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# Stock Exchange Mergers and Market Efficiency

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## **Abstract**

The aim of this paper is to examine the positive and negative impacts of stock exchange mergers on the informational efficiency of the markets. We consider a range of factors in relation to the stock exchange merger, that can potentially affect market efficiency, after a merger. These factors include the maturity of the markets being merged, the size of the markets, and different types of mergers (developed markets versus developing markets; large stock exchange mergers versus small stock exchange mergers; and domestic stock exchange mergers versus cross-border stock exchange mergers). For this purpose, we use a time-varying return predictability test which allows us to detect periods of (in)efficiency, and thus to conduct a comparative analysis for pre-merger and post-merger periods. We find that increases in efficiency are less frequent than decreases in efficiency after a stock exchange merger. Finally, we provide the empirical evidence that the impact on efficiency depends on range of the characteristics of the merger: stock exchange's country's level of development, size, geographical diversification and industrial diversification.

*Keywords:* Stock exchange mergers; Market efficiency; Martingale difference sequence.

*JEL Classification:* C12; C14; G14; G15.

# 1 Introduction

On February 2011, the NYSE Euronext Inc. and Deutsche Börse AG announced their intentions to merge. This deal would have created the world's largest stock exchange operator. Despite a competing hostile bid made by the NASDAQ and InterContinental Exchange in April 2011, the offer was approved by the shareholders of both firms in July 2011. In December 2011, the U.S. Justice Department blessed the tie-up of the NYSE Euronext and Deutsche Börse on the condition that the German exchange operators agreed to sell its 31.5% stake in Direct Edge Holdings LLC. However, in early February 2012, the European Commission decided to block the deal under the pretence that this merger would have led to create a near monopoly on the international market of European derivatives. As expected, NYSE Euronext Chairman, Jan-Michiel Hessels regretted that decision: *“Our merger would have created a high standard for transparency, stability and efficiency in the global capital markets, and we proposed significant and tangible remedies designed to address the European Commission’s concerns with the transaction”* (Business Wire, 2012).

Since the end of the 1990s, a number of stock exchanges have merged following the trend toward demutualization of the stock exchanges – the process of converting exchanges from nonprofit, member-owned organizations to for-profit, investor-owned corporations – which started in the early 1990s (Aggarwal, 2002; Aggarwal and Dahiya, 2006).<sup>1</sup> This process of demutualization has made securities trading more competitive.<sup>2</sup> These mergers can be viewed as the manifestation of consolidation of exchanges both geographically and across products.

It is believed that stock exchange mergers have strong positive effects such as increased liquidity, market shares or efficiency; or potentially negative consequences including increased fees or lowered quality of service. According to Pagano and

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<sup>1</sup>For a discussion of the demutualization process see Aggarwal (2002).

<sup>2</sup>Aggarwal and Dahiya (2006) give four factors driving the demutualization of stock exchanges: (i) deregulation of trading exchanges, (ii) growing conflicts of interest between existing owners, (iii) new developments in information technology and the rise of electronic communication networks (ECNs) or alternative trading system (ATSs), and (iv) shifting regulatory landscape.

Padilla (2005), integration of stock exchanges produces a number of significant direct and indirect efficiency gains. In their empirical study, Pagano and Padilla (2005) examine Euronext, created in 2000, from the merger between the French, Dutch, Portuguese and Belgian stock exchanges. In particular, they show that (1) the average trading fees have significantly decreased in Paris and Amsterdam, (2) the bid-ask spreads of the securities for main indices fell in Paris, Brussels and Amsterdam, (3) the trading volume increased in Paris, Brussels and Amsterdam, and (4) the volatility of the large-cap securities traded in Paris, Brussels, Amsterdam and Lisbon fell after the merger. These results strongly suggest that the possibility that market efficiency improves after stock exchange mergers, although Pagano and Padilla (2005) does not test this hypothesis directly. Implicitly, the results of Pagano and Padilla (2005) seem to indicate that stock exchange mergers do not affect all merging stock markets in the same way: for example, the beneficial impacts of the merger seem to be weaker in Portugal stock exchange than in the others. On the other hand, it is possible that stock exchange mergers lead to negative impacts. For example, elimination of a competitor might have a dramatic impact on competition in this industry, and the stock exchange company might try to take advantage from this increased market power to increase fees or to lower quality of service which could reduce efficiency after the merger<sup>3</sup>. Given this, it is of interest to test whether the market efficiency improves after a stock exchange merger, paying attention to the question of “in which cases does efficiency increase after a stock exchange merger?”

The efficient market hypothesis (EMH) of Samuelson (1965) and Fama (1965) states that asset prices fully and instantaneously reflect all available and relevant information. Since price adjustment to a new piece of information is instantaneous and accurate, the returns cannot be predicted. As a result, prices in an efficient market follow a random walk or a martingale process.<sup>4</sup> Under the weak-form efficiency where the information set consists of past prices and returns, future prices and their returns are purely unpredictable based on past price information. Most of the studies for the EMH

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<sup>3</sup>see, for example, Kim and Singal (1993)

<sup>4</sup>See Escanciano and Lobato (2009b) for a distinction between random walk and martingale process.

on financial markets have tested whether the returns follow a martingale difference sequence (MDS), where the returns are uncorrelated with the past values.

This paper is a step forward in the understanding of stock exchange mergers. We examine the positive and negative impacts of stock exchange mergers on the informational efficiency of the markets. We consider a range of factors in relation to the stock exchange merger, that can potentially affect market efficiency, after a merger, by studying the impacts of 31 mergers on the efficiency of 37 stock exchanges. These factors include the maturity of the markets being merged, the size of the markets, and different types of mergers (developed markets versus mergers under-developed markets; large stock exchange mergers versus small stock exchange mergers; and domestic stock exchange mergers versus cross-border stock exchange mergers). For this purpose, we evaluate time-varying return predictability using the generalized spectral shape test of Escansiano and Velasco (2006) for the martingale difference hypothesis (MDH). We use moving sub-sample window of 3 months, which allows us to detect periods of (in)efficiency, and thus to conduct a comparative analysis for pre-merger and post-merger periods. Furthermore, to analyze the evolution of the merger effect across the time, we take different lengths of subperiods, i.e. one month, three months, six months, nine months, and twelve months.

The remainder of this paper is organized as follows: Section 2 presents a brief review on the effects of stock exchange mergers. Section 3 suggests some hypotheses linked with the effect of mergers on the efficiency. The MDS test of Escansiano and Velasco (2006) is presented in Section 4. The empirical results are discussed in Section 5, and Section 6 concludes.

## 2 Effects of stock exchange mergers: A brief review

This section provides a brief review of the effects of the stock exchange mergers. Overall, while it is largely expected that stock exchange mergers bring economic gains, it is also possible that they bring negative impacts.

First, it is believed that a merger between two stock exchanges can increase liquidity of the stock traded on that stock market. As explained by Nielsson (2009), if trading volume of a particular stock is low, then, the bid-ask spread is typically high which makes the stock less liquid. Following a stock exchange merger, the potential investor base may increase, and the order book may fill and the transaction cost may be reduced.

Second, the gains from merger can come from the economies of scale (the combined firm can produce more of a same product or service at a lower cost than two separate firms can) and from the economies of scope (the combined firm can produce more of different products or services at a lower cost than two separate firms can). Economies of scale may be achieved when two domestic exchanges merge; while economies of scope may be achieved when a stock exchange merges with a commodity exchange. Kokkoris and Olivares-Caminal (2008) explain that merger of financial markets in Europe will benefit the corporate sector since it will lower trading costs due to positive economies of scale and synergy effects.

Third, horizontal integration can attract market shares (share of trading);<sup>5</sup> while vertical integration (acquisitions of brokers, acquisition of providers of electronic trading services, ...), on the other hand, could increase the margins of the stock exchanges resulting in a reduction of the trading costs.<sup>6</sup>

Conversely, according to the market power theory, the merged stock exchange

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<sup>5</sup>For example, in a study based on 3 US regional stock exchange mergers, Arnold et al. (1999) show that stock exchange consolidation provide narrower bid-ask spreads and attract market share from other exchanges.

<sup>6</sup>For example, Goldberg et al. (2002) explain how the consolidation of stock exchanges and clearing or settlement agencies in Europe could allow to increase stock liquidity and decrease fees charged by stock exchanges.

may try to exploit monopolistic rents by increasing the trading fees which would increase the transaction costs and thus stock's illiquidity. As such, Nielsson (2009) recognizes that firms may experience a lower stock liquidity after a stock exchange merger, in particular as a result of a potential monopolistic behavior by the newly merged exchange. The regulators are fairly vigilant in making sure that the deal will not have significant adverse effect on the industry's competition and rule against those deals.

Unfortunately, the actual impact of stock exchange mergers are largely unknown, as there are very few theoretical or empirical studies analyzing their impact. One of a few studies is Nielsson (2009), who studies how Euronext stock exchange merger impacts stock liquidity of listed firms. He finds that the main beneficiaries are big firms with foreign sales but observes no systematic pattern in the distribution of merger benefits across industries or listing locations. This may be due to the fact that following the merger, stocks traded on a national stock exchange become more accessible to foreign investors. More visible firms (large firms and those which operate abroad) may be thus more attractive for foreign investors. In any case, no clear evidence is found for the firms that suffered from a decreased liquidity. Moreover, according to Nielsson (2009), Euronext stock exchange merger increases Euronext's market share at the expense of the London Stock Exchange, but no evidence of Euronext enhancing its competitive stand in terms of attracting new firm listings is found. In a related paper, Arnold et al. (1999) showed that merging stock exchanges increase market share and provide narrower bid ask spreads. Finally, Khan and Vieito (2012) investigate the impact of the merger between the Portuguese Stock exchange and Euronext in 2002 on informational market efficiency. Their results show a mixed evidence of improvement in market efficiency during the post-merger period.

### **3 Hypotheses development**

We only focus on the mergers by stock exchanges where the bidders acquire 100% of the target's shares. This allows us to focus on the effect of an unexpected stock

exchange's merger on the efficiency of the stocks traded on this market. It is well-known that a prior ownership (a toehold) increases the bidder's probability of a successful full acquisition (see, for example, Goldman and Qian, 2005). Therefore, if a stock exchange already owns a stake in another stock exchange, the likelihood of a successful acquisition will be higher. Thus, the stock market response to the announcement of an acquisition might be different depending on whether the stock exchange has established a prior ownership or not and on the size of this toehold. Indeed it is possible that the pre-merger efficiency of a stock exchange be impacted by this ownership if stock exchange mergers have an impact on efficiency. For example, if stock exchange mergers have a positive impact on efficiency, the fact that a merger is more likely to occur may influence investors' behaviors because the stocks traded on this stock exchange would be more attractive which can increase the efficiency. To avoid this bias in the calculation of the pre-merger efficiency, it might be better to focus on unexpected mergers, that is mergers without prior ownership by the bidder. Our final sample is made of 31 mergers where the bidder or the target is a stock exchange which merged either with another stock exchange, a commodity exchange or a services provider. In a domestic merger, the bidder and the target come from the same country. Therefore, in a domestic merger, only the stocks listed in this country may be impacted by the merger. In a cross-border merger, the bidder and the target come from different countries. In that case, the merger could impact the efficiency of the stocks listed in the target's and in the bidder's home countries. Thus, we have studied the impact of our 31 mergers on the efficiency of 37 stock exchanges. Further details of these mergers are listed in Table 11 to 13 of the paper.

In this section, we formulate a number of hypotheses to be empirically tested in this paper. We consider a range of factors in relation to the stock exchange merger, that can potentially affect market efficiency, after a merger. These factors include the maturity of the markets being merged, the size of the markets, and different types of mergers.

### **3.1 Stock exchange mergers in developed countries versus those in developing countries**

The conventional wisdom is that emerging markets are less efficient than developed markets (Griffin et al. 2010). If so, one might assume that the potential for improving the efficiency is greater for stock exchange mergers in developing than in developed ones. However, while Griffin et al. (2007) report no evidence that better country-level legal, regulatory, and governance characteristics are positively related to higher levels of market efficiency, Shamsuddin and Kim (2010) find the degree of efficiency of stock markets is negatively correlated with equity market development. Given these contrasting results, it is of interest to test whether stock exchange merger impacts differently on the efficiency of the markets developing and developed countries. Based on this, the first hypothesis of interest is:

*Hypothesis 1: stock exchange mergers have the same impact on the efficiency of the markets of developing and developed countries.*

Under Hypothesis 1, the frequencies of improved efficiency of the markets of developing and developed countries should be statistically no different. In the empirical analysis presented in Section 5, we classify the countries into developing and developed ones, following the definitions of the World Economic Forum (see WEF, 2012).

### **3.2 Stock exchange size**

Ben Slimane (2010) studied the creation of Euronext and observed a beneficial impact of the merger on stock volatility only for the Portuguese market. She explains that this may be due to its lower size and level of development. This may suggest that the size of stock exchange impact stock exchange merger outcomes. Therefore, it is possible that increase in the degree of market efficiency is higher for the merger between small stock exchanges, since the potential for improvement is greater in this case. On the

other hand, the impact of a small stock exchange merger may be too small to significantly increase the efficiency. Whether increases in the efficiency are higher in the merger of small stock exchanges than in the merger of large ones is an empirical issue, and the following hypothesis of interest can be formulated:

*Hypothesis 2: The size of stock exchanges plays no role in the improvement of the degree of market efficiency, after the merger.*

Under Hypothesis 2, the frequencies of the improved market efficiency should be statistically no different between the mergers of the small exchanges and large ones.

### **3.3 Domestic pure stock exchange mergers**

To shed further light on the impact of stock exchange mergers on the efficiency, we compared domestic pure stock exchange mergers to other kind of mergers. We define a pure stock exchange merger as a merger between two stock exchanges (in contrast to a merger between a stock exchange and a commodity exchange or a services provider). Domestic pure stock exchanges mergers should (1) simplify trading, (2) increase liquidity and (3) consolidate the offer of domestic securities. The improved international reputation and the easier access to information may attract some institutional and foreign investors, with a potential to lure more companies into going public. In that case, higher trading volume will drive down the trading fees and thus, will increase the efficiency of the stocks traded on this exchange. By contrast, it is also possible that the stock exchange companies use their increased market power after a merger to raise trading fees which would decrease the efficiency of the stocks traded on this exchange. Thus, whether domestic pure stock exchanges mergers increase or decrease efficiency is an empirical issue:

*Hypothesis 3: A domestic pure stock exchange merger brings no gain in market efficiency*

### **3.4 Domestic pure stock exchange mergers versus cross-border pure stock exchanges mergers**

Technological breakthroughs, such as computerized trading, which has lowered fees per trade, have made cross border trading easier and thus have created an international competition between stock exchanges to dominate trading globally. Consistent with this view, Kokkoris and Olivares-Caminal (2008) argue that cross-border pure stock exchange mergers aim at exploiting economies of scale in trading. Moreover, cross-border pure stock exchanges mergers may be a way for the stock market to improve its standing as a regional financial center. On the other hand, increase in market efficiency may be harder or longer to achieve in cross-border pure stock exchange mergers than in domestic pure stock exchange mergers, because of differences in taxation treatments and in regulations in each country. For example, the three-way merger between the Peruvian, Colombian and Chilean stock exchanges has been disrupted by the existence of different tax rates on their profits in each country, which has slowed down the integration process. Thus, whether cross-border stock exchanges mergers increase or decrease efficiency is an empirical issue:

Hypothesis 4a: *A cross-border stock exchange merger has no impact on market efficiency.*

Under the alternative to Hypothesis 4a, efficiency will increase after a cross-border stock exchange merger due to economies of scale in trading.

Hypothesis 4b: *A cross-border stock exchange merger and a domestic stock exchange merger have the same impact on the market efficiency.*

Under the alternative to Hypothesis 4b, increases in efficiency are more frequent

after a domestic stock exchange merger than after a cross-border stock exchange merger due to difficulties in the integration process (for example in the standardization of the exchange rules).

By nature, in a cross-border merger, the target firm and the bidding firm come from different countries. However, differences in stock market development (in size or liquidity for example) as well as in corporate governance may have an impact on stock market efficiency. If the bidder is characterized by a better stock market development and/or a better corporate governance, the potential for efficiency improvement may be larger for the target than for the bidder. Conversely, the target stock exchange may be acquired by the bidder stock exchange precisely because this acquisition will increase the efficiency of the stocks listed on the bidder stock exchange. Therefore, the merger may have a different impact on the efficiency of the stocks listed on the target's stock exchange and on the bidder's stock exchange. Thus, whether cross-border stock exchanges mergers impact both target and acquirer efficiency is an empirical issue:

*Hypothesis 5: Neither targets nor bidders will experience a significant increase in the efficiency after a cross border stock exchange merger.*

When the Hypothesis 5 is rejected, there are three possible outcomes:

- *Both targets and bidders will experience a significant increase in the efficiency, after a cross border stock exchange merger.*
- *Only targets will experience a significant increase in the efficiency, after a cross border stock exchange merger.*
- *Only bidders will experience a significant increase in the efficiency, after a cross border stock exchange merger.*

### 3.5 Domestic pure stock exchange mergers versus domestic diversifying stock exchange mergers

A large number of theoretical works has been undertaken concerning whether or not diversifying mergers are in the best interests of the shareholders. According to Denis, Denis and Sarin (1997) diversification costs outweigh the benefits. Indeed, it is often difficult to produce efficiency gains when the target and the bidder do not belong to the same industry. On the contrary, Kokkoris and Olivares-Caminal (2008) argue that mergers combining different activities (for example, a merger between a broker or a services provider and a stock exchange) seek to provide a more comprehensive financial service to customers which could improve efficiency. Thus, whether domestic diversifying stock exchange mergers increase or decrease efficiency is an empirical issue:

Hypothesis 6a: *Efficiency will increase after a diversifying stock exchange merger due to the creation of a more comprehensive financial service to customers.*

Hypothesis 6b: *Increase in efficiency is higher after a domestic stock exchange merger than after a diversifying stock exchange merger due to diversification costs.*

## 4 Tests for Return Predictability

In this section, we present a statistical test for stock return predictability capable of detecting both linear and nonlinear dependence **present in financial time series (Lim and Brooks, 2006; Lim, 2007; Lim et al., 2008)**, namely the generalized spectral shape (GSS) test of Escansiano and Velasco (2006). The GSS test is a generalized version of the spectral shape test of Durlauf (1991), constructed based on the observation that the spectral density of a martingale difference sequence (MDS) is flat. The test is capable of detecting both linear and nonlinear dependence structures. In a recent Monte Carlo study, Charles et al. (2011) found that this test shows desirable size and

power properties in small samples, under a wide range of martingale processes and non-martingale alternatives.<sup>7</sup>

The null hypothesis of interest is  $H_0 : E(Y_t | Y_{t-1}, Y_{t-2}, \dots) = \mu$ , where  $\mu$  is a real number. Escanciano and Velasco (2006) express the above null hypothesis in a form of pairwise regression function. That is,  $H_0 : m_j(y) = 0$ , where  $m_j(y) = E(Y_t - \mu | Y_{t-j} = y)$ , against  $H_1 : P[m_j(y) \neq 0] > 0$  for some  $j$ . They note that the above null hypothesis is equivalent to the following condition:

$$\gamma_j(x) \equiv E[(Y_t - \mu)e^{ixY_{t-j}}] = 0,$$

where  $\gamma_j(x)$  represents an autocovariance measure in a non-linear framework and  $x$  represents any real number. Escanciano and Velasco (2006) propose the use of the generalized spectral distribution function, whose sample estimate is written as

$$\widehat{H} = \widehat{\gamma}_0(x)\lambda + 2 \sum_{j=1}^{\infty} \left(1 - \frac{j}{T}\right) \widehat{\gamma}_j(x) \frac{\sin(j\pi\lambda)}{j\pi},$$

where  $\widehat{\gamma}_j(x) = (T-j)^{-1} \sum_{t=1+j}^T (Y_t - \bar{Y}_{T-j}) e^{ixY_{t-j}}$  and  $\bar{Y}_{T-j} = (T-j)^{-1} \sum_{t=1+j}^T Y_t$ . Under the null hypothesis, the above generalized spectral distribution function has the value  $\widehat{H}_0(\lambda, x) = \widehat{\gamma}_0(x)\lambda$ , and the test statistic for  $H_0$  is constructed as

$$\begin{aligned} S_T(\lambda, x) &= (0.5T)^{1/2} \{ \widehat{H}(\lambda, x) - \widehat{H}_0(\lambda, x) \} \\ &= \sum_{j=1}^{T-1} (T-j)^{0.5} \widehat{\gamma}_j(x) \frac{\sqrt{2} \sin(j\pi x)}{j\pi}. \end{aligned}$$

To evaluate the value of  $S_T$  for all possible values of  $\lambda$  and  $x$ , Escanciano and Velasco (2006) use the Cramer-von Mises norm to obtain the statistic of the form

$$D_T^2 = \sum_{j=1}^{T-1} \frac{(T-j)}{(j\pi)^2} \sum_{t=j+1}^T \sum_{s=j+1}^T \exp(-0.5(Y_{t-j} - Y_{s-j})^2). \quad (1)$$

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<sup>7</sup>Khan and Vieto (2012) study the impact of Euronext stock exchange consolidation on market efficiency, and perform numerous statistical tests: serial correlation test, runs test, multiple variance ratio test of Chow and Denning (1993) and ranks and signs test of Wright (2000).

Escanciano and Velasco (Theorem 2, 2006) show that the test statistic  $D_T^2$  is consistent against all pairwise alternatives to the null hypothesis, and asymptotically follows a weighted sum of independent chi-squared distributions. To implement the test in small samples, Escanciano and Velasco (2006) propose the use of the wild bootstrap which is conducted in three stages as follows:

1. Form a bootstrap sample of size  $T$  as  $Y_t^* = \eta_t Y_t$  ( $t = 1, \dots, T$ ), where  $\eta_t$  is random variable with zero mean and unit variance;
2. Calculate  $D_T^{2*}$ , the  $D_T^{2*}$  statistic calculated from  $\{Y_t^*\}_{t=1}^T$ ;
3. Repeat 1 and 2  $B$  times, to produce the bootstrap distribution of the GSS statistic  $\{D_T^{2*}(j)\}_{j=1}^B$ .

The test for  $H_0$  against the two-tailed alternative can be conducted using the  $p$ -value, which is estimated as the proportion of the absolute values of  $\{D_T^{2*}(j)\}_{j=1}^B$  greater than the absolute value of the observed statistic  $D_T^{2*}$ . For  $\eta_t$ , we use the two point distribution given in Escanciano and Velasco (2006; p.164).

## 5 Empirical results

### 5.1 Data

We use daily closing spot prices from the following stock exchange markets: Amsterdam Stock Exchange (AEX), Athens Stock Exchange (ATHEX), Australian Stock Exchange (ASX), Bolsa de Valores de Colombia (BVC), Bolsa de Valores de Lima (BVL), Bolsa de Santiago de Chile (BSC), Borsa Italiana, Dubai Financial Market (DFM), Euronext, Johannesburg Stock Exchange (JSE), Kuala Lumpur Stock Exchange (KLSE), Lisbon Stock Exchange, London Stock Exchange (LSE), Moscow Interbank Currency Exchange (MICEX), New York Stock Exchange (NYSE), Paris Stock Exchange, Sao Paulo Stock Exchange (SAO), Stock Exchange of Hong Kong (SEHK), Stock Exchange of Singapore, Tokyo Stock Exchange (TSE), Toronto Stock Exchange (TSX), and Zagreb Stock Exchange (ZSE). The full list of the stock

exchanges considered and the indices used are given in Table ???. The data are obtained from Thomson Financial Datastream. Throughout the study, returns are calculated as:

$$R_t \equiv (P_t - P_{t-1})/P_{t-1} \times 100$$

with  $R_t$  the return at day  $t$ , and  $P_t$  the index level at day  $t$ .

For each merger, the data cover the period of 15 months before and after the date of merger. The dates of merger are given in Tables 11-13 ("Date effective"). We employ fixed-length moving sub-sample window of 3 months, which consists of around 66 daily observations, before and after the date of merger. This sample size allows us to analyze the effect of the merger on the short term, and also to have relatively good performance for the GSS test.

## 5.2 Details of testing procedure

The empirical analysis in this paper computes the GSS test statistic in a rolling window framework to detect the evolving nature of linear and nonlinear predictability, respectively, and hence changing degree of market efficiency over time. We evaluate time-varying return predictability by applying the GSS test with 3-months fixed-length moving sub-sample windows. For the post-merger (pre-merger) period, the first sub-sample window covers the period from the date of merger to three months after (before). After the GSS test is conducted for the first sub-sample, the window is moved one daily observations forward (backward), and the test statistic is recalculated. This process continues to the end of the data points. Given that the rolling window approach is able to detect periods of (in)efficiency, the relative efficiency of stock markets can be assessed by comparing the total time periods these markets exhibit significant linear or nonlinear serial dependence over time (see Lim, 2007; Lim and Brooks, 2006; Lim et al., 2008).

We also conduct a comparative analysis for pre-merger and post-merger sub-periods with an equal number of observations. To analyze the evolution of the merger effect across the time, we take different lengths of subperiods, i.e. one month, three months, six months, nine months, and twelve months. For each sub-period, we

compute the proportions of the  $p$ -values less than 0.05 ( $p$ ) and the mean of the  $p$ -values ( $m$ ). Let  $p_1$  and  $p_2$  represent the sample proportion estimate of the  $p$ -values less than 0.05 for pre- and post-merger sub-periods, respectively; and  $m_1$  and  $m_2$  represent the sample mean estimate of the  $p$ -values for pre- and post-merger sub-periods, respectively. We can test individually  $H_{0p1} : p_1 = 0.05$  against  $H_{1p1} : p_1 > 0.05$  and  $H_{0p2} : p_2 = 0.05$  against  $H_{1p2} : p_2 > 0.05$ . Rejection of  $H_{0p1}$  in favor of  $H_{1p1}$  is evidence against the MDH for the pre-merger period, and rejection of  $H_{0p2}$  in favor of  $H_{1p2}$  is evidence against the MDH for the post-merger period. Since the samples are overlapped because of using rolling windows, the statistical significance of the tests in successive sub-periods are tested from the nonparametric McNemar test. We can also test the null hypothesis that the two population proportions and means are equal, i.e.  $H_{0p} : p_1 - p_2 = 0$  and  $H_{0m} : m_1 - m_2 = 0$ , respectively. The alternative hypothesis is  $H_{1p} : p_1 - p_2 < 0$  (or  $H_{1p}^* : p_1 - p_2 > 0$ ) for the proportions and  $H_{1m} : m_1 - m_2 < 0$  or  $H_{1m}^* : m_1 - m_2 > 0$ ). To test for these hypotheses, we use the nonparametric McNemar test for the proportion comparison, and the nonparametric Wilcoxon test for the mean comparison.

Given the information above, we apply the following testing strategies:

*Step 1: Individual proportion tests*

- If  $H_{0p1}$  and  $H_{0p2}$  are not rejected, then the MDH is accepted for the pre- and post-merger periods;
- If  $H_{0p1}$  is not rejected and  $H_{0p2}$  is rejected, then the MDH is accepted for the pre-merger period but rejected for the post-merger period;
- If  $H_{0p1}$  is rejected and  $H_{0p2}$  is not rejected, then the MDH is accepted for the post-merger period but rejected for the pre-merger period;
- If  $H_{0p1}$  and  $H_{0p2}$  are rejected, the MDH is rejected for the pre- and post-merger periods, and we go to step 2.

*Step 2: Proportion comparison test*

- If  $H_{0p}$  is rejected against  $H_{1p}$  ( $p_1 - p_2 < 0$ ), then both sub-periods are inefficient and the pre-merger period is less inefficient than the post-merger period. Therefore, the merger can imply a loss of efficiency;
- If  $H_{0p}$  is rejected against  $H_{1p}^*$  ( $p_1 - p_2 > 0$ ), then both sub-periods are inefficient and the pre-merger period is more inefficient than the post-merger period. Therefore, the merger can imply a gain of efficiency;
- If  $H_{0p}$  is not rejected ( $p_1 - p_2 = 0$ ), then both sub-periods are efficient, and we go to step 3.

*Step 3: Mean comparison test*

- If  $H_{0m}$  is rejected against  $H_{1m}$  ( $m_1 - m_2 < 0$ ), then the pre-merger period is less efficient than the post-merger period. Therefore, the merger can imply a gain of efficiency;
- If  $H_{0m}$  is rejected against  $H_{1m}^*$  ( $m_1 - m_2 > 0$ ), then the pre-merger period is more efficient than the post-merger period. Therefore, the merger can imply a loss of efficiency.

## **5.3 Results**

We study the impact of 31 mergers on the efficiency of 37 stock exchanges. Tables ??–?? display the mergers between stock exchanges, between a stock exchange and a provider of services, and between a stock exchange and a commodity exchange, respectively. We give both the announced and effective dates of each merger, and the name, the country and the industry of the target and the acquiror.

### **5.3.1 General analysis**

The overall analysis of the results reveals some interesting findings. Firstly, the GSS test shows, in most of our observations, a significant evolution of the efficiency of the stock prices (Table ??). According to the GSS test, in only 29.07% of our 172 observations, the stock market has experienced no significant changes in efficiency

after a stock exchange merger. This means that in most of the cases, a stock exchange merger has a significant impact on the efficiency. Secondly, taken globally, the results indicates that, following a stock exchange mergers, decreases in the efficiency (41.28% of the cases) are more common than increases in the efficiency (29.65% of the cases). Therefore these results cast doubt on the supposed benefits of stock exchange mergers on the efficiency, and tend to be fairly consistent with the market power theory. Thirdly, the results are conditional on the length of the subperiods since we observe a decrease in the frequency of efficiency improvements after a stock exchange merger in the long term.

### **5.3.2 Stock exchange mergers in developed countries versus stock exchange mergers in developing countries**

As mentiobed before, we follow the definitions of the World Economic Forum to classify the countries into developed and developing ones. This allowed us to construct a subsample of 10 deals where a developing country's stock exchange merged with another firm (another stock/commodity exchange or a provider of services) and a subsample of 27 deals where a developed country's stock exchange merges with another firm. Table ?? shows that in developing countries, even if the stock market may be more efficient in the short term after a stock exchange merger with another firm, it is undoubtedly significantly less efficient in the long term.

Increases in the efficiency of stock markets are more frequently observed after a stock exchange merger in a developing country than in developed countries only in the very short term, namely less than 1 month (Table ??). In all the other cases, increases in the efficiency of stock markets are more prevalent in developed countries than in developing countries.

To sum up, our results indicate the overall rejection of Hypothesis 1 that stock exchange mergers have the same impact on the efficiency of the markets in developing and developed countries. The evidence show that, in the medium and long terms, the impact of stock exchange mergers results more frequently in efficiency improvements

in developed countries than in developing countries; while the reverse is the case in the very short term.

### **5.3.3 Stock exchange size**

We collected information concerning the size of the merger on Thompson One Banker Database. We focus only on domestic mergers and obtained information concerning 16 deals. We split our sample in two so that we had 8 small mergers (average size of \$26.57 million with a minimum size of \$5.37 million and a maximum size of \$121 million) and 8 large mergers (average size of \$934.88 with a minimum size of \$140 million and a maximum size of \$2,259.09 million). The results of Table ?? display that small deals resulting in significantly less efficient stock market after the merger. This is particularly true in the long term since no small merger improved efficiency for a subperiod of more than 9 months.

The comparison of small mergers results with those obtained for large mergers offers some very interesting insights (Tables ?? and ??). Especially, large mergers tend to result in the increase of efficiency in long term with high frequency. Our evidence shows strong evidence against Hypothesis 2 that the size of stock exchanges play no role in the improvement of market efficiency after the merger. We find that small stock exchange mergers may be too small to significantly increase the efficiency; while large stock exchange mergers show strong tendency to increase the efficiency.

### **5.3.4 Domestic pure stock exchange mergers**

In order to test Hypotheses 3, we focused on the 11 domestic pure stock exchange mergers of our sample (Table ??). The results show that the stock market is significantly less efficient after the merger than before. These results are particularly meaningful in the debate over the impact of stock exchange mergers. Whereas the results are mixed in the very short term (as many deals result in efficiency increase than in efficiency decrease one month after the merger), in the medium to long term, the results clearly show a decrease in the efficiency after the merger. Therefore, domestic

mergers between two stock exchanges tend to have a negative impact on efficiency, which is the evidence against Hypothesis 3.

### **5.3.5 Domestic pure stock exchange mergers versus cross border pure stock exchange mergers**

To test Hypotheses 4a and 4b, we focused on the six cross border stock exchange mergers of our sample. The results of Table ?? seem to indicate that the efficiency of stocks listed on a stock exchange will decrease after a cross-border stock exchange merger which invalidates Hypothesis 4a. The comparison with the results given in Table ?? indicates that for most length of subperiods, cross-border pure stock exchange mergers result more frequently in an efficiency decrease than domestic pure stock exchange mergers which contradicts Hypothesis 4b.

We have then split our sample between targets and bidders of a cross border stock exchange merger in order to study whether there are differences in the changes of the efficiency of their stocks. The results given in Tables ?? and ?? tend to invalidate Hypothesis 5. Even if the number of observations is quite low, our evidence tends to indicate that, on the long term, both target's and bidder's stocks seem to be less efficient after than before a cross border stock exchange.

This result is very interesting from a theoretical and policy point of view, because it calls into question the justification of cross-border stock exchange mergers since neither the acquirer nor the target seem to benefit from this kind of mergers in term of efficiency. Conversely, both stock exchanges suffer from a decrease in the efficiency.

### **5.3.6 Domestic pure stock exchange mergers versus domestic diversifying stock exchange mergers**

Finally, we studied the impact of diversifying stock exchange mergers on efficiency (Table ??). The results are somewhat mixed. In the short to medium term, they tend to indicate an increase in the efficiency; whereas, in the long term, the results tend to indicate a decrease in the efficiency after a diversifying stock exchange merger. Thus,

Hypothesis 6a is validated in the short term but not in the long term.

The comparison between domestic focusing and domestic diversifying stock exchange mergers (Tables 6 and 10) seems to indicate that stock exchange's diversification might be useful to increase efficiency since efficiency improvements are more frequent after a diversifying merger than after a focusing merger. This invalidates Hypothesis 6b.

## **6 Conclusion**

The aim of this paper is to examine the impact of stock exchange mergers on informational efficiency of the markets. Indeed, there is currently an important debate among practitioners; among scholars; and between advocates and opponents of stock exchange mergers. Proponents of stock exchange mergers argue that integration of stock exchanges produces a number of significant direct and indirect efficiency gains such as decreases in the trading fees, in the bid-ask and the volatility of the securities as well as increases in the trading volumes (see for example Pagano and Padilla, 2005). By contrast, critics of stock exchange mergers generally refer to the market power theory to emphasize that the merged stock exchanges may try to exploit monopolistic rents by increasing the trading fees which would increase the transaction costs and thus stock's illiquidity. Therefore, according to the point of view, stock exchange mergers may have a positive or a negative impact on efficiency.

Despite the importance of the issue, there are very few studies analyzing the impact of stock exchanges mergers on efficiency. In this paper, we have studied the impact of 31 mergers on the efficiency of 37 stock exchanges in order to fill this gap. Our results should be of interest not only to practitioners and scholars; but also to policymakers, because the approach used allowed us to compare different types of mergers and to study in which cases efficiency increases (or decreases) after a stock exchange merger.

Firstly, we show that stock exchange mergers do have an impact on market efficiency. Taken together, our results indicate a significant change in efficiency after a stock exchange merger in almost 71% of our 172 observations. Secondly, and more importantly, we show that there may be a ground for the concerns of the

critics of stock exchange mergers. Indeed, in our full sample and in most of our sub-samples (domestic pure stock exchange mergers, cross border stock exchange mergers, domestic diversifying stock exchange mergers), increases in efficiency are less frequent than decreases in efficiency after a stock exchange merger. This result is in contrast with that of Khan and Vieto (2012); and raises the question in relation to the motives underlying stock exchange mergers. It also encourages supervisory authorities to carefully evaluate the impact of these mergers. Thirdly, we show that the positive impact of stock exchange mergers on efficiency tends to decline over time. That is, the positive impact of a stock exchange merger is more frequent in the short term than in the long term. This effect has to be considered by those who would measure the impact of a stock exchange merger and incites to use different lengths of subperiods. Finally, we show that the impact on efficiency depends on range of the characteristics of the merger: stock exchange's country's level of development, size, geographical diversification and industrial diversification.

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