 50$	0.01 0.01
	$1 < P < 50$	0.10 0.01	$5 < P < 50$	0.05F 0.01	$50 < P < 100$	0.01 → 0.05	$50 < P < 100$	0.05 → 0.01
	$50 < P < 100$	0.10 → 0.05	$50 < P < 100$	0.05F → 0.05	$100 < P < 500$	0.01 0.10	$100 < P < 500$	0.10 0.01
	$100 < P < 500$	0.10 0.10	$100 < P < 500$	0.10F 0.10	$P > 500$	0.01 0.50	$P > 500$	0.50 0.01
	$P > 500$	0.10 0.50	$500 < P < 5000$	1.00F 0.50				
			$P > 5000$	10.0F 0.50				
<i>Panel B</i>			2001	2002	2003	2004	2005	2006
Fraction of individual equity derivatives in total value of volume (%)			13	11	6	6	11	6

There are a few discrepancies in the architectural structure of the individual exchanges that should be noted. First, the governance of the exchanges was different prior to the merger. The Amsterdam exchange demutualized in 1997, making it one of the first exchanges in the world to do so. The other three exchanges demutualized as part of the Euronext merger. The demutualization of exchanges has been shown to be associated with increased liquidity of the stock issued by the exchange itself, i.e. the stock of the newly demutualized exchange company (see e.g. Mendiola and O'Hara, 2003; Aggarwal, 2002; Aggarwal and Dahiya, 2006). Although this empirical work does not deal with demutualization effects on liquidity of all other stocks listed on the demutualized exchange, the possibility that demutualization raises liquidity in general should not be ruled out. For example, demutualization may strengthen profit motives of the exchange and thus increase marketing strategies aimed at attracting order flows. Therefore it will be important to recognize that the estimated merger effects in this study will only apply to the Euronext merger and cannot be generalized to other stock exchange mergers, such as any consolidations without demutualization of participating exchanges.

Second, when estimating the amount of trading in stocks it is important to note that part of stock trading occurs in derivatives markets. All of the local Euronext exchanges had established a derivative exchange prior to the merger.¹⁰ Thus, an analysis of cash market volume will be inadequate if a large fraction of trading takes place on derivatives markets. Furthermore, investors may shift from one market to the other as trading conditions change (Mayhew, Sarin, and Shastri, 1995). In order to compare the amount of trading taking place in derivatives and cash markets, the trading volume in individual options and futures is estimated as the number of traded contracts, times the number of underlying shares in each contract, times the price per share (future price or strike price).¹¹ Table 3 (panel b) reports this derivatives volume as a fraction of the total value of trading across the four local exchanges. The results indicate that over the 2001–2006 period only 6–13% of trading in individual stocks is concentrated on derivatives markets. Moreover, this estimate is lower in practice since the estimated derivative volume inherently assumes that every stock option will be exercised.¹² Also, there is not a systematic trend in the fraction of trading concentrated on derivatives markets in the merger period. Thus, the relatively moderate amount of derivatives trading is not likely to significantly influence the Euronext merger estimates.

Third, tick sizes (the minimum price increment at which trades may be made) are harmonized across individual exchanges in the sample period. The various effects of tick

¹⁰The AEX-option exchange in Amsterdam, the BELFOX exchange in Brussels (which had agreed to merge with the Brussels exchange by end of 1999), the Oporto Derivatives Exchange in Portugal and the MATIF interest rate products and commodities exchange and the MONEP equity exchange in France. Also, in January 2002 Euronext completed its acquisition of the London International Financial Futures and Options Exchange (LIFFE, now Euronext.liffe), which is a London-based derivatives company.

¹¹Derivative volume is typically reported using this methodology, e.g. by the World Federation of Stock Exchanges. Prior to 2001 derivatives volume was generally only reported as the number of traded contracts. Unfortunately this measure cannot be compared between markets, e.g. in 1999 there were 3.6 million contracts traded with a value of 33 billion dollars on the UK LIFFE derivative exchange, while in France there were 68 million contracts traded with a mere value of 4 billion dollars.

¹²For example, in France there are between 15% and 45% of options contracts left unexercised at year-ends 2001–2006 (World Federation of Exchanges, www.world-exchanges.org). Thus, assuming that a third of all options are never exercised, the fraction of volume in individual stocks concentrated on derivatives markets drops to 4–9%.

size changes on liquidity have been widely documented in the literature (Harris, 1997; Jones and Lipson, 2001; Goldstein and Kavajecz, 2000; Bessembinder, 2003; Bacidore, Battalio, and Jennings, 2003). Table 3 summarizes the historic information available on tick sizes changes occurring in the sample period. The Paris exchange introduced new tick sizes in January 1999, before the start of the merger. No further tick size changes occur in the sample period for Paris, since the consolidated Euronext exchange adopted the Paris tick size structure and did not change it until after the sample period, i.e. in January 2007. The consolidated Euronext exchange does not have any historical information available on tick size changes in Brussels, but the Amsterdam and Lisbon exchanges aligned their tick size structure to the Paris model in January 2003 and June 2002, respectively. The four previously identified key merger events did not take place in any of these months, i.e. the tick size changes in these two exchanges did not occur simultaneously to any merger events (such as trading system harmonization). Thus, even though such changes are important, the subsequent analysis does not directly examine tick size changes, in particular since the effects of tick size changes have already been widely explored in the literature. Instead, the focus will be on the four identified events of the merger process (see Table 2), which have not been examined to the same extent. But accordingly, it is worth reemphasizing that the results presented in the empirical analysis do not necessarily extend to other stock exchange mergers following a different merger path, e.g. excluding tick size harmonization.

The main dataset of the paper is provided by Thomson One Banker (which incorporates Datastream, Worldscope and Thomson Financial) and consists of a panel of monthly observations on all listed firms on Euronext from September 1996 to September 2006. This amounts to 1,506 firms, where the majority of firms (70%) is listed in Paris, while 25% are listed in Amsterdam or Brussels, and the remaining in Lisbon. The dataset also includes data on firms listed outside Euronext, which is useful for comparison purposes and for creating additional control groups. These are firms listed on stock exchanges in Frankfurt, London and Spain (BME).¹³ This adds another 4,240 firms to the dataset. Summary statistics are given in Table 4.

Liquidity, the outcome variable of interest, can be measured in various ways. One simple measure is trading volume, i.e. the number of shares traded in a firm over a given period. A better measure is turnover, which is the measure used in the paper. It is defined as the number of shares traded (in a particular firm) relative to the number of outstanding shares. This corrects the volume measure by taking into account that a single share represents a different proportion of a firm depending on the total number of outstanding shares. Turnover statistics is reported using the same method in Brussels, Lisbon and Paris (Pagano and Steil, 1996). Amsterdam, however, used to incorporate both the buy and the sell side of each transaction into its turnover statistics. As of October 2001 the Dutch Central Bureau of Statistics shifted from a double counting measure to a single counting one (Faulconbridge, Engelen, and Hoyer, 2007). Thus, to make Amsterdam trading volume comparable across time and exchanges it is divided by two prior to this date.¹⁴

¹³The Spanish stock exchanges of Madrid, Barcelona, Bilbao and Valencia go under the name of the company that integrates the exchanges, i.e. “Bolsas y Mercados Españoles” (BME). The dataset includes the largest 137 of BME listed firms and all Frankfurt and London listed firms. The Frankfurt exchange also goes under the name of Deutsche Börse and is the largest of 8 German exchanges.

¹⁴This procedure is applied in several other studies, such as Degryse (1999), Anderson and Tychon (1993), Helbling (1993) and Pagano and Röell (1993). See further details on the comparability of turnover reporting in Atkins and Dyl (1997), whose results support an adjustment factor of approximately 50%.

Table 4

Summary statistics

All figures in the table are from the Thomson One Banker dataset. Panel A reports total figures and panel B reports means, with standard deviations in parentheses. Non-Euronext firms are firms from the exchanges of Frankfurt (1188 firms), London (2915) and BME (137). Turnover is reported in percentages (multiplied by 100). Amivest is reported in thousands of EUR per 1% price change. Bid-ask spreads are reported in percentages of the mid-quote (see formula Section 5.3). Returns are measured as daily percentage changes in price and volatility is measured by a rolling estimate (a moving average) of standard deviation over the past 20 business days, which is then scaled to annual volatility (i.e. multiplied by square-root of 250). Foreign sales and domestic assets are average annual figures (not monthly). GDP per capita is average quarterly GDP (billions of EUR) as a proportion of the population (millions) of the country where the exchange is located. GDP per capita for non-Euronext firms consists of GDP of Britain, Germany and Spain. Monthly data on the value of traded shares (both electronic order book transactions and negotiated deals) is provided by the Federation of European Securities Exchanges (not reported in table), where the mean value of volume is 189 (42) bill. EUR for Euronext and 701 (152) across Frankfurt, London, BME, Milan and OMX (OMX data includes the stock exchanges of Copenhagen, Stockholm, Helsinki and Vilnius, but not the national stock exchanges of Iceland, Latvia and Estonia).

	Amsterdam	Brussels	Lisbon	Paris	Euronext	Non-Euronext
Panel A: Total figures						
Number of firms	174	204	79	1,049	1,506	4,240
Number of firms w/for. sales	122	68	30	462	682	1,496
Proportion of Euronext firms (%)	12	14	5	70	100	0
Prop. of firms in exchange w/for. sales (%)	70	33	38	44	45	29
Panel B: Means (st.dev.)						
Turnover	0.26 (0.45)	0.08 (0.21)	0.16 (0.63)	0.13 (0.48)	0.14 (0.46)	0.23 (0.48)
Amivest	470 (2058)	57 (391)	116 (742)	198 (1275)	213 (1316)	213 (2296)
Bid-ask spread	2.81% (8.00%)	4.26% (11.0%)	10.4% (26.8%)	7.81% (18.5%)	6.93% (17.6%)	7.24% (10.1%)
Returns	0.06% (3.36%)	0.05% (2.67%)	0.01% (4.50%)	0.10% (3.73%)	0.08% (3.60%)	0.06% (3.72%)
Price volatility	0.28 (0.42)	0.22 (0.35)	0.24 (0.41)	0.31 (0.48)	0.29 (0.46)	0.29 (0.46)
Foreign sales (mill. EUR)	3,240 (11,300)	913 (2,333)	425 (741)	1,610 (6,180)	1,790 (7,120)	917 (5,940)
Domestic assets (mill. EUR)	3,760 (22,000)	3,760 (14,200)	2,040 (7,980)	2,480 (7,410)	2,910 (13,000)	3,600 (25,200)
Market value (mill. EUR)	3,370 (1,170)	1,260 (5,940)	797 (1,980)	1,480 (7,150)	1,660 (7,610)	1,290 (7,580)
GDP per capita	6.72 (0.90)	6.33 (0.65)	3.08 (0.38)	6.28 (0.59)	6.16 (1.00)	6.72 (0.90)

Turnover captures one specific dimension of liquidity, namely the amount of trading that takes place among market investors. The objective of this study is to answer whether the consolidation of stock exchanges increases the amount of trading in individual stocks. In other words, does market activity increase (and for which firms) as stock exchange merger facilitates cross-border trade and thus effectively enlarges the market place? This is exactly the liquidity dimension that turnover measures and the one that merger hypotheses in Section 2 directly relate to. However, to append to the overall liquidity discussion, two other measures of liquidity are introduced in Section 5.3. These are bid-ask spreads and the Amivest ratio, which capture the cost and market impact dimensions of liquidity.

The dataset offers a number of firm variables that make it possible to investigate whether the effect of the stock exchange merger differs depending on firm type. These variables represent the main firm characteristics described in Section 2, namely foreign exposure, firm size, industry and exchange location. More specifically, foreign exposure is captured by foreign sales, size is proxied by firm market value and the industry specification is provided by the Thomson database.

Lastly, an additional dataset is provided by the Federation of European Securities Exchanges (FESE), which consists of monthly observations from January 2000 to August 2006. The data consists of the Euro value of volume for 6 major exchanges in Europe, namely Euronext, Frankfurt, London, BME (Spain), Milan and the consolidated OMX exchange. The data is aggregated on the stock exchange level (so firm heterogeneity cannot be explored) and is used for examining how the Euronext merger has affected the market shares of European exchanges (Section 5.4).

4. Methodology

To analyze heterogeneous effects of the Euronext stock exchange merger on stock liquidity, the empirical analysis employs a fixed effects regression with dummy variables capturing the key event dates. The model is

$$T_{it} = \alpha + \beta D_{it}^{\text{events}} + \gamma X_i^1 D_{it}^{\text{events}} + \theta X_i^2 D_{it}^{\text{events}} + \delta X_i^1 X_i^2 D_{it}^{\text{events}} + \lambda Z_{it} + \pi D_{it}^{\text{month}} + c_i + \varepsilon \quad (1)$$

where the subscripts refer to firm i and time t . Liquidity, the outcome variable of interest, is measured by turnover, T_{it} . The four merger events (see Table 2) are represented by a $T \times 4$ matrix of dummy variables, D^{events} . Each event dummy takes value 0 before the relevant merger event, but value 1 at the date of occurrence and until the final sample date. This specification will give coefficient estimates that measure the effect of each individual event. Adding up the coefficient estimates will then measure the cumulative effect of the key merger events, i.e. the overall effect of the merger process, which is of primary interest.¹⁵

To measure the heterogeneous effects that the merger may have on firms, the regression equation must include variables on firm characteristics. Eq. (1) represents the case where two measures of firm characteristics are included in the model, namely X^1 and X^2 (e.g. firm size and foreign sales). The firm characteristics are interacted with the merger events to measure the heterogeneous effects of the merger. The coefficients on these interaction terms (γ and θ) therefore measure the incremental merger effect on stock liquidity for different types of firms (incremental to effect β). These firm characteristics are also jointly interacted with the merger events in order to measure the incremental merger effect on firms that possess both characteristics (e.g. big firms with foreign sales may experience a greater post-merger liquidity than purely domestically operating big firms). Thus, the coefficients γ , θ and δ are the heterogeneous merger effects of interest in the study.

¹⁵Note that no event occurs simultaneously across all exchanges and that the events are sufficiently far apart for liquidity changes to materialize before the next event occurs. Also note that the event dummies take value 1 only when an event has occurred in at least two exchanges so the impact of consolidation can realize. For example, the trading event dummy does not take value 1 for firms listed in Paris until in May 2001 when the Brussels exchange joins the platform. One exception to this rule is the Eurolist event for Parisian firms since in February 2005 the three main markets of Paris (Premier Marché, Second Marché and the Nouveau Marché) merged into one, which formed the foundation of the Eurolist which was launched 2 months later.

Regressions of the type presented in Eq. (1) generally require that firm characteristics are also added as control variables, i.e. without interacting them with merger events. But in the empirical analysis that follows these firm characteristics are generally time constant. Thus, they are effectively included in c_i , which is a vector of fixed effects that takes out any (unobserved) time-constant firm specific characteristic which may explain variation in liquidity. Hence only time-varying explanatory variables need to be included in the regression model. Time-variant control variables are represented by Z_{it} , i.e. variables that may influence liquidity but are independent of the process of integration. For example, GDP per capita in each of the four Euronext countries is unrelated to the merger but may influence trading volume (there is typically more stock market activity in economic upturns).

The model also includes monthly dummies, i.e. dummy variables that pick the up the average variation in liquidity for each calendar month. The monthly dummies can therefore be thought of as a time trend in the most flexible format available (a month fixed effect), which is desirable because trading volume is typically a very volatile series. These monthly dummies will control for all events that are unrelated to the merger and take place in other months than the key merger events. Moreover, in the months where the key merger events do occur, the monthly dummies will capture all unrelated events that are common to the four exchanges. In other words, the dummies filter out the average monthly change in liquidity across all firms on the four local exchanges. Thus, the coefficients of interest will measure variation beyond the average variation in liquidity in the months where merger events take place. Hence the merger effects are identified from the fact that no merger event occurs simultaneously across all exchanges (explaining why the monthly dummies are not collinear with the event dummies). This implies that when an event takes place in one exchange, the firms listed on other exchanges will serve as a control set.

The last sub-section of the paper analyses the competitive effects of the Euronext merger. The methodology used in that section of the paper examines if the market share of Euronext (i.e. share of trading) has increased—and if so, from which exchange(s) has the increase been drawn. In other words, has the merger proved to enhance the competitive stand of Euronext? The methodology, which originates to Zellner (1962) and is typically referred to as SURE (seemingly unrelated regressions), involves estimating a simultaneous equation system where the dependent variable in each equation is the market share of a particular exchange and explanatory variables are merger event dummies and various controls. This allows for testing not only whether the merger had a statistically significant effect on Euronext's market share, but also examines from which non-merging markets the additional market share was drawn. It is the potential existence of a common explanatory factor of market shares of all exchanges that necessitates the joint estimation of the equation system. Specifically, such a factor would induce contemporaneous correlation between error terms across separate exchange regressions, which would not be accounted for by running OLS on each equation separately.

5. Empirical results

5.1. Firm heterogeneity

There are two dimensions of firm heterogeneity that this sub section examines; namely foreign exposure and firm size. Table 5 reports the cumulative effect of the merger on stock turnover. The columns represent fixed effects regressions including nearly 1,200 firms listed

in Euronext in the sample period 1996–2006. Column (1) reports the cumulative effect of the four merger events, controlling for gross domestic product (GDP) per capita and including monthly dummies. Interestingly, the effect of merger on stock turnover is non-significant. Therefore the merger has *not* increased turnover of the average firm. The coefficient on GDP per capita is positively significant, which is what one would expect given that trading volume is generally higher in economic upturns.

The remaining regressions reported in Table 5 analyze whether firms experience heterogeneous merger outcomes, i.e. whether the merger effect is different for big/small firms or firms with/without foreign exposure. A firm is considered big if its market value lies in the top 10% across all firms at the outset of the merger process (January 2000). Likewise, small firms are defined as those in the bottom 10% in terms of market value. This definition leads to a similar sub sample of big firms as used in Padilla and Pagano (2005), i.e. their study consists of 104 large caps included in the main indexes of the four national exchanges. Thus the results of the two studies are directly comparable. Foreign exposure is defined in terms of foreign sales, measured using a dummy with value 1 if the firm had foreign sales at the outset of the merger process. Therefore the size and foreign exposure variables are time constant variables (thus avoiding endogeneity), which implies that they are automatically dropped from the fixed effects regressions. But recall that the objects of primary interest are the interaction terms of these firm characteristics with the merger events.

Regression (2) in Table 5 adds the interaction of merger events with foreign exposure, where foreign exposure is measured by foreign sales. The merger variable is again non-significant, which indicates that firms without foreign sales were unaffected by the merger. However, the interaction term of merger events and foreign sales returns a positive and significant coefficient. This implies that although firms in general do not benefit from merger in terms of liquidity, those firms which have foreign sales do relatively better than other firms. This supports the idea that foreign investors prefer to invest in firms in which they have an informational advantage. Regression (3) controls both for size and foreign exposure, so the non-significant coefficient on the merger variable now implies that medium sized firms without foreign sales were unaffected by the merger. The coefficient on foreign sales is still positively significant and there is also a large and highly significant effect for big firms. In other words, the turnover of big firms increases by 0.13% more than for the medium sized firm with no foreign sales.¹⁶ These significant responses of big firms and firms with foreign sales are of real economic significance since the average daily turnover per month for Euronext firms is 0.14% in the sample period. In contrast, regression (3) reports no merger effect for small firms. This implies that the conclusions of Padilla and Pagano (2005) of higher post-merger liquidity are restricted to their specific sample of big firms, i.e. small or medium sized firms do not enjoy the same benefits from merger. This is also interesting in light of the fact that merging stock exchanges tend to pitch that “... the real winners are smaller and medium-sized companies” (OMX, 2007,

¹⁶The absolute effect of the merger on big firms in general is 0.15%, which is statistically significant at the 1% level. This number is obtained by adding up (i) the effect on the medium sized firm without foreign exposure (−0.01), (ii) the effect on big firm (0.13) and (iii) the incremental effect if the firm is both big and has foreign sales, which is the interacted effect (0.05) times the proportion of firms with foreign sales (0.46). Turnover is measured in average daily turnover per month, so this roughly corresponds to a 3% higher turnover per month (assuming 20 trading days per month), where the average monthly turnover for big firms in the sample period is $0.34\% \times 20 = 6.8\%$.

Table 5 (continued)

Turnover	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				Flex. trend	Cutoff 20%	Cutoff 5%	Assets as size	Time-varying	Log f.sales	Log f.sal.&size	Cross-list.	Control gr.
BME listed*merger												−0.17*** (0.05)
London listed*merger												−0.16*** (0.05)
GDP per capita	0.07*** (0.02)	0.06** (0.02)	0.06*** (0.02)	0.06*** (0.02)	0.05** (0.02)	0.05*** (0.02)	0.06** (0.02)	0.06*** (0.02)	0.05** (0.02)	0.05** (0.02)	0.06*** (0.02)	0.21*** (0.07)
Constant	−0.20 (0.12)	−0.14 (0.12)	−0.12 (0.11)	−0.15 (0.11)	−0.08 (0.11)	−0.10 (0.11)	−0.13 (0.12)	−0.14 (0.11)	−0.10 (0.11)	−0.09 (0.11)	−0.15 (0.12)	−0.57* (0.31)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Monthly dummies	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Number of observations	113,111	113,111	113,111	113,111	113,111	113,111	113,111	113,111	113,111	113,111	113,111	29,542
Flexible trend	No	No	No	Yes	No	No	No	No	No	No	No	Yes
Number of firms	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	1,180	263
R-squared	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.23

p.15). Finally, there is no significant incremental effect of both having foreign sales and being big (or small), as indicated by the last two interaction terms in regression (3).

Overall, the results are in harmony with those of Kang and Stulz (1997) who find a similar pattern of foreign investment in Japanese stocks, i.e. foreign investment tends to be concentrated in large, export-oriented firms that are presumably more familiar to foreign investors. Also, Pagano, Röell, and Zechner (2002) find that foreign sales and firm size have the largest impact on a firm's decision to list abroad, allowing it to capitalize on reputation acquired in foreign markets.

A sensitivity analysis of these main heterogeneity results are carried out in regressions (4)–(10) of Table 5. First, using monthly dummies may be excessively restrictive since it takes out the bulk of the variation in turnover, i.e. it filters out average monthly changes in turnover across all firms. In particular, in cases where a merger event happens simultaneously in two or more exchanges, the monthly dummy for that particular month may absorb most of the merger effect. That is, in such a case the effect of the merger event will primarily consist of the reaction of firms listed in the other (one or two) exchanges where the event occurs in different months. Thus, regression (4) of Table 5 drops the monthly coefficients and instead includes a flexible time trend, namely a fifth order polynomial. The average turnover of London listed firms with foreign sales is also included to further control for turnover variation unrelated to the merger, i.e. to control for non-merger related events that may generally affect stock liquidity in world markets.¹⁷ The results are virtually unchanged from the base model, with big firms and firms with foreign sales enjoying relatively higher post-merger stock liquidity compared to other firms. In addition to dropping monthly dummies, we also explore the merger effect when not using any merger event dummies. In other words, a simple before-after comparison is produced in a non-regression based framework, where turnover is computed for each firm over a 3-month period before and after each merger event. The pre- vs. post-merger difference reveals an increase in turnover, but again only for big firms with foreign sales (not reported). Moreover, the increase is significantly higher than among similar types of firms listed in London, Frankfurt or Madrid.¹⁸

As a second robustness check, the choice of the 10% cutoff level when defining small and big firms is somewhat arbitrary. Thus regression (5) in Table 5 defines big (small) firms as those who have market values in the top (bottom) 20% across all firms at outset of the merger. The relative merger effect on big firms is still significant, but it non-surprisingly becomes lower as big firms are on average smaller in size. The coefficient on firms with foreign sales becomes weaker, which is as expected since the liquidity improvement of international firms in the 80–90% size category is no longer represented in the foreign sales

¹⁷Note that when monthly dummies are included in the regression model this variable is redundant (multicollinear to monthly dummies) since it is the same across all of the four Euronext exchanges. Average London turnover is measured across firms with foreign sales to provide an apple-to-apple comparison, since globalization trends may have improved liquidity of firms, irrespective of the Euronext merger. The author thanks an anonymous referee for pointing this out.

¹⁸These results are available from the authors upon request. In more detail, the results show only a significantly higher level of turnover for big Euronext firms with foreign sales (0.049 increase) and the same types of London listed firms (0.027 increase)—where the increase among Euronext firms is significantly higher than for London listed firms. The magnitudes naturally differ from the regression based results (although the overall results are nonetheless the same) since the two methodologies differ substantially, e.g. the simple before-after comparison does not include any control variables. Thus we restrict our reported results to the more reliable regression based framework.

coefficient. Similarly, when big (small) firms are defined based on a 5% cutoff level, the foreign sales coefficient again rises as big firms become more narrowly defined (regression (6)). The merger effect on big firms also remains significantly positive.¹⁹ Therefore the model specification is robust to changes in the firm size cutoff level since in all cases the merger effect is of similar magnitude and in each case it is statistically significant.

Third, measuring firm size with market value may be problematic since anything that affects stock prices will affect market value. Therefore the size definition can indirectly be influenced by various economic variables or investor sentiment. The seventh regression in Table 5 attempts to address this concern by defining firm size in terms of domestic asset value reported in firms' accounts. Big (small) firms are now defined as those in the top (bottom) 10% in terms of asset book value. The results are very similar; there is still a positive and significant firm size and foreign exposure effect. The big firm effect is smaller, but now the interaction of being both big and having foreign sales is significantly positive.²⁰

Another possible specification is to use the actual market values and foreign sales figures (instead of using dummy variables) when defining firm size and foreign exposure. Using the actual values may be advantageous to using dummy values as it mitigates the possibility of discarding relevant information in defining firm size and foreign exposure. Also, it could be argued that turnover may increase because firms are becoming more noticeable abroad due to factors unrelated to the merger, such as increased presence in product and labor markets—and this increased visibility may be reflected in an increased level of foreign sales. This potential correlation between time-varying foreign sales and turnover is controlled for in regression (8) in Table 5, where the dummy specification for foreign sales has been replaced by the log of time-varying foreign sales. Foreign sales levels and turnover are not significantly related and the key results are unchanged with big firms and firms with foreign sales experiencing relatively higher turnover gains at merger dates. However, this specification may be problematic if foreign sales have increased as direct results of the Euronext merger, leading to endogeneity between time-varying foreign sales and merger dummies.²¹ Thus, an attractive alternative is to use foreign sales levels at their reported values at the outset of the merger. This specification is reported in regression (9), where the foreign exposure is measured by log of foreign sales at the outset of the merger process (January 2000). Regression (10) repeats regression (9), but now the binary dummy definitions for size are also replaced by logs of actual market values. The estimates verify earlier results, with big firms and firms with foreign sales enjoying relatively higher post-merger liquidity. Specifically, converting the coefficient estimates of regression (10) indicates that an average firm with foreign sales enjoyed 0.06% higher post-merger liquidity compared to medium sized firms without foreign sales, while for big firms the relative gain is 0.09% (obtained by multiplying coefficient estimates with the mean of the log covariates).

¹⁹One might intuitively expect the big firm coefficient in regression (3) to increase. However, this need not be the case if e.g. foreign investors are just as familiar with the top 10% of firms, as they are with the top 5%—thus increasing their trading in both to the same extent when the stock exchanges merge. For example, Belgian investors may be just as familiar with Shell—one of Netherlands's largest companies—as they are with Philips, which is relatively smaller (but still big). Also, with a 5% cutoff there are fewer firms left in the big firm sample, which may make estimates less stable.

²⁰Foreign assets (not foreign sales) are also used as a measure of foreign exposure (not reported). This also leads to very similar results, except the big firm effect is even larger. The reported analysis thus uses foreign sales as the measure of foreign exposure, since it gives more conservative estimates.

²¹Also, the analysis uses monthly turnover statistics while foreign sales data is only reported annually. Thus within-year foreign sales are projected using a linear combination of year-end values.

As established in the different regression specifications of Table 5, big firms and firms with foreign sales enjoyed higher post-merger turnover. If this is attributed to the merger successfully inducing cross-border trading, one would expect the positive effects to be lower for firms that were already accessible to foreigners before the merger. In particular, as suggested in Section 2, firms that are cross-listed before the merger may be less likely to gain from the merger since foreigners are more likely to be already trading in those firms, compared to other Euronext firms. Regression (11) tests this by adding a cross-listing indicator which picks up the merger effect for any firm that was cross-listed before the merger took place. Thus, the positive size and foreign sales effect now applies to those big firms and firms with foreign sales which were not cross-listed before the merger. The results indicate that the firms who were already cross-listed in other Euronext exchanges before the merger did not experience positive turnover gains, which conforms to idea that foreigners already had access to these firms.

Finally, a fruitful way to investigate whether other events than those related to the merger are driving the results, is to compare the outcomes of big Euronext listed firms with foreign sales (experiencing higher turnover at merger dates) to outcomes of similar firms listed elsewhere. The general turnover trends over the entire sample period can be observed for different subgroups in Figs. 1 and 2. Fig. 1 shows a spread between turnover among big, international firms and other Euronext stocks. The difference appears to increase in the latter half of the period, once the merger process has started. The figure also suggests that the effect may be gradual and it may take a while for turnover improvements to fully realize. The difference in turnover becomes less pronounced in Fig. 2 which compares the trend among big, international firms in Euronext against same types of firms in Frankfurt, Madrid and London.²² However, there seems to be some degree of divergence starting around the outset of the merger process in 2000. This may be of interest for exchanges contemplating merger in order to improve their competitive position in terms of liquidity, although it is important to note that the different trends across exchanges may of course be unrelated to the merger, i.e. it needs to be quantified whether the merger events are directly associated with any possible outperformance of Euronext listed firms. For example, if the merger events are truly influential, one should expect Euronext listed firms to react more strongly to the events than, say, Frankfurt listed firms. To investigate this, regression (12) estimates the merger effect for a sample of big firms with foreign sales across different exchanges, where firm characteristics now represent the exchanges in which firms are listed. Thus the regression uses Frankfurt, BME and London listed firms as control groups to the Euronext treatment group. In other words, regression (12) compares the change in turnover before and after the merger events (1st difference) between big firms with foreign sales listed on Euronext and big firms with foreign sales listed in Frankfurt, BME or London (2nd difference).²³ Using firms listed in e.g. Germany or Spain as control groups

²²The data covers Frankfurt floor volume but not the Xetra order book, which explains why Frankfurt turnover is lower than in other exchanges.

²³The merger dates for Frankfurt/BME/London listed firms are assumed to be September 2000, May 2001, March 2002 and April 2005. We control separately for turnover trends within each exchange, since we may observe different turnover trends across exchanges due to exchange (country) specific events that are unrelated to the merger. Thus, we measure variation in turnover above the general trend within each exchange around the merger events. The within exchange trend takes a form of a 5th order polynomial (month fixed effects within each exchange would absorb all variation in turnover in the merger months for Frankfurt, BME and London listed firms, because in those exchanges the merger events happen simultaneously across all firms—unlike for Euronext firms).

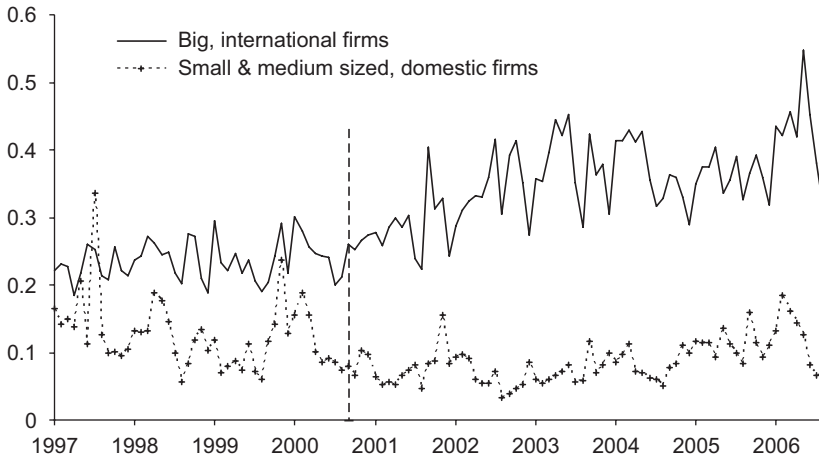


Fig. 1. Turnover trends across Euronext firms.

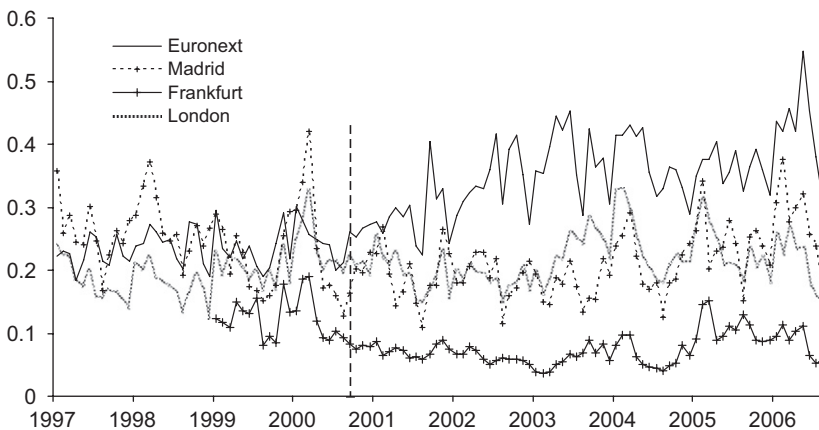


Fig. 2. Turnover trends across exchanges.

addresses concerns such as whether the Euro or EU integration (but not the merger) is driving turnover variation. The results indicate a significant increase in turnover for big Euronext firms with foreign sales, while the same types of firms listed in Frankfurt, BME or London fare relatively worse around the merger dates and experience a net effect close to zero—consistent with the merger benefiting only participating exchanges.

5.2. Merger effect across listing locations

Examining if listing location matters in terms of which firms gain relatively most in terms of liquidity is tricky. First, running a separate regression for each exchange results in collinearity between the event dummies and monthly dummies. Therefore the monthly dummies are replaced by a flexible time trend, i.e. a fifth order polynomial. As before

(regression 4, Table 5), the average turnover of London listed firms with foreign sales is also included to further control for non-merger related events affecting liquidity in world markets. Second, the firm size variables are defined over the whole sample, so when the sample is divided across listing locations, few big (small) firms remain in some sub samples. For example, among the smallest 10% of firms (based on market value), there are only 6 small firms that originally were listed in Amsterdam. Also, nothing is gained by redefining firm size within each exchange separately, since it leads to even fewer firms in some sub samples (8 small Lisbon firms instead of 15). Moreover, redefining firm size within each exchange is problematic because e.g. a big firm within a particular exchange may no longer fulfill the definition of being big on the new, post-merger market. Thus, in order to produce meaningful results the sample size of big (small) firms is increased by widening the size definition to the top (bottom) 20% of firms in terms of market value (the key results of the study are robust to this change in size definition, as is shown in Section 5.1). Third, comparing the merger effect across exchanges is tricky because it is difficult to interpret results in accordance to the hypotheses put forward in Section 2. Specifically, it demands partial judgment by the observer to declare which exchange had the most restrictive regulatory framework before the merger. The results are reported in Table 6.

The merger effect across listing locations is largely consistent with previous results. First, for Paris listed firms we observe a familiar asymmetric pattern in liquidity benefits across firm types. The merger has benefited the largest Paris listed firms and firms with foreign sales, while not influencing the trading activity of small or medium sized firms operating domestically. These results are reassuring as the Paris exchange underwent minimal structural changes with the Euronext merger, since all stocks migrated to the already existing Paris trading system (NSC). Hence, the familiar pattern observed for Paris listed firms suggests that previous results are not likely to be driven by changes in the architectural microstructure that are non-related to the true merger effect. Second, the same general results hold true in the case of Lisbon. Big firms with foreign sales experience higher post-merger trading activity, although the positive effect is only realized if both criteria are fulfilled, i.e. the firm is both big and has foreign sales. Third, controlling for firm size and foreign exposure, the estimates show that medium sized firms without foreign sales listed in Brussels experienced a significantly positive merger effect. This supports the hypothesis that the exchange with the smallest domestic investor base should experience the highest liquidity gains. This result is also intuitive when noting that Belgians share (in part) the same language with neighboring France, which is the most populated Euronext country. With regards to firm heterogeneity, there is a strong positive size effect for Brussels listed firms. There is not a clean foreign sales advantage, but small firms do experience a liquidity gain from having foreign sales. Finally, the merger has not significantly influenced any types of Amsterdam listed firms. The fact that the merger has affected subgroups of firms on all the local exchanges, except Amsterdam, is an intriguing result. What makes Amsterdam listed firms different from firms listed elsewhere? One noteworthy difference is that foreigners were already relatively more involved in the Amsterdam market before the merger, as discussed in Section 2. In fact, an exceptionally high fraction of trading volume in Dutch equities was already generated by foreign investors (Pagano and Steil, 1996). Therefore one would not expect the merger to significantly increase the international attention that Dutch firms receive relatively to firms listed in the other participating exchanges. The pre-existing scale of international

Table 6

Merger effect on turnover across exchanges

The merger dummy shows the combined effect of all four merger events on turnover. Firm size and foreign sales are dummies indicating whether the firm was big/small (in terms of market value) or had foreign sales at the outset of the merger period (there are no firms small with foreign sales listed in Lisbon). All regressions include firm fixed effects, but monthly dummies are replaced by a 5th order polynomial (flexible time trend). Robust standard errors are reported in parenthesis, clustered by security to allow for heterogeneity and autocorrelation within securities. Significance is reported at the 10% (*), 5% (**) and 1% (***) level.

Turnover	Amsterdam	Brussels	Lisbon	Paris
Merger	−0.08 (0.07)	0.05*** (0.02)	0.02 (0.09)	−0.01 (0.03)
For. sales*merger	0.02 (0.07)	−0.01 (0.02)	0.01 (0.06)	0.05** (0.03)
Small*merger	−0.19 (0.18)	−0.03 (0.04)	0.08 (0.07)	−0.00 (0.03)
Big*merger	−0.01 (0.08)	0.09*** (0.03)	−0.06 (0.07)	0.15*** (0.04)
For. sales*small*merger	0.26 (0.25)	0.08* (0.04)	(N/A)	−0.04 (0.03)
For. sales*big*merger	0.14 (0.10)	0.02 (0.05)	0.18** (0.09)	0.03 (0.06)
London turnover	1.07*** (0.13)	0.28*** (0.04)	0.95*** (0.34)	0.47*** (0.04)
GDP per capita	0.01 (0.05)	−0.03 (0.05)	−0.13 (0.25)	0.06 (0.09)
Constant	−0.03 (0.24)	0.15 (0.25)	0.30 (0.56)	−0.28 (0.49)
Fixed effect	Yes	Yes	Yes	Yes
Monthly dummies	No	No	No	No
Flexible time trend	Yes	Yes	Yes	Yes
Number of observations	16,085	13,307	6,514	77,205
Number of small firms	12	23	31	220
Number of big firms	50	24	20	126
Number of firms w/ for. sales	123	69	30	468
Number of firms in total	148	138	67	827
R-squared	0.07	0.03	0.01	0.07

interest in Dutch equities is thus a plausible explanation of why the Euronext merger did not boost trading in Amsterdam listed firms to the same extent as in the other 3 exchanges.

To summarize, in 3 out of 4 exchanges the positive merger effect is concentrated on big firms and (partly) firms with foreign sales. The exception are Amsterdam listed firms, which already were experiencing a high level of foreign interest before the merger took place. Lastly, turnover in each exchange is non-surprisingly positively related to turnover in London.

To supplement the results reported in Table 6, it is informative to plot the evolution of cross-border trading over the merger period. Fig. 3 shows the fraction of cross-border trading within the Euronext market, i.e. the share of value of volume on each Euronext marketplace originating from other Euronext members not located in the corresponding country. For example, the share of total trading in Amsterdam listed firms by members of

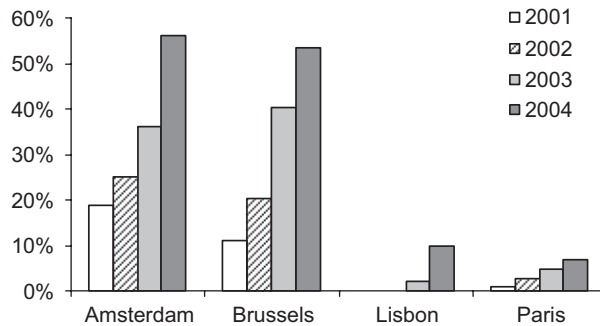


Fig. 3. Share of trade by non-local Euronext members.

other Euronext exchanges rose from 19% to 56%, i.e. it tripled in 2001–2004. Thus there is still an indication that the merger may have increased trading activity on the Amsterdam exchange, but the relative increase is even higher for the other participating exchanges. For Brussels and Lisbon the cross-border trading nearly rose by a factor of five and for Paris the increase was relatively highest, i.e. seven fold (from 1% to 7%). Although it is important to stress that no causation is established, Fig. 3 still suggests that the merger to some extent facilitated cross-border trading among the Euronext exchanges. Also, since value of volume has risen in all exchanges in the sample period, this increase in cross-border trading is not likely to be purely a substitution effect where investors shift their focus from the domestic market to the foreign one.

Finally, it should be briefly noted that the merger effect across industries is also examined (not reported). In other words, have firms in particular industries gained relatively more liquidity following the merger? Controlling for firm size and foreign exposure, the results do not show any clear indication of heterogeneous industry effects, i.e. the average firm in one industry did not enjoy relatively higher liquidity than the average firm in any other industry.

5.3. Other liquidity dimensions and outcome variables

The previous section indicates that the Euronext merger increased the level of trading volume in big firms and firms with foreign sales. In other words, liquidity increased in the sense that trading activity (turnover) for these firms rose. The turnover measure thus directly answers whether the merger successfully expanded the level of (foreign) trading in the participating exchanges. This is what the study set out to analyze and it is the liquidity dimension that the merger hypotheses in Section 2 directly relate to. But there are also other liquidity dimensions that are interesting to explore, such as how much will a trade cost, how long will it take and what will be the impact on market price? Two additional liquidity measures are introduced in this section that capture the cost and market impact dimensions of liquidity, namely bid-ask spreads and the Amivest liquidity ratio. These measures are introduced to append to the overall analysis of how the merger has affected stock liquidity in broader terms.

The Amivest ratio is a liquidity measure that relates to the depth of the market, i.e. the impact trading has on market price. In other words, it captures the notion that large

amounts can be traded in a liquid stock without any significant changes in the stock price. Limited price sensitivity is desirable as it reduces volatility and thus the uncertainty in the market place. The Amivest ratio measures the trading volume associated with a unit change in stock price. More precisely, it is defined as the monthly Euro volume divided by the monthly sum of the absolute value of daily percentage change in stock price, i.e.

$$\text{Amivest}_i = \frac{\sum_{t=1}^T V_{i,t}}{\sum_{t=1}^T |R_{i,t}|} \quad (2)$$

where $V_{i,t}$ and $|R_{i,t}|$ are Euro trading volume and absolute return, respectively, for stock i on day t (with T being the number of trading days in a month). In other words, the Amivest measure is the average ratio of Euro volume to absolute return, where the average is taken over all days in the relevant month. A high Amivest ratio therefore indicates that investors can trade a large number of shares without big changes in price. Hence, an increase (decrease) in the Amivest measure shows an increase (decrease) in market depth. Sample distributions of the Amivest liquidity ratio often exhibit extreme values (Hasbrouck, 2005) and thus we follow the common practice of taking the natural log of the Amivest measure in the subsequent analysis.²⁴

Columns (1) and (2) in Table 7 report the key regression equations of the previous sections, where the Amivest ratio is now the measure of liquidity. Interestingly, the results depict a significant merger coefficient, implying that the merger has benefited the average firm (regression (1)). Therefore, the market has deepened on average. However, when estimating the merger effect on different firm types separately, regression (2) reveals that the positive merger effect is limited to a sub-sample of firms. As with the turnover liquidity dimension, the positive merger effects are concentrated on big firms and firms with foreign sales, while other firm types are not affected. The coefficient estimate for big firms in regression (2) implies that 90% more Euros need to shift hands after the merger to produce a 1% change in stock price, compared to the average firm.²⁵ Thus, the market has deepened substantially for the largest capitalization stocks. The same is true for firms with foreign sales where the liquidity gain is relatively higher than for other firm types, akin to the results that apply to the turnover measure. In short, the results for the turnover liquidity measure (market activity) also apply for the Amivest liquidity ratio (market depth), i.e. the merger is not only associated with an increase in turnover for big firms and firms with foreign sales, it also increases the market depth of these stocks.

²⁴See for example Cooper, Groth, and Avera (1985) and Amihud, Mendelson, and Lauterbach (1997). Other microstructure studies employing the Amivest measure include e.g. Hasbrouck (2005), Adaoglu (2006), Khan and Baker (1993), Berkman and Eleswarapu (1998) and Muscarella and Piwowar (2001).

²⁵The “average firm” refers to a domestic, medium sized firm. The absolute merger effect on big firms (i.e. not relative to other firms) is 0.78 (0.20), obtained as before (see footnote in Section 5.1 accompanying the interpretation of regression (3) in Table 5). Thus, 78% more Euros need to be traded in big firms after the merger for a 1% change to occur in the price of big stocks. The average Amivest measure for big firms in the sample period is 1,722 thousand Euros. Thus, an additional amount of approximately 1,350 thousand Euros need to be traded post-merger for a 1% price change to occur for big firms. For comparison, in Cooper, Groth, and Avera (1985) the average Amivest measure is \$1,699 thousand for the largest stocks listed on NYSE.

Table 7

Merger effect on other outcome variables

The merger dummy shows the combined effect of all four merger events on the Amivest liquidity ratio, bid-ask spreads, stock returns and volatility. The Amivest liquidity ratio captures market depth as it represents the value of volume associated with a unit change in price, i.e. Euros traded per 1% change in price. Bid-ask spreads capture the cost dimension to liquidity and are defined as a percentage of the mid-quote. Returns are measured as daily percentage changes in price and volatility is measured by a rolling estimate (a moving average) of standard deviation over the past 20 business days, which is then scaled to annual volatility for easier interpretability (i.e. multiplied by square-root of 250). Firm size and foreign sales are dummies indicating whether the firm was big/small (in terms of market value) or had foreign sales at the outset of the merger period. Robust standard errors are reported in parenthesis, clustered by security to allow for heterogeneity and autocorrelation within securities. Significance is reported at the 10% (*), 5% (**) and 1% (***) level.

	Ln(Amivest)		Ln(Spread)		Returns		Ln(Volatility)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Merger	0.22*	0.01	−0.16***	−0.01	0.27***	0.25***	−0.36***	−0.34***
	(0.13)	(0.14)	(0.03)	(0.05)	(0.04)	(0.05)	(0.03)	(0.05)
For. sales*merger		0.19*		−0.21***		−0.01		−0.02
		(0.11)		(0.06)		(0.06)		(0.06)
Small*merger		−0.00		0.17		−0.10		0.18*
		(0.21)		(0.14)		(0.18)		(0.10)
Big*merger		0.90***		−0.68***		0.45***		−0.30*
		(0.26)		(0.23)		(0.17)		(0.18)
For. sales*small*merger		−0.03		0.02		0.25		0.42**
		(0.33)		(0.22)		(0.25)		(0.18)
For. sales*big*merger		−0.29		0.35		−0.18		−0.04
		(0.31)		(0.25)		(0.18)		(0.20)
Constant	0.62	0.81	−4.03***	−4.03***	0.25**	0.26**	−1.97	−1.97
	(0.78)	(0.76)	(0.02)	(0.02)	(0.12)	(0.12)	(0.02)	(0.02)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data frequency	Monthly	Monthly	Daily	Daily	Daily	Daily	Daily	Daily
Monthly dummies	Yes	Yes	No	No	No	No	No	No
Within period flexible trend	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	109,459	109,459	358,825	358,825	385,370	385,370	382,988	382,988
Number of firms	1,192	1,192	1,277	1,277	1,284	1,284	1,273	1,273
R-squared	0.03	0.13	0.01	0.10	0.00	0.00	0.01	0.01

Bid-ask spreads capture the cost-dimension of liquidity, i.e. the difference in bid and ask quotes indicates the turnaround costs of transacting in a stock.²⁶ Here it is defined as a percentage of the mid-quote, i.e.

$$\text{Spread}_i = \frac{P_A - P_B}{((P_A + P_B)/2)} \quad (3)$$

²⁶Other possible measures that capture the cost dimension of liquidity are brokerage commission and Roll's (1984) implicit spread. However, brokerage commissions are negotiated and depend on factors that are hard to quantify, such as the size of the transaction, the business value of the particular investor and the time of day or year. The Roll implicit spread is obtained from only transaction price data and is useful in cases where bid-ask quotes are not available. Finally, using intra-day data on bid-ask spreads would be better than daily data, since end of day quotes need not necessarily reflect the average spread of the day. Unfortunately, intra-day data could not be obtained.

where P_A and P_B are the quoted ask and bid prices, respectively. Daily bid-ask spreads are obtained for every firm in the sample (available for 1,277 firms) over a 2-month period surrounding every merger event for each of the four exchanges. This results in more than 350,000 observations. The key regression equations are reported in columns (3) and (4) in Table 7, where a flexible time trend (5th order polynomial) is used to control for time trends within each event window. The results indicate that firms on average have narrower bid-ask spreads post-merger (column 3), but this is driven by liquidity improvements of big firms and firms with foreign sales (column 4). Only for these subsets of firms does the cost dimension of liquidity improve after the merger, consistent with previous results.

The results on bid-ask spreads are consistent with the two other studies that have empirically explored the effect of stock exchange mergers on liquidity. First, Arnold, Hersch, Mulherin, and Netter (1999) show a decline in bid-ask spreads due to 3 regional stock exchange mergers in the US in the 1940s and 50s. Second, Padilla and Pagano (2005) show that the harmonization of clearing systems in the Euronext exchanges lead to a 27% decrease in the bid-ask spreads in a sample of 104 large caps (we obtain a relative 34% decrease for big firms as a result of the clearing system harmonization).

To sum up, any type of post-merger liquidity improvement is concentrated on big firms and firms with foreign sales. The focus has been on the amount of trading (turnover), i.e. whether the level of trading increases as stock exchange merge and traders acquire easier access to foreign markets. This is confirmed by the data, but the increased trading activity is restricted to a sub sample of firms. To supplement these key results, this section indicates that the market depth and trading costs have also improved, but only for the same subset of firms.

Lastly, to make the analysis of the Euronext merger complete, an attempt is made to measure the merger effect on both stock returns and volatility. Given that the volume of trades has increased for big firms and firms with foreign sales, it is likely that increased trading has affected the price of these stocks. However, daily valuation changes that are specifically due to the merger can be hard to capture as stock price is affected by numerous factors, all of which are very hard to control for. Moreover, if traders anticipate the merger to have positive effects they would react as soon as the merger is announced. Examining price movement around the merger announcement dates indicate no abnormal increases in stock returns (not reported). This is consistent with Fig. 1 which shows no observable increases in turnover until the merger process is under way. But note that a valuation effect could occur at other points in time. First, traders might already have anticipated the merger before the formal announcement, in which case it is hard to pinpoint the exact time the effect should realize.²⁷ Second, if traders do not expect the merger to improve liquidity for particular firms (and a priori there is no undisputable reason to think so, as argued in Section 2) they do not bid up stock prices until they observe improvements in liquidity. In this case the merger effect can be analyzed as before, i.e. around the dates where the liquidity improving merger events occur. With these caveats in mind, regressions 5–6 in Table 7 are presented, where daily stock returns are obtained over a 2-month period surrounding every merger event. The results indicate an overall valuation

²⁷Factiva searches indicate that there is considerable media speculation of exchange merger in 1999–2000 where many candidates are named in various sorts of alliances. For example, at this time LSE and Deutsche Börse were planning to merge, OMX attempted to acquire the LSE, up to 8 European exchanges were contemplating a pan-European merger, etc.

increase around the merger dates (regression 5), where the relatively highest increase occurs among the largest set of firms (regression 6). Firms with foreign sales, which experience a more modest increase in turnover than big firms, do not experience a relatively higher valuation gain than the average firm (but a gain nonetheless). Hence, the results are mostly in harmony with the estimated merger effect on liquidity, although the results should perhaps not be overemphasized given the unpredictable nature of price changes.

The merger effect on price volatility is presented in the last two columns of [Table 7](#), where volatility is measured by a rolling estimate (a moving average) of standard deviation over the past 20 business days. Regression 7 indicates an overall decrease in volatility, which is consistent with increased market depth (higher Amivest ratio). There is a considerable volatility decrease among big firms, which is consistent with [Padilla and Pagano \(2005\)](#) who estimate a 25% decrease in volatility among big firms as a result of clearing system harmonization (here this event is associated with a 21% decrease in volatility for big firms). Again there is not an additional volatility decrease for firms with foreign sales beyond that experienced by the average firm. Interestingly, the only group of firms that does not experience lower volatility is small firms, where the net effect is not significantly different from zero.

5.4. Competitive effect of merger

Previous sections indicate that the Euronext merger has increased trading activity in big firms and those with foreign sales, which amounts to about half of the sample firms. Thus it is natural to ask whether this increase in trading on Euronext has affected trading activity in other European exchanges. That is, has Euronext attracted order flow from other exchanges, thereby improving its market share compared to non-merging exchanges? To analyze whether the merger has proved to be an effective means of competition, a simultaneous equation system is estimated where the dependent variable in each equation is the market share of a particular stock exchange. Market share is measured as the fraction of the Euro value of volume across European exchanges. For exchanges involved in mergers, the pre-merger values are summed market shares of the merging exchanges. The explanatory variables of interest are merger event dummies, which in each equation (i.e. for each exchange) capture the change in market share associated with the Euronext merger. Variables which control for other market influences are a flexible time trend (5th order polynomial) and GDP per capita in the country of the relevant exchange. Also, because market share is analyzed, the data effectively controls for overall changes that are common to all stock exchanges (e.g. general rise in value of volume).

The results are reported in [Table 8](#). The data consists of monthly observations from January 2000 to August 2006, where market share is reported in percentage units (i.e. multiplied by 100). The analysis covers six major stock exchanges in Europe, which together hold more than 90% of the European market share. The six exchange regressions (columns) are estimated simultaneously using the seemingly unrelated regression methodology (SURE). First, panel A reports that the merger is associated with a 2.18% increase in Euronext's market share. This is a sizeable change given that the market share of Euronext was 20.5% at the outset of the merger process and when noting that market share is generally a slow-moving variable. The results also indicate that this increase is

Table 8

Merger effect on market shares of exchanges

The merger dummy shows the combined effect of all four merger events on market shares of stock exchanges, where market share is reported in percentage units. Market share is defined in terms of the Euro value of trading volume. The data, which is provided by the Federation of European Securities Exchanges, is from January 2000 to August 2006, i.e. 480 observations in total (80 for each exchange). The event dates for all exchanges are set to September 2000, May 2001, March 2002 and April 2005. In panel A a system of equations is estimated simultaneously (SURE regression), with the dependent variable in each equation being market share of the particular stock exchange. Panel B estimates each equation separately (OLS). Panel C makes small sample adjustments (to panel A) in calculating standard errors. Specifically, this implies using an alternative divisor in computing the covariance matrix for the equation residuals, i.e. $\hat{\sigma}_{ij} = e'_i e_j / n$ is replaced by $\hat{\sigma}_{ij} = e'_i e_j / \sqrt{(n - k_i)(n - k_j)} \cdot \sqrt{(n - k_i)(n - k_j)}$, where k_i and k_j are the number of parameters in equations i and j . Significance is reported at the 10% (*), 5% (**) and 1% (***) level.

Market share	Euronext	Frankfurt	London	BME	Milan	OMX
<i>Panel A</i>						
Merger	2.18** (0.91)	0.74 (0.81)	−5.78*** (1.72)	1.44 (1.08)	1.90* (1.02)	−0.13 (0.52)
GDP per capita	−1.52 (2.65)	−4.85*** (1.80)	4.98 (4.22)	7.13** (3.38)	−6.33** (2.74)	1.63** (0.58)
Constant	28.39* (16.48)	39.52*** (6.88)	9.08 (23.84)	−22.22* (13.38)	41.06*** (13.75)	−4.15 (4.19)
Flexible trend	Yes	Yes	Yes	Yes	Yes	Yes
Mkt. sh. in Jan. 2000 (%)	20.5	18.7	38.2	7.6	8.0	7.0
Number of obs.	80	80	80	80	80	80
R-squared	0.31	0.69	0.52	0.72	0.32	0.44
<i>Panel B</i>						
Merger	2.13** (0.98)	0.77 (0.87)	−5.13*** (1.90)	1.72 (1.18)	2.04* (1.10)	−0.20 (0.56)
GDP per capita	−8.68 (6.45)	−6.41* (3.39)	22.53* (11.77)	16.76** (7.59)	−18.49*** (5.35)	2.34** (0.91)
Constant	72.77 (40.04)	45.39*** (12.86)	−89.73 (66.28)	−60.20** (29.98)	101.91*** (26.82)	−9.14 (6.53)
Flexible trend	Yes	Yes	Yes	Yes	Yes	Yes
Mkt. sh. in Jan. 2000 (%)	20.5	18.7	38.2	7.6	8.0	7.0
Number of obs.	80	80	80	80	80	80
R-squared	0.32	0.69	0.54	0.73	0.37	0.45
<i>Panel C</i>						
Merger	2.18** (0.98)	0.74 (0.87)	−5.78*** (1.86)	1.44 (1.16)	1.90* (1.10)	−0.13 (0.56)
GDP per capita	−1.52 (2.86)	−4.85** (1.94)	4.98 (4.55)	7.13** (3.64)	−6.33** (2.95)	1.63** (0.63)
Constant	28.39* (17.75)	39.52*** (7.41)	9.08 (25.67)	−22.22 (14.41)	41.06*** (14.80)	−4.15 (4.51)
Flexible trend	Yes	Yes	Yes	Yes	Yes	Yes
Mkt. sh. in Jan. 2000 (%)	20.5	18.7	38.2	7.6	8.0	7.0
Number of obs.	80	80	80	80	80	80
R-squared	0.31	0.69	0.52	0.72	0.32	0.44

drawn from the London Stock Exchange, which has experienced a substantial loss in market share. Interestingly, the London exchange is the only exchange which has lost significant market share, which suggests that the merger is associated with trading activity

drifting from London towards Europe's mainland exchanges.²⁸ Overall, four out of the six exchanges have increased their market shares, but the increase is only significant for Euronext and (surprisingly) the Milan exchange. Thus the merger has enhanced the competitive stand of Euronext.

Theoretical papers that partly relate to competitive effects of stock exchange mergers include early papers by Pagano (1989) and Chowdhry and Nanda (1991). They present a theory of clustering of trading volume, i.e. they argue that if transaction costs are limited then liquidity will concentrate on a few markets. Portes and Rey (2005) also demonstrate theoretically that the asset flow is determined by market size. Thus one would expect a bigger exchange, namely the merged Euronext exchange, to attract further market share. The results reported in Table 8 thus support these theoretical arguments. On the empirical side, Arnold, Hersch, Mulherin, and Netter (1999) study the effect of three US regional stock exchange mergers on market share, using the same framework as applied here. They find that two out of the three mergers had a positive effect on the market share of the merging exchange. For the non-effective merger, Arnold, Hersch, Mulherin, and Netter (1999) argue that the lack of significance may be due to limited competition among particular exchanges, e.g. due to being in different time zones. One might thus expect that the Euronext merger would not significantly affect market shares since cross-border competition is likely to be more limited than regional competition. But interestingly, the results in Table 8 indicate that cross-border exchanges are affected by the merger, with Euronext attracting market share from the London exchange.

Although the theoretical literature is in line with Euronext gaining market share as a result of the merger, it does not answer why the increase is primarily at the expense of the London exchange but not other European exchanges. One can only speculate if the new pan-European exchange perhaps created a direct competitor to the London exchange, since the London exchange was no longer the predominantly biggest exchange in Europe.

For robustness, panel B in Table 8 repeats the estimation of panel A, but estimating each equation separately by OLS. Running OLS separately on each exchange equation is only equivalent to the SURE methodology if there is no contemporaneous correlation between error terms across separate exchange regressions. Otherwise the OLS estimator is inefficient (but consistent). The result are almost unchanged, which implies that there is little evidence of a common explanatory factor inducing contemporaneous correlation. For further robustness, it should be noted there are 480 observations in the simultaneous estimation of the six regression equations, which may raise concerns of small sample size. Thus panel C reports estimation results where small sample adjustments are made (to panel A) in calculating standard errors. This implies using an alternative divisor in computing the covariance matrix for the equation residuals, i.e. the asymptotically justified estimator that uses sample observations (n) is replaced by $\sqrt{(n-k_i)(n-k_j)}$, where k_i and k_j are the number of parameters in equations i and j . This adjustment does not have a significant effect on the estimates.

²⁸Note that this does not imply that London's market share has decreased in Europe over the sample period (in fact, it is roughly unchanged), it only means that the Euronext merger has affected its market share negatively. Other factors are likely to have contributed positively to the market share of London throughout the sample period. Likewise, nothing is being said about the change in Euronext's market share in general, only about the changes in market share associated with the merger.

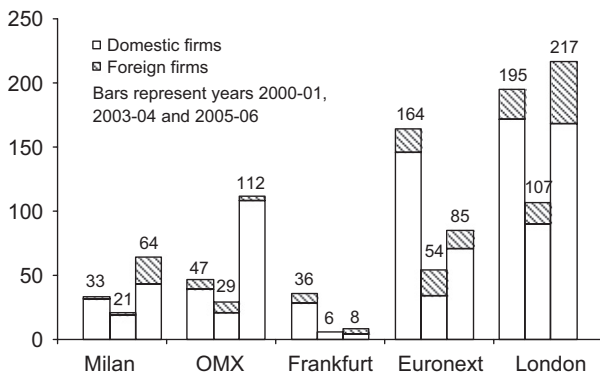


Fig. 4. Number of new firms listing in 2001–2006.

Finally, another informative indicator of the competitive standing of European exchanges is how well they have managed to attract new listings. The evolution of the number of new firms listed is graphed in Fig. 4.²⁹ Euronext has experienced a decline in the number of new listings in the merger period, while three of the other four exchanges have experienced a rise. However, it is more reasonable to compare only the number of foreign listings, since firms typically tend to list in their home countries due to costs of listing abroad, such as complying with foreign regulations and operating in a different language. Thus it is informative to see where foreign listings are concentrated, i.e. in which exchange firms decide to list provided that they choose to list abroad in the first place. Fig. 4 also reveals a similar pattern for foreign firms, i.e. the number of foreign firms listing in Euronext is fairly stable in the merger period and there is no clear indication of Euronext outperforming other exchanges in terms of attracting foreign listings.

6. Concluding remarks

To conclude, stock exchange mergers may not be in the interest of all firms. However, although the liquidity gains are restricted to particular types of firms, namely big firms and those with foreign exposure, there are two things to note. First, the foreign sales effect applies to a large fraction of firms since in the Euronext sample almost every other firm has foreign sales. Second, there is no clear evidence that the Euronext merger led to decreased liquidity for any types of firms, which suggests that the merger may still be Pareto improving.

Nonetheless, the asymmetric distribution of gains is still a concern which is worth contemplating for prospective stock exchange partners. As Magnus Bocker, chief executive of OMX, remarks: “Everyone is starting to see the opportunities that a larger market creates”, while noting that “merger built solely on shareholder value and cost issues will fail” (Economist, 2006b, d).

²⁹BME is excluded from Fig. 4 due to limited data availability on number of firms listed. Also, only the main market of the London Stock Exchange is depicted. In particular, the figure does not include firms listed on AIM, which is a growth market for smaller companies. The AIM market has grown fast in recent years and had 1,634 firms listed in 2006 (462 new listings in 2006, thereof 124 foreign firms).

With regards to future work, a similar framework as is applied here may be used to examine the effects of other stock exchange interactions. For example, the OMX merger between the Nordic and Baltic stock exchanges is an interesting case, where the level of cooperation has followed a similar process as the one for Euronext. Also, the NYSE-Euronext merger is bound to be a focal point of future research, once further steps have been taken towards unification. None of the key merger events outlined in this paper have yet taken place in the trans-atlantic merger process, but if akin steps are taken it will be interesting to see if similar merger effects are realized.³⁰ There are further interesting, unexplored examples of increased merger activity, such as the NASDAQ-OMX merger, the consolidation between London and Milan, mergers among derivative exchanges, various flirting with the Tokyo exchange and Indian stock exchanges—and numerous within country mergers such as in Spain, Japan and India.

Finally, there are of course various complications and practical issues that this study has set aside. For example, changes in the regulatory environment of stock exchanges will be an important concern in the near future. Above all is the “Market in Financial Instrument Directive” (MiFID) that came into play in November 2007, which is an EU directive that aims to make cross-border trading in securities in Europe simpler and promote competition between trading venues. This entails breaking up trading monopolies by removing rules that deter competition and promoting new types of trading venues that can be offered by other financial intermediaries, such as banks (creating so called “dark pools of liquidity”). But even though a legislative fragmentation of liquidity may increase competition among financial service providers, it may also cause many stock exchanges to further consolidate forces and seek safety in size.

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³⁰At the moment Euronext and NYSE representatives are discussing with different regulators on both sides of the Atlantic about possibilities of establishing so-called cross-memberships. This is comparable to the first key merger event in the Euronext process, where members of each local exchange became members of other participating exchanges.

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