

15 November 2017

**DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS
COMPETITION COMMITTEE**

Cancels & replaces the same document of 14 November 2017

**Quantifying Horizontal Merger Efficiencies in Multi-Sided Markets: An
Application to Stock Exchange Mergers - Note by Enrique Andreu and Jorge
Padilla**

**Hearing on Re-thinking the use of traditional antitrust enforcement tools in multi-sided
markets**

21-23 June 2017

This paper by Enrique Andreu and Jorge Padilla was submitted as background material for Item 8 at the 127th meeting of OECD Competition Committee on 21-23 June 2017. This is the final version. The authors were given an opportunity to review and finalise the paper after the discussion.

The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Organisation or of the governments of its member countries. More documents related to this discussion can be found at www.oecd.org/daf/competition/rethinking-antitrust-enforcement-tools-in-multi-sided-markets.htm

JT03422934

Quantifying Horizontal Merger Efficiencies in Multi-Sided Markets: an Application to Stock Exchange Mergers

Note by Enrique Andreu and Jorge Padilla *

Abstract.

Stock exchanges are platforms operating in multi-sided markets. Mergers between stock exchanges can produce significant efficiency benefits, some of which can accrue directly or indirectly to the users of the integrated exchange: intermediaries (brokers and dealers), final investors and issuers (listed companies). In particular, stock exchange integration can reduce the implicit costs of trading by increasing market liquidity. In this paper we investigate the liquidity implications of the integration of Euronext's cash market. We find that the series of cash mergers that led to the creation of Euronext had a positive impact on liquidity – namely, on bid-ask spreads, volatility and traded volume. This exercise illustrates how past mergers can be used to assess empirically the potential efficiencies resulting from mergers between platforms operating in multi-sided markets.

Keywords: Efficiencies, liquidity, mergers, multi-sided markets, platforms regression, thick markets.

JEL numbers: K21, L4, N2

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1. Introduction

1. Multi-sided markets are characterized by the presence of cross-platform welfare effects that users cannot internalize absent pricing and non-pricing coordination by a platform.¹ Those welfare effects can be *access externalities* (the benefit a user on one side of a platform generates for users on the other side of the platform) or *usage externalities* (the benefit a user on one side of a platform generates for a user of the other side of the platform when increasing the number of transactions in that platform).²

2. As explained by Wright (2004) and Evans and Schmalensee (2007), some of the standard economic intuitions that underpin antitrust policy and merger control in traditional (one-sided) markets need not apply in multi-sided markets.³ In particular, mergers between platforms competing in multi-sided markets need not be anticompetitive. First, the merger may be welfare enhancing even when it leads to higher post-merger prices for both sides of the market because users on either side of the merged platform will benefit from increased access to a greater pool of users on the other side of platform.⁴ Second, the merger may even result in a reduction in prices since the merged platform may internalize the cross-group externalities between the merging platforms: if the merging platforms become “interoperable”,⁵ then each of the merging platforms will lower prices to benefit from the increase in demand on the other platform.⁶

3. The empirical evidence of the price and welfare effects of mergers in two-sided markets is sparse. Some of these studies have focused on media markets, since those are considered to be good examples of two-sided markets. Chandra and Collard-Wexler

¹ See, e.g. Rochet, J.C., and J. Tirole (2006) “Two-sided markets: a progress report,” *RAND Journal of Economics*, 37(3): 645-667

² Professors Hermalin and Katz note that in these markets the sum of the socially optimal prices for the platform services will be above or below marginal cost, either because a reduction in the number of users on one side has an infra-marginal impact on the surplus derived from the users of the other side, or because the reduction in the number of users on one side may affect the probability that a user on the other side finds a suitable partner with whom to transact. See Hermalin, B.E, and M. L. Katz (2017) “What’s so special about two-sided markets?,” forthcoming in *Economic theory and public policies: Joseph Stiglitz and the teaching of economics*, Columbia University Press.

³ See, e.g., Wright, J., (2004) “One-sided logic in two-sided markets,” *Review of Network Economics*, 3(1): 44-64, and Evans, D.S., and R. Schmalensee (2007) “The industrial organization of markets with two-sided platforms,” *Competition Policy International*, 3(1): 151.

⁴ Evans, D.S. (2003) “The anti-trust economics of multi-sided platform markets,” *Yale Journal on Regulation*, 20(2): 325-382.

⁵ That is, if users on one side of one the merging platforms can transact with users on the other side of the other merging platforms.

⁶ See Chandra, A., and A. Collard-Wexler (2009) “Mergers in two-sided markets: an application to the Canadian newspaper industry,” *Journal of Economics and Management Strategy*, 18(1), 1045-1070; Fillistrucchi, L., Klein, T., and T. Michielsen (2012) “Assessing unilateral merger effects in a two-sided market: an application to the dutch daily newspaper market”, *Journal of Competition Law and Economics*, 8(2): 297-329; and Baranes, E., Cortade, T. and A. Cosnita-Langlais (2016), “Merger control on two-sided markets: is there need for an efficiency defense?,” NET Institute, available at www.NETinst.org.

(2009) investigated the price effects using data on a series of large merger in the Canadian newspaper industry in the late 1990s.⁷ Chandra and Collard-Wexler employed difference-in-difference and difference-in-difference matching methods to compare price changes in newspapers which change hands with those that did not and found that these mergers did not lead to higher prices either for subscribers or advertisers. More recently, Jeziorski (2014) examines the effects of mergers in the U.S. radio industry.⁸ He finds that they increase listener welfare marginally but have a more significant negative welfare effect on advertisers.

4. A few authors have conducted post-mortem econometric analysis of mergers (i.e. ex-post merger evaluations) among stock exchanges in order to assess their potential efficiencies, if any. Stock exchanges are widely considered to be multi-sided markets.⁹ Stock exchange integration may in principle increase welfare by increasing market liquidity and, hence, reducing the implicit costs of trading. The reduction of implicit costs may in particular result from a reduction of bid-ask spreads or lower price volatility (because a larger and more stable order flow reduces the noise induced by individual orders). There are numerous mechanisms through which stock exchange mergers can increase liquidity and decrease users' implicit costs.¹⁰ A merger between exchanges will increase liquidity if it helps intermediaries to defray the costs of access to the trading platform and of maintaining a continuous market presence. Standardized access to market data, indices and post-trading services helps also the liquidity of integrated cash markets. Also harmonized trading functionality, rules and regulations will reduce the regulatory costs of trading in different markets. In addition, liquidity will increase if the merger reduces adverse-selection costs, due to the presence of informed traders. This will happen if the merger has a positive impact on trading activity and the additional order flow comes mainly from uninformed traders or elicits more aggressive competition between informed ones. A stock exchange merger may also increase liquidity (and lead to lower bid-ask spreads) if it reduces the inventory-holding costs of market makers. This is because the merger is likely to make the order flow more predictable and lower the costs of rebalancing market-makers' inventories after the execution of large orders. Finally, liquidity may increase (and bid-ask spreads may fall) because the merger is likely to induce entry by market professionals operating elsewhere, as a result e.g. of harmonized rules and admission criteria, and thereby lead to greater competitive pressure both in quote-setting and in brokerage fees.

5. In the U.S., Arnold et al. (1999) studied the effects on liquidity of three successive mergers between regional U.S. stock exchanges in the 1940's and 1950's.¹¹ They found that the bid-ask spreads of merged exchanges were narrower than those on the remaining exchanges. The trend towards an efficient, consolidated capital markets

⁷ See Chandra, A., and A. Collard-Wexler (2009), *op. cit.* note 6.

⁸ See Jeziorski P. (2014) "Effects of mergers in two-sided markets: the U.S. radio industry," *American Economic Journal: Microeconomics*, 6(4): 35-73.

⁹ See Cantillon, E., and P.L. Yin (2011), "Competition between exchanges: a research agenda," *International Journal of Industrial Organization*, 29 (3): 329-336.

¹⁰ See Pagano, M., and J. Padilla (2005a), "The economics of cash trading: an overview", report prepared for Euronext, and references therein.

¹¹ See Arnold, T., P. Hersch, J.H. Mulherin, and J. Netter (1999) "Merging Markets", *Journal of Finance*, 54(3): 1083-1107.

infrastructure is more recent in Europe than in the United States, but shows similar benefits. Pagano and Padilla (2005b) investigated the liquidity effects resulting from the integration of the French, Belgian, Dutch and Portuguese stock exchanges between September 2000 and November 2003.¹² These mergers led to the creation of Euronext. This sequence of mergers provides an extremely valuable natural experiment for the purposes of estimating the liquidity effects of cash exchange mergers. First, the multi-stage nature of the Euronext integration process – with three sequential mergers – makes it possible to better identify the liquidity impact of stock exchange mergers, as it allows the empirical estimation to deal more rigorously with spurious correlation. Second, since the timing of the three mergers was predetermined at the outset and there were no departures from the merger plan, there should be no concerns about reverse causality.

6. Pagano and Padilla (2005b) found that the creation of Euronext led to a reduction in the bid-ask spreads of the large-cap securities traded in Paris, Brussels, Amsterdam and Lisbon. They also found that the integration of those exchanges also led to an increase in traded volume and a reduction in volatility for those stocks. Nielsson (2009) also examined the liquidity effects of the Euronext integration process.¹³ Unlike Pagano and Padilla (2005b), he analyzed the impact of the merger on the liquidity of all firms' stocks listed in the Paris, Brussels, Amsterdam and Lisbon exchanges and not just large caps. Nielsson found that the Euronext mergers increased the liquidity and, therefore, reduced the implicit trading costs of large caps. However, he found no statistically significant effect of the merger on small and medium caps.

7. A difficulty with both studies is that their datasets are relatively limited and, in particular, the duration of the post-merger period is short. Pagano and Padilla (2005b) only had data until December 2004 – one year after the last integration event; Nielsson (2009) only until 2006. This raises the concern that the effects that they attribute to the Euronext mergers may not have been properly identified. Since the mergers took place at the time of the collapse of the dot.com bubble (2000-2002) and the recession of the European economy (2000-2001) and the U.S. economy (2002-2004), the post-merger increase in liquidity documented in these papers may simply reflect the growth of trading volumes in the aftermath of these crises.

8. Distinguishing between the liquidity effect of the mergers and these crises requires data on a longer post-merger period than that used in Pagano and Padilla (2005b) and Nielsson (2009). A longer post-merger period could help identify the effect of the mergers correctly because, unlike the effect of the crises, the liquidity impact of a stock exchange merger should be long lasting: the reduction in access costs, adverse selection costs, inventory costs, and the increase in the strength of competition among intermediaries resulting from the merger will likely persist indefinitely.

9. This paper thus revisits the analysis conducted by Pagano and Padilla (2005b) using data from December 2000 to December 2010 to test whether, other things equal, the mergers that led to the creation of Euronext had a long-lasting effect on bid-ask spreads, volatility and volume. Expanding the post-merger period requires controlling for the important changes in European cash trading that took place after the creation of Euronext.

¹² Pagano, M., and J. Padilla (2005b), "Efficiency gains from the integration of exchanges: lessons from the Euronext "natural experiment," report prepared for Euronext.

¹³ Nielsson, Ulf (2009) "Stock exchange merger and liquidity: the case of Euronext," *Journal of Financial Markets*, 12(2): 229-267.

Most importantly, the Markets in Financial Instruments Directive (MiFID) led to the entry of new trading platforms (MTFs), which in a short time captured a significant market share and is likely to have had an effect on liquidity. In addition, Euronext implemented a tick size change in 2007, which is also likely to have had an impact on market liquidity.

10. Our results confirm Pagano and Padilla's conclusions and show that the impact on market liquidity that they identified is long lasting, as one would expect if those effects were indeed caused by the creation of Euronext. Like them, we find that the creation of Euronext increased the liquidity of the merging exchanges. This led to a reduction in the bid-ask spreads and historical volatility of large-cap securities traded in Paris, Brussels, Amsterdam and Lisbon. The creation of Euronext also resulted in an increase in traded volume. These results are not only economically meaningful and statistically significant, they are also robust and unlikely to be explained by omitted variables and reverse causality (endogeneity).

11. This paper also investigates the potential liquidity impact of the merger between Euronext and the NYSE Group (NYSE). This merger took place in April 2007. Because, unlike the Euronext mergers, it did not involve the integration of the trading and clearing platforms of the merging parties, we would expect the merger to have no impact on liquidity. This is indeed what the data shows. We believe these results are consistent with our findings on the creation of Euronext and serve to confirm them, since testing for the liquidity impact of the merger between Euronext and the NYSE Group (NYSE) amounts to performing a "placebo test."

12. The remainder of this paper is structured as follows. Section 2 describes the integration process that led to the creation of Euronext and the subsequent changes to the industry. In Section 3 we investigate the impact of Euronext integration process on bid-ask spreads using different data sources and econometric models. Section 4 presents several robustness tests: using alternative integration dates, different measures of liquidity (volatility and traded volume) and alternative controls. In Section 5, we analyze the impact of the merger between NYSE and Euronext. Section 6 discusses the causal interpretation of the results in Sections 3 to 5. Finally, Section 7 concludes with some more general comments about the assessment of efficiencies in horizontal mergers in multi-sided industries. All tables and figures described in the text can be found in the annexes to the paper.

2. The creation of Euronext

13. The creation of Euronext in September 2000 resulted in the integration of the French, Belgian, Dutch, and Portuguese stock exchanges into a single trading and clearing platform. Prior to the creation of Euronext, there were four separate trading and three separate clearing platforms (Portugal had no CCP). Since November 2003, the users of the Paris, Brussels, Amsterdam, and Lisbon exchanges have operated on a single trading platform and a single clearing platform.

14. The integration of the cash markets that formed Euronext proceeded in stages. First, the trading platform of the Paris market –the NSC system– became the platform for the other three cash markets. In May 2001, the Brussels exchange migrated its trading platform to the NSC system. Amsterdam followed suit in October 2001. Cash trading fees

were harmonized across Amsterdam, Brussels and Paris. The Lisbon exchange migrated to the NSC system in November 2003.

15. The exchanges that form Euronext also integrated their clearing platforms. That process took place in parallel, but with some delay, relative to the integration of the cash trading platforms. The Paris market adopted the externally sourced Clearing 21 system in September 2000. The Brussels cash market was migrated to the Clearing 21 system in March 2002, while Amsterdam migrated in October 2002. Clearing operations across the three locations were consolidated into Clearnet SA. Clearing in Lisbon was created in November 2003.

16. Following Pagano and Padilla (2005b) our analysis considers the liquidity impact of the migration of cash trading and clearing on the Amsterdam, Brussels, Paris and Lisbon cash markets onto common trading and clearing platforms. However, we have also analyzed the potential effect of the integration of the trading platforms as a robustness test.

17. Since the creation of Euronext in November 2003 several events are likely to have impacted the liquidity of the securities traded in Euronext. We highlight (and control for) two such events in this paper. First, in November 2007 competitive trading platforms known as multilateral trading facilities (or MTFs) entered the European cash trading market. They have grown rapidly since then. MTFs are trading systems that make cash instruments from different exchanges or sources available for trading. Currently there are over five different pan-European blue-chip MTFs operating in Europe, the largest of which is Chi-X. Second, in 2007 the Euronext tick size (the minimum price increment at which trades may be made) was reduced and this is likely to have had an impact on liquidity. Previous empirical literature has found that a reduction in the tick size leads to a bid-ask spread reduction. This is because investors are able to tighten their quotes when the minimum price increment becomes smaller.

3. An econometric analysis of Euronext bid-ask spreads

18. In this section we analyze the impact of the creation of Euronext on bid-ask spreads using standard multiple regression techniques. Bid-ask spreads are the most-often used indicator of cash trading liquidity. We first describe the bid-ask spread data we use, the methodology employed and our main results.

3.1. Bid-ask spread data

19. We use the bid-ask spread measure calculated by Bloomberg for the main securities traded in Amsterdam, Brussels, Lisbon and Paris exchanges. The *Bloomberg's bid-ask spread* is defined as the difference between the daily closing ask price (P_A) and the daily closing bid price (P_B), normalized as follows:

$$Bid - Ask Spread = \frac{(P_A - P_B)}{((P_A + P_B)/2)},$$

20. This bid-ask spread measure has been calculated using bid and ask prices provided by Bloomberg for each of the securities included in the main indices of the Paris, Brussels, Amsterdam and Lisbon stock exchanges: CAC 40, BEL 20, AEX, and

PSI, respectively. We have data on a daily basis for the period between 1 December 2000 and 31 December 2010: 362,103 observations.^{14,15}

21. Figure 1 in Annex 1 plots estimated year-month fixed effects for a model of the bid-ask spread on stock i at time t for each of the stock exchanges under analysis. It shows us the evolution of the average (across stocks, within month) bid-ask spread on each stock exchange. For the Amsterdam, Belgium, and Paris exchanges, the basic pattern in the data is: bid-ask spreads remain flat up to 2002 and fall during the post-merger era (until the crisis hits in 2007 and 2008, when bid-ask spreads rise and then subsequently decline as we move into 2010).

3.2. Econometric methodology

22. In order to assess the impact of the creation of Euronext on market liquidity, we conduct a multi-stage *before and after* analysis around the three key integration milestones: (1) the integration of the clearing and trading functions of the Paris and Brussels stock exchanges in March 2002; (2) the integration of the Amsterdam trading and clearing system into Euronext in October 2002; and (3) the integration of the Lisbon stock exchange in November 2003. That is, we compare the daily bid-ask spreads defined above *after* each of the integration dates with the same daily bid-ask spreads *before* integration. Our basic models relate our bid-ask spread measure with an *integration dummy* that equals 1 after integration and 0 before integration.

23. To isolate the impact of the creation of Euronext on bid-ask spreads, we control for other factors that may explain differences in bid-ask spreads over time and across securities traded on the different exchanges. This requires using multiple regression techniques.¹⁶ We include in our basic regression model security fixed effects, a measure of market volatility and indicator variables for relevant macroeconomic, political, and regulatory events.¹⁷ These variables take into account that differences in bid-ask spreads between securities may persist over time and that bid-ask spread fluctuations may be driven by factors other than the integration. We also included controls for volume and volatility from non-Euronext exchanges, domestic GDP per capita, the volume traded at MTFs, and an indicator variable to capture the effect of Euronext's tick change in 2007.

24. More formally, we estimated a security-level panel-data model using Bloomberg's daily, security-level bid-ask spread data and a security-level panel-data model using Euronext's security-level weighted average bid-ask spread data. We used a panel data approach because this allows us to (1) avoid complex aggregation issues, (2) estimate the impact of integration on all the exchanges of the Euronext platform in a single regression, and (3) obtain estimates for the impact of integration in the various exchanges of Euronext that can be readily compared.

25. Our basic security-level panel-data model can be formally written as,

¹⁴ Data includes all securities that have composed each index at any time throughout the sample period.

¹⁵ Annex 1 provides descriptive statistics on the bid-ask spreads provided by Bloomberg. Note that these are normalized bid-ask spreads.

¹⁶ These techniques make it possible to estimate the relationship between two variables when the variable under investigation is potentially influenced by many other factors.

¹⁷ A list of these events is reported in Annex 2.

$$y_{it} = \alpha + \beta_1 \text{Integration}_{it} + \beta_2 Z_{it} + \beta_3 X_{it} + \eta_i + \lambda_t + \varepsilon_{it}$$

where:¹⁸

- y_{it} is the natural logarithm of the bid-ask spread of security i at period t .
- Integration_{it} is a dummy variable that takes the value of 1 for any security i and period t after the integration of the trading and clearing platforms of the exchange where security i is traded, and 0 otherwise. The sign of the coefficient of the integration dummy characterizes the relation between the bid-ask spread and the creation of Euronext. A negative sign would indicate that bid-ask spreads declined (and thus liquidity increased) as a result of the creation of Euronext.
- Z_{it} is a vector of variables that control for other determinants of the liquidity of the market. We included: the (20-day) historical volatility of the FTSE100 and DAX indices (source: Bloomberg); the traded volume on the Frankfurt exchange (source: Deutsche Börse); a tick size dummy, which takes a value of 1 after 2007 and is equal to 0 before then;¹⁹ the per capita GDP of each of the countries with Euronext exchanges (source: Eurostat); and the volume traded at MTFs (source: Bloomberg).²⁰

26. The first two controls are meant to capture common trends of a global or pan-European nature that could have affected the bid-ask spreads of Euronext's large-cap securities and that have nothing to do with the process of formation of Euronext. We would expect to find a positive relation between bid-ask spreads and the volatility of the FTSE100 and DAX indices, and a negative relationship between bid-ask spreads and the volume traded on the Frankfurt exchange, a proxy for market growth. The tick size dummy is meant to capture the impact on liquidity of the reduction in tick size implemented in all Euronext exchanges in 2007. We introduce a GDP per capita measure because it may drive the volume traded in each of the four Euronext exchanges. Increases in volume may have an impact on liquidity and, hence, on bid-ask spreads. Finally, the volume traded at MTFs may also have had an impact on the liquidity of the regulated exchanges that integrated Euronext and thus on their bid-ask spreads. The sign of this variable may be negative (if it proxies an increase in overall traded volume) or positive (if MTFs divert significant liquidity out of the regulated exchanges).

- X_{it} is a vector of dummy variables that controls for some relevant economic and political events. These events may have affected the liquidity of the Euronext exchanges before and after the creation of Euronext (see the list of events considered in Annex 2).
- η_i is a vector of fixed effects: one per security. These dummies are introduced to capture security-specific factors that may influence the liquidity of those securities and that are independent of the process of integration.

¹⁸ See Annex 3 for further description of the variables and data used in this paper.

¹⁹ See Euronext (2007), "Further information following the info-flash of 5 January 2007 regarding new trading hours and tick size on the Euronext Cash Market.

²⁰ We include the daily volume of securities listed in the CAC 40, BEL 20, AEX and PSI indices traded on Chi-X and Bats.

- λ_t is a vector of monthly fixed effects. These dummies control for monthly-specific shocks that may have affected liquidity in the stock exchange markets under consideration and that have nothing to do with the process of integration.
- ε_{it} denotes the standard statistical error.

27. This panel data model is estimated using ordinary least squares (OLS). We calculate robust standard errors, clustering at the security level to allow for heteroskedasticity and autocorrelation of the errors. Because the creation of Euronext was triggered by an exogenous policy decision, we can safely place a causal interpretation on the econometric estimates for the *Integration* dummy, provided other relevant changes in the economic environment are controlled for. Causality runs from the integration events to the estimated changes in liquidity.²¹

3.3. Econometric results

28. This Section reports the results of the econometric estimation of the basic model described above.²² Table 3 presents the results of our empirical analysis using the Bloomberg measure of the daily bid-ask spreads of the securities included in the main indices of the Amsterdam, Brussels, Lisbon and Paris stock exchanges. Column (1) describes the impact of integration on the average bid-ask spread of the securities listed in those exchanges. Columns (2) and (3) replicate the model in Column (1) controlling for changes in the volatility of the DAX index²³ and in the volume traded on the Frankfurt exchange. These controls are added to take account of potential liquidity trends that are unrelated to the creation of Euronext. Column (4) also includes the effect of the Euronext tick size reduction in 2007, and Columns (5) and (6) control in addition for the entry and growth of MTFs and changes in per capita GDP in each of the four Euronext countries. Once again, the logic behind these controls is to isolate the liquidity impact of the creation of Euronext and avoid confounding it with the effects of these other variables.

29. The regressions in all columns include monthly dummies, security dummies and dummies controlling for a few salient events that may have affected the behavior of bid-ask spreads in the relevant exchanges. Across all specifications we find that the average bid-ask spreads of the securities included in the main indices of the Paris, Brussels, Amsterdam and Lisbon stock exchanges fell as a result of the creation of Euronext. This effect is statistically significant in Columns (1) to (3) which include controls for changes in the volatility of the securities listed in the DAX and traded volumes on the Frankfurt exchange. Both of these control variables have the expected sign (positive for volatility and negative for traded volumes) and are statistically significant.

30. However, when we include the indicator for the change in the tick size, the growth of MTFs and GDP per capita as controls, the estimated impact of the integration continues to be negative but is no longer statistically significant. Each of the additional control variables has an impact on bid-ask spreads that is consistent with finance and

²¹ See also Nielsson (2009, page 12) for further discussion of this issue.

²² The main econometric results in this paper are included in Tables 3 to 5 and can be found in Annex 4 below.

²³ Results are unchanged if we replace this volatility measure for the volatility of the FTSE index. See Annex 5 below.

economic theory. The tick size reduction led to a reduction in the bid-ask spread as did the increasing volume of trades on MTFs and the GDP per capita.

31. The loss of statistical significance of the integration dummy in Columns (4) to (6) should not be a matter of concern, as is most likely due to multicollinearity.²⁴ A way to test for this is to disaggregate the impact of integration to consider the changes in bid-ask spreads resulting from each of the three steps in the creation of Euronext. The sequential nature of Euronext's integration process allows the empirical analysis to control in part for spurious correlations that could bias the estimation of the impact of integration.

32. This can be done in two alternative ways. First, we define three different integration dummies: *Phase 1* (which equals 1 for any security i and period t after the integration of Brussels with Paris if security i is traded either in Brussels or Paris, and 0 otherwise); *Phase 2* (which equals 1 for any security i and period t after the integration of Amsterdam if security i is traded either in Brussels, Paris or Amsterdam, and 0 otherwise), and *Phase 3* (which equals 1 for any security i and period t after the integration of Lisbon if security i is traded either in Brussels, Paris, Amsterdam or Lisbon, and 0 otherwise). This approach makes it easier to disentangle the liquidity impact of the integration from the effects of other unrelated changes that may have occurred post-merger.

33. Table 4 presents the results of this alternative modelling approach. We find a statistically significant and material decline of the average bid-ask spreads of the securities included in the main indices of the Paris, Brussels, Amsterdam and Lisbon stock exchanges as a result of the creation of Euronext under all specifications (i.e., in Columns (1) to (6)). In particular, *Phase 1* and *Phase 3* are statistically significant even when we include the indicator for the change in the tick size, the growth of MTFs and GDP per capita as controls. Note also that the estimated coefficients of all of the control variables continue to be statistically significant and have signs which are consistent with economic and finance theory. The estimated coefficients of the three phase variables in Columns (5) and (6) imply that the creation of Euronext has led to a non-transitory reduction in bid-ask spreads of approximately 50%. Columns (5) and (6) also show that the largest decline occurred when the Brussels and Paris exchanges were integrated. The subsequent integration of the Amsterdam and Lisbon exchanges had a smaller impact on the bid-ask spreads.

34. An alternative approach is to replace the integration dummy in Table 3 by four country-specific integration dummies: *Paris* (which takes a value of 1 for any security i traded in Paris and period t after the integration of Brussels with Paris, and 0 otherwise); *Brussels* (which takes a value of 1 for any security i traded in Brussels and period t after the integration of Brussels with Paris, and 0 otherwise); *Amsterdam* (which takes the value of 1 for any security i traded in Amsterdam and period t after the integration of Amsterdam in the Euronext platform, and 0 otherwise); and *Lisbon* (which takes the value of 1 for any security i traded in Lisbon and period t after the integration of Lisbon in the Euronext platform, and 0 otherwise). These variables may capture the differential effect of integration on the Paris, Brussels, Amsterdam and Lisbon markets. This is

²⁴ Multicollinearity occurs when some of the control variables are linearly related. When this linear relationship is strong, the variation in the explanatory variables is insufficient to accurately calculate the effect of these explanatory variables on the dependent variable. See Kennedy P. (2003), *A Guide to Econometrics* 5th edition, Cambridge: MIT Press, Chapter 11.

important since the liquidity impact of Euronext's creation may have been different in the various exchanges, reflecting differences, among other things, in size, depth and breadth.

35. Table 5 presents the results of this alternative modelling approach. We find that the negative effect of integration on the average bid-ask spread identified in Table 4 is largely driven by the effect of integration on the liquidity of the securities listed in the CAC 40 and the BEL 20. Note that this is true even after controlling for the change in the tick size in 2007, the entry and subsequent growth of MTFs, and GDP per capita. From Columns (4) and (5), we observe that the average bid-ask spread of the securities in the CAC 40 fell approximately 59% as a result of integration. The bid-ask spread of the securities in the BEL20 fell approximately 25%. These effects are material and statistically significant. The results for Amsterdam are not so clear cut, however. We find that while the impact of integration on the bid-ask spreads of the securities listed in the Amsterdam index was to reduce spreads, the relation is not statistically significant. Finally, we note that integration led to an increase of the bid-ask spreads in Lisbon.²⁵

4. Robustness tests

36. In this section we report the results of several robustness tests.²⁶ First, we repeat the various analyses in Section III using different integration milestones: we employ as relevant cut offs the dates at which the trading platforms of the different exchanges were integrated, as opposed to the dates at which their clearing platforms were integrated. Second, we investigate the impact of the creation of Euronext on alternatives measures of liquidity: volatility and volume. Third, we present the results of our econometric analysis adding the price of the securities and market capitalization as additional explanatory variables. The results of these robustness checks confirm the main findings of Section III, namely that the creation of Euronext increased the liquidity of the merging exchanges and, therefore, reduced the implicit costs of trading. The increase in liquidity is reflected in lower bid-ask spreads even after using alternative integration dates. It also results in lower volatility and higher volume.

4.1. Alternative integration milestones

37. Using Bloomberg's bid-ask spread data, we analyze the impact of the creation of Euronext on liquidity using the dates of trading platform integration as the cut off points that separate the three different phases of the creation of Euronext: the merger of Paris and Brussels, the integration of Amsterdam and the integration of Lisbon. We employ the same methodology and control variables as in section III, but for expositional simplicity restrict attention to the regression using the *Phase 1*, *Phase 2* and *Phase 3* dummies as dependent variables.

38. Table 6 presents the results of the econometric analysis. As above we comment the results reported in Columns (5) and (6) only, because they include all relevant

²⁵ This could be consistent with Pagano (1989) and Chowdry and Nanda (1991) who argue that liquidity will tend to concentrate in a few markets if transaction costs are limited. See Pagano, M. (1989), "Trading volume and asset liquidity", *Quarterly Journal of Economics*, 104(2), 255-274 and Chowdry, B. and V. Nanda (1991), "Multimarket trading and market liquidity", *Review of Financial Studies*, 4(3), 483-511.

²⁶ The tables discussed in this Section can be found in Annex 5 below.

controls.²⁷ The three integration dummies have a negative sign, indicating that each of the three exchange mergers had a positive impact on liquidity and, hence, led to a reduction in the implicit costs of trading. The estimates of the coefficients for *Phase 1* and *Phase 3* are statistically significant. While the coefficient for the *Phase 2* dummy is not statistically significant, this does not necessarily imply that the merger of Amsterdam had no liquidity impact. This is because the integration of Amsterdam into Euronext took place only five months after the integration of Paris and Brussels and, as a result, our model may not be able to estimate with sufficient precision the effect of *Phase 2* of the integration process. The largest decline in bid-ask spreads occurred at the time of the integration of the Paris and Brussels exchanges.

4.2. Alternative measures of liquidity

39. We analyze the impact of the creation of Euronext on two additional liquidity measures: volatility and volume.²⁸

4.2.1. Impact on volatility

40. Other things equal, markets with a large number of traders (i.e., thick markets) are less volatile than thinner markets. Larger and more stable order flows in thick markets reduce the noise induced by individual orders, since they tend to average out and, therefore, to exert less pressure on prices. Moreover, thick markets have a tighter bid-ask spread and thus the “bid-ask price bounce” induced by large orders is smaller. In addition, the price concession necessary to execute a large order is smaller in thick markets because there is a greater likelihood of finding a trading counterparty. For all these reasons, a merger between exchanges that results in a thicker market should lead also to lower volatility.²⁹

41. Following Pagano and Padilla (2005b), we analyze the impact of integration on volatility using 20-day historical volatility data for the securities included in the CAC 40, BEL 20, AEX, and PSI. The source of this data is Bloomberg. We have data on a daily basis for the period between 3 January 2000 and 31 December 2010. The number of observations is 365,335. We use the same econometric methodology employed in section III. We include all controls used above plus, in addition, the historical volatility of the CAC 40, BEL 20, AEX, and PSI indices. We introduce this variable as an additional way to isolate, to the extent possible, the effect of integration on volatility from other confounding factors such as shocks to the global or European economy, or shocks that are idiosyncratic to the exchanges considered but are not related to the integration process.³⁰

42. Table 7 presents the results of the econometric analysis of the impact on volatility of the creation of Euronext using *Integration* as the dependent variable. We find that the historical volatility of the large-cap securities traded in Paris, Brussels, Amsterdam and Lisbon fell as a result of the creation of Euronext. This effect is statistically significant in

²⁷ Note however that the results reported in Columns (1) to (4) are qualitatively similar.

²⁸ See Annex 3 for precise definitions of these measures.

²⁹ Pagano, M. (1989a) “Endogenous market thinness and stock price volatility”, *Review of Economic Studies*, 56: 268-288.

³⁰ Results including this additional control can be found in Column (3) in Table 7. Because of the addition of this additional variable we have seven columns in Table 7.

all specifications. It is also material from an economic viewpoint. According to the estimation in Columns (6) and (7), which are the ones that we prefer given that they include all relevant controls, volatility fell on average approximately 9% once the integration of the four exchanges was completed.

4.2.2. *Impact on volume*

43. We also analyze the impact of the creation of Euronext on traded volume, measured for the purposes of this analysis by the number of shares traded for the securities included in the CAC 40, BEL 20, AEX, and PSI. The number of shares traded for these securities has been obtained from Bloomberg. We have data on a daily basis for the period between 3 January 2000 and 31 December 2010. The number of observations is 382,146. Once again we use the same methodology and the same control variables as in section 3.

44. Table 8 presents the results of the econometric analysis. We find that traded volume in the Paris, Brussels, Amsterdam and Lisbon exchanges increased as a result of the creation of Euronext. This effect is statistically significant. It is also material from an economic viewpoint. According to the estimations in Columns (5) and (6), which are the ones that we prefer given that they include all relevant controls, volume increased by approximately 25% in the period after the integration. A thicker market (i.e., a market with more traders and greater traded volume) is a more liquid market.³¹ Therefore, our findings on the effect of the Euronext mergers on traded volume confirm our previous results on bid-ask spreads and volatility: the Euronext mergers increased liquidity.

4.3. Additional control variables

45. The regression models described above are used to estimate the impact of integration on the average bid-ask spread of the securities listed in those exchanges controlling for changes in the volatility of the DAX index, the volume traded on the Frankfurt exchange, the effect of the Euronext tick size reduction in 2007, the entry and growth of MTFs and changes in per capita GDP. These controls are included in the regression model to isolate the liquidity impact of the creation of Euronext from the effect of these other variables on the bid-ask spread. As a further robustness test on the results, we re-estimated our models including the price of the securities and market capitalization as additional explanatory variables.³² The detailed regression results are shown in Tables 9 to 14 in Annex 5 below. We find that the inclusion of these variables does not alter the conclusions of the analysis reported by the Parties. In particular, we continue to find that the integration of Euronext's clearing and trading platforms led to a statistically significant and economically material increase in liquidity, as measured by the (normalized) bid-ask spread.

³¹ Pagano, M. (1989b) "Trading volume and asset liquidity", *Quarterly Journal of Economics*, 104: 255-274.

³² The models were estimated including as control variables the price of the securities and market capitalization variables separately and including both variables jointly. Note that floating market capitalization data from Bloomberg is only available as of January 2005, and therefore, it is not possible to include this variable as an additional control variable. Our results remain qualitatively unaltered irrespective of whether the price of the securities and market capitalization variables are included separately or jointly.

5. The NYSE- Euronext merger

46. The NYSE- Euronext merger took place in April 2007. In this section, we explore the impact of the NYSE-Euronext merger in April 2007 on the bid-ask spreads of the Euronext exchanges. We would expect to find no statistically significant impact of the merger on bid-ask spreads, given that the merger did not involve the integration of the trading and/or clearing platforms of NYSE and Euronext. We use the same methodology and the same control variables as in section 3, except that we add a dummy variable (*NYSE merger*) that takes the value of one after 4 April 2007 and zero otherwise. We restrict the sample to three years before and after the NYSE-Euronext merger to isolate the impact of this event. Estimation results are presented in Table 15.³³ We find no effect of the merger once we control for the tick size reduction and the entrance of MTFs. This implies that the liquidity effects that we have identified in this paper are not due to a mere change in ownership but rather the consequence of the integration of the underlying trading and clearing platforms of the merging exchanges.

6. Identification and causality

47. Our econometric results show that exchange mergers that result in the integration of the underlying trading and clearing platforms produce material liquidity effects, which reduce the *implicit* cost of trading and thus ought to benefit market participants and offset the potentially adverse impact of the merger on exchange fees (i.e. the *explicit* cost of trading). However, before these results can be extrapolated to other mergers across stock changes, a few comments on endogeneity and causality are in order.

48. First, the multi-stage nature of the Euronext integration process –with three sequential mergers– makes it possible in our opinion to identify the liquidity impact of stock exchange mergers. In particular, we agree with Pagano and Padilla (2005b) and Nielsson (2009) that the staggered introduction of merger events across the four participating exchanges allows the empirical estimation to deal more rigorously with spurious correlation.

49. Second, to the best of our knowledge, the timing of the four mergers was predetermined at the outset and there were no departures from the merger plan. Therefore, we believe that there are no reasons to doubt the causal interpretation we have given to our regression results. We find no reason to be concerned about reverse causality and spurious correlation. There is no evidence that liquidity increased in the years prior to the merger. There is also no evidence that a third omitted factor triggered the mergers and the change in liquidity.

50. In particular, there is no evidence of a downward trend in the data,³⁴ as we proceed to discuss. Note first that if there was an omitted trend, we would expect the residuals of a model like those reported in Section 3 which excluded the integration dummies, *Integration_{it}*, to show a continuously declining trend. However, as shown in Figure 2 in Annex 7, this is not the case. (Dotted lines show the integration dates.) The time evolution of the residuals (the bid-ask component not explained by all relevant controls except the merger integration indicators) reveals that the main trends present in

³³ See Annex 6.

³⁴ See next Section for further discussion on this issue.

the original data are properly captured by the control variables included in the models presented in Section III. The difference between actual and predicted bid-ask spreads follow a stable pattern during the pre-merger period and then during the post-merger. However, it falls significantly below their pre-merger mean value once exchanges are integrated into Euronext, indicating the presence of a level shift following the mergers. Thus, the analysis of the difference between actual and predicted bid-ask spreads does not show a downward trend prior to the integration of the Euronext exchanges. On the contrary, the graphical analysis show a different evolution of the bid ask spreads before (fluctuating around a stable mean) and after (decreasing over time) the integration of the exchanges. In other words, it appears to require the introduction of step functions like the integration dummies in the models of Section III.

51. We have tested for the existence of an omitted trend indicating a general trend toward increasing liquidity that was unrelated to the Euronext integration more formally. In particular, we have modified the models in Section III above by removing the integration dummies, $Integration_{it}$, and introducing instead a series of quarter-year fixed effects for each exchange. That is, for each exchange, we have introduced as many dummy variables as quarters in the sample; each quarter dummy takes a value of 1 in that quarter and 0 otherwise. We have then estimated the exchange by exchange, instead of pooling all exchanges into a single regression. The results are consistent with those in Section III above.³⁵ Figure 3 in Annex 7 shows the results of the estimated quarterly fixed effects of the modified. None of these estimates shows a downward trending pattern, which further confirms that the effects of the Euronext mergers are not picking up an omitted long-term trend.

52. Third, the mergers that gave rise to Euronext involved exchanges with a similar structure. They were all hybrid markets with limit order book emphasis. They had all introduced an order driven, electronic, continuous market at the time of the merger. Therefore, the liquidity impact we have identified cannot be attributed to changes in market structure.

53. Fourth, while Amsterdam had demutualized in 1997, a few years before its integration in Euronext, the other three mergers demutualized as part of the merger. This may raise doubts about whether the liquidity impact that we have attributed to the mergers is instead the effect of demutualization. We do not believe that this alternative explanation is correct. While the economic literature has found that demutualization is likely to have an impact on the liquidity of the newly demutualized exchange,³⁶ there is no evidence of effects across exchanges. However, we find evidence that each sequential merger had a positive impact on the liquidity of the Paris and Brussels exchanges. We also find evidence that the integration process increased liquidity in Amsterdam, which as noted before had demutualized prior to the merger.

54. Fifth, our results on the liquidity effect of the merger cannot be attributed to tick size harmonization. This is for the following reasons: (a) the Paris exchange – which benefited most from the merger in terms of increased liquidity – introduced new tick sizes in 1999, before the start of the integration; (b) Amsterdam and Lisbon aligned their tick sizes to the Paris model in dates that did not overlap with the merger dates; (c) while

³⁵ See Tables 16 to 19 in Annex 7.

³⁶ Aggarwal, R., (2002), “Demutualization and corporate governance of stock exchanges”, *Journal of Applied Corporate Finance*, 15(1): 105-113.

changes in tick size may have an impact on the liquidity of the stock exchange where the tick change occurs, we find evidence that each merger had an impact on the other participating exchanges; and (d) we find a permanent effect of each phase of integration even after controlling for the tick change of 2007, which does not square with an alternative interpretation that attributes the liquidity effects of the creation of integration to the process of tick size harmonization that run parallel to the integration process.

55. Sixth, the Euronext integrations pre-dated the introduction of MTFs. The effects that the model identifies are therefore clearly attributable to the mergers. However, our econometric analysis of efficiencies in the cash market also indicates that the introduction and subsequent growth of MTFs led to a statistically significant increase in liquidity, i.e. a reduction in bid-ask spreads and volatility and an increase in traded volume. There is no contradiction between the positive effects of exchange fragmentation, which results in increasing competition for a given security and, hence, a possible reduction in the *explicit* cost of trading and integration, and exchange integration, where different securities traded in different venues are pooled together and distributed to a wider set of traders.

7. Concluding remarks

56. Stock exchanges are platforms that coordinate traders willing to sell with those willing to buy. Because traders in either side can be inefficiently rationed and not all traders provide good matchings to their potential counterparts, stock exchanges are clear-cut examples of multi-sided platforms. Therefore, mergers between exchanges need not lead to higher prices and, on the contrary, are likely to benefit all, or some, of the market participants by increasing liquidity. In this paper we have shown that the efficiency effects of mergers in multi-sided markets, such as stock exchanges, are not merely theoretical and can be assessed using standard econometric techniques. Note finally that while some of these efficiencies might have been clawed back in the form of higher trading fees, a significant share of them must have been appropriated by the users of Euronext. This would be true in a one-sided market, since not even a monopolist would normally be able to fully appropriate these demand-side efficiencies, but is even more so in multi-sided markets, where post-merger price competition may be fiercer.

57. This paper illustrates how the efficiencies created by the merger of two or more platforms can be estimated empirically *ex post*. The so-called *post-mortem approach* to the quantification of horizontal merger efficiencies requires estimating the link between past concentrations and platform measures which directly or indirectly capture the magnitude of the access and usage externalities benefiting users on both sides of the platform. As we have seen above, this is a complex exercise because it requires controlling for possible confounding factors, taking into account the potential endogeneity of the mergers, performing robustness tests, etc. Extrapolating the results of *ex-post* analyses of this sort when reviewing a new merger is also challenging, since not all mergers are equal and the market context where the past mergers took place may not resemble that applying to the new transaction. However, none of this means that this approach has no value. The alternative is to simulate the impact of the platform merger on users' utilities or profits. This requires estimating demand functions on both sides of the market, including direct and indirect network effects, which is a much more complex exercise. Besides the usual complexity in demand estimation, these simulations must take account of the degree of interoperability across the merging platforms that existed pre-merger and of the prevalence of multi-homing in one or more market sides.

Annex 1: Descriptive statistics

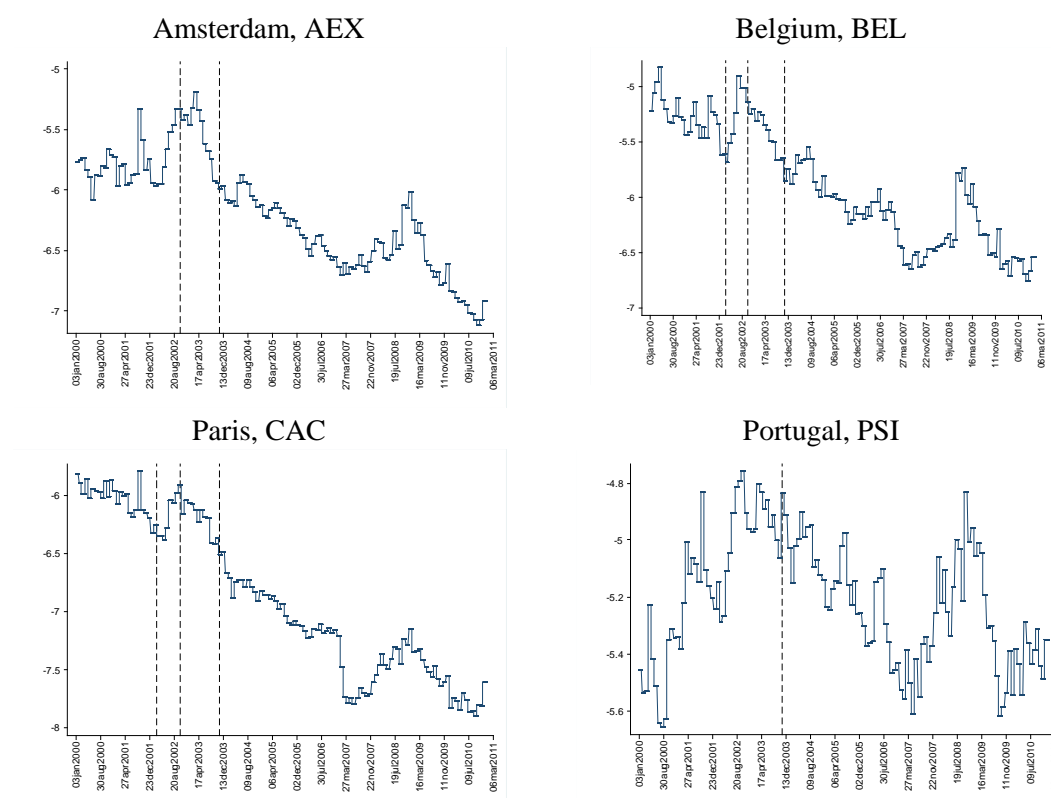
Table 1 provides descriptive statistics on the (normalized) bid-ask spreads provided by Bloomberg.

Table 1. Descriptive statistics for the Bloomberg-based bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, 3 January 2000 – 31 December 2010

Index	Number of observations	Average	Standard deviation	Minimum	Maximum
Amsterdam (AEX)	98,613	0.012	0.052	0	1.887
Belgium (BEL)	69,892	0.005	0.013	0	1.78
Paris (CAC)	114,825	0.002	0.003	0	0.479
Lisbon (PSI)	78,773	0.012	0.060	0	1.995

Source: Bloomberg e.

Figure 1. Estimated year-month fixed effects – Bid-ask spread for AEX, BEL, CAC, and PSI securities. Jan 2000-Dec 2010



Note: The vertical lines indicate the different consolidation dates of the Paris, Brussels and Amsterdam exchanges into Euronext. The first line shows the integration of the Paris and Brussels exchanges, the second one the integration of the Amsterdam exchange and the third one, the integration of the Lisbon exchange..

Source: Bid-ask spreads calculated using price data provided by Bloomberg.

Annex 2: List of events

- April 18, 2000: crash of high-tech share values;
- May 3, 2001: new economic regulation in France - financial, competition and enterprise regulations;
- September 11, 2001: terrorist attacks in New York and Washington D.C.;
- October 8, 2001: invasion of Afghanistan.
- December 3, 2001: Enron bankruptcy filed and Argentine financial crisis;
- October 14, 2002: Bali terrorist attack;
- March 21, 2003: invasion of Iraq;
- March 11, 2004: terrorist attacks in Madrid;
- May 29, 2005: rejection of European Constitution by France;
- July 7, 2005: London terrorist bombings;
- October 27, 2005: French riots;
- May 2006: Bird flu outbreak;
- July 12, 2006: war in Lebanon;
- October 24, 2007: Merrill Lynch announces \$8.4 billion loss;
- March 16, 2008: Bear Stearns acquired by JPMorgan Chase;
- September 6, 2008: Fannie Mae & Freddie Mac acquired by US Government;
- September 15, 2008: Lehman Brothers bankruptcy;
- September 16, 2008: loan to AIG to avoid bankruptcy;
- October 3, 2008: TARP bill enacted with \$700 billion in bailout funds;
- October 8, 2008: UK bailout package worth £500 billion;
- December 11, 2008: Madoff arrested for Ponzi scheme;
- January 18, 2009: RBS announces largest corporate loss in UK history;
- August, 2009: H1N1 flu;
- August 7, 2008: war in Georgia, Russia;
- November 26, 2009: Dubai defers debt;
- April 15, 2010: Iceland volcanic ash; and
- May 2, 2010: Greek €110 billion loan agreement reached.

Annex 3: Dataset description

Table 2. Dataset description

Variable	Description	Data Source	Mean	Std. Deviation	Min	Max
Dependent Variables						
Normalized bid-ask spread	The normalized difference between the daily closing ask price and the daily closing bid price for each of the constituent securities of the CAC 40, the BEL 20, the AEX and the PSI indices.	Bloomberg ⁽¹⁾	0.01	0.04	0	2.00
Number of shares (Millions of trades)	The daily number of shares traded of each of the constituent securities of the CAC 40, the BEL 20, the AEX and the PSI indices.	Bloomberg ⁽¹⁾	2.31	4.84	0	309.84
20-Day historical volatility	The annualized standard deviation of the daily returns of each of the constituent securities of the CAC 40, the BEL 20, the AEX and the PSI indices over a 20 day window. Returns are computed using last prices.	Bloomberg ⁽¹⁾	0.22	0.23	0	5.62
Explanatory variables:						
DAX volatility	The annualized standard deviation of the daily returns of the DAX index over a 20 day window. Returns are computed using last prices. ⁽³⁾	Bloomberg	0.14	0.08	0.04	0.51
FTSE100 volatility	The annualized standard deviation of the daily returns of the FTSE100 index over a 20 day window. Returns are computed using last prices.	Bloomberg	0.12	0.07	0.03	0.52
Traded volume on the Frankfurt exchange (Millions of trades)	Monthly number of shares traded on the Frankfurt exchange. It corresponds to the traded volume registered at Xetra.	Deutsche Börse	771.92	252.15	328.1	1836.23
MTF volume (Millions of trades)	Daily total number of shares of CAC 40, BEL20, AEX and PSI securities traded in Chi-X and Bats. ⁽⁴⁾	Bloomberg	44.21	36.65	0	266.03
Per capita GDP	Yearly, Euros per inhabitant	Eurostat				
		France	24,627	638	23,700	25,600
		Belgium	25,872	958	24,600	27,200
		Netherlands	27,672	1,256	26,300	29,700
		Portugal	12,627	179	12,400	12,900

Notes: (1) Data includes all securities that have composed each of the main indices at any point in time during the sample period. Ask price mnemonic: Px_Ask; bid price mnemonic: Px_Bid; volume mnemonic: Px_Volume; last price mnemonic: Px_Last.

(2) There are 17,295 observations with a zero bid-ask spread.

(3) There are no last prices for the DAX index on the 24th and 31st of December of each year.

(4) Statistics are calculated over the period with positive MTF volumes (from April 2007 onwards).

Annex 4: Econometric results – Baseline

Table 3: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, 3 January 2000 – 31 December 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Integration	-0.590*** [0.000]	-0.530*** [0.000]	-0.119** [0.024]	-0.071 [0.174]	-0.068 [0.193]	-0.019 [0.698]
DAX volatility (log of)		0.245*** [0.000]	0.365*** [0.000]	0.406*** [0.000]	0.418*** [0.000]	0.359*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.911*** [0.000]	-0.314*** [0.000]	-0.307*** [0.000]	-0.166*** [0.000]
Tick change dummy				-0.519*** [0.000]	-0.322*** [0.000]	-0.047 [0.590]
Per capita GDP						-4.859*** [0.000]
MTF volume (log of)					-0.012** [0.016]	-0.022*** [0.000]
Constant	-4.666*** [0.000]	-4.146*** [0.000]	16.643*** [0.000]	3.243*** [0.000]	3.076*** [0.000]	49.412*** [0.000]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	362,103	357,936	332,831	332,832	332,831	332,831
R-squared	0.523	0.533	0.570	0.590	0.599	0.603

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) “A comparative study of unit root tests with panel data and a simplified test”, Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

(c) The sample is composed by 158 large caps. It includes securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) Bid-ask spreads calculated using price data provided by Bloomberg.

Table 4: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon by phases, 3 January 2000 – 31 December 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Phase 1	-0.344*** [0.004]	-0.356*** [0.003]	-0.14 [0.219]	-0.238** [0.031]	-0.241** [0.029]	-0.259** [0.016]
Phase 2	-0.155 [0.160]	-0.168 [0.120]	-0.187* [0.050]	-0.174* [0.065]	-0.175* [0.062]	-0.125 [0.115]
Phase 3	-0.570*** [0.000]	-0.519*** [0.000]	-0.310*** [0.000]	-0.172*** [0.000]	-0.164*** [0.000]	-0.117** [0.016]
DAX volatility (log of)		0.109*** [0.000]	0.225*** [0.000]	0.306*** [0.000]	0.317*** [0.000]	0.307*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.642*** [0.000]	-0.177*** [0.000]	-0.173*** [0.000]	-0.110*** [0.002]
Tick change dummy				-0.461*** [0.000]	-0.332*** [0.000]	-0.180* [0.053]
Per capita GDP						-2.669** [0.047]
MTF volume(log of)					-0.008 [0.106]	-0.014** [0.018]
Constant	-4.530*** [0.000]	-4.304*** [0.000]	10.500*** [0.000]	0.08 [0.921]	0.001 [0.999]	25.781* [0.054]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	362,103	357,936	332,831	332,831	332,831	332,831
R-squared	0.558	0.563	0.597	0.606	0.606	0.607

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) "A comparative study of unit root tests with panel data and a simplified test", Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

(c) The sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) Bid-ask spreads calculated using price data provided by Bloomberg.

Table 5: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon by exchange, 3 January 2000 – 31 December 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Paris	-1.119*** [0.000]	-1.073*** [0.000]	-0.586*** [0.000]	-0.594*** [0.000]	-0.592*** [0.000]	-0.561*** [0.000]
Brussels	-0.757*** [0.000]	-0.724*** [0.000]	-0.247** [0.017]	-0.257** [0.012]	-0.256** [0.012]	-0.143 [0.182]
Amsterdam	-0.491*** [0.003]	-0.432*** [0.008]	-0.147 [0.306]	-0.085 [0.549]	-0.081 [0.563]	0.023 [0.851]
Lisbon	-0.127 [0.101]	-0.029 [0.722]	0.247*** [0.002]	0.349*** [0.000]	0.356*** [0.000]	0.287*** [0.000]
DAX volatility (log of)		0.272*** [0.000]	0.380*** [0.000]	0.426*** [0.000]	0.440*** [0.000]	0.389*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.900*** [0.000]	-0.262*** [0.000]	-0.253*** [0.000]	-0.146*** [0.000]
Tick change dummy				-0.553*** [0.000]	-0.324*** [0.000]	-0.11 [0.178]
Per capita GDP (log of)						-3.800*** [0.001]
MTF volume (log of)					-0.015*** [0.005]	-0.021*** [0.000]
Constant	-4.777*** [0.000]	-4.184*** [0.000]	16.449*** [0.000]	2.111*** [0.008]	1.909** [0.016]	38.133*** [0.001]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	362,103	357,936	332,831	332,831	332,831	332,831
R-squared	0.534	0.545	0.592	0.592	0.607	0.609

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) "A comparative study of unit root tests with panel data and a simplified test", Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

(c) The sample is composed by 158 large caps. It includes securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) Bid-ask spreads calculated using price data provided by Bloomberg.

Annex 5: Econometric results – Robustness

Alternative integration milestones

Table 6: Impact of integration of trading platforms on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, 3 January 2000 – 31 December 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Phase 1	-0.407*** [0.001]	-0.405*** [0.001]	-0.422*** [0.000]	-0.314*** [0.004]	-0.316*** [0.004]	-0.305*** [0.006]
Phase 2	-0.059 [0.576]	-0.086 [0.400]	0.071 [0.402]	-0.098 [0.252]	-0.102 [0.235]	-0.089 [0.270]
Phase 3	-0.657*** [0.000]	-0.610*** [0.000]	-0.414*** [0.000]	-0.264*** [0.000]	-0.256*** [0.000]	-0.179*** [0.000]
DAX volatility (log of)		0.104*** [0.000]	0.216*** [0.000]	0.298*** [0.000]	0.308*** [0.000]	0.298*** [0.000]
DB volume (log of)			-0.659*** [0.000]	-0.183*** [0.000]	-0.178*** [0.000]	-0.111** [0.020]
Tick change dummy				-0.455*** [0.000]	-0.330*** [0.000]	-0.152 [0.101]
Per capita GDP						-3.089** [0.034]
MTF volume(log of)					-0.008 [0.120]	-0.015** [0.015]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-4.538*** [0.000]	-4.301*** [0.000]	10.718*** [0.000]	0.211 [0.745]	0.122 [0.853]	30.121** [0.032]
Observations	362,103	357,936	332,831	332,831	332,831	332,831
R-squared	0.557	0.561	0.596	0.605	0.605	0.606

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) “A comparative study of unit root tests with panel data and a simplified test”, Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

(c) The sample is composed by 158 large caps. It includes securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) Bid-ask spreads calculated using price data provided by Bloomberg.

Alternative measures of liquidity: volatility**Table 7 Impact of integration on 20 day-historical volatility of large caps in Paris, Brussels, Amsterdam and Lisbon by phases, 3 January 2000 – 31 December 2010**

Ln (volatility)	1	2	3	4	5	6	7
Integration	-0.187*** [0.000]	-0.062** [0.025]	-0.122*** [0.000]	-0.071*** [0.005]	-0.085*** [0.001]	-0.088*** [0.000]	-0.085*** [0.001]
DAX volatility (log of)		0.596*** [0.000]		0.589*** [0.000]	0.576*** [0.000]	0.561*** [0.000]	0.557*** [0.000]
Index volatility (log of)			0.588*** [0.000]				
Traded volume on the Frankfurt exchange (log of)				0.211*** [0.000]	0.012 [0.544]	-0.001 [0.979]	0.006 [0.770]
Tick change dummy					0.177*** [0.000]	-0.114*** [0.003]	-0.100** [0.029]
Per capita GDP (log of)							-0.251 [0.632]
MTF volume(log of)						0.018*** [0.000]	0.018*** [0.000]
Constant	-1.550*** [0.000]	-0.243*** [0.000]	-0.140*** [0.001]	-5.090*** [0.000]	-0.616 [0.193]	-0.338 [0.481]	2.075 [0.691]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	365,335	363,248	365,335	336,252	336,252	336,252	336,252
R-squared	0.275	0.470	0.512	0.497	0.505	0.507	0.507

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) "A comparative study of unit root tests with panel data and a simplified test", Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%

(c) The sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) 20-Day historical volatility calculated using last prices provided by Bloomberg.

Alternative measures of liquidity: traded volume

Table 8: Impact of integration on number of shares traded for large caps in Paris, Brussels, Amsterdam and Lisbon, 3 January 2000 – 31 December 2010

Ln (number of shares)	1	2	3	4	5	6
Integration	0.607*** [0.000]	0.244*** [0.001]	0.271*** [0.000]	0.253*** [0.000]	0.253*** [0.000]	0.254*** [0.000]
Per capita GDP (log of)		9.117*** [0.000]	9.359*** [0.000]	6.876*** [0.000]	5.852*** [0.005]	5.812*** [0.007]
Traded volume on the Frankfurt exchange (log of)				0.403*** [0.000]	0.293*** [0.000]	0.296*** [0.000]
DAX volatility (log of)			0.105*** [0.001]	0.053* [0.068]	0.030 [0.319]	0.032 [0.270]
Tick change dummy					0.149 [0.119]	0.182 [0.216]
MTF volume (log of)						-0.002 [0.820]
Constant	9.373*** [0.000]	-83.758*** [0.000]	-86.048*** [0.000]	-69.931*** [0.000]	-57.031*** [0.006]	-56.677*** [0.007]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	382,146	382,146	377,403	349,152	349,152	349,152
R-squared	0.760	0.771	0.774	0.783	0.783	0.783

Notes:

(a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) "A comparative study of unit root tests with panel data and a simplified test", Oxford Bulletin of Economics and Statistics, pp. 631-652.

(b) * significant at 10%; ** significant at 5%; *** significant at 1%.

(c) The sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period.

(d) Number of shares traded provided by Bloomberg.

Additional control variables

Table 9 presents the results of the econometric analysis of the impact of the integration by phases on the normalized bid-ask spreads when the daily market capitalization is included as an additional control.

Table 9: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, controlling for market capitalization, by phases, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Phase 1	-0.227*** [0.000]	-0.215*** [0.001]	-0.094 [0.125]	-0.183*** [0.002]	-0.193*** [0.001]	-0.191*** [0.001]
Phase 2	-0.402*** [0.000]	-0.400*** [0.000]	-0.390*** [0.000]	-0.372*** [0.000]	-0.384*** [0.000]	-0.389*** [0.000]
Phase 3	-0.327*** [0.000]	-0.353*** [0.000]	-0.198*** [0.000]	-0.078* [0.054]	-0.042 [0.290]	-0.045 [0.308]
DAX volatility (log of)		-0.055* [0.051]	0.038 [0.123]	0.114*** [0.000]	0.152*** [0.000]	0.153*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.439*** [0.000]	-0.028 [0.319]	-0.005 [0.847]	-0.011 [0.690]
Tick change dummy				-0.410*** [0.000]	0.143** [0.026]	0.131** [0.035]
Per capita GDP (log of)						0.234 [0.805]
MTF volume (log of)					-0.036*** [0.000]	-0.035*** [0.000]
Market capitalization (log of)	-0.618*** [0.000]	-0.626*** [0.000]	-0.604*** [0.000]	-0.592*** [0.000]	-0.612*** [0.000]	-0.614*** [0.000]
Constant	0.647* [0.064]	0.602* [0.069]	10.522*** [0.000]	1.182** [0.032]	0.868 [0.119]	-1.39 [0.881]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	347,837	345,605	329,145	329,145	329,145	329,145
R-squared	0.625	0.627	0.642	0.65	0.652	0.652

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 10 presents the results of the econometric analysis of the impact of the integration by exchanges on the normalized bid-ask spreads when the daily market capitalization is included as an additional control.

Table 10: Impact of integration on the normalized bid ask spread of large caps in Paris, Brussels, Amsterdam and Lisbon controlling for market capitalization, by exchanges, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Paris	-1.046*** [0.000]	-1.041*** [0.000]	-0.700*** [0.000]	-0.702*** [0.000]	-0.702*** [0.000]	-0.697*** [0.000]
Brussels	-0.639*** [0.000]	-0.636*** [0.000]	-0.294*** [0.000]	-0.301*** [0.000]	-0.299*** [0.000]	-0.285*** [0.000]
Amsterdam	-0.630*** [0.000]	-0.616*** [0.000]	-0.367*** [0.000]	-0.303*** [0.000]	-0.302*** [0.000]	-0.288*** [0.000]
Lisbon	0.038 [0.586]	0.057 [0.427]	0.280*** [0.000]	0.370*** [0.000]	0.392*** [0.000]	0.383*** [0.000]
DAX volatility (log of)		0.062** [0.014]	0.161*** [0.000]	0.208*** [0.000]	0.239*** [0.000]	0.234*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.636*** [0.000]	-0.072** [0.015]	-0.038 [0.206]	-0.026 [0.267]
Tick change dummy				-0.494*** [0.000]	0.147** [0.021]	0.171*** [0.004]
Per capita GDP (log of)						-0.48 [0.563]
MTF volume (log of)					-0.041*** [0.000]	-0.041*** [0.000]
Market capitalization (log of)	-0.675*** [0.000]	-0.663*** [0.000]	-0.613*** [0.000]	-0.594*** [0.000]	-0.617*** [0.000]	-0.614*** [0.000]
Constant	1.020*** [0.000]	1.061*** [0.000]	15.185*** [0.000]	2.331*** [0.000]	1.764*** [0.003]	6.332 [0.439]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	347,837	345,605	329,145	329,145	329,145	329,145
R-squared	0.614	0.616	0.638	0.65	0.653	0.653

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 11 presents the results of the econometric analysis of the impact of the integration by phases on the normalized bid-ask spreads when the daily closing price of each security is included as an additional control.

Table 11: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, controlling for daily closing price of the security, by phases, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Phase 1	-0.265*** [0.000]	-0.247*** [0.000]	-0.076 [0.229]	-0.176*** [0.004]	-0.186*** [0.002]	-0.186*** [0.001]
Phase 2	-0.442*** [0.000]	-0.436*** [0.000]	-0.412*** [0.000]	-0.398*** [0.000]	-0.415*** [0.000]	-0.416*** [0.000]
Phase 3	-0.426*** [0.000]	-0.464*** [0.000]	-0.269*** [0.000]	-0.129*** [0.001]	-0.089** [0.011]	-0.090** [0.036]
DAX volatility (log of)		-0.074*** [0.010]	0.032 [0.226]	0.115*** [0.000]	0.157*** [0.000]	0.157*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.534*** [0.000]	-0.061** [0.017]	-0.036 [0.165]	-0.038 [0.149]
Tick change dummy				-0.468*** [0.000]	0.165** [0.012]	0.162** [0.018]
Per capita GDP (log of)						0.056 [0.955]
MTF volume (log of)					-0.041*** [0.000]	-0.041*** [0.000]
Closing price of the security (log of)	-0.558*** [0.000]	-0.572*** [0.000]	-0.574*** [0.000]	-0.573*** [0.000]	-0.601*** [0.000]	-0.601*** [0.000]
Constant	-2.752*** [0.000]	-2.862*** [0.000]	9.425*** [0.000]	-1.157** [0.039]	-1.614*** [0.005]	-2.16 [0.828]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	360,460	356,315	331,215	331,215	331,215	331,215
R-squared	0.607	0.611	0.635	0.645	0.647	0.647

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 12 presents the results of the econometric analysis of the impact of the integration by exchanges on the normalized bid-ask spreads when the daily closing price of each security is included as an additional control.

Table 12: Impact of integration on the normalized bid ask spread of large caps in Paris, Brussels, Amsterdam and Lisbon controlling for daily closing price of the security, by exchanges, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6
Paris	-1.198*** [0.000]	-1.178*** [0.000]	-0.728*** [0.000]	-0.735*** [0.000]	-0.739*** [0.000]	-0.730*** [0.000]
Brussels	-0.828*** [0.000]	-0.814*** [0.000]	-0.352*** [0.000]	-0.363*** [0.000]	-0.365*** [0.000]	-0.337*** [0.000]
Amsterdam	-0.775*** [0.000]	-0.749*** [0.000]	-0.429*** [0.000]	-0.367*** [0.000]	-0.373*** [0.000]	-0.345*** [0.000]
Lisbon	-0.068 [0.279]	-0.042 [0.523]	0.245*** [0.000]	0.349*** [0.000]	0.373*** [0.000]	0.356*** [0.000]
DAX volatility (log of)		0.079*** [0.002]	0.181*** [0.000]	0.228*** [0.000]	0.262*** [0.000]	0.251*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.768*** [0.000]	-0.114*** [0.000]	-0.075*** [0.007]	-0.050** [0.032]
Tick change dummy				-0.566*** [0.000]	0.166** [0.011]	0.215*** [0.001]
Per capita GDP (log of)						-0.925 [0.273]
MTF volume (log of)					-0.047*** [0.000]	-0.048*** [0.000]
Closing price of the security (log of)	-0.595*** [0.000]	-0.582*** [0.000]	-0.568*** [0.000]	-0.569*** [0.000]	-0.602*** [0.000]	-0.597*** [0.000]
Constant	-2.753*** [0.000]	-2.638*** [0.000]	14.880*** [0.000]	0.188 [0.745]	-0.575 [0.335]	8.261 [0.327]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	360,460	356,315	331,215	331,215	331,215	331,215
R-squared	0.590	0.593	0.628	0.644	0.647	0.648

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 13 presents the results of the econometric analysis of the impact of the integration by phases on the normalized bid-ask spreads when the market capitalization and the daily closing price of each security are included as additional controls.

Table 13: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, controlling for market capitalization and closing price of the security, by phases, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6	7	8
Phase 1	-0.241** [0.029]	-0.259** [0.016]	-0.193*** [0.001]	-0.191*** [0.001]	-0.186*** [0.002]	-0.186*** [0.001]	-0.185*** [0.001]	-0.183*** [0.001]
Phase 2	-0.175* [0.062]	-0.125 [0.115]	-0.384*** [0.000]	-0.389*** [0.000]	-0.415*** [0.000]	-0.416*** [0.000]	-0.403*** [0.000]	-0.410*** [0.000]
Phase 3	-0.164*** [0.000]	-0.117** [0.016]	-0.042 [0.290]	-0.045 [0.308]	-0.089** [0.011]	-0.090** [0.036]	-0.051 [0.175]	-0.057 [0.201]
DAX volatility (log of)	0.317*** [0.000]	0.307*** [0.000]	0.152*** [0.000]	0.153*** [0.000]	0.157*** [0.000]	0.157*** [0.000]	0.143*** [0.000]	0.144*** [0.000]
Traded volume on the Frankfurt	-0.173*** [0.000]	-0.110*** [0.002]	-0.005 [0.847]	-0.011 [0.690]	-0.036 [0.165]	-0.038 [0.149]	-0.009 [0.723]	-0.017 [0.522]
Exchange (log of)	-0.332*** [0.000]	-0.180* [0.053]	0.143** [0.026]	0.131** [0.035]	0.165** [0.012]	0.162** [0.018]	0.184*** [0.004]	0.166*** [0.006]
Tick change	-0.332*** [0.106]	-0.180* [0.018]	0.143** [0.000]	0.131** [0.000]	0.165** [0.000]	0.162** [0.000]	0.184*** [0.000]	0.166*** [0.000]
Dummy	-0.008 [0.106]	-0.014** [0.018]	-0.036*** [0.000]	-0.035*** [0.000]	-0.041*** [0.000]	-0.041*** [0.000]	-0.040*** [0.000]	-0.039*** [0.000]
MTF volume (log of)	-0.008 [0.106]	-0.014** [0.018]	-0.036*** [0.000]	-0.035*** [0.000]	-0.041*** [0.000]	-0.041*** [0.000]	-0.040*** [0.000]	-0.039*** [0.000]
Per capita GDP (log of)		-2.669** [0.047]		0.234 [0.805]		0.056 [0.955]		0.337 [0.709]
Market capitalization (log of)			-0.612*** [0.000]	-0.614*** [0.000]			-0.436*** [0.000]	-0.438*** [0.000]
Last price of the security (log of)					-0.601*** [0.000]	-0.601*** [0.000]	-0.200* [0.064]	-0.200* [0.064]
Constant	0.001 [0.999]	25.781* [0.054]	0.868 [0.119]	-1.39 [0.881]	-1.614*** [0.005]	-2.16 [0.828]	0.05 [0.947]	-3.2 [0.724]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	332,831	332,831	329,145	329,145	331,215	331,215	327,529	327,529
R-squared	0.606	0.607	0.652	0.652	0.647	0.647	0.651	0.651

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 14 presents the results of the econometric analysis of the impact of the integration by exchanges on the normalized bid-ask spreads when the market capitalization and the daily closing price of each security are included as additional controls.

Table14: Impact of integration on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, controlling for market capitalization and closing price of the security, by exchanges, 3 Jan 2000 – 31 Dec 2010

Ln (bid-ask spread)	1	2	3	4	5	6	7	8
Paris	-0.592*** [0.000]	-0.561*** [0.000]	-0.702*** [0.000]	-0.697*** [0.000]	-0.739*** [0.000]	-0.730*** [0.000]	-0.713*** [0.000]	-0.708*** [0.000]
Brussels	-0.256** [0.012]	-0.143 [0.182]	-0.299*** [0.000]	-0.285*** [0.000]	-0.365*** [0.000]	-0.337*** [0.000]	-0.316*** [0.000]	-0.302*** [0.000]
Amsterdam	-0.081 [0.563]	0.023 [0.851]	-0.302*** [0.000]	-0.288*** [0.000]	-0.373*** [0.000]	-0.345*** [0.000]	-0.331*** [0.000]	-0.318*** [0.000]
Lisbon	0.356*** [0.000]	0.287*** [0.000]	0.392*** [0.000]	0.383*** [0.000]	0.373*** [0.000]	0.356*** [0.000]	0.385*** [0.000]	0.376*** [0.000]
DAX volatility (log of)	0.440*** [0.000]	0.389*** [0.000]	0.239*** [0.000]	0.234*** [0.000]	0.262*** [0.000]	0.251*** [0.000]	0.233*** [0.000]	0.228*** [0.000]
Traded volume on the Frankfurt exchange (log of)	-0.253*** [0.000]	-0.146*** [0.000]	-0.038 [0.206]	-0.026 [0.267]	-0.075*** [0.007]	-0.050** [0.032]	-0.04 [0.159]	-0.029 [0.196]
Tick change dummy	-0.324*** [0.000]	-0.11 [0.178]	0.147** [0.021]	0.171*** [0.004]	0.166** [0.011]	0.215*** [0.001]	0.184*** [0.004]	0.207*** [0.000]
MTF volume (log of)	-0.015*** [0.005]	-0.021*** [0.000]	-0.041*** [0.000]	-0.041*** [0.000]	-0.047*** [0.000]	-0.048*** [0.000]	-0.045*** [0.000]	-0.045*** [0.000]
Per capita GDP (log of)	-3.800***	[0.001]	-0.48	[0.563]	-0.925	[0.273]	-0.443	[0.569]
Market capitalization		-0.617***	-0.614*** [0.000]	[0.000]		-0.467***	-0.464*** [0.000]	[0.000]
Last price of the security (log of)				-0.602***	-0.597*** [0.000]	-0.170* [0.000]	-0.171* [0.084]	[0.083]
Constant	1.909** [0.016]	38.133*** [0.001]	1.764*** [0.003]	6.332 [0.439]	-0.575 [0.335]	8.261 [0.327]	1.053 [0.164]	5.271 [0.500]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	332,831	332,831	329,145	329,145	331,215	331,215	327,529	327,529
R-squared	0.607	0.609	0.653	0.653	0.647	0.648	0.651	0.651

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample is composed by 158 large caps. In particular, we include securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC-40, BEL-20, AEX and the PSI) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Annex 6: Impact of the NYSE-Euronext merger

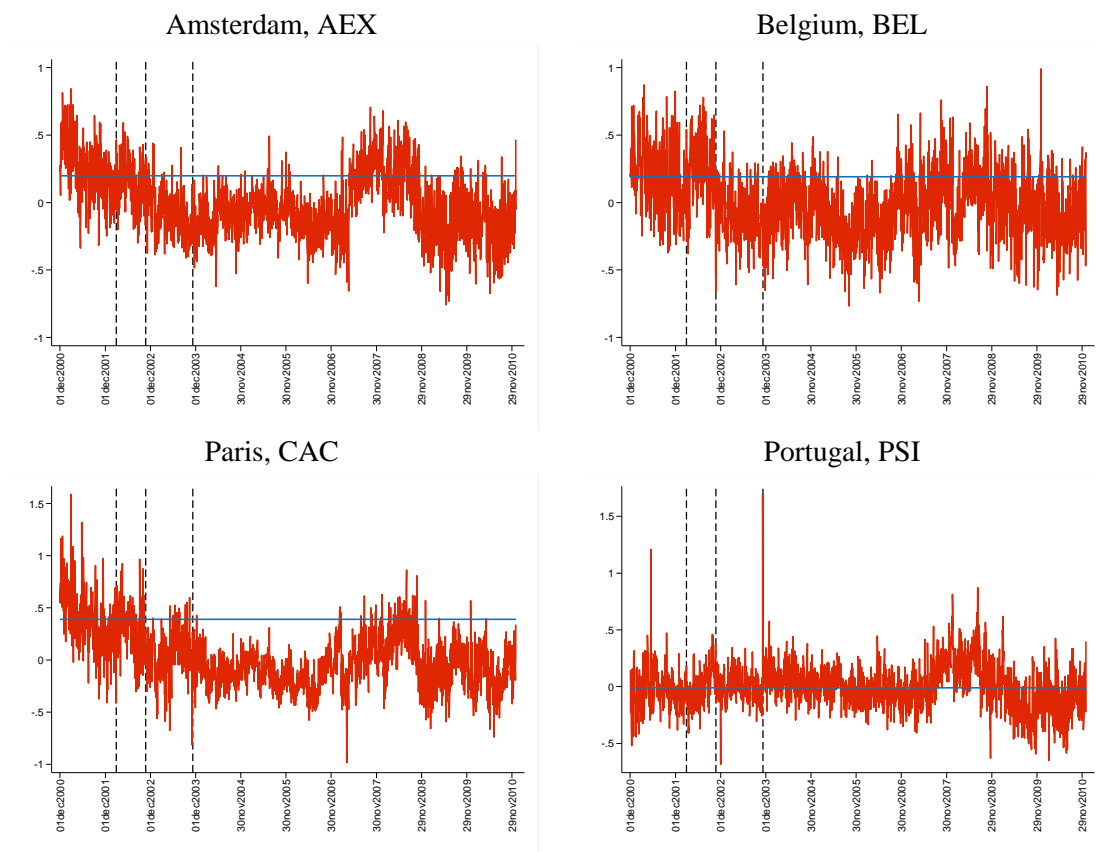
Table 15: Impact of the NYSE-Euronext merger on the normalized bid-ask spreads of large caps in Paris, Brussels, Amsterdam and Lisbon, 2 January 2004 – 31 December 2010

Ln (bid-ask spread)	1	2	3	4	5	6	7
NYSE merger	-0.351*** [0.000]	-0.471*** [0.000]	-0.328*** [0.000]	-0.039 [0.327]	-0.011 [0.779]	-0.004 [0.924]	0.012 [0.777]
DAX volatility (log of)		0.247*** [0.000]	0.291*** [0.000]	0.272*** [0.000]	0.276*** [0.000]	0.272*** [0.000]	0.290*** [0.000]
Traded volume on the Frankfurt exchange (log of)			-0.414*** [0.000]	-0.243*** [0.000]	-0.244*** [0.000]	-0.215*** [0.002]	-0.243*** [0.001]
Tick change Dummy				-0.374*** [0.000]	-0.347*** [0.000]	-0.320*** [0.000]	
Per capita GDP						-0.582 [0.640]	-1.549 [0.152]
MTF volume (log of)					-0.003 [0.602]	-0.005 [0.521]	-0.023*** [0.000]
Constant	-5.122*** [0.000]	-4.483*** [0.000]	5.065*** [0.000]	1.183 [0.267]	1.22 [0.244]	6.514 [0.574]	17.068* [0.085]
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Security fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	243,373	242,051	242,051	242,051	242,051	242,051	242,051
R-squared	0.625	0.633	0.635	0.637	0.637	0.637	0.636

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities. Estimation residuals are stationary according with the Fisher stationary test for panel regressions. See Maddala, G.S. and S. Wu (1999) "A comparative study of unit root tests with panel data and a simplified test", Oxford Bulletin of Economics and Statistics, pp. 631-652. (b) * significant at 10%; ** significant at 5%; *** significant at 1%. (c) The sample is composed by 158 large caps. It includes securities that have composed the main index of the Paris, Brussels, Amsterdam and Lisbon exchanges (the CAC 40, BEL20, AEX and the PSI) at any point throughout the sample period. (d) Bid-ask spreads calculated using price data provided by Bloomberg.

Annex 7: Possible omitted variables

Figure 2. Average residuals by stock exchange



Note: (i) the horizontal line represents the average residual before the integration of Paris; (ii) dotted vertical lines shows dates of integration: Paris and Brussels on 1 March 2002; Amsterdam on 25 October 2002; and Lisbon on 1 November 2003.

Table 16: Regression results using a specification without integration variables and adding quarter-year index fixed effects, Paris (CAC) securities only, 1 December 2000 – 31 December 2010

Ln (bid-ask spread)	[1]	[2]	[3]	[4]
DAX volatility	0.030**	-0.001	-0.003	-0.004
(log of)	[0.010]	[0.923]	[0.806]	[0.716]
Traded volume on the	-0.036	-0.026	-0.022	-0.024
Frankfurt exchange (log of)	[0.170]	[0.298]	[0.367]	[0.334]
Tick change	-0.538***	-0.577***	-0.628***	-0.602***
Dummy	[0.000]	[0.000]	[0.000]	[0.000]
Per capita GDP	-10.980***	-8.708**	-8.807**	-8.594**
(log of)	[0.003]	[0.020]	[0.019]	[0.022]
MTF volume	-0.013***	-0.013***	-0.014***	-0.013***
(log of)	[0.000]	[0.000]	[0.000]	[0.000]
Market capitalization		-0.453***		-0.274***
(log of)		[0.000]		[0.000]
Last price of the			-0.464***	-0.216***
security (log of)			[0.000]	[0.001]
Constant	105.009***	86.076**	84.377**	83.964**
	[0.005]	[0.023]	[0.026]	[0.027]
Quarter-year fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	No
Security fixed effects	Yes	Yes	Yes	Yes
Observations	106,153	106,061	106,152	106,060
R-squared	0.39	0.412	0.411	0.413

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample contains securities that have composed the main index of the Paris exchange (the CAC 40) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 17: Regression results using a specification without integration variables and adding quarter-year index fixed effects, Belgium (BEL) securities only, 1 December 2000 – 31 December 2010

Ln (bid-ask spread)	[1]	[2]	[3]	[4]
DAX volatility	0.133***	0.106***	0.109***	0.109***
(log of)	[0.000]	[0.000]	[0.000]	[0.000]
Traded volume on the	0.083**	0.093**	0.081*	0.083**
Frankfurt exchange (log of)	[0.048]	[0.029]	[0.051]	[0.049]
Tick change	-0.457***	-0.559***	-0.601***	-0.601***
Dummy	[0.006]	[0.000]	[0.000]	[0.000]
Per capita GDP	-11.477**	-9.262**	-9.395**	-9.425**
(log of)	[0.018]	[0.026]	[0.023]	[0.024]
MTF volume	-0.012**	-0.012**	-0.013**	-0.013**
(log of)	[0.029]	[0.028]	[0.023]	[0.023]
Market capitalization		-0.406***		0.009
(log of)		[0.000]		[0.897]
Last price of the			-0.420***	-0.425***
security (log of)			[0.000]	[0.000]
Constant	109.343**	89.804**	89.699**	89.912**
	[0.025]	[0.033]	[0.031]	[0.032]
Quarter-year fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	No
Security fixed effects	Yes	Yes	Yes	Yes
Observations	64,160	63,985	64,140	63,965
R-squared	0.421	0.437	0.448	0.448

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample contains securities that have composed the main index of the Brussels exchange (the BEL 20) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 18: Regression results using a specification without integration variables and adding quarter-year index fixed effects, Amsterdam (AEX) securities only, 1 December 2000 – 31 December 2010

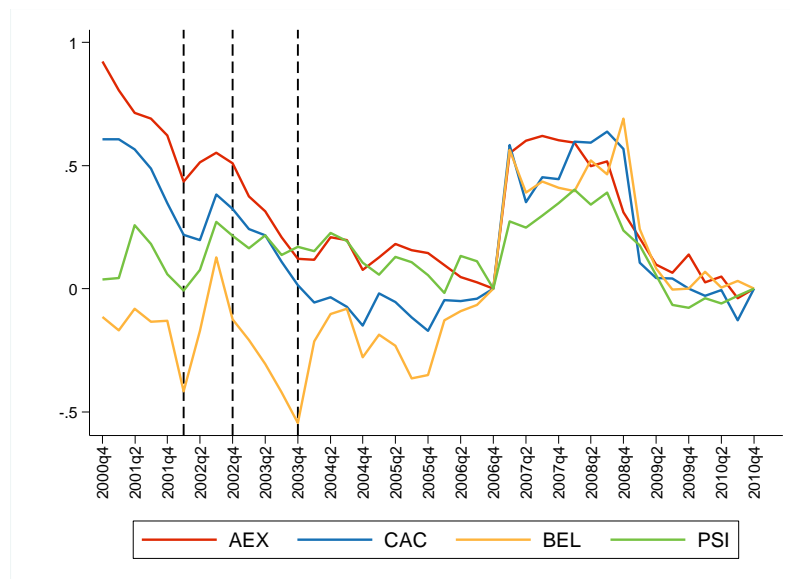
Ln (bid-ask spread)	[1]	[2]	[3]	[4]
DAX volatility	0.148***	0.081***	0.076***	0.079***
(log of)	[0.000]	[0.000]	[0.000]	[0.000]
Traded volume on the Frankfurt exchange (log of)	0.058**	0.050*	0.033	0.04
	[0.038]	[0.066]	[0.230]	[0.154]
Tick change	-0.371*	-0.633***	-0.704***	-0.652***
Dummy	[0.084]	[0.000]	[0.000]	[0.000]
Per capita GDP	0	0	0	0
(log of)	[.]	[.]	[.]	[.]
MTF volume	0.003	0.002	0.001	0.002
(log of)	[0.424]	[0.540]	[0.700]	[0.606]
Market capitalization		-0.747***		-0.576***
(log of)		[0.000]		[0.000]
Last price of the security (log of)			-0.814***	-0.202
			[0.000]	[0.207]
Constant	-7.522***	-1.125	-4.934***	-1.807*
	[0.000]	[0.141]	[0.000]	[0.057]
Quarter-year fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	No
Security fixed effects	Yes	Yes	Yes	Yes
Observations	89,720	86,388	89,394	86,062
R-squared	0.618	0.737	0.732	0.737

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample contains securities that have composed the main index of the Amsterdam exchange (the AEX 25) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Table 19: Regression results using a specification without integration variables and adding quarter-year index fixed effects, Portugal (PSI) securities only, 1 December 2000 – 31 December 2010

Ln (bid-ask spread)	[1]	[2]	[3]	[4]
DAX volatility	0.112***	0.091***	0.090***	0.089***
(log of)	[0.000]	[0.000]	[0.000]	[0.000]
Traded volume on the Frankfurt exchange (log of)	0.047	0.054*	0.042	0.041
Tick change dummy	[0.108]	[0.065]	[0.107]	[0.108]
Per capita GDP (log of)	-0.141	-0.298	-0.403**	-0.408**
	[0.334]	[0.119]	[0.027]	[0.029]
MTF volume (log of)	0	0	0	0
	[.]	[.]	[.]	[.]
Market capitalization (log of)	0.013***	0.013***	0.014***	0.014***
	[0.002]	[0.002]	[0.001]	[0.001]
Last price of the security (log of)		-0.366**		-0.128
		[0.021]		[0.583]
Constant	-6.244***	-3.926***	-5.727***	-4.957***
	[0.000]	[0.002]	[0.000]	[0.002]
Quarter-year fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	No	No	No	No
Security fixed effects	Yes	Yes	Yes	Yes
Observations	72,798	72,711	71,529	71,442
R-squared	0.489	0.501	0.494	0.495

Notes: (a) Robust p-value in brackets, clustered by security to allow for heteroskedasticity and autocorrelation within securities; (b) * significant at 10%; ** significant at 5%; *** significant at 1%; (c) the sample contains securities that have composed the main index of the Lisbon exchange (the PSI 20) at any point throughout the sample period; (d) all regressions include a set of single-day event dummies; (e) bid-ask spreads calculated using price data provided by Bloomberg.

Figure 3. Estimated quarter-year-index fixed effects by exchange, 2000Q4-2010Q4

Note: (i) Estimated time fixed effects are fitted under specification 4 in Tables 17 to 20; (ii) The sample used begins on 1 December 2000 as volumes traded on the Frankfurt exchange are available from that date on.