The Impact of Cross-listing on the Home Market's Information Environment and Stock Price Efficiency

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ABSTRACT

An improvement in a firm's information environment is one possible benefit of cross-listing a firm's shares. We empirically examine the changes in the information asymmetry and informational efficiency of prices of cross-listed stocks in their home market around a firm's cross-listing in the US. Using intraday stock trading data we estimate market microstructure measures of information asymmetry, including the effective spread, information asymmetry components of the spread and price impact, and intraday stock return autocorrelation as a measure of price efficiency. Our results suggest that cross-listing in the US is associated with a significant improvement in the quality of the firm's information environment and stock price efficiency in the home market. The improvement in the information environment is stronger for cross-listings that take place after the adoption of the Sarbanes-Oxley Act in the US in 2002. Overall, our results provide broad support for the legal and reputational bonding hypotheses and demonstrate that stricter disclosure associated with a US cross-listing is beneficial.

KEYWORDS: cross-listing, information environment, information asymmetry, informational efficiency of stock prices

JEL classifications: G14, G23, G30

1. Introduction

Cross-listing, which is a firm listing its shares on a foreign stock exchange in addition to its home market, continues to be a prominent feature of global financial markets. At the end of 2014, 528 non-US stocks from 47 countries were listed on the NYSE, comprising 21% of total NYSE listings.[1] From a firm's perspective, the benefits of cross-listing may include greater stock liquidity, lower costs of capital and higher market valuation (Diamond and Verrecchia, 1991; Easley and O'Hara, 2004; Chemmanur and Fulghieri, 2006). These benefits are most likely gained by listing on exchanges that have a better information environment through stricter disclosure and more active regulators, institutions and analysts. Greater information production in the foreign host market after cross-listing should feedback to the cross-listed firm's home market, improving the stock's information environment and price efficiency at home (Domowitz, Glen and Madhavan, 1998). In this paper we empirically test whether cross-listing on the NYSE is associated with an improvement in information environment and stock price efficiency of the cross-listing stock in its home market.

Several of the commonly proposed explanations for cross-listing have implications for information asymmetry and the stock price efficiency of a cross-listed firm. The legal bonding hypothesis argues that firms benefit from cross-listing in markets with stricter rules and laws. Cross-listing firms must meet the mandatory disclosure and listing requirements of the foreign market and the existing disclosure requirements in the home market.[2] This should result in greater information dissemination to markets following the cross-listing. In particular, cross-listing on the NYSE involves registration and compliance with the listing requirements of the United States Securities and Exchange Commission (SEC) including additional mandatory information disclosure (Coffee, 2002). Leuz (2003) points out that firms cross-listing in the US are required to file form 20-F, which requires extensive disclosure of the firm's financial and business information, in addition to requiring restatements of accounting information as per either US GAAP or IFRS post 2008. Additionally, firms also face scrutiny from the SEC and become subject to US civil liability for most breaches of the Securities Exchange Act 1934.

[1] Data source: the NYSE web-site https://www.nyse.com/

[2] Several theoretical papers focus on the rationale to cross-list on stock exchanges with stringent listing and disclosure requirements. Cantale (1996) and Fuerst (1998) show that firms cross-list on stock exchanges with strict disclosure requirements to signal there quality. Huddart, Hughes and Brunnermeier (1999) show that stock exchanges increase disclosure requirements in order to compete for order flow; i.e. greater disclosure reduces costs of trading and attracts liquidity. Chemmanur and Fulghieri (2006) show that cross-listing on a foreign exchange with high disclosure standards enhances investors' effectiveness in producing information and reduces investors' monitoring costs.

Additionally, cross-listing in markets with more active regulators and stricter audit processes should also signal an intent to produce more accurate disclosures.[3] Effectively, a non-US firm cross-listed in the US bonds itself to the US rules and regulations, providing superior investor protection (Coffee, 2002; Doidge, Karolyi and Stulz, 2004) and signals a better information environment. Khanna, Palepu and Srinivasan (2004) show that non-US firms cross-listed in the US have significantly higher levels of disclosure compared to firms that do not cross-list. Additionally, Seigal (2005) argues that the benefit derived from a cross-listing in the US is more reputational than it is legal. Complying with US rules builds a reputation within the US market which results in the firm gaining easier access to additional financing while breaches, even those that go unpunished by the SEC and courts, result in restricted market access.

Firms that cross-list in the US also benefit from greater visibility and exposure to the scrutiny of "reputational intermediaries" such as financial analysts and other participants in the foreign host market (Baker, Nofsinger, and Weaver, 2002; Coffee, 2002). In particular, cross-listing in the US is associated with an increase in analysts' coverage that facilitates the production and dissemination of information after the cross-listing (Baker et al., 2002; Lang, Lins, and Miller, 2003; Eaton, Nofsinger and Weaver, 2007; and Lee and Valero, 2010). The additional information created should reduce the information asymmetry and the adverse selection costs of trading cross-listed stocks (Brennan and Subrahmanyan, 1995). Furthermore, Ferreira and Matos (2008) report that cross-listing attracts greater institutional ownership, both in the foreign and home markets, increasing informal monitoring of the firm. Greater institutional ownership is associated with lower spreads and lower adverse selection components of spreads (Jennings, Schnatterly and Seguin, 2002). Overall, we expect a significant improvement in a firm's information environment after cross-listing in the US whether as an outcome of bonding to the US rules and regulations, as a result of greater visibility and informal market monitoring or due to reputational effects both in the home and host markets.

[3] Eaton et al. (2007) show that accounting standards also play a role in reducing information asymmetry after a cross-listing in the US. However, accounting standards are becoming less relevant in recent years due to a significant effort undertaken in harmonization and international convergence of accounting standards. For example, from 2005 all European listed companies are required to prepare financial statements in accordance with International Financial Reporting Standards (IFRS). Canada adopted IFRS from January 2011. In the United States from March 2008 non-US firms listed in the US exchanges are not required to provide reconciliations of differences in financial statements prepared under IFRS and US GAAP, effectively accepting IFRS as recognised accounting standards.

In this study, we evaluate the impact of cross-listing on the NYSE on the information environment at home. We employ a sample of 208 non-US firms from 18 different countries that cross-list on the US exchanges between 1997 and 2014, and a matched sample of home market firms not listed in the US to control for changes in firm characteristics and country-level factors. Using intraday trading data, we estimate the measures of the quality of the information environment including the effective spread, two measures of the adverse selection component of spreads, price impact and the autocorrelation in intraday returns. Our results provide strong evidence that cross-listing on the NYSE is associated with a significant improvement in the firm's information environment and stock price efficiency. We control for two possible explanations for the improvement in the information environment, potential increases in financial analysts' coverage and institutional ownership following the cross-listing. After controlling for these explanations we find no significant evidence that either can fully explain the documented improvement in the information environment and stock price efficiency. Additionally, we exploit the adoption of the Sarbanes-Oxley Act 2002 (SOX) as a quasi-natural experiment. SOX markedly increased the level of disclosure in the US (Coats, 2007). We consider the impact of cross-listings on the information environment before and after the adoption of SOX and find a stronger improvement in the information environment in the post-SOX period. This suggests that stringent disclosure requirements in the host market contribute to the improvements in information environment and stock price efficiency of cross-listed stocks in their home markets. Additionally and consistent with prior evidence (see Bailey, Karolyi and Salva, 2006; Fernandes and Ferreira, 2008; Foucalt and Fresard, 2012) we find that the improvement in the information environment is particularly strong for developed market firms. Our results also hold after controlling for potential self-selection bias using the Heckman procedure and after controlling for the level of trading activity in the US.

We contribute to the literature by examining the benefits of cross-listing on the information environment in the home market using market microstructure measures of information asymmetry. An ongoing issue with identifying the potential sources of benefits from cross-listing is that cross-listing in a better quality market brings improvement in a number of inter-related aspects at the same time. This makes it difficult to isolate the impact on the information environment as improvements may be also driven by changes in stock liquidity. Studies recently have looked at different proxies to measure the quality of the information environment of cross-listed stocks, either in the home or foreign markets. Studies exploring the home market information environment have relied on relatively indirect measures

of the information environment including volatility and trading volume reaction to earnings announcements (Bailey, Karolyi and Salva, 2006) and stock price informativeness (Fernandes and Ferreira, 2008; Foucault and Frésard, 2012). Studies exploring the information environment in the foreign market have used market microstructure measures and report that cross-listed stocks tend to have wider spreads and higher information asymmetry components of the spreads than comparable US stocks (Bacidore and Sofianos, 2002; Jiang and Kim, 2005). Additionally, firms from countries with weaker investor protection are penalised more heavily (Chung, 2006). When managers consider a cross-listing, however, they are likely more concerned with the firm's information environment relative to domestic peers rather than US firms. Therefore, the impact on the information environment at home will play an important role in determining the success or failure of a cross-listing.

The second issue we examine is whether cross-listing has an impact on the informational efficiency of stock prices. Attaining price efficiency is a crucial function of financial markets and it is directly related to the level of information transparency, i.e. greater information production is associated with more efficient prices (Hendershott and Jones, 2005; Comerton-Forde and Putniņš, 2013). Additional disclosure and information production in the foreign market after cross-listing should feedback to the home market and lead to more efficient pricing at home. Liu (2007), who employs abnormal runs of return series, and Korczak and Bohl (2005), who use autocorrelation of daily returns for a small sample of Central and Eastern European stocks, find that a US cross-listing is associated with an improvement in stock price efficiency. To add to the literature, we examine efficiency of intraday stock prices of cross-listed stocks.[4]

The rest of the paper is organised as follows. In Section 2, we discuss market microstructure measures of information asymmetry and price efficiency that we employ to evaluate the changes in the quality of information environment after cross-listing in the US. In Section 3 we discuss the data used in the empirical analysis. In Section 4 we report and discuss the results. Finally, In Section 5 we conclude.

[4] Tests of informational efficiency of prices that use high frequency data have higher statistical power and greater precision compared to tests that use daily data (Comerton-Forde and Putniņš, 2013).

2. Measures of Information Asymmetry and Price Efficiency of Cross-listed Stocks

Based on the argument that cross-listing is associated with an increase in information dissemination to markets, we expect the quality of the stock's information environment and stock price efficiency to improve after cross-listing. To test this proposition, we estimate several measures of information asymmetry and price efficiency in the home market for a period of six months before (from -7 to -1 months) and six months after (from +1 to +7 months) the month of the cross-listing for each sample firm.[5]

Information Asymmetry

To proxy the level of information asymmetry before and after cross-listing we estimate three spread-based measures and the price impact of trades. First, we estimate the effective spread as follows:

$$ES_t = 2 * D_{t*}\left(\frac{p_t - m_t}{m_t}\right) \qquad (1)$$

where p_t is the traded price, m_t is the midpoint of the prevailing bid and ask quotes at the time of the trade and D_t is a trade indicator variable that has a value of 1 for buyer-initiated transactions and a value of -1 for seller-initiated transactions.[6] We estimate the effective spread for each trade and then calculate the average for the period of six months before and the period of six months after the cross-listing for each firm. We concentrate on the effective spread as it allows for trades to occur at prices either inside or outside of the quoted bid and ask prices, giving a better representation of the true cost of trading.[7]

[5] To ensure the robustness of our findings, we also run the tests with the same measures for twelve months before (from -13 to -1 months) and twelve months after (from +1 to +13 months) the month of cross-listing. The results are broadly consistent and, therefore, are not reported for the sake of brevity, but are available upon request.

[6] As the data do not contain information on who initiated the trade, we follow Lee and Ready (1991) and estimate the trade indicator variable by comparing the quotes to the transaction price. If the traded price is above the midpoint of the quoted spread the trade is classified as a buyer-initiated while trades that occur below the midpoint are classed as seller-initiated. Trades that occur at the midpoint are left undetermined. Unlike Lee and Ready (1991), we do not lag quotes to determine the trade indicator, because the majority of markets we examine are electronic markets where the risk of quotes and trades being recorded in the wrong order are dramatically lower (see Peterson and Sirri, 2003).

[7] We also estimate the quoted percentage spreads. As the results are consistent with the results for the effective spread, we only report the effective spread results for the sake of brevity.

Extant literature has shown that spreads reduce following a cross-listing in the US (e.g. Domowitz et al., 1998; Foerster and Karolyi, 1998).[8] Both Foerster and Karolyi (1998) and Domowitz et al. (1998) attribute the decrease in bid-ask spreads to the increase in inter-market competition after cross-listing in the US. However, spreads compensate for both liquidity risk and information asymmetry risk (Glosten and Milgrom, 1985). Therefore, a reduction in spreads after cross-listing could indicate a reduction in either liquidity risk, information asymmetry or both. To disentangle the effects of cross-listing, we also employ more sophisticated measures of information asymmetry. In particular, we employ two spread decomposition models, specifically the models of Lin, Sanger and Booth (1995) and Madhavan, Richardson and Roomans (1995), to estimate the information asymmetry components of spreads.[9] We also estimate the price impact of a trade, another measure of information asymmetry used in the literature (e.g. Eleswarapu, Thompson and Venkataraman, 2004).

Many of the market microstructure models of spreads view spreads as composed of (i) compensation for risks faced by liquidity providers, specifically inventory holding and order processing costs, and (ii) compensation for information asymmetry (Glosten and Milgrom, 1985). To isolate the cost of information asymmetry we employ the spread decomposition models of Lin et al. (1995) and Madhaven et al. (1995). Both models separate spreads into costs associated with the cost of information asymmetry and liquidity risk. Specifically, the models assume that trades that result in permanent shifts in the fundamental value of the stock are driven by the arrival of new information, and therefore represent information asymmetry risk. As the spread is set to compensate a market maker for the risks they face, the information asymmetry component of the spread is a measure of the risk of unpriced information that may be exploited by better informed counterparties, and therefore the quality of the information environment.

The model of Lin et al. (1995) (referred to as LSB model thereafter) models the degree of information asymmetry as the response of the midpoint to a trade at the bid or ask, i.e.

[8] The evidence is mixed. For example, Berkman and Nguyen (2010) examine the change in stock liquidity, measured by the quoted bid-ask spread after cross-listing in the US and find no significant evidence that cross-listing reduces spreads.

[9] Other adverse selection models have been proposed by Huang and Stoll (1997) and Glosten and Harris (1988). All the models use similar reasoning although differ considerably in the method of estimation. The Lin et al. (1995) methodology has been shown to produce fewer implausible estimates (Van Ness, Van Ness and Warr 2001).

$$\Delta m_{t+1} = \lambda z_t + e_{t+1}, \qquad (2)$$

where Δm_{t+1} is the change in the log of the quoted midpoint at time t; $z_t = p_t - m_t$ where p_t is the log of the trade price at time t, and λ is the information asymmetry component of the spread (expressed as a percentage) (referred to as IA_LSB thereafter). Equation (2) is estimated using OLS. We estimate the IA_LSB for each firm for the period of six months before and for the period six months after the cross-listing.

Alternatively, the model of Madhaven et al. (1995) (referred to as MRR model thereafter) dynamically relates the order flow to transaction price returns to determine the information asymmetry component of the spread. Madhaven et al. (1995) argue that bid and ask prices adjust to encourage trade direction reversals, such that a buy is followed by a sell, to minimise the inventory risk to a market maker. Therefore, evidence of sequences where buys follow buys and sells follow sells suggest informed trading. Specifically, transaction price returns are modelled as

$$p_t - p_{t-1} = \theta (x_t - \rho x_{t-1}) + \phi (x_t - x_{t-1}) + u_t, \qquad (3)$$

where x_t is a trade indicator variable that equals 1 for buyer-initiated trades, -1 for seller-initiated trades and 0 for trades at the midpoint at time t, θ is the per share cost of information asymmetry, ϕ is the per share compensation for inventory holding and order processing costs, ρ is the first-order autocorrelation of the trade direction and u_t captures the impact of price discreteness and new public market-wide information releases. To control for the fact that the error term in equation (3) is likely to be non-normal (e.g. due to price discreteness), we estimate the model using the GMM procedure employed in Madhavan et al. (1997).

In the MRR model θ and ϕ both represent dollar costs of their respective risks. Following Madhavan et al. (1997), we compute the proportion of information asymmetry using the following:

$$\text{IA\_MRR} = \theta/(\theta+\phi), \qquad (4)$$

where θ and ϕ are the estimates from equation (3). We use the proportion of information asymmetry in the spread to make the value relative and, therefore, comparable regardless of the price level or spread size. We estimate the IA_MRR for each firm for the period of six months before and for the period six months after the cross-listing.

In addition to the spread-based measures, we also estimate the price impact of a trade as a measure of information asymmetry (e.g. Huang and Stoll, 1997; Eleswarapu et al., 2004). Price impact measures the permanent impact of the arrival of new information in the order flow by examining the change in the underlying value of a stock between the time of the trade and at some point in the near future. Although the underlying value of a security is not directly observed, it is commonly proxied by the midpoint of the bid and ask quote (e.g. Bessembinder and Kaufman, 1997; Huang and Stoll, 1996, among others). Therefore, we measure the price impact of a trade as the absolute difference between the quoted midpoint *n* periods after the trade and the quoted midpoint at the time of a trade divided by the midpoint at the time of the trade, i.e.

$$PI_t = D_t * \left(\frac{M_{t+n} - M_t}{M_t} \right), \tag{5}$$

where M_t is the quoted midpoint. Although the price impact measure has been shown to be relatively insensitive to the choice of *n* (Werner, 2003), using a larger window may cause other events to affect the estimation of the price impact. Following Huang and Stoll (1997), we choose a 5-minute window.[10] We estimate the price impact for each trade and then calculate the average for the period of six months before and the period of six months after the cross-listing for each firm.

Price Efficiency

An improvement in the information environment, indicated by greater information production and disclosure, should result in more efficient pricing (Hendershott and Jones, 2005). Following Comerton-Forde and Putniņš (2013), we estimate the informational efficiency of stock prices using the autocorrelation of the intraday returns over 60 second intervals.[11] This price efficiency measure focuses on deviations from the requirement that informationally efficient prices should follow a random walk and not be predictable based on past information. The degree to which returns deviate from this requirement indicates the level of inefficiency in prices. The presence of autocorrelation in the intraday returns, either positive

[10] To ensure the robustness of our findings, we also run the tests with the measure of price impact estimated for 1-minute and 30-minute windows. The results are consistent and, therefore, are not reported for the sake of brevity.
[11] We also estimate price efficiency over 10 second and 300 second intervals. The results are consistent and for the sake of brevity we only report the 60 second interval results.

or negative, results in short-run predictability and, therefore, indicates that returns deviate from a random walk. We use the prevailing quoted midpoint at the end of each interval to calculate the midpoint returns. We estimate first-order return autocorrelations for each stock such that

$$Autocorrelation_k = Corr(r_{k,t}, r_{k,t-1}) \quad (6)$$

where k represents 60 seconds intervals and $r_{k,t}$ is the midpoint returns at time t. We then take the absolute value of the autocorrelation and estimate its average over the period of six months before and the period of six months after the cross-listing for each stock. Larger values, or greater predictability in returns, indicate less efficient prices.

3. Sample and Summary Statistics

Sample selection

To investigate the impact of cross-listing on a stock's information environment and price efficiency, we hand-collect a sample of non-US firms that have cross-listed on the US exchanges including the NYSE, AMEX and Nasdaq between 1997 and 2014. We obtain information on non-US stocks listed on the NYSE, AMEX and NASDAQ from the stock exchanges' web-sites, Compustat and Datastream. Because we analyze stocks' trading environment in their home markets, we exclude direct foreign IPOs, i.e. when stocks do not have a home market listing, and exclude stocks that are listed in the home market at the same time or after being listed in the US. Next, we exclude stocks without coverage in Datastream, our data source for firm level variables. Finally, we check for availability of intraday trading data in Thompson Reuters Tickhistory (available from 1997). In order to estimate our intraday measures of information asymmetry and stock price efficiency we require on average five or more trades per day. After applying the above sample selection criteria, we obtain a sample of 208 firms from 18 countries. Sample distribution by home country is reported in Table 1. Owing to the close proximity and ease of cross-listing, over half our sample are Canadian cross-listed firms (115 firms). The UK and Japan are the next most common home markets, contributing 26 and 10 firms respectively. Although the sample contains stocks from both developed and emerging countries, emerging countries make up only a small number of observations (19 cross-listings from six countries). Table 1 also reports the distribution of the sample by year of cross-listing. The largest number of cross-listing events took place between 2000 and 2002, with 66 cross-listings in total.

[TABLE 1]

Intraday stock trading data, including price, volume traded and prevailing bid and ask quotes for the home market, are obtained from Thompson Reuters Tick History (available via the SIRCA database). Firm characteristics, such as firm market value and market-to-book ratio, are obtained from Datastream. Table 2 presents summary statistics of trading activity in the home market and firm characteristics of the sample cross-listed stocks for the 6-month window before and after the cross-listing. Specifically, we report the total number of trades and average trade size, as indicators of trading activity, and market value and market-to-book ratio as firm characteristics. The table also reports the statistical significance of the differences in the means and medians between the pre- vs. post- cross-listing period based on t-tests and the Wilcoxon Signed Rank test accordingly. The results suggest that there is an increase in the total number of trades after cross-listing, however, only the difference in medians is statistically significant. We find no significant changes in firm characteristics or in average trade size in the period following the cross-listing relative to the period before the cross-listing.

[TABLE 2]

In addition to non-US stocks cross-listed on the NYSE our sample includes matched home market firms that have not cross-listed their shares in the US. For each sample cross-listing firm we identify a matched domestic firm from the same home market and industry based on four digit SIC codes. Further, we find the closest match based on firm size, measured by market capitalization, market-to-book ratio and stock price in the period prior to the cross-listing. Our matching criteria are characteristics that are closely related to the levels of spreads, information asymmetry and price efficiency, giving us the closest possible match to the information environment of our cross-listing firms.[12] We expect that the information environment of matched firms is unaffected by the cross-listing events of the sample firms.

[12]We also consider time since IPO for the sample cross-listed and the matched firms. Both groups have comparable time since IPO of around 13 years on average. Based on a t-test and the Wilcoxon rank-sum test, there are no significant differences in the means or medians of the time since IPO variable between the cross-listed firms and the matched firms.

4. Results

Cross-listing and Information Environment: Univariate Analysis

We begin our examination of the impact that cross-listing has on the home market information environment and price efficiency by examining the univariate differences between our proxies before and after the cross-listing for the sample cross-listed firms as well as for the matched firms. We report the results in Table 3. We test univariate differences in means and medians before and after the cross-listing using a t-test for the difference in means and the Wilcoxon Signed Rank test for the differences in medians. In general, for the sample of cross-listing stocks, we see evidence of an improvement in the information environment and price efficiency in the home market after cross-listing. In particular, we observe a significant reduction in the median values of the effective spread, although the difference in means is not statistically significant. Further, we observe a reduction in the effective spread for 152 out of 208 stocks, 73% of the sample. We find stronger evidence when we examine measures of the information asymmetry component of spreads. The difference in the mean and median values are significant for the spread decomposition measures estimated using the MRR (*IA_MRR)* model, and for the median values for the LSB model (*IA_LSB)*. The reduction occurs for more than half of the sample firms for both measures. We also see strong evidence of a reduction in the price impact measure, with significant reductions in both the mean and median values, and in the price efficiency based on the significant reduction in the autocorrelation measure. The reduction in price impact and autocorrelation occur in more than 58% of the sample.

[TABLE 3]

We also examine the differences in the information environment variables for the matched sample. We observe no significant differences before vs. after the cross-listing for any of the variables. This is as expected, suggesting that there has been no systemic changes in the markets around the time of the cross-listing that would explain the changes in the cross-listing firms. Finally, we examine the differences between the sample and matched firms in the pre and post periods separately. In the pre cross-listing period we observe no statistical difference between the sample and matched firms for the mean of the effective spread, and either mean or medians for the *IA_LSB* and price impact measures, and statistically larger values for the *IA_MRR* and the autocorrelation. In the post cross-listing period, we find that the sample firms, on average, have lower values for the effective spread and the price impact measure. The differences in the *IA_MRR* and the autocorrelation measure are insignificant in the post cross-

listing period. The results therefore indicate that following a cross-listing there is a significant decrease in all our variables, except *IA_LSB*, going from either no difference to significantly less or from significantly greater to no statistical difference. Overall, the results of the univariate analysis provide preliminary evidence that after a cross-listing in the US cross-listing firms experience a significant reduction in the cost of trading, the degree of information asymmetry and a significant improvement in price efficiency.

Cross-listing and Information Environment: Multivariate Analysis

To control for other potential explanations for the changes in information environment and stock price efficiency after cross-listing we conduct multivariate regression analysis. We include matched firms to account for changes in firm characteristics and market-wide effects that may explain our findings, but that are unrelated to the cross-listing event. We compare a treatment group that has been exposed to an event (in our case cross-listing firm's sample) with a control group that has not undergone such a change (our matched firms). To determine the impact of cross-listing on our information asymmetry measures, we estimate a regression in the following form:

$$IE_i = \alpha + \beta_1 D\_CL_i * D\_Post_i + \beta_2 D\_Post_i + \beta_3 D\_CL_i + \sum_k \gamma_k Control_{ki} + \varepsilon_i, \qquad (7)$$

where the dependent variable, IE_i, is one of our measures of the information asymmetry and price inefficiency as defined in section 2. Our main explanatory variable of interest is the interaction variable D_CL_i*D_Post_i, the product of a *Cross-listed sample* dummy variable (D_CL_i) and a *Post cross-listing* dummy variable (D_Post_i). An estimate of this interaction variable will indicate whether information asymmetry and price inefficiency of cross-listed stocks are significantly affected by the cross-listing event, beyond the changes experienced by all stocks (both cross-listing and matched). The *Cross-listed sample* dummy variable (D_CL_i) equals one if the stock belongs to the cross-listing sample and zero if the stock belongs to the matched sample. This variable captures any potential differences in the information environment of cross-listing and matched stocks. The *Post cross-listing* dummy variable (D_Post_i) equals zero for the time period before the cross-listing event and one after the cross-listing event. This variable controls for changes in the information environment after the cross-listing experienced by both cross-listing and matched firms.

We also include in our regressions several control variables. First, we control for the level of trading activity of the stock, which has been shown to affect transaction costs, proxied by the *Number of Trades* (defined as the log of the average number of trades per day in the home market) and *Trade Size* (defined as the log of average volume traded per transaction in the home market). More actively traded stocks and stocks with larger average trade size should have lower costs of trading (Easley and O'Hara, 1987; Lin et al., 1995). Second, we control for firm characteristics such as *Firm Size* (defined as the log of market capitalisation) as larger firms generally have better information environments due to greater exposure, market scrutiny and analysts' coverage, and market-to-book ratio (*MTB*) as a measure of the firm's growth opportunities and equity risk premium, related to the level of information asymmetry (Griffin and Lemmon, 2002). To reduce the impact of outliers, we winsorize all variables at 1% on both sides of the distribution. Finally, we control for industry, country and time variations by including industry, country and year fixed effects. We estimate the regressions using an OLS estimation procedure with clustered standard errors by firm. Table 4 reports the estimation results.

[TABLE 4]

The estimation results show that the *Cross-listing*Post* variable is negative and statistically significant for all our information environment and price efficiency proxies, indicating a marked reduction in all of our measures. Our results provide strong evidence that cross-listing in the US comes with a significant improvement in the firm's information environment, reducing the firm's information risk, and a significant improvement in the stock's price efficiency. The Cross-listing sample variable is positive and statistically significant for two out of five measures, suggesting that cross-listing stocks have greater information asymmetry relative to matched stocks based on the MRR model and price impact. The Post cross-listing variable is mainly insignificant with the exception of effective spread and price impact, demonstrating there are no significant changes after the cross-listing event for our matched firms for most of the variables.

With regards to the control variables, in line with the expectations, we observe a negative relationship between the number of trades and the measures of information

asymmetry, effective spread, IA_LSB, and Price Impact. Also we observe a negative relationship between firm size and effective spread, IA_MRR and Price Impact. These results indicate that more actively traded stocks and stocks of larger firms have a better information environment with less information asymmetry costs built into spreads and a lower price impact of trades, which is consistent with prior evidence (Collins, Kothari and Rayburn, 1987; Easley and O'Hara, 1987; Lin et al., 1995). Of note, we find a positive relationship between firm size and autocorrelation. Other control variables offer only sporadic, if any, significance. Noteworthy, we observe particularly high R-Squared values for the two information asymmetry component estimates (IA_LSB and IA_MRR) and the price impact measure.

Sources of Improvement in Information environment after Cross-listing

Our analysis so far provides evidence that a cross-listing in the US improves a firm's information environment, with reductions in the amount of information asymmetry priced into spreads, less permanent price impact from trades and improved price efficiency. As discussed earlier, there are several potential channels of improvement in the information environment after the cross-listing in the US. Primarily, additional information dissemination to the markets after cross-listing could be the result of tighter information disclosure rules and stricter legal environment, as stated by the legal bonding theory of cross-listing (Coffee, 2002; Doidge et al., 2004), or reputational benefits as suggested in the reputational bonding hypothesis (Siegal, 2005). Additionally, cross-listing is potentially associated with greater information production via financial analysts' coverage and greater monitoring as a result of increased institutional ownership. In this section, we examine whether changes in a firm's information environment and price efficiency after a cross-listing are driven by the changes in analysts' coverage and institutional ownership after cross-listing.

Cross-listing and Information Environment: The Role of Financial Analysts

First, we explore the role of financial analysts. An increase in analysts' coverage after a cross-listing (potentially due to greater visibility of the firm and also due to additional coverage by financial analysts in the foreign market), should increase the amount of information being disseminated, and help to identify mispricing in the market (Brennan and Subrahmanyam, 1995). To examine the role of analysts around cross-listing, we obtain the total

number of analysts' 1-year earnings-per-share (EPS) forecasts for each firm for the six-month period before and after the cross-listing from the I/B/E/S database (variable *Analysts*).[13] Although we observe a slight increase in the intensity of analysts' coverage of cross-listing firms after the cross-listing (average monthly 7.9 forecasts after the cross-listing vs. 7.7 forecasts before the cross-listing), the difference is not statistically significant. To evaluate the impact of analysts' coverage on a firm's information environment, we re-estimate equation (7) with the addition of the variable *Analysts*. The estimation results are reported in Table 5. We observe that the analysts' coverage is negatively related to a firm's information environment in all regressions, and is statistically significant for three out of five measures – Effective spread, IA_MRR and Price Impact. This means stocks with more analysts' coverage have a better information environment. However, the inclusion of the Analysts variable does not change the earlier results reported in Table 4. In particular, even after controlling for analysts' coverage, the Cross-listed*Post variable remains negative and significant for all measures of information asymmetry and price efficiency. This indicates that increased analysts' coverage is not the only source of the improvement in the information environment and price efficiency after the cross-listing.

[TABLE 5]

Cross-listing and Information Environment: The Role of Institutional Investors

Next, we examine the role of institutional investors. Greater institutional ownership increases informal monitoring and, therefore, improves the firm's information environment (Jennings et al., 2002).[14] We estimate a measure of institutional ownership, variable *Institutional Investors*, as a proportion of the company's equity owned by domestic and foreign institutions. We obtain ownership data for the six-month period before and after the cross-listing from Datastream. We observe that cross-listing firms experience a small increase in

[13] We have also considered measures of analysts' forecast accuracy (deviation of forecasts from the actual EPS) and of analysts' forecast dispersion (coefficient of variation of 1-year EPS forecasts). We find that both analysts' forecast accuracy and analysts' forecast dispersion are insignificant in explaining a firm's information environment and do not affect estimation results for other variables of interest.

[14] Evidence on the effects of institutional ownership on a firm's information environment is mixed. For example, Dey and Radhakrishna (2012) report that institutional trading increases the adverse selection component of spreads.

institutional ownership after the cross-listing (from 11.9% to 12.0%); however, the difference in average institutional ownership before and after cross-listing is not statistically significant. As ownership data are available in Datastream only from 2002, we lose a significant number of observations. For consistency, we first re-estimate equation (7) employing the reduced sample and then estimate equation (7) again with the addition of the Institutional Investors variable. Estimation results are reported in Table 6. We find no evidence that the improvement in the information environment and price efficiency after cross-listing are related to the changes in institutional ownership. The significance of the Cross-listing*Post variable remains unchanged after inclusion of the Institutional Investors variable. The Institutional Investors variable itself is insignificant in three of the five models suggesting that institutional ownership has no significant impact on a stock's information environment and stock price efficiency. Overall, the results on the role of analysts' coverage and institutional investors imply that other channels of information dissemination, such as legal bonding to the US listing rules and regulations, greater disclosure, increased firm visibility and reputational bonding, remain important.

[TABLE 6]

The role of stringent disclosure requirements: The Sarbanes-Oxley Act

As discussed above, one of the likely channels of improvement in a firm's information environment after cross-listing in the US is compliance with stringent reporting and listing requirements of the SEC resulting in dissemination of additional and more accurate firm-specific information. These requirements in the US increased even further as a result of the adoption of the Sarbanes-Oxley Act (SOX) in July 2002 in response to the corporate governance failures of a number of prominent US companies. SOX has imposed considerable new disclosure and listing requirements for publicly listed firms including non-US firms cross-listing in the US. Coats (2007) argues that SOX improved corporate governance and reliability, transparency and accountability of financial reporting and disclosed information. A marked increase in disclosure requirements after SOX should further improve information environment of stocks listed on US exchanges. Indeed, Jain, Kim and Rezaee (2008) report that quoted and effective spreads and adverse selection components of the spreads of US stocks have reduced

significantly in a long run after the adoption of SOX. In the context of our study, we expect that an increase in disclosure requirements in the foreign host market, the US, after the adoption of SOX, makes the effects of cross-listing on information environment of cross-listing firms even stronger. Therefore, we expect that cross-listings in the US that takes place after the adoption of SOX have a stronger positive impact on a cross-listing stock's information environment and price efficiency compared to the impact of cross-listings before SOX. Following Cohen, Dey, and Lys (2008), we split our sample into pre- and post-SOX periods (up and including year 2001 and including and after year 2002, accordingly) and re-estimation equation (7) for each of the sub-samples. The estimation results are reported in Table 7.

[TABLE 7]

The results for pre-SOX period (reported in Panel A of Table 7) show that cross-listing has a significant negative impact measure on information asymmetry for the IA_LSB, price impact and Autocorrelation measures. In the post-SOX period the results are stronger. In particular, we find statistically significant negative relationship for all our dependent variables with the exception of IA_LSB. Overall, we observe that the improvement in information environment and price efficiency of cross-listing stocks is stronger after the adoption of SOX. This provides further support for the argument that it is the stringent disclosure and listing requirements as a result of cross-listing in the US that drives the benefit for firms.

Cross-listing and Information Environment: The Role of the US Share of Trading

Prior studies have concluded that the benefits of cross-listing depend on the receptivity of the US market of the cross-listed firm. For example, King and Segal (2009) argue that those firms that attract more US investors see greater valuation benefits from cross-listing. We evaluate US interest in a cross-listed company by measuring the US share of trading. A higher US share of trading indicates a more active market in the US relative to the home market after cross-listing. This could also indicate that order flows of cross-listed stocks migrate from the home market to the foreign market following the cross-listing, potentially resulting in a deterioration in market quality at home (Domowitz et al., 1998). We define the US share of

trading as the number of the US trades in the period following the cross-listing divided by the number of trades in the home market. To control for the potential impact of the US share of trading, we re-estimate equation (7) including the US share of trading variable. The results, reported in Table 8, are largely unchanged by the inclusion of this control variable as the *Cross-list*Post* variable remains significant for all measures of information asymmetry and price efficiency. The inclusion of US Share of Trading variable also leaves the significance of the other controls unchanged and is itself only related to Effective spread. Therefore, we do not find evidence that the improvement of the home market information environment and price efficiency is affected by the level of trading in the foreign market.

[TABLE 8]

Cross-listing and Information Environment: The Impact of the US Public Debt

Issuing US public debt may impact the information environment of the firms as US public debt requires additional disclosure similar to equity issues (Miller and Puthenpurackal 2002; Ball, Hail and Vasvari, 2013).[15] To address the concern that US public debt issues may impact the information environment and stock price efficiency of the cross-listed firms, we have identified whether the sample firms have had US public debt issued before the cross-listing event using the Fixed Income Securities Database (FISD) which contains information on all US debt issues. We filter the database to focus on Yankee debt issues to the public market, as private issues do not impose additional disclosure requirements on the firms. Of our sample of 208 cross-listed firms, we find 15 firms have issued US public debt prior to the cross-listing event. In the regression analysis we control for the potential impact of US public debt issues on the information environment and stock price efficiency of the firms by including a dummy variable, which equals 1 for firms with prior US public debt issues. We re-estimate equation (7) with the addition of variable US public debt and report the results in Table 9 of the paper. We can see that the inclusion of the US public debt variable does not change the main results. In particular, even after controlling for prior US public debt issues, the *Cross-listed*Post* variable remains negative and significant for all measures of information

[15] We thank the referee for the valuable suggestion to consider US public debt issues by non-US firms cross-listed in the US.

asymmetry and price efficiency. The US public debt variable itself only significant for Effective Spread, and even then indicates a positive relationship. Our results are therefore unaffected by the inclusion of the public debt dummy. However, given the small number of observations of firms that had prior public debt issues, we are unable to delve deeper into this issue in this paper.

[TABLE 9]

Self-selection bias correction: Heckman procedure

As a final robustness test we consider the impact of self-selection bias on our results. Doidge et al. (2004) among others have highlighted that statistical analysis of the effects of cross-listings is potentially biased as the outcome of cross-listings may be driven by the characteristics of the firms that choose to cross-list rather than the act of cross-listing. In our case, firms with a better quality information environment could be more likely to cross-list, and this could bias our estimation of the relationship between cross-listing and the quality of the information environment. While using matched sample and observations before and after the cross-listing control for this to a large degree, the Heckman (1979) two-stage procedure has also been employed extensively to control for potential self-selection biases.

In the first stage of the Heckman procedure we employ a probit regression to estimate the probability of a firm undertaking a cross-listing. We include a number of factors that may affect the probability of cross-listing, such as firm characteristics - firm size and book-to-market ratio, and measures of stock liquidity - the number of trades and trade size. In addition, following Fernandes and Ferreira (2008), we include in the probit model characteristics of the home country that reflect the quality of legal system, disclosure and the level of economic development. The quality of legal system and disclosure are captured by the legal origin, a dummy variable for English law from La Porta et al. (1998), and judicial efficiency index and disclosure requirements index from La Porta et al. (2006). Economic development is measured by GDP per capita obtained from UN Statistics Division. The first column of Table 10 reports the estimation results of the probit model. We observe that firm size is positively related to the probability of cross-listing while trade size, which could indicate greater information asymmetry, is a negative predictor of the cross-listing decision. Regarding home country

characteristics, the legal origin is a significant determinant of the cross-listing decision with firms from English law countries more likely to cross-list.

Next, we use the estimated probability to cross-list from the probit model to calculate the inverse mills ratios, which we then include in the second stage regressions (see Doidge et al., 2004 for a detailed discussion). The second stage results, reported in Table 10, are largely unchanged from our main results reported in Table 4. We observe statistically significant reductions in all five measures of information asymmetry and stock price inefficiency after the cross-listing compared with the matched sample. Overall, the results from Heckman procedure show that the relationship between cross-listing and the quality of information environment that we document is robust to controlling for potential self-selection bias of cross-listing decision.

[TABLE 10]

5. Conclusion

In this paper we examine the changes in the quality of a firm's information environment and stock price efficiency in the home market after cross-listing in the US. We estimate several market microstructure measures: (i) the effective spread, the information asymmetry components of spreads from models of Lin et al. (1995) and Madhaven et al. (1995) and the price impact to proxy the quality of the information environment and (ii) autocorrelation of intraday quoted returns as a proxy of price efficiency.

Our sample includes 208 non-US firms from 18 different countries that cross-list on the NYSE between 1997 and 2014 as well as the same number of matched domestic firms. Our findings suggest that cross-listing on the NYSE is associated with a significant improvement in the firm's information environment and stock price efficiency. Additionally, we examine the role of financial analysts and institutional investors after cross-listing and find that the changes in financial analysts' coverage and institutional ownership cannot fully explain the documented improvement in the quality of a cross-listed firm's information environment. Instead, we suggest that the improvements occur as an outcome of stricter disclosure requirements and regulations associated with a listing on the US stock exchange. We also show that the benefits associated from a cross-listing increased after the adoption of Sarbanes-Oxley Act in 2002, and that for the most part the benefits occurred for firms from developed markets.

Our findings contribute to the debate on potential sources of benefits of international cross-listing. We explicitly evaluate the changes in a cross-listing firm's information environment and price efficiency. Our results broadly support the legal and reputational bonding hypotheses of cross-listing.

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Table 1: Cross-listed Firms: Sample Distribution

	All years	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Argentina	2				1									1					
Australia	8					1	3						2			1	1		
Brazil	4				2									2					
Canada	115	5	1	4	7	9	9	8	7	14	5	15	5	2	9	13	1	1	
Chile	2								1	1									
Finland	2			1	1														
France	9				1	4	2		1										1
Germany	9		2	1	3	2	1												
Greece	1						1												
India	3				1	1			1										
Ireland	1										1								
Israel	4															2		2	
Japan	10		1	1	1	3	2				1				1				
Mexico	2		1															1	
Norway	2														1	1			
South Africa	6		2				2	1								1			
Spain	2	2																	
United Kingdom	26	3	5	2	4	4	1	2	1		1		1	1		1			
Total	208	10	12	9	21	24	21	11	11	15	8	15	8	6	11	19	2	4	1

The table reports the number of stocks in the sample that cross-list on the NYSE, NASDAQ and AMEX by country and by year.

Table 2: Trading Activity and Firm Characteristics Before and After Cross-listing: Summary Statistics

	Full Sample	6 Months		
		Pre	Post	Difference
		Total Number of Trades		
Mean	89,333	78,872	99,795	20,923
Median	26,337	21,169	36,075	14,906**
Std. Dev.	145,145	136,197	153,188	
Min	10	14	10	
Max	925,103	925,103	891387	
		Average Trade Size		
Mean	3,908	4,168	3,649	-520
Median	1,229	1,401	1,127	-274
Std. Dev.	7,586	8,041	7,112	
Min	56	56	56	
Max	50,944	50,944	50,944	
		Market Value		
Mean	154,257	161346	147,546	-13,799
Median	1,671	1504	1756	252
Std. Dev.	705,390	727,296	685,719	
Min	10	10	10	
Max	4,226,385	4,226,385	4,226,385	
		Market-to-Book		
Mean	3.53	3.66	3.41	-0.26
Median	2.43	2.48	2.42	-0.06
Std. Dev.	5.13	5.83	4.36	
Min	-2.74	-2.74	-2.74	
Max	49.32	49.32	49.32	

The table reports mean, median, standard deviation (Std. Dev.), minimum (Min) and maximum (Max) values of trading activity and firm characteristics variables for the sample of 176 stocks that cross-list in the US, averages for six months before (Pre) and six months after (Post) the cross-listing. N decreases is the number of occurrences when the difference in means (Post minus Pre) is negative. The last column reports the difference in mean and median values (Post minus Pre) and their statistical significance based on t-test for the difference in means and Wilcoxon signed-rank test for the difference in medians.

Table 3: Information Environment and Price Efficiency: Univariate Tests

	Cross-listed Firms			Matched Firms			Pre	Post
	Pre	Post	Diff	Pre	Post	Diff	CL-Matched	CL-Matched
				Effective Spread				
Mean	0.013	0.010	-0.003	0.015	0.018	0.003	-0.002	-0.008***
Median	0.007	0.005	-0.002*	0.009	0.008	-0.001	-0.003**	-0.004***
Std. Dev.	0.028	0.019		0.025	0.035			
Min	0.001	0.001		0.001	0.001			
Max	0.217	0.217		0.217	0.217			
N decreases		152			120			
N obs.		208			208			
				IA_LSB				
Mean	0.238	0.213	-0.025	0.235	0.235	0.000	0.003	-0.022
Median	0.221	0.189	-0.032*	0.217	0.195	-0.022	0.004	-0.006
Std. Dev.	0.193	0.183		0.169	0.190			
Min	0.000	0.000		0.000	0.000			
Max	0.966	0.966		0.916	0.944			
N decreases		98			94			
N obs.		188			190			
				IA_MRR				
Mean	0.511	0.462	-0.049*	0.454	0.435	-0.018	0.057**	0.027
Median	0.497	0.466	-0.031*	0.472	0.427	-0.045	0.025**	0.039
Std. Dev.	0.241	0.232		0.221	0.222			
Min	0.013	0.013		0.013	0.013			
Max	0.980	0.954		0.980	0.980			
N decreases		91			84			
N obs.		159			172			
				Price Impact				
Mean	0.005	0.004	-0.001***	0.006	0.007	0.001	0.000	-0.003***
Median	0.004	0.003	-0.001**	0.004	0.005	0.001	0.000	-0.002***
Std. Dev.	0.005	0.004		0.006	0.008			
Min	0.001	0.001		0.001	0.001			
Max	0.039	0.025		0.039	0.039			
N decreases		132			100			
N obs.		208			208			
				Autocorrelation				
Mean	0.256	0.208	-0.048***	0.218	0.230	0.012	0.038**	-0.022
Median	0.211	0.167	-0.044***	0.171	0.187	0.016	0.041**	-0.019
Std. Dev.	0.188	0.159		0.168	0.168			
Min	0.003	0.003		0.003	0.003			
Max	0.909	0.909		0.909	0.909			
N decreases		117			94			
N obs.		199			205			

The table reports mean, median, standard deviation (Std. Dev.), minimum (Min), maximum (Max) values and the number of observations (N obs.) of variables that measure the quality of information environment and stock price efficiency. Statistics are reported for the sample of 176 stocks that cross-listing in the US, averages for six months before (Pre) and six months after (Post) the cross-listing. N decreases is the number of occurrences when the difference in means (Post minus Pre) is negative. The last column reports the difference in mean and median values (Post minus Pre) and their statistical significance based on t-test for the difference in means and Wilcoxon signed-rank test for the difference in medians.

Table 4: The Impact of Cross-listing on Information Environment and Price Efficiency of Cross-listed Stocks

	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.006**	-0.020*	-0.045**	-0.002***	-0.064***
	(-2.18)	(-1.84)	(-2.51)	(-6.56)	(-3.94)
Cross-listed sample	0.003	0.005	0.075***	0.001***	0.020
	(1.30)	(0.44)	(3.90)	(3.20)	(1.22)
Post cross-listing	0.004*	-0.002	-0.009	0.001***	0.017
	(1.77)	(-0.25)	(-0.79)	(5.73)	(1.41)
Number of Trades	-0.005***	-0.021***	0.000	-0.001***	-0.007
	(-4.88)	(-2.93)	(0.02)	(-4.51)	(-1.11)
Trade Size	-0.000	-0.016**	-0.050***	0.000	-0.012
	(-0.14)	(-2.03)	(-4.08)	(1.04)	(-1.60)
Firm Size	-0.003**	-0.006	-0.022**	-0.001***	0.017**
	(-2.52)	(-1.04)	(-2.33)	(-4.45)	(2.53)
Market-to-Book	0.000	0.001	0.001	0.0001**	-0.001
	(0.80)	(1.00)	(0.92)	(1.99)	(-1.00)
Constant	0.127***	0.766***	0.612***	0.016***	0.248***
	(3.84)	(5.45)	(4.09)	(3.69)	(2.61)
Year fixed effects	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
N observations	722	669	599	628	703
R-squared	0.402	0.701	0.575	0.643	0.425

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 5: Information Environment and Price Efficiency: The Role of Financial Analysts

	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.006**	-0.020*	-0.045**	-0.002***	-0.064***
	(-2.16)	(-1.84)	(-2.51)	(-6.40)	(-3.94)
Analysts	-0.001*	-0.001	-0.004**	-0.0001***	0.000
	(-1.78)	(-0.84)	(-2.01)	(-3.25)	(0.03)
Cross-listed sample	0.003	0.004	0.070***	0.001***	0.020
	(1.09)	(0.35)	(3.66)	(2.69)	(1.22)
Post cross-listing	0.004*	-0.002	-0.010	0.001***	0.017
	(1.75)	(-0.26)	(-0.79)	(5.56)	(1.41)
Number of Trades	-0.004***	-0.021***	0.001	-0.0007	-0.007
	(-4.68)	(-2.90)	(0.09)	(-4.03)	(-1.11)
Trade Size	-0.000	-0.016**	-0.052***	0.000	-0.012
	(-0.26)	(-2.09)	(-4.11)	(0.85)	(-1.60)
Firm Size	-0.003**	-0.005	-0.017*	-0.001***	0.017**
	(-2.08)	(-0.83)	(-1.84)	(-4.06)	(2.47)
Market-to-Book	0.000	0.001	0.001	0.0001*	-0.001
	(0.69)	(0.89)	(0.69)	(1.75)	(-0.99)
Constant	0.124***	0.761***	0.608***	0.014***	0.248**
	(3.84)	(5.48)	(4.08)	(3.75)	(2.57)
Year fixed effects	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
N observations	722	669	599	628	703
R-squared	0.408	0.701	0.579	0.655	0.425

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 6: Information Environment and Price Efficiency: The Role of Institutional Investors

	Panel A. Basic Model					*Panel B. The Role of Institutional Investors*				
	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*	*Effective spread*	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.002**	-0.009	-0.047*	-0.002***	-0.054**	-0.002**	-0.009	-0.044*	-0.002***	-0.055**
	(-2.03)	(-0.79)	(-1.94)	(-5.67)	(-2.58)	(-1.99)	(-0.70)	(-1.81)	(-5.69)	(-2.59)
Institutional Investors						0.003	0.075**	0.157**	0.001	-0.029
						(1.28)	(2.04)	(2.01)	(1.15)	(-0.58)
Cross-listed sample	0.001	0.001	0.069***	0.001***	0.019	0.001	0.000	0.069***	0.001***	0.020
	(1.53)	(0.04)	(2.77)	(3.74)	(1.09)	(1.51)	(0.02)	(2.82)	(3.77)	(1.10)
Post cross-listing	0.002***	-0.010	-0.016	0.001***	0.017	0.002***	-0.011	-0.019	0.001***	0.017
	(2.78)	(-1.35)	(-0.96)	(5.89)	(1.03)	(2.72)	(-1.48)	(-1.15)	(5.75)	(1.05)
Number of Trades	-0.004***	-0.022***	0.002	-0.001***	-0.017***	-0.004***	-0.021***	0.005	-0.001***	-0.018***
	(-9.26)	(-3.13)	(0.18)	(-5.21)	(-2.65)	(-8.99)	(-2.87)	(0.38)	(-4.98)	(-2.67)
Trade Size	0.002***	-0.012	-0.068***	0.001***	-0.000	0.002***	-0.013*	-0.068***	0.001***	0.000
	(3.27)	(-1.58)	(-4.48)	(2.79)	(-0.02)	(3.22)	(-1.66)	(-4.66)	(2.69)	(0.00)
Firm Size	-0.000	-0.010	-0.029**	-0.001***	0.026***	-0.000	-0.013	-0.035**	-0.001***	0.027***
	(-0.71)	(-1.28)	(-2.06)	(-3.61)	(3.19)	(-0.89)	(-1.60)	(-2.37)	(-3.56)	(3.11)
Market-to-Book	0.000	0.002	0.009*	0.000	0.004	0.000	0.002	0.009*	0.000	0.004
	(0.77)	(0.71)	(1.87)	(1.45)	(1.09)	(0.79)	(0.76)	(1.91)	(1.44)	(1.08)
Constant	0.024***	0.610***	0.761***	0.011***	0.311***	0.025***	0.618***	0.778***	0.012***	0.308***
	(4.03)	(4.35)	(3.87)	(3.68)	(2.94)	(4.04)	(4.45)	(3.89)	(3.74)	(2.90)
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N observations	397	385	344	349	382	397	385	344	349	382
R-squared	0.797	0.666	0.544	0.806	0.353	0.798	0.671	0.553	0.808	0.354

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 7: Information Environment and Price Efficiency: Before and After the Adoption of the Sarbanes-Oxley Act

	Panel A. Before SOX					*Panel B. After SOX*				
	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*	*Effective spread*	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.009	-0.041*	-0.024	-0.002***	-0.049*	-0.004*	-0.011	-0.051**	-0.002***	-0.068***
	(-1.34)	(-1.87)	(-0.86)	(3.30)	(-1.84)	(-1.96)	(-0.87)	(-2.28)	(-5.64)	(-3.23)
Cross-listed sample	0.005	0.007	0.059**	0.001	-0.021	0.003	0.002	0.072***	0.002***	0.036*
	(0.83)	(0.35)	(2.36)	(1.33)	(-0.77)	(1.65)	(0.12)	(3.06)	(4.14)	(1.92)
Post cross-listing	0.006	0.022*	0.011	0.001***	0.021	0.002***	-0.011	-0.019	0.002***	0.012
	(1.15)	(1.75)	(0.62)	(2.71)	(1.08)	(2.75)	(-1.21)	(-1.18)	(5.13)	(0.75)
Number of Trades	-0.005**	-0.030	-0.015	-0.0003	0.005	-0.005***	-0.018***	0.007	-0.001***	-0.015**
	(-2.49)	(-1.42)	(-0.85)	(-1.52)	(0.44)	(-8.32)	(-2.87)	(0.63)	(-6.40)	(-2.36)
Trade Size	-0.002	0.007	0.002	0.0004	-0.052**	0.002***	-0.017**	-0.080***	0.001**	-0.003
	(-0.73)	(0.40)	(0.12)	(1.35)	(-2.57)	(3.09)	(-2.01)	(-5.32)	(2.26)	(-0.42)
Firm Size	-0.005*	0.018	0.002	-0.001***	0.024**	-0.000	-0.016**	-0.031**	-0.001***	0.019**
	(-1.70)	(1.32)	(0.17)	(-2.88)	(2.23)	(-0.85)	(-2.39)	(-2.56)	(-3.54)	(2.23)
Market-to-Book	0.000	0.002	0.004**	0.0004**	-0.004***	0.000**	-0.000	0.001	0.0001**	0.001
	(0.33)	(1.53)	(1.99)	(5.32)	(-3.13)	(2.46)	(-0.11)	(0.53)	(2.02)	(1.54)
Constant	0.200***	0.241	0.109	0.015**	0.477**	0.007	0.828***	1.068***	0.009**	0.196*
	(4.68)	(1.32)	(0.55)	(2.40)	(2.50)	(0.77)	(5.70)	(5.18)	(2.50)	(1.70)
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N observations	263	222	198	219	259	459	447	401	409	444
R-squared	0.479	0.804	0.702	0.713	0.571	0.525	0.649	0.506	0.757	0.399

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 8: Information Environment and Price Efficiency: Controlling for the US Share of Trading

	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.006**	-0.019*	-0.048***	-0.002***	-0.069***
	(-2.11)	(-1.73)	(-2.66)	(-6.43)	(-4.19)
US Share of Trading	0.002*	-0.004	0.011	0.000	-0.003
	(1.74)	(-0.96)	(1.04)	(1.44)	(-0.84)
Cross-listed sample	0.000	0.010	0.070***	0.001***	0.029*
	(0.06)	(0.84)	(3.43)	(3.10)	(1.76)
Post cross-listing	0.004*	-0.002	-0.010	0.001***	0.017
	(1.68)	(-0.24)	(-0.81)	(5.73)	(1.44)
Number of Trades	-0.002***	-0.025***	0.006	-0.001	-0.014*
	(-2.68)	(-3.05)	(0.48)	(-3.52)	(-1.92)
Trade Size	0.001	-0.016**	-0.052***	0.000	-0.014*
	(0.87)	(-2.11)	(-4.01)	(0.96)	(-1.83)
Firm Size	-0.004***	-0.004	-0.025**	-0.001***	0.022***
	(-3.43)	(-0.65)	(-2.43)	(-4.36)	(2.82)
Market-to-Book	0.000	0.001	0.001	0.0001**	-0.002
	(1.07)	(0.88)	(1.03)	(2.03)	(-1.10)
Constant	0.112***	0.768***	0.627***	0.016***	0.277***
	(4.09)	(5.62)	(3.92)	(4.02)	(2.81)
Year fixed effects	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
N observations	710	659	589	618	691
R-squared	0.413	0.701	0.572	0.646	0.431

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 9: Information Environment and Price Efficiency: Impact of the US Public Debt

	Effective spread	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
Cross-listed*Post	-0.006**	-0.020*	-0.045**	-0.002***	-0.064***
	(-2.17)	(-1.85)	(-2.51)	(-6.56)	(-3.94)
US public debt	0.022**	-0.020	0.075	0.001	-0.064
	(2.37)	(-0.41)	(1.42)	(1.20)	(-1.57)
Cross-listed sample	0.003	0.005	0.075***	0.001***	0.020
	(1.22)	(0.45)	(3.89)	(3.20)	(1.26)
Post cross-listing	0.004*	-0.002	-0.010	0.001***	0.017
	(1.76)	(-0.25)	(-0.80)	(5.72)	(1.41)
Number of Trades	-0.004***	-0.021***	0.001	-0.001***	-0.008
	(-4.68)	(-2.94)	(0.06)	(-4.40)	(-1.29)
Trade Size	-0.000	-0.016**	-0.050***	0.000	-0.012
	(-0.05)	(-2.03)	(-4.03)	(1.07)	(-1.65)
Firm Size	-0.003***	-0.006	-0.022**	-0.001***	0.018***
	(-2.74)	(-1.03)	(-2.40)	(-4.45)	(2.73)
Market-to-Book	0.000	0.001	0.001	0.000**	-0.001
	(0.80)	(1.00)	(0.94)	(2.01)	(-0.99)
Constant	0.125***	0.769***	0.603***	0.016***	0.253***
	(3.73)	(5.42)	(3.98)	(3.65)	(2.70)
Year fixed effects	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES	YES
N observations	722	669	599	628	703
R-squared	0.419	0.701	0.577	0.643	0.428

The table reports OLS regression estimation results of Equation (7). Dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). The sample includes firms that cross-list in the US and matched domestic firms. Standard errors are clustered at firm level and t-statistics are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.

Table 10: Self-selection Bias Correction: Heckman Procedure

	First stage	*Second stage*				
	Cross-listed	*Effective spread*	*IA_LSB*	*IA_MRR*	*Price impact*	*Auto-correlation*
	(1)	(2)	(3)	(4)	(5)	(6)
Cross-listed*Post		-0.006**	-0.020*	-0.045**	-0.002***	-0.064***
		(-2.16)	(-1.85)	(-2.51)	(-6.54)	(-3.93)
Cross-listed sample		0.003	0.005	0.075***	0.001***	0.019
		(1.28)	(0.45)	(3.88)	(3.16)	(1.21)
Post cross-listing		0.004*	-0.002	-0.010	0.001***	0.017
		(1.75)	(-0.24)	(-0.80)	(5.70)	(1.38)
Number of Trades	0.059*	-0.005***	-0.021***	0.000	-0.001***	-0.007
	(1.71)	(-4.89)	(-2.93)	(0.03)	(-4.50)	(-1.08)
Trade Size	-0.073*	-0.000	-0.016**	-0.051***	0.000	-0.012
	(-1.82)	(-0.14)	(-2.03)	(-4.08)	(1.04)	(-1.60)
Firm Size	0.056*	-0.003**	-0.006	-0.022**	-0.001***	0.017**
	(1.84)	(-2.52)	(-1.04)	(-2.33)	(-4.44)	(2.53)
Market-to-Book	-0.003	0.000	0.001	0.001	0.0001**	-0.001
	(-0.36)	(0.80)	(0.99)	(0.93)	(1.99)	(-0.99)
English law	0.519**					
	(2.02)					
Disclosure	-0.608					
	(-1.09)					
Judicial efficiency	-0.063					
	(-0.76)					
GDP per capita	0.128					
	(1.08)					
Inverse Mills ratio		-0.000	0.000	-0.000	-0.000	-0.000
		(-0.28)	(0.21)	(-0.15)	(-0.47)	(-0.23)
Constant	-1.461	0.127***	0.767***	0.612***	0.016***	0.247***
	(-1.62)	(3.83)	(5.44)	(4.08)	(3.68)	(2.60)
Year fixed effects		YES	YES	YES	YES	YES
Industry fixed effects		YES	YES	YES	YES	YES
Country fixed effects		YES	YES	YES	YES	YES
N observations	791	722	675	599	628	703
R-squared	0.0224	0.402	0.686	0.575	0.643	0.425

The table reports the Heckman (1979) procedure estimation results. The sample includes firms that cross-list in the US and matched domestic firms. Column (1) reports the first-stage probit model estimation results with *Cross-listed* as the dependent variable. Columns (2) - (6) report the second-stage OLS estimation results of Equation (7) with the Inverse Mills ratios estimated from the first stage. In the second stage the dependent variables are the measures of the quality of a stock's information environment and price efficiency: effective spread computed as in Eq. (1); IA_LSB computed as in Eq. (2); IA_MRR computed as in Eq. (3) & (4); price impact computed as in Eq. (5); and autocorrelation computed as in Eq. (6). Standard errors are clustered at firm level and t-statistics (z-statistics for the first stage probit model) are reported in parentheses. *** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.