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Three Essays on Pricing and Volume Distributions of Cross-Listed Stocks

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THREE ESSAYS ON PRICING AND VOLUME DISTRIBUTIONS OF CROSS-LISTED STOCKS

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DEDICATION

I dedicate this dissertation to my family, a never-ending source of love, strength and support. A special gratitude to my parents, Shuping Li and Panlong Wang, for their unconditional love, support and belief in me. Words cannot express how grateful I am for all of the sacrifices that they have made on my behalf. I also have a special thanks to my beloved husband, Xun Sun, who provides me endless love, caring and encouragement. Without his support, this journey would not have been possible. I also dedicate this dissertation to my friends who have been supporting me in my academic journey and incenting me to strive towards my goal.

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DISTRIBUTIONS OF CROSS-LISTED STOCKS

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ABSTRACT

This dissertation provides empirical evidences in global cross-listed stocks trading volume and pricing. The first essay documents the global trading volume distribution of cross-listed stocks and examines factors that make a host market competitive in attracting order flows from the counterpart domestic market. The results show that host markets are more successful in attracting trading volume when they have a higher information factor, have lower bid-ask spreads, provide better investor protection and information disclosure, share the common language or legal origin with the counterpart home markets and locate closer to the home market. The second essay investigates the market competitiveness among rival host markets based on a unique sample of global firms simultaneously cross-listed in multiple foreign countries. I present the global cross-listings and trading volume distributions cross host-home markets as well as over time, and provide robust evidences that host markets are more successful in attracting trading volume from other competing markets when they have lower bid-ask spreads, better legal protection, more market liquidity, higher level of financial development, and where the firms with longer listing history. Interesting,

I consistently find that host countries with English common law origins are able to attract trading volume while French civil law origin host countries attract less trading activities. The third essay investigates the cross-listed stock price discovery process. I use synchronous trading data and the error correction model to find that prices on the home and the U.S. markets are co-integrated and mutually adjusting. The price adjustment in response to price disparity happens in both the home market and the U.S. (host) market. In most cases, domestic prices are dominant for the price discovery. However, I also observe a statistically significant amount of feedback from the U.S. markets. The greater the competition offered by the U.S. market, represented as larger U.S. proportion of trading volume, more informative U.S. share price, more liquidity, better legal protection and closer to the home market, the more price adjustment from domestic side toward the U.S. price.

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CHAPTER I

Introduction

The dissertation provides empirical evidences in global cross-listed stocks trading volume and pricing, from three perspectives. The first essay documents the global trading volume distribution of cross-listed stocks and examines factors that make a host market competitive in attracting order flows from the counterpart domestic market. The results show that host markets are more successful in attracting trading volume when they have a higher information factor, have lower bid-ask spreads, provide better investor protection and information disclosure, share the common language or legal origin with the counterpart home markets and locate closer to the home market. Additionally, small but mature high-tech firms with high growth rate, volatile stock returns and high foreign sales are prone to execute more trading in host markets.

The second essay investigates the market competitiveness of attracting order flows among rival host markets based on a unique sample of firms simultaneously cross-listed in multiple foreign countries. We present the global cross-listings and trading volume distributions cross host-home markets as well as over time. We find that the U.S. is not only the largest host market in attracting the foreign listings but also the most competitive markets in attracting trading volume from other foreign markets. The U.S. market kept leading all global markets during and after 2002

dot-com bubble crisis and 2008 financial crisis. Several host markets, like the U.K. and Hong Kong, also developed to popular trading venues for foreign firms. We find that host market/country characteristics are critical in determining the volume distribution among competing foreign markets. We provide robust evidences that host markets are more successful in attracting trading volume from other competing markets when they have lower bid-ask spreads, better legal protection, more market liquidity, higher level of financial development, and where the firms with longer listing history. Interesting, we consistently find that host countries with English common law origins are able to attract trading volume while French civil law origin host countries attract less trading activities. Additionally, companies prefer to trade in the host market which provides more stock price information, less stock price correlation with its home market, locates closer to their home market in time zone, however, these factors become secondary importance in determining the market competitiveness.

The third essay investigates the cross-listed stock price discovery process. We find that prices on the home and the U.S. markets are co-integrated and mutually adjusting. We construct the error correction model to document the quarterly "speed of price discovery" for each cross-listed firm. Our findings includes that the price adjustment in response to price disparity happens in both the home market and the U.S. (host) market. In most cases, domestic prices are dominant for the price discovery. However, we also observe a statistically significant amount of feedback from the U.S. markets. The greater the competition offered by the U.S. market, which can be represented as larger U.S. proportion of trading volume, more informative U.S. share price, more liquidity, better legal protection and closer to the home market, the greater the U.S. contribution to the price discovery, the more price adjustment from domestic side toward the U.S. price. In addition, we also observe that larger firm with longer U.S. market listing history from a lower economic growth home country usually has higher domestic adjustment toward the U.S. price.

My dissertation will fill the gaps in previous literature by providing comprehensive analysis on trading volume distribution based upon the global sample while previous studies mainly investigated on U.S. sample only. Second, this dissertation is the first to investigate the competitiveness among the rival host markets for multiple cross-listed stocks. Third, this study is the first to use the long run mutiple countries intra-day data to study the speed of price adjustment in a cointegrated time-series system of paired cross-listed shares which share a common stochastic trend and to successfully address the synchronous trading issue across global markets.

My dissertation not only contributes to the academic literatures but also provides insightful results to practitioners. The results can guide investors construct their global diversified portfolio in taking advantage of the arbitrage opportunity, place orders at markets with lower liquidity cost, ensure the feasibility of investors trading strategies. Regulators and policymakers may adjust policies and improve the market soundness in order to make a country's stock market more competitive and therefore enhance the developments of domestic financial markets.

CHAPTER II

Essay I. The determinants of trading volume distribution: Evidence from globally cross-listed stocks

Using a sample of 642 cross-listed companies with 771 cross-listings from 39 home (domestic) countries over the period of 1981 to 2010, we conduct a comprehensive analysis of global trading volume distribution and factors that contribute to market competitiveness in attracting order flows. To the best of our knowledge, this study is the first to examine the global distribution of trading volume of globally cross-listed firms as well as factors that contribute to a competitive host market.

Previous studies on trading volume distribution have restricted their samples to firms that cross-list in the United States, although the U.S. accounts for less than 30 percent of the globally cross-listed firms and its importance has been dwindling (See, for example, *Baruch et al.*, 2007; *Halling et al.*, 2008; *Barclay et al.*, 2003; *Sarkissian and Schill*, 2009; *Kutan and Zhou*, 2006). Over the last decade, we have observed steady growth in global cross-listings, with the total number of depositary receipt (DR) programs around the world increasing from $1,534$ to $3,364$ between 2000 and 2010.[1] However, over the same period, the number of U.S.-listed DR programs has

[1]In addition to DR problems, firms may also directly list their shares on a foreign exchange. The data on global DR problems are obtained from the BNY Mellon, DR Market Review, 2000 and 2010

decreased from 608 to 410.[2]

Recent studies have revealed that the passage of SOX is one of the most common reasons that foreign firms leave U.S. markets (See, for example, *Fernandes et al.*, 2010; *Marosi and Massoud*, 2008; *Doidge et al.*, 2010; *Bianconia et al.*, 2013). Small foreign firms with low trading volume have been more likely to exit U.S. markets, because the bonding costs of continued U.S. registration outweigh the benefits, especially after the passage of SOX. Given the increasing importance of non-U.S. markets as a destination of cross-listings, more studies are needed to bring non-U.S. markets into consideration. However, earlier studies on trading volume distribution of cross-listings have primarily used the sample of American depositary receipts (ADRs) or foreign shares listed in U.S. markets only. The growth of non-U.S. host markets highlights the need for a comprehensive study of globally cross-listed firms.

For this study, we hand-collect the global sample of cross-listings at the end of 2010 from 10 major host markets: Belgium, France, Germany, Japan, the Netherlands, Portugal, Singapore, South Africa, the U.K., and the U.S..[3] We first report stylized facts of the trading volume distribution between a host market and counterpart home markets. In the competition of attracting trading activities, on average, host markets win against counterpart home markets by a narrow margin. The overall trading activities executed in all host markets is 1.154 times those in the counterpart home markets. However, market competitiveness varies greatly across host countries.

We next examine factors that contribute to a competitive host market. The literature suggests a group of information- and non-information-based variables that may help a host market attract order flows. Given that the U.S. equity market does not always dominate in the price discovery of cross-listed stocks, it is important to ex-

editions.

[2]The data are obtained from the BNY Mellon, DR Market Review, 2000 and 2010 editions.

[3]In 2010, these 10 countries represented only 31.4 percent of the global market capitalization but accounted for more than 60 percent of foreign-listed companies. Source: World Federation of Exchanges, Annual Statistics, Domestic market capitalization, 2010; number of listed companies, 2010 (URL: `http://www.world-exchanges.org/statistics/annual/`).

amine the significance of information-based variables by including cross-listed stocks in non-U.S. host markets (*Eun and Sabherwal*, 2003; *Su and Chong*, 2007). We find robust evidence that information factor, common language or legal origin and time zone play vital roles in attracting order flows to a host market. We also document the importance of non-information-based variables. Host markets are better positioned to attract order flows from their counterpart home markets when they have lower bid-ask spreads and offer better investor protection and information disclosure. Additionally, companies from less-developed economies with advanced financial markets observe larger shares of their trading executed in host markets. In terms of firm characteristics, we find that small and mature firms with high growth rate, more volatile stock returns and more foreign sales will conduct more trading in host markets. We also observe high-tech cross-listings execute more trading in their host markets.

Our contribution to the literature is three-fold. First, there is no agreement on a theory of order flow distribution after companies cross-list their shares abroad. Thus, empirical studies are needed to document the distribution of globally cross-listed shares. One of the perceived benefits of cross-listing is increased trading volume and liquidity for the cross-listed firms (*Abdallah et al.*, 2011; *King and Segal*, 2009; **?**). Many financial theories argue against the development of an active foreign market due to the tendency toward order agglomeration (*Admati and Pfleiderer*, 1988) and the information disadvantage of foreign investors (*Dvořák*, 2005). However, some studies have documented the evidence of order mitigation toward foreign markets (*Domowitz et al.*, 1998; *Levine and Schmukler*, 2007), which would be of great concern to policymakers and investors in domestic emerging markets. We add strong evidence to the literature by documenting the distribution of trading activities of globally cross-listed shares. Our results show that, overall, host markets are slightly better than the home markets in attracting trading volume, although market competitiveness varies across host markets.

Second, we extend previous studies such as *Baruch et al.* (2007) and *Halling et al.* (2008) by deriving our results from a comprehensive sample of globally cross-listed shares. The literature has mainly used samples of ADRs or cross-listed shares in the United States only. For example, *Baruch et al.* (2007) develops a multimarket trading model, predicting a higher share of trading volume for a host market where the cross-listed stock returns have higher correlation with returns of other assets in the market. *Halling et al.* (2008) uses U.S.-listed foreign shares and examines the magnitude of firm and market characteristics to explain variations in the foreign share of trading volume. However, a study that draws samples of cross-listed firms from a single host market (in this case, the U.S.) is unable to evaluate those factors that are absent from this particular host market. *Karolyi* (2006) points out that studies on multiple host markets have uncovered the importance of culture, geographic proximity and investor familiarity, which are not present in studies that focus only on the U.S. market as a cross-listing destination (see also *Pagano et al.*, 2001, 2002; *Sarkissian and Schill*, 2004; **?**). Moreover, foreign listings in the U.S. market constitute less than 30 percent of globally cross-listed shares (*Sarkissian and Schill*, 2009). Thus, the results derived from the U.S. samples may not be generalized to non-U.S. host markets. Given the increasing importance of non-U.S. markets as a destination of cross-border listings, more studies are needed to bring the non-U.S. markets into consideration. In this study, we fill this gap by investigating the trading activities of 771 cross-listings from 39 home countries listed in 10 major stock markets. We extend the previous studies of *Baruch et al.* (2007) and *Halling et al.* (2008) to potentially identify factors that are absent from the U.S. market. For example, we document that whether a host market shares the same language or legal origin with the home market is important in determining the trading volume share in the host market, thus identifying two additional information-based variables.

Third, our sample includes 216 cross-listings (28 percent of overall sample) that

simultaneously list on more than one foreign markets. This enables us to evaluate the impact of multiple cross-listings and to correct the bias in measuring trading volume and the information factor as a result of ignoring multiple cross-listings. In our regression analysis, we observe that multiple cross-listings have a significantly negative impact on the volume share of a host market. If the firm cross-lists on more than one foreign market, the volume share of any of the host markets is significantly lower. In order to take into consideration the impact from competing host markets, we revise the measure of trading volume share and information factor used in the literature (*Halling et al.*, 2008; *Baruch et al.*, 2007). The results reported in our study are thus free from any bias caused by failing to incorporate the impact of multiple cross-listings.

The remainder of the paper proceeds as follows: Section 3.2 describes the sampling process and documents the distribution of cross-listings across home and host markets. Section 3.1 details our main research questions and variables construction. Sections 2.3 discusses our empirical findings. Section 4.6 presents results of robustness checks. Section 3.5 concludes our study.

2.1 Sampling process and distribution of cross-listings

To construct our global cross-listing sample, we hand-collected lists of cross-listing firms from the official stock exchange websites in 10 countries at the end of 2010. If such a list was not available on the exchange website, we contacted the statistics or research department of stock exchange via e-mail and/or phone. Following the sample construction method of *Sarkissian and Schill* (2009), we excluded financial firms, investment fund, or trusts from our sample. We also excluded firms from tax havens, such as Bermuda, the Cayman Islands, Jersey, or the Netherlands Antilles. We further acquired the weekly stock price, trading volume and market index data available from Datastream between January 1981 and December 2010. The final

sample includes 642 companies with 771 cross-listings. The number of cross-listings is significantly higher than that of firms due to multiple cross-listings by many firms.

In Table 2.1, we present the distribution of sample cross-listings grouped by home and host markets. Sample cross-listings represent 39 home countries and 10 host countries: Belgium, France, Germany, Japan, the Netherlands, Portugal, Singapore, South Africa, the U.K., and the U.S. (including NYSE, NASDAQ and AMEX). Overall, host markets in developed countries attract the majority of cross-listings. In terms of the number of cross-listings, the U.S. is the largest host market, with 330 cross-listings from 29 domestic countries, while Portugal is the smallest host market, with four cross-listings from two domestic countries. Among all the domestic markets, Canada has the largest number of firms listed overseas, while 85 percent (= 127/150) of those Canadian cross-listings choose the U.S. as their trading venue. The U.S. is the second-largest domestic country with 111 cross-listings trading in eight foreign countries. The most popular destinations of U.S.-originated cross-listings include Japan (35), France (21), the U.K. (19), and Belgium (18).

Table 2.1: Distribution of global cross-listings

In this table, we present the distribution of 642 firms with totally 771 cross-listings from 39 home markets in 10 major financial markets. Panel A reports the distribution of all cross-listings by home and host markets. The discrepancy between the number of firms and the number of cross-listings in some home countries is due to the presence of multiple cross-listings for some global traded firms. Panel B reports distribution of 771 sample cross-listings by the number of cross-listings per firm, grouped by home markets.

Panel A: Distribution of global cross-listings by host and home markets

			Host market									
Home market	Total No. of firms	Total No. of listings	Belgium	France	Germany	Japan	The Netherlands	Portugal	Singapore	South Africa	The United Kingdom	The United States
Argentina	10	10										10
Australia	37	40				3			6	4	22	5
Austria	1	1			1							
Belgium	10	10		7			2					1
Brazil	19	19										19
Canada	141	150	5	3		4	2			7	2	127
China	12	13							1		1	11
Denmark	2	2										2
Finland	1	2			1							1
France	18	24	8		3	3	4					6
Germany	17	24	2	5		9	2					6
Greece	3	3										3
Hong Kong	13	13				1	1		9			2
India	9	9										9
Indonesia	1	1									1	
Ireland	24	26									20	6
Israel	36	36	1								1	34
Italy	7	10		3	4							3
Japan	38	54	3	9	4		6		2		14	16
Jordan	1	1									1	
South Korea	8	11				1					2	8
Luxembourg	11	11	6	2				2		1		
Malaysia	1	1				1						
Mexico	5	5										5
Morocco	2	2		2								
The Netherlands	22	33	8	11	2	1					2	9
New Zealand	1	1										1
Norway	3	4		1					1		1	1
Philippines	1	1										1
Russia	5	5									5	
South Africa	11	20	4	4							6	6
Spain	7	13		3		2		2			3	3
Swaziland	2	2				2						
Sweden	6	7				2	2				1	2
Switzerland	10	10		1	1	1	1				2	4
Taiwan	6	6										6
Turkey	2	2									2	
The United Kingdom	66	78	2	9	1	12	8		5	18		23
The United States	73	111	18	21	9	35	7		1	1	19	
Total	642	771	57	81	26	77	35	4	25	31	105	330

Table 2.1 (Cont'd)

Panel B: Number of global cross-listings by home markets

		Number of a firm's global cross-listings				
Home market	Total	1	2	3	4	5
Argentina	10	10				
Australia	40	34	6			
Austria	1	1				
Belgium	10	10				
Brazil	19	19				
Canada	150	132	18			
China	13	11	2			
Denmark	2	2				
Finland	2		2			
France	24	15	2	3	4	
Germany	24	14	2	3		5
Greece	3	3				
Hong Kong	13	13				
India	9	9				
Indonesia	1	1				
Ireland	26	22	4			
Israel	36	36				
Italy	10	4	6			
Japan	54	26	16	12		
Jordan	1	1				
South Korea	11	6	2	3		
Luxembourg	11	11				
Malaysia	1	1				
Mexico	5	5				
Morocco	2	2				
The Netherlands	33	16	4	9	4	
New Zealand	1	1				
Norway	4	2	2			
Philippines	1	1				
Russia	5	5				
South Africa	20	6	4	6	4	
Spain	13	4	2	3	4	
Swaziland	2	2				
Sweden	7	5	2			
Switzerland	10	10				
Taiwan	6	6				
Turkey	2	2				
The United Kingdom	78	58	12		8	
The United States	111	49	28	21	8	5
Total	771	555	114	60	32	10

Panel B of Table 2.1 summarizes the number of cross-listings by home market. Although the majority of cross-listed firms (555 out of 642) only list one foreign market, 87 firms list shares on two or more foreign stock exchanges, totaling 216 multiple cross-listings, about 28 percent (= 216/771) of our sample.[4] More specifically, 14.7 percent, 7.8 percent, 4.2 percent and 1.3 percent of the sample firms cross-list on 2, 3, 4, and 5 foreign markets, respectively. The U.S. has the most firms (38) with 62 multiple cross-listings. Some home countries, like Finland (2), Italy (6), Japan (28), the Netherlands (17), South Africa (14), Spain (9) and the U.S. (62) have more firms with multiple cross-listings than single cross-listings.

2.2 Hypotheses and variable construction

The focus of our study lies in documenting the trading volume distribution between home and host markets and examining the market and firm characteristics in explaining a host market's competitiveness against counterpart home markets. We first discuss our measurements of trading volume shares and then discuss various market- and firm-level variables that may explain the variations in volume shares.

2.2.1 Trading volume shares

To study the trading volume distribution between a host market and its counterpart home market, *Baruch et al.* (2007) and *Halling et al.* (2008) calculate volume share for each cross-listing as the ratio between the trading volume of the host market i to the volume of the firm's home market ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$, where $i = 1, ..., n$; $n \geq 1$; n is the total number of firm's host markets.). This measurement considers only the trading volume of the foreign market and that of the domestic market, and thus excludes the trading volume of other foreign host markets if the firm cross-lists

[4] As a comparison, about 25 percent of the sample firms in *Sarkissian and Schill* (2009) have at least two cross-border listings.

in multiple host markets simultaneously. In our sample, about 28 percent of firms list on multiple host markets. Limiting to one host market and excluding the trading volume of other competing host markets may skew the calculation of volume share and generate biased results. To address this concern, we improve the traditional method by calculating the volume share of the host market as the ratio of trading volume in one host market i to the total global trading volume of each cross-listed firm ($\text{Vol}_{HT,i}/(\sum_{i=1}^{n} \text{Vol}_{HT,i} + \text{Vol}_{HM})$; $i = 1, ..., n$; $n \geq 1$; n is the total number of host markets). As robustness checks, we also run all our regression models using the volume share measure of *Baruch et al.* (2007) and *Halling et al.* (2008). As detailed in Sections 2.3 and 3.4.1, the results are similar.

To construct trading volume shares, we first collect weekly turnover in volume, i.e., number of shares traded, for all sample cross-listings in both their home and host markets over the sample period between January 1981 and December 2010 (Source: Datastream). For ADRs and GDRs, we also collect bundle ratios from Worldscope and adjust the host market volume by multiplying the bundle ratios. For every sample cross-listing, we first calculate weekly volume share, and then use the annual average as our measure of volume share.

2.2.2 Information factor

Baruch et al. (2007) proposes a theoretical model to explain the variations in volume shares of cross-listed stocks (henceforth, the BKL information factor). The BKL information factor is estimated as the correlation between cross-listed asset returns and the returns of other assets traded on that market. It represents incremental information generated from the host market in addition to that from the counterpart home market. Accordingly, the BKL model predicts that the share of trading volume for the cross-listed stock in a market is positively associated with the respective information factor. Using the U.S. sample, *Baruch et al.* (2007) and *Halling et al.* (2008)

document evidence to support the BKL model prediction that proportionally more volume takes place in the U.S. than in counterpart home markets if the cross-listed asset has a higher information factor. In other words, the stock with the higher information factor, or higher correlation to other assets in the host market, is expected to have a proportionally higher trading volume in that host market.

In this paper, we use the BKL information factor to measure the incremental information provided by the host market in addition to that provided by the domestic markets. For every cross-listed stock in our sample, we first regress weekly domestic market returns of stock i on the weekly index return in the domestic market and obtain the R-square, R_r^2, in the restricted model. We next estimate the unrestricted model by adding weekly index returns of a host market as additional regressors, and obtain the new R-square, R_{ur}^2, in the unrestricted model:

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \epsilon_{i,t}, \tag{2.1}$$

where $\boldsymbol{\beta}^{home}_{i,t}$ is a 3×1 vector of asset i's loadings on index returns of the home market, and $\boldsymbol{R}^{home}_{m,t}$ is a 3×1 vector of index returns (R_m) of the home market. We estimate the equation at every week t within a three-week window, from the previous week $(t-1)$ to the following week $(t+1)$; that is, $\boldsymbol{\beta}'^{home}_{i,t} = \left(\beta^{home}_{i,t-1}, \beta^{home}_{i,t}, \beta^{home}_{i,t+1}\right)'$ and $\boldsymbol{R}^{home}_{m,t} = \left(R^{home}_{m,t-1}, R^{home}_{m,t}, R^{home}_{m,t+1}\right)'$, to account for non-synchronous trading across markets in different time zones.

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \boldsymbol{\beta}'^{host}_{i,t} \boldsymbol{R}^{host}_{m,t} + \xi_{i,t}, \tag{2.2}$$

where $\boldsymbol{\beta}^{host}_{i,t}$ is a 3×1 vector of asset i's loadings on index returns of the host market, and $\boldsymbol{R}^{host}_{m,t}$ is a 3×1 vector of index returns of the host market from weeks $t-1$ to

$t+1$, with $\boldsymbol{\beta}_{i,t}^{host} = \left(\beta_{i,t-1}^{host}, \beta_{i,t}^{host}, \beta_{i,t+1}^{host}\right)'$ and $\boldsymbol{R}_{m,t}^{host} = \left(R_{m,t-1}^{host}, R_{m,t}^{host}, R_{m,t+1}^{host}\right)'$.

From Datastream, we obtain the domestic market weekly stock prices for each cross-listed share and weekly market index prices for both home and host markets. In our main results, all data series are converted to the local currency of the respective host market. As a robustness check, we also convert all data series into the U.S. dollar as a common currency, and the results are similar. For each stock, we first calculate weekly (Friday to Friday) stock returns and corresponding market index returns. We use weekly returns to avoid problems caused by infrequent trading and nonsynchronous trading around the world at higher frequencies.[5] We run a pair of time series regressions simultaneously for each cross-listing in every sample year based on data from the past 48 months. If the available data is less than 36 months, we drop that firm-year observation to avoid biased estimates. We calculate the incremental information provided by the new market regarding the price of stock i in week t as the following:

$$\text{Information factor}_{i,t} = \frac{\left(R_{ur}^2 - R_r^2\right)/3}{\left(1 - R_{ur}^2\right)/\left(n-6\right)}, \tag{2.3}$$

where n is the number of weekly returns used in both restricted and unrestricted models.

2.2.3 Market characteristic determinants of trading volume

Certain market characteristics may better facilitate trading activities. For example, *Claessens et al.* (2002) finds that countries with higher income per capita, better macro policies, more efficient legal systems, better shareholder protection, and more open financial markets tend to attract more trading activity.[6] In this study, we

[5]It is conventional in international finance literature to use weekly or monthly stock or index prices (See, for example, *Bekaert et al.*, 2009; *Baruch et al.*, 2007; *Halling et al.*, 2008; *Fernandes and Ferreira*, 2008; *Hou et al.*, 2011; *Eun et al.*, 2008; *Zhou and Zhu*, 2012).

[6]Using data for the world's 45 largest stock exchanges, *Lo* (2013) analyzes the stock exchanges' performance on listing and trading competition and designs a competition matrix to help the stock

identify the following six groups of market characteristics.

(i) Trading cost: *Eun and Sabherwal* (2003) and *Pulatkonak and Sofianos* (1999) suggest that relative trading cost of the host market in comparison to the domestic market influences the division of trading volume share between the U.S. (host) and its counterpart home market. Following *Eun and Sabherwal* (2003) and *Foerster and Karolyi* (1998)'s method, we define the bid-ask spread as the ratio of the bid-ask price difference to the midpoint. We first calculate the annual average bid-ask spread for each cross-listing in different markets and then calculate the trading cost ratio of the bid-ask spread of a host market to that of the counterpart home market. We expect that the volume share of a host market is inversely associated with the trading cost ratio of the host market.

(ii) Time zone: The geographic proximity of a host market to its counterpart home market may affect information flow between the markets and thus sway the distribution of trading volume (*Davis and Henderson*, 2008; *Pirinsky and Wang*, 2006; *Sarkissian and Schill*, 2004; *Coval and Moskowitz*, 2001; *Pulatkonak and Sofianos*, 1999). We expect a higher volume share for a host market if it is located closer to the home market. We obtain the time zone for each stock exchange from WorldClock's website[7]. For example, Frankfurt is located in time zone "UTC/GMT+1" and is recorded as "+1"; New York is located in time zone "UTC/GMT−5" and is recorded as "−5." Then, we calculate the difference between the time zone of the host market and its counterpart home market and define time zone difference as the integer portion of the ratio of the difference over 3. In the above example, the time zone difference is 2 $(= (+1 - (-5))/3)$.

(iii) Legal protection for shareholders: Previous studies have shown that trading in the U.S. (host market) is higher due to the benefit of better legal protection for shareholders. (*Halling et al.*, 2008; *Pulatkonak and Sofianos*, 1999). This illustrates

exchanges to position themselves.

[7]The URL is `www.timeanddate.com/worldclock/`.

that investors prefer to become shareholders of a company in a country where stronger investor protection and more information disclosure is provided. Accordingly, we expect that host markets with better legal protection are expected to have higher trading volume shares than their counterpart home market, as well as rival host markets. We proxy the legal protection for shareholders using four variables. The first is *insider trading law enforcement*, which equals 1 in year t of country i if the country passed insider trading laws before or in year t, and 0 otherwise. The data concerning insider trading law enforcement is obtained from *Bhattacharya and Daouk* (2002). Our second measure is *antidirector rights index* from *La Porta et al.* (1998), which has been cited in numerous articles as a measure of shareholder protection. The index is the sum of six antidirector rights scores ranging from 0 (e.g., Belgium in our sample) to 5 (e.g. Canada and the U.S. in our sample). A higher index indicates better legal protection for minority shareholders. Our third measure is the information disclosure requirement of each financial market, *disclosure index* from *La Porta et al.* (2006), which is estimated from the arithmetic mean of six variables of information disclosure.[8] The last measure is the legal protection of minority shareholders against expropriation by corporate insiders, *anti-self-dealing index* from *Djankov et al.* (2008), which is the average of the ex ante and ex post control of self-dealing for each country.[9] In our regression models, we use the difference of each proxy between a host market and its counterpart home market. Overall, investors are supposed to place more orders in the financial market with better legal protection. We expect a positive association between the volume share of a host market and the aforementioned measures of legal protection in that host market.

[8]Information disclosure index is measured from six perspectives: prospectus, compensation, shareholders, inside ownership, contracts irregular and transactions for each country (*La Porta et al.*, 2006).

[9]The principal components of "control of self-dealing" measurement include (1) approval by disinterested shareholders; (2) disclosures by buyer; (3) disclosures by Mr. James; (4) independent review; (5) each of the elements in the index of disclosure in periodic filings; (6) standing to sue; (7) rescission; (8) ease of holding Mr. James liable; (9) ease of holding the approving body liable; and (10) access to evidence (*Djankov et al.*, 2008).

(iv) Language and legal origin barriers: Difference in language and legal origin play important roles in firms' choice of cross-listing destinations. *Sarkissian and Schill* (2004), *Grinblatt and Keloharju* (2001), and *Hau* (2001) find that domestic investors are more familiar with a firm's operations, accounting practices, and capital market environment. Such advantages make trading in the home market cheaper and more efficient, especially when information is short-lived and execution speed is critical during the trading. From this perspective, we expect that a domestic market has more information-based trades if the host country differs in official languages or legal origins. Thus, language or legal barriers will lead to more trading in the home market (*Halling et al.*, 2008). We create two dummy variables based on country level language and legal origin. We collect the official languages for all countries in our sample from the World Bank website and legal origin data from *La Porta et al.* (1998). The language (or legal origin) difference dummy variable equals 1 if the host and home market do not have common language (or legal origin) and 0 otherwise. We expect a negative relationship between volume share of a host market and the presence of difference in language or legal origin between the host market and its counterpart home market.

(v) Domestic market development: Previous studies suggest that an advanced financial market in the home country will help domestic investors to acquire foreign assets and simultaneously facilitate foreign investors to acquire domestic assets (*Lane and Milesi-Ferretti*, 2008; *Martin and Rey*, 2006). Thus, the domestic volume share of a cross-listed firm is expected to be positively correlated to financial development in the home market. For example, *Halling et al.* (2008) shows that the fraction of trading in the U.S. (host market) is negatively related to financial development in the counterpart home market. Accordingly, we measure *domestic financial development* using the sum of stock market capitalization and private credit as a ratio of GDP. The data is from *Beck et al.* (2009) which was updated in 2012 and is available on

the World Bank website.

In addition, some studies (See, for example, *Halling et al.*, 2008; *Gagnon and Karolyi*, 2010; *Lane and Milesi-Ferretti*, 2008) find that emerging markets have more regulatory constraints, like tighter capital control, that adversely impact the international capital flow and prevent foreign investors from trading domestic stocks. Therefore, we define *economic development of the home market* using country classifications from World Bank. Domestic development equals 1 if the home country is a developing economy and 0 otherwise. We expect higher trading volume share in a host market if the counterpart home market is an emerging economy.

(vi) Region dummy: We construct five regional dummies (Europe and Israel; Canada and the U.S.; South America and Mexico; Asia, Australia, and New Zealand) for home markets in order to control for variation clustered by region.

2.2.4 Firm characteristic determinants of trading volume

Firm characteristics always play some role in cross-listing destination and impact trading activities. Certain types of companies may tend to trade abroad (or locally). To test firm characteristics' impact, we build two groups of proxies and test their impact on trading volume distribution between a host market and its counterpart home market.

(i) Firm visibility: We use three variables to measure a firm's visibility abroad. First, we use firm size as a proxy (*Kang and Stulz*, 1997; *Merton*, 1987). Large market capitalization may indicate that the firm is more visible in the host market, leading to a higher volume share. Thus, *firm size* is expected to be positively related to volume share in a host market. However, some empirical studies do not provide much support for that argument. For example, *Halling et al.* (2008) finds that *firm size* is negatively correlated to trading volume share in the host market. They attribute this negative association to the fact that NASDAQ attracts mostly younger and smaller

high-tech companies. We measure *firm size* using logged firm market capitalization converted to U.S. dollars.[10] Annual data on market capitalization is obtained from the Worldscope database.

Our second proxy of firm's visibility is *firm age*. Firms with longer presence in a foreign market usually are better known to foreign investors and thus may attract a higher volume share in a foreign host market. *Eun and Sabherwal* (2003) shows a positive association between the years listed in the U.S. (the host) market and the trading volume in the U.S. Although it is difficult to find an accurate measurement for *firm age* on the host market, we use the number of years since each cross-listed stock's first trading data in the host market recorded in the Datastream as a proxy. citeKang-Stulz:1997 suggests that export-oriented firms attract more foreign investors because those firms are more visible and familiar to foreign investors.

Using *fraction of foreign sales* as a proxy, *Baruch et al.* (2007) and *Halling et al.* (2008) find a positive correlation between foreign sales and volume share of a host market. Similarly, we expect a positive association between the *fraction of foreign sales* and volume share of a market. We obtain annual percentages of foreign sales for each cross-listed firm from the Worldscope database.

(ii) Sensitivity to private information: Some types of firms are more sensitive to private information, which may affect their information-based trading. If domestic investors have relative advantages in obtaining private information, more shares will be traded in the home market than in host markets. However, if there is little barrier for information to be transmitted between host and home markets, we expect a higher volume share in host markets. *Halling et al.* (2008) suggests that technology firms are more sensitive to private information such as patents and innovation. As our first proxy for sensitivity to private information, we construct a *high-tech sector indicator* variable, which equals 1 if the firm is technology-oriented and 0 otherwise, based on

[10]Conversion of market capitalization to a common currency is necessary in order to rule out the variation in market capitalization caused by different currencies.

the SIC Code obtained from the Worldscope database.

Second, the value of a high-growth firm depends more on its future growth opportunities than its current performance; thus, information about the future growth of this type of firm is more important to investors. The empirical evidence of such impact is inconsistent among previous studies. For example, *Halling et al.* (2008) argues that foreign trading activity is negatively related to the growth of a company. However, *Pagano et al.* (2002) shows that European high-growth firms are more likely to list abroad and have more trading activity in the U.S. (host market). In this paper, we estimate *asset growth* based on the U.S. dollar-denominated total assets value in the home market for each firm, collected from the Worldscope database.

Third, firms with higher *stock return volatility* are more opaque to investors, so they are more sensitive to private information. *Pagano et al.* (2002) shows that foreign trading volume is negatively related to volatility for companies from emerging countries. *Halling et al.* (2008) finds that trading activities in the U.S. (host market) are comparatively high for volatile companies from developed countries. Following the *Domowitz et al.* (1998) method, we measure return volatility using the annual standard deviation of weekly stock returns in the home market for each cross-listed stock.

2.3 Trading volume distribution between home and host markets

We investigate the competitiveness of the host market compared to counterpart home markets by documenting the distribution of trading volume first and then examining the determinants of such trading volume distribution between host and home markets.

2.3.1 Summary Statistics

Table 2.2 reports the sample mean of all variables we discussed in Section 3.1, grouped by host countries. Our first measurement of volume share is the ratio of trading volume in host market i to the total global trading volume of a firm $(\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i} + \text{Vol}_{HM}))$, where the global trading volume is the sum of the trading volume in a firm's home market and those in all host markets if the firm cross-lists on multiple foreign host markets. Table 2.2 shows that, on average, the host market can attract 24.509 percent of a cross-listed firm's total global trading volume. However, substantial variations exist across host markets. The United States leads all host markets with 36.563 percent of global trading volume, followed by Singapore (30.540 percent), Portugal (28.512 percent), the United Kingdom (25.931 percent) and the Netherlands (22.114 percent). Japan (4.863 percent) and Germany (4.697 percent) trail all host markets by attracting lowest share of global trading volume. Other host countries that account for less than 10 percent of global trading volume include Belgium (7.430 percent) and France (6.060 percent).

Our second measurement of volume share is the ratio of the host market's trading volume divided by that of the home market $(\text{Vol}_{HT,i}/\text{Vol}_{HM})$(*Baruch et al.*, 2007; *Halling et al.*, 2008). This definition of volume share examines the competitiveness between the host market of interest and the counterpart home market and ignores the trading volume on other competing host markets if a firm cross-lists on multiple foreign markets. Table 2.2 shows that, on average, trading volume of a host market is 1.154 times of that of its counterpart home market. Half of the sample host markets are able to attract more trading volume than their counterpart home markets. Among them, Singapore (2.477) leads all host markets in attracting global trading volume from its counterpart home markets, followed by Portugal (2.366), the U.S. (1.649), the U.K. (1.285) and the Netherlands (1.236). Japan attracts the lowest volume share, holding about one-tenth (0.101) of the trading activity of its counterpart host

countries, followed by Germany (0.170) and France (0.415). As a comparison, *Halling et al.* (2008) reports a higher volume share for the U.S. (2.351). The lower volume share reported in Table 2.2 is partly due to our inclusion of firms with multiple cross-listings. If we limit our sample to firms with only one foreign cross-listing, as in the case of *Halling et al.* (2008), the average volume share is 2.285 for the U.S.

Table 2.2: Cross-listing sample summary statistics: firm- and market-level characteristics

This table reports summary statistics of all foreign cross-listings. We calculate the trading volume share in two ways. The first is the ratio of trading volume in host market i to the global trading volume of the firm ($\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM})$). The second is the ratio between the trading volume in host market i to that in the counterpart home market ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$). *The information factor* for firm i in year t equals $\left[\left(R^2_{ur} - R^2_r\right)/3\right]/\left[\left(1 - R^2_{ur}\right)/\left(n-6\right)\right]$, where n is the number of weekly returns used in both restricted and unrestricted models, and K is the number of existing markets in the restricted model, R^2_{ur} is the R^2 from the unrestricted model: $R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t}\boldsymbol{R}^{home}_{m,t} + \boldsymbol{\beta}'^{host}_{i,t}\boldsymbol{R}^{host}_{m,t} + \xi_{i,t}$, and R^2_r is the adjusted R^2 from the restricted model: $R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t}\boldsymbol{R}^{home}_{m,t} + \epsilon_{i,t}$ (*Baruch et al.*, 2007). *Trading cost difference* is the bid-ask spread of the host market divided by that of the home market, where the bid-ask spread is the ratio of the bid-ask price difference and the midpoint. *Firm size* is the market capitalization of the cross-listed firm in the home market of a cross-listed firm. *Firm age* is the number of years since the firm first appeared in the Datastream database. *Asset growth* is the difference of the U.S. dollar-dominated total assets in year t and in year $t-1$, divided by the value in year $t-1$. *Stock return volatility* is the standard deviation of weekly stock returns in the home market. *High-tech sector indicator* equals to 1 if the firm is technology-oriented and 0 otherwise, based on the SIC code obtained from the Worldscope database. *Financial development* in the home market is the sum of stock market capitalization and private credit as a ratio of GDP (*Beck et al.*, 2000). *Domestic economy class* equals to 1 if the home country is a developing economy and 0 otherwise. *Insider trading law enforcement difference* is the relative value of insider trading law enforcement in the host market to that of the home market, where insider trading law enforcement equals 1 in year t for country i if that country passed insider trading law in year t or before, and 0 otherwise. *Shareholder protection difference* is the difference in the antidirector rights index between a host market and the home market (*La Porta et al.*, 1998). *Anti-self-dealing difference* is the difference in the anti-self-dealing index between a host market and the home market. *Disclosures difference* is the difference in the disclosures index between a host market and the home market. *Time zone difference* is the difference between the time zones in a host market and its counterpart home market, divided by 3. The *language (or legal origin) difference* indicator equals 1 if the host market and the home market have no common official language (or legal origin), and 0 otherwise.

Panel A summarizes mean values for firm characteristics, grouped by host market. Panel B reports mean values for country characteristics, grouped by host market. Mean values are calculated by averaging the variables over time for each cross-listing, and then by averaging cross-listing means within each host country. Panel C presents the correlation coefficients of the variables.

Panel A: Company characteristics

Host country	Number of cross-listings	Volume ratio ($\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM})$) (%)	Volume share ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$)	Information factor	Trading cost diff. (HT/HM)	Firm characteristics in the home market					
						Firm size (Bil. USD)	Foreign sales (%)	Firm age (year)	Asset growth (%)	Volatility (%)	High-tech sector (%)
Belgium	57	7.430	0.468	2.091	19.553	18.776	50.917	11.928	8.168	4.657	17.227
France	81	6.060	0.415	2.160	21.182	18.658	46.158	11.028	8.910	4.597	13.468
Germany	26	4.697	0.170	2.439	5.713	13.638	48.317	9.640	6.994	4.587	6.739
Japan	77	4.863	0.101	1.448	21.036	20.030	40.968	9.438	8.613	4.422	23.796
The Netherlands	35	22.114	1.236	2.053	17.195	15.267	47.476	7.255	8.497	5.246	26.923
Portugal	4	28.512	2.366	2.417	27.178	15.750	25.773	4.133	17.165	4.090	0.000
Singapore	25	30.540	2.477	1.965	14.122	3.425	62.155	11.645	14.320	6.752	4.865
South Africa	31	21.593	0.657	2.883	4.017	6.057	66.059	8.205	18.833	7.682	0.000
The United Kingdom	105	25.931	1.285	1.734	5.612	13.244	43.987	11.231	12.681	5.776	19.184
The United States	330	36.563	1.649	2.008	1.226	10.379	48.702	10.589	15.101	6.330	24.107
Total	771	24.509	1.154	1.945	8.657	13.844	46.864	10.458	12.021	5.594	20.436

Panel B: Country characteristics

Host country	Financial development (HM, % of GDP)	Domestic economy class (HM, %)	Insider trading law enforcement difference ($HT - HM$)	Shareholder protection difference ($HT - HM$)	Anti-self-dealing index difference ($HT - HM$)	Disclosures index difference ($HT - HM$)	Time zone difference ($HT - HM$)	Legal origin difference (%)	Language difference (%)
Belgium	243.894	5.905	0.089	−4.018	0.019	−0.407	0.549	71.721	100.000
France	244.087	6.376	0.088	−0.711	−0.165	−0.005	0.157	73.713	100.000
Germany	225.801	0.000	−0.161	−2.839	−0.234	−0.370	0.100	70.084	95.816
Japan	205.447	4.678	−0.100	−0.292	−0.152	−0.102	3.104	86.924	100.000
The Netherlands	230.976	0.000	−0.147	−1.947	−0.390	−0.290	1.950	85.265	100.000
Portugal	222.763	0.000	−0.619	−1.000	0.150	−0.083	0.000	0.000	100.000
Singapore	282.108	4.639	0.046	−0.670	0.146	0.159	0.505	11.892	100.000
South Africa	265.123	0.000	−0.965	0.169	0.010	−0.014	0.233	0.000	100.000
The United Kingdom	210.213	11.079	0.324	0.887	0.303	0.057	−0.810	35.298	41.691
The United States	190.096	17.980	0.118	0.884	0.055	0.235	−1.303	34.828	45.673
Total	210.934	10.795	0.059	−0.099	0.004	0.036	−0.029	51.547	68.973

Table 2.2 (Cont'd)
Panel C: Correlation coefficients of company and country characteristics

Variable	Volume ratio ($\mathrm{Vol}_{HT,i}$/($\sum \mathrm{Vol}_{HT}$ +Vol_{HM}))	Volume share ($\mathrm{Vol}_{HT,i}$/Vol_{HM})	Info. factor	Time zone diff.	Trading cost diff.	Insider trading law diff.	Shrd-prot diff.	Anti-self-dealing diff.	Disclos. diff.	Fin. develp.	Domestic. economy class	Law origin diff.	Lan-guage diff.	Foreign sales	Firm Size	Firm age	Asset growth	Volti.
Volume share ($\mathrm{Vol}_{HT,i}$/Vol_{HM})	0.83																	
Information factor	0.09	0.06																
Time zone diff	−0.13	−0.07	−0.07															
Trading cost diff	−0.42	−0.26	−0.05	0.27														
Insider trading law diff	0.07	0.08	−0.04	−0.26	−0.07													
Shareholder protection diff	0.30	0.19	−0.03	−0.49	−0.31	0.23												
Anti-self-dealing dif	0.19	0.14	−0.00	−0.46	−0.11	0.23	0.64											
Disclosures diff	0.34	0.22	−0.01	−0.57	−0.33	0.28	0.88	0.58										
Financial development	−0.23	−0.14	0.11	0.08	0.15	−0.09	−0.37	−0.25	−0.39									
Domestic economy Class	0.14	0.06	−0.04	−0.19	−0.08	0.31	0.21	0.18	0.30	−0.30								
Legal origin diff	−0.33	−0.18	−0.03	0.17	0.20	−0.09	−0.16	−0.07	−0.17	0.07	0.13							
Language diff	−0.31	−0.14	0.02	0.08	0.30	−0.11	−0.10	−0.02	−0.11	0.05	0.23	0.70						
Foreign sales	0.12	0.12	0.10	−0.05	−0.02	−0.00	0.04	−0.01	0.06	0.10	−0.20	−0.06	−0.05					
Firm size	−0.32	−0.21	0.05	0.12	0.19	−0.07	−0.08	−0.01	−0.12	0.19	−0.10	0.28	0.21	0.04				
Firm age	−0.02	0.04	0.15	−0.06	0.07	0.04	−0.03	0.03	−0.02	0.24	−0.05	0.00	−0.00	0.10	0.22			
Asset growth	0.14	0.09	−0.02	−0.06	−0.07	0.03	0.07	0.03	0.09	−0.08	0.06	−0.12	−0.12	−0.02	−0.05	−0.09		
Volatility	0.33	0.21	0.01	−0.11	−0.17	−0.00	0.09	0.06	0.11	−0.01	0.12	−0.21	−0.21	0.09	−0.27	−0.11	0.03	
High-tech sector	0.06	0.05	0.01	−0.04	−0.05	−0.03	0.08	0.05	0.05	−0.03	−0.00	0.08	0.08	0.04	0.12	0.01	−0.03	0.00

Pane A of Table 2.2 reports the average information factor for each host market as well as the whole sample. Overall, the sample mean of the information factor is 1.945. Among 10 host countries, South Africa (2.883) provides the most price-relevant information for cross-listed firms while Japan (1.448) provides the least additional price-relevant information. The average information factor for the U.S. is 2.008, which is similar to the statistics reported in *Baruch et al.* (2007) (1.83 for firms from developed countries and 2.02 for firms from developing countries) and in *Halling et al.* (2008) (1.804). Untabulated results show that, on average, our sample host markets provide more incremental information for cross-listed stocks from developing markets than for those from developed markets: the sample average information factor for cross-listed firms from developing markets is 2.190, slightly higher than the average of 1.896 for cross-listed firms from developed markets.

We examine trading cost ratio between the bid-ask spread of a host and that of the counterpart home market for each cross-listed stock. We report the market level average of such ratio. A ratio higher than 1 means that the average trading cost in that host market is higher than the home market for the sample cross-listings. We observe that, in all 10 host markets, cross-listed firms have higher trading cost than that in the home market. The sample average bid-ask spread for the host markets is 8.657 times that of the counterpart home market. The U.S. has lowest trading cost premium with the bid-ask spread 1.226 times that of counterpart home markets. Germany (5.713), South Africa (4.017) and the U.K. (5.612) also have lower trading cost premiums than the sample average, while the other six host markets have relatively higher trading cost premiums. Portugal has the highest trading cost premium at 27.178 times the trading cost in its counterpart home market.

For firm characteristics, great variations exist among the 10 host markets. We winsorize all firm-level variables at the 5th and 95th percentiles. The sample average firm size in terms of market capitalization is $13.844 billion (U.S.). Typically,

larger firms list in Japan (20.030 billion), France (18.658 billion) and Belgium (18.776 billion), while smaller firms list in Singapore (3.425 billion) and South Africa (6.057 billion). Firms listed in Japan are about six times larger than those listed in Portugal. The sample mean of foreign sales is 46.864 percent, indicating that an average cross-listed firm generates a significant portion of sales from abroad and thus has great exposure among potential foreign investors. As a comparison, *Halling et al.* (2008) finds that firms cross-listed in the U.S. generate 43 percent of their sales from foreign markets. Most of the cross-listed stocks are mature, averaging 10.379 years in the respective host markets. Among the 10 host markets, Portugal (4.133 years) and the Netherlands (7.255 years) attract younger companies, while Belgium (11.928 years) and Singapore (11.645 years) attract more mature companies. The average annual growth of our sample firms is 12.021 percent. High-growth firms are attracted to listing in South Africa (on average, 18,833 percent), Portugal (17.165 percent) and the U.S. (15.101 percent). Foreign firms listed in Germany have lowest assets growth 6.994 percent. Stock return volatility does not show much variation across the 10 host countries with a sample average volatility of 5.594 percent, within the range of 4.090 percent (observed in Portugal) to 7.682 percent (in South Africa). Overall, 20.436 percent of the sample cross-listings belong to the high-tech sector. The Netherlands (26.923 percent) leads all host markets in attracting technology-oriented companies, followed by the U.S. (24.107 percent) and Japan (23.796 percent). At the other extreme, South Africa and Portugal attract zero cross-listings from the high-tech sector.

Pane B of Table 2.2 reports the summary statistics of market-level characteristics, grouped by host market. The sample average of domestic financial development, measured as the sum of private credit and stock market capitalization as a ratio of GDP, is 210.934 percent, with little variation across the 10 host markets. Among them, the U.S. (190.096 percent) attracts more cross-listed firms from less-developed domestic financial markets, while South Africa (265.123 percent) has cross-listings

from more-developed financial markets. The results on domestic economic development are similar to those on financial development. On average, 10.795 percent of the sample cross-listed firms are from developing economies, and the rest (89.205 percent) are from developed economies. All cross-listed firms in Germany, the Netherlands, Portugal, and South Africa are from developed countries. The U.S. (17.980 percent) and the U.K. (11.079 percent) have the highest percentage of cross-listings from developing countries. Four proxies for the different legal protection between host and home markets exhibit similar patterns. The U.S. and the U.K. lead the other host markets by having consistently positive estimated coefficients on all four proxies of legal protection, which means higher level of insider trading law enforcement, better minority shareholder protection, more control in self-dealing and more information disclosure requirements, relative to their respective home markets. More specifically, the U.K. has the highest relative levels of insider trading law enforcement (0.324), minority shareholder protection (0.887) and anti-self-dealing protection (0.303). The U.S. leads the other host markets by having the highest relative disclosure index (0.235). On the other hand, Germany, Japan and the Netherlands have negative values across all four legal proxies, showing lower level legal protection in those host countries than in their counterpart home markets. Specifically, Belgium has the lowest relative minority shareholder protection index (-4.018) and disclosure index (-0.407); Portugal has the lowest level of insider trading law enforcement (-0.619) and the Netherlands has the lowest anti-self-dealing index (-0.390). The sample average time zone difference is -0.029, indicating that host markets generally attract cross-listings from neighboring time zones. Some host markets attract cross-listings from distant time zones, such as Japan with an average time zone indicator of 3.104. Several others mainly attract companies from the same or neighboring time zones, such as Portugal with an average time zone difference of 0. On average, sample host markets attract $51,547$ percent of cross-listings from countries with the same legal origin. As

usual, cross-country variations exist: all cross-listings in Portugal and South Africa come from countries with the same legal origin, however, most foreign cross-listings in Japan (87.924 percent) are from countries with different legal origins. Considering language similarities between the host and the home markets, the U.S. and the U.K. share the most language similarity with counterpart home countries of cross-listed firms. For the U.S. and U.K., 45.673 percent and 41.691 percent of their cross-listings are from domestic markets with different languages, respectively. More than half of the foreign listings in the U.S. and the U.K. are from English-speaking countries. Belgium, France, Japan, the Netherlands, Portugal, Singapore and South Africa all have cross-listings from home countries with different official languages.

Panel C of Table 2.2 reports the correlation matrix of the aforementioned variables. The two measures of volume share are highly correlated with a correlation coefficient of 0.83. The signs of correlation coefficients between volume share and all explanatory variables are the same for the two measures of volume share, with the only exception of firm age. Also, signs of the correlation between explanatory variables and volume share proxies are consistent with our predictions outlined in Section 3.1, except for firm size. The absolute values of correlation coefficients among explanatory variables are mostly below 0.5, with exceptions: the correlation coefficient among shareholder protection index, anti-self-dealing index and disclosure index; and that between language difference and legal origin difference. In the regression analysis, we avoid including the highly correlated pairs in the same regression model to eliminate multicollinearity issue.

2.3.2 Univariate regression analysis

To further examine the impact of each factor on trading volume distribution, we run regression analysis of each explanatory variable against the logarithm of volume share in two ways and report the results in Panels A and B of Table **??**, respectively.

The standard errors are robust to heteroskedasticity and are adjusted for clustering by firm and by year. We focus our discussion on the results based on the models using $\log(\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i} + \text{Vol}_{HM}))$ as the dependent variable. The results based on the $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$ as the dependent variable are similar. In line with our initial predictions, results show that additional price relevant information contributed by a host market, which is measured by the information factor, increases the share of trading volume executed on that host market. Geographic proximity, measured by host-home market time zone difference, and the culture similarity, measured by host-home language and legal origin difference indicators, can influence information flow between the host market and the home market, and thus impact the share of global volume executed on the host market. As expected, we observe that farther distance in time zone and the presence of different languages or different legal origins between the host and the home market will reduce the volume share of the host market. A host market with a higher relative trading cost is shown to significantly decrease its proportion of global trading volume. Better legal protection for investors in a host market relative to counterpart home markets increases the share of global trading volume on that host market, evident from the highly significant positive coefficients on four proxies of legal protection (insider trading law enforcement, shareholder protection index, anti-self-dealing index and disclosure index). Firms from less-developed domestic countries tend to execute more trading in the host market, evident from the positive coefficients on developing economy dummy, and negative coefficients on the financial development dummy.

In terms of firm characteristics, we first document evidence from the impact of firm visibility on the distribution of global trading volume. Investors trade more shares of smaller firms with higher portion of foreign sales on a foreign host market. Results based on firm age are inconclusive so far. Our results also provide evidence that firms with higher sensitivity to private information execute a greater portion of their trading on a foreign host market, evident from the significantly positive signs of firm growth, return volatility and high-tech firm indicator. Domestic investors have an information advantage over foreign investors on home markets, and thus foreign investors shy away from trading on the home market of firms that are sensitive to private information. We also include an indicator variable of multiple cross-listings that equals 1 if a firm is cross-listed on more than one host market. Results show that multiple cross-listings reduce the volume share in one host market by 3.276, statistically significantly at the 1 percent level. Referring to the adjusted R^2 for each univariate regression model, disclosure index difference, shareholder protection index difference, firm size and multiple cross-listing dummy are able to explain a high portion (more than 20 percent) of variables in volume share individually.

2.3.3 Multivariate regression analysis

We next perform a series of panel regressions to evaluate the relative importance of market and firm characteristics in determining the distribution of trading volume. Table 2.3 shows the model exploration process and Table 2.4 presents our final sets of multivariate models with different fixed effects. The dependent variable is the log of trading volume share, which is calculated in two ways. Panel A reports the results from regressions using the log of volume share as the ratio of trading volume in a host market to the global trading volume of the firm $\log(\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i} + \text{Vol}_{HM}))$. Panel B reports the results from regressions using the log of volume share as the ratio between the trading volume in a host market to that in the counterpart home

market ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$). In all regression models, we apply the panel regression with firm-year two-way clustering standard errors.[11] We take one-year lags to the information factor, firm size, growth, foreign sales, stock volatility and domestic financial development variables, due to the potential high correlation between those variables and volume shares in the same year (*Baruch et al.*, 2007; *Halling et al.*, 2008). The number of observations in each model varies depending on data availability.

To avoid multicollinearity and to find the most stable models, we first group the potential variables by definition and then incorporate independent variables gradually by definition. Table 2.3 reports the results of multivariate regression from model exploration. In both Panels A and B, we start with Model 1 as our basic specifications by including information factor, time zone difference and trading cost difference. Then we try to add more explanatory variables from different categories. Models 2–5 further include one of the legal protection proxies in each of the models. Models 6–7 separately test the two domestic development proxies. Models 8–9 separately test the two culture difference proxies. Models 10–12 further include firm visibility and Models 13–15 include the factors of sensitivity to private information and all of the aforementioned variables. We try to keep at least one proxy from each category in the final model. Ideally, we keep the variable that represents each category with the highest significant explanatory power, the lowest correlation coefficient with other independent variables and the lowest variance inflation factor. We avoid including the highly correlated variables in the same models. Eventually, Models 14 and 15 become our complete models with two combinations of variables that represent all categories in explaining trading volume without causing any statistical issues. Given that the results are similar for the two versions of volume ratio, our discussion will focus on the results generated using $\log(\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i}+\text{Vol}_{HM}))$ as the dependent variable

[11] Clustering by firm accounts for the possible correlation between observations of same firm over different years. Clustering by year accounts for the possible correlation between observations on different firms in the same year.

in Panel A.

In general, the results agree with our predictions and what we reported in Table **??**. First, the results prove that incremental stock price information provided by the host market will help the host market to attract order flows. The estimated coefficients of information factor are positive and statistically significant at 1 percent level in all model specifications with the estimated coefficient ranging from 0.109 in Model 1 to 0.164 in Model 15, indicating that a one-unit increase in information factor results in a 17.82 percent ($= \exp(.164) - 1$) increase in global volume share of the host market in Model 15.

Second, the friction of global trading will reduce the trading volume in foreign markets. The estimated coefficients on time zone are negative and statistically significant at 5 percent in all specifications, indicating that the closer in time zone a host market is located to its counterpart home market, the higher volume share is executed in the host market. Using the estimated coefficient in Models 14 and 15 as an example, if a cross-listed firm is from a home country that is one time zone category farther away (equivalent to three-to-six hours difference in our definition), the global volume share of the host market decreases by 28.25 percent ($= \exp(-.332) - 1$) in Model 14 and 29.95 percent ($= \exp(-.356) - 1$) in Model 15. The estimated coefficients on trading cost are negative and statistically significant in all 15 models, indicating that the investor will avoid costly trading. The higher relative trading cost between the host and the home market, the lower trading volume share in that host market.

Third, our results suggest that stronger legal protection for investors in a host relative to home market will lead to a higher volume share for the host market. Models 2–4 show that the estimated coefficients on shareholder protection (anti-director trading) difference, insider trading law difference, anti-self-dealing index difference and disclosure index difference are all positive and statistically significant at 1 percent, implying that a stronger legal control in the host market on anti-director trading,

insider trading, anti-self dealing and information disclosure will significantly increase its global share of trading volume. Because these four proxies are highly correlated with each other, we only include one of them as a representative in the final models. Model 14 includes shareholder protection difference and it shows that a one-unit increase in the shareholder protection index difference in the host market relative to the counterpart home market increases the host market's trading share by 45.93 percent ($= \exp(.378) - 1$). Model 15 includes the insider trading law enforcement difference instead and show that if the host market enforces the insider trading law while the home market does not, the host market will increase its volume share by 70.57 percent ($= \exp(.534) - 1$).

Fourth, the positive significant coefficients of domestic economy class shows that if the cross-listed firm originated from the developing economy, more trading will be executed in the host market. Likewise, the coefficients on domestic financial development have consistently negative signs in Models 7 and 15, which indicate that if the cross-listing is from the better-developed domestic financial market, relatively less trading will be executed in the host market. However, the size of the coefficient of the domestic finance market is small, implying a limited impact of domestic financial development on trading volume distribution.

Fifth, we confirm that culture similarity plays an important role in influencing the destination of global trading. The negative estimated coefficients on both the language and legal origin dummies imply a higher volume share for the host market if the host market and its counterpart home market share one or more common languages, or the same legal origin.

Table 2.3: Determinants of global trading volume distribution – Multivariate regressions

This table reports the results from multivariate regressions. The dependent variable is the log of trading volume share, which is calculated in two ways. Panel A reports the regression results where the log of volume share is calculated as the ratio of trading volume in a host market to the global trading volume of the firm ($\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM})$). Panel B reports the regression resutls where the log of volume share is calculated as the ratio between the trading volume in a host market to that in the counterpart home market ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$). The information factor and other independent variables are defined in Table 2.2. We take one year lag for the information factor, firm size, asset growth, foreign sales, domestic financial development, trading cost difference, and stock return volatility. Firm size are expressed in log terms. Each column reports panel regression results with multiple listing fixed effect. Standard errors are robust to heteroskedasticity and are adjusted for two-way clustering by firm and by year. R^2 is adjusted for degrees of freedom. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logged volume ratio of host market to the sum of home and host markets ($\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$) as the dependent variable

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Information															
Information factor	0.109***	0.121***	0.133***	0.110***	0.123***	0.123***	0.125***	0.163***	0.117***	0.114***	0.160***	0.122***	0.128***	0.154***	0.164***
	(3.580)	(3.877)	(3.994)	(3.651)	(3.934)	(3.997)	(3.939)	(5.056)	(4.010)	(3.846)	(4.526)	(3.765)	(3.929)	(4.037)	(4.567)
Geographic proximity															
Time zone dif.	−0.452***	−0.223**	−0.438***	−0.376***	−0.192**	−0.429***	−0.440***	−0.249***	−0.207**	−0.205**	−0.172**	−0.272***	−0.275***	−0.332***	−0.356***
	(−6.639)	(−2.702)	(−6.401)	(−5.212)	(−2.485)	(−6.252)	(−6.414)	(−3.283)	(−2.647)	(−2.630)	(−2.266)	(−3.053)	(−3.092)	(−3.835)	(−4.944)
Trading cost															
Trading cost dif.	−0.011*	−0.021***	−0.011**	−0.011*	−0.020***	−0.011**	−0.011**	−0.017***	−0.019***	−0.019***	−0.024***	−0.022***	−0.022***	−0.018***	−0.026***
	(−2.097)	(−3.762)	(−2.145)	(−2.081)	(−3.697)	(−2.159)	(−2.172)	(−3.534)	(−3.741)	(−3.750)	(−5.149)	(−4.971)	(−4.745)	(−4.655)	(−5.051)
Legal protection															
Shareholder Prot. dif		0.432***						0.389***	0.409***	0.410***	0.449***	0.419***	0.432***	0.378***	
		(5.919)						(5.733)	(5.611)	(5.609)	(6.715)	(5.679)	(5.877)	(5.579)	
Insider trading law dif.			0.780**												0.534**
			(2.764)												(2.297)
Anti-self-dealing dif.				1.532**											
				(2.855)											
Disclosures dif.					3.537***										
					(7.493)										
Domestic Development															
Dome. Economy Class						0.878***		1.756***	1.716***	1.719***	1.559***	2.164***	2.049***	2.326***	
						(3.015)		(5.359)	(4.509)	(4.525)	(5.135)	(4.465)	(4.322)	(6.193)	
Dome. fin. development							−0.005**								−0.006***
							(−2.657)								(−4.374)
Culture															
Language dif.								−2.593***						−2.740***	
								(−12.238)						(−11.331)	
Legal origin dif.									−1.824***	−1.830***	−1.347***	−1.683***	−1.670***		−1.108***
									(−7.105)	(−7.099)	(−5.014)	(−6.168)	(−6.296)		(−4.158)
Firm visibility															
Firm age										0.006					0.025*
										(0.474)					(1.778)
Firm size											−0.318***				−0.305***
											(−4.554)				(−4.114)
Foreign sales												0.796*	0.849*	0.692*	
												(1.903)	(2.005)	(2.012)	
Sensitivity to private info.															
Firm growth													0.901**		1.025***
													(2.528)		(3.105)
High-tech sector														0.642**	
														(2.233)	
Volatility														10.953***	
														(3.812)	
Multi. cross-listings	−3.621***	−2.936***	−3.626***	−3.542***	−2.934***	−3.607***	−3.552***	−2.348***	−2.512***	−2.527***	−1.782***	−2.443***	−2.412***	−2.112***	−2.361***
	(−12.155)	(−9.549)	(−12.660)	(−11.538)	(−9.654)	(−12.453)	(−11.626)	(−8.662)	(−7.876)	(−7.745)	(−5.969)	(−6.962)	(−6.829)	(−7.169)	(−7.611)
Constant	−2.797***	−2.827***	−2.918***	−2.789***	−3.114***	−2.932***	−1.713***	−1.592***	−2.401***	−2.449***	1.894**	−3.103***	−3.282***	−2.909***	2.731***
	(−12.050)	(−11.691)	(−10.958)	(−12.429)	(−13.233)	(−11.671)	(−3.847)	(−10.256)	(−9.586)	(−9.395)	(2.292)	(−6.879)	(−6.909)	(−8.063)	(3.353)
No of obs.	3,428	3,310	3,428	3,427	3,310	3,428	3,398	3,310	3,310	3,310	3,211	2,413	2,329	2,413	3,050
Adj. R-Sq (%)	38.06	46.05	38.97	39.26	47.37	38.79	39.04	57.20	52.20	52.21	56.79	54.64	55.44	62.14	52.43

Panel B: Logged volume ratio of host market to home market ($\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$) as the dependent variable

Independent variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Information															
Information factor	0.141***	0.152***	0.172***	0.143***	0.156***	0.157***	0.162***	0.201***	0.149***	0.138***	0.207***	0.152***	0.162***	0.184***	0.209***
	(3.723)	(3.997)	(4.278)	(3.788)	(4.088)	(4.139)	(4.273)	(5.251)	(4.152)	(4.010)	(5.021)	(3.776)	(3.951)	(4.052)	(5.302)
Geographic proximity															
Time zone dif.	−0.442***	−0.199*	−0.424***	−0.354***	−0.153	−0.416***	−0.429***	−0.228**	−0.182*	−0.175*	−0.130	−0.257**	−0.258**	−0.325***	−0.331***
	(−5.590)	(−2.083)	(−5.301)	(−4.292)	(−1.677)	(−5.218)	(−5.365)	(−2.678)	(−2.019)	(−1.946)	(−1.522)	(−2.581)	(−2.603)	(−3.456)	(−4.165)
Trading cost															
Trading cost dif.	−0.013**	−0.023***	−0.013**	−0.013**	−0.023***	−0.013**	−0.012**	−0.018***	−0.021***	−0.021***	−0.026***	−0.025***	−0.024***	−0.020***	−0.028***
	(−2.119)	(−3.773)	(−2.175)	(−2.102)	(−3.703)	(−2.182)	(−2.205)	(−3.557)	(−3.748)	(−3.779)	(−5.051)	(−4.921)	(−4.696)	(−4.604)	(−5.030)
Legal protection															
Shareholder Prot. dif		0.477***						0.427***	0.449***	0.452***	0.511***	0.457***	0.468***	0.408***	
		(5.290)						(4.987)	(4.937)	(4.928)	(6.371)	(5.162)	(5.270)	(4.959)	
Insider trading law dif.			1.011***												0.614*
			(2.898)												(2.100)
Anti-self-dealing dif.				1.781**											
				(2.713)											
Disclosures dif.					4.105***										
					(6.778)										
Domestic Development															
Dome. Economy Class						1.004**		2.101***	2.039***	2.052***	1.855***	2.727***	2.599***	2.894***	
						(2.793)		(5.259)	(4.484)	(4.522)	(5.126)	(4.758)	(4.596)	(6.429)	
Dome. fin. development							−0.006**								−0.007***
							(−2.787)								(−4.616)
Culture															
Language dif.								−2.938***						−3.091***	
								(−11.108)						(−10.901)	
Legal origin dif.									−2.036***	−2.057***	−1.374***	−1.851***	−1.818***		−1.067***
									(−6.392)	(−6.470)	(−4.242)	(−5.473)	(−5.540)		(−3.402)
Firm visibility															
Firm age										0.020					0.048**
										(1.247)					(2.609)
Firm size											−0.438***				−0.444***
											(−5.572)				(−5.253)
Foreign sales												1.200**	1.257**	1.040**	
												(2.449)	(2.574)	(2.584)	
Sensitivity to private info.															
Firm growth													1.130**		1.355***
													(2.725)		(3.863)
High-tech sector														0.857**	
														(2.336)	
Volatility														15.176***	
														(4.220)	
Multi. cross-listings	−4.105***	−3.339***	−4.112***	−4.013***	−3.309***	−4.090***	−4.022***	−2.676***	−2.870***	−2.923***	−1.845***	−2.698***	−2.661***	−2.284***	−2.504***
	(−11.933)	(−9.234)	(−12.534)	(−11.249)	(−9.278)	(−12.282)	(−11.355)	(−8.277)	(−7.594)	(−7.486)	(−5.373)	(−6.544)	(−6.408)	(−6.594)	(−7.012)
Constant	−2.080***	−2.121***	−2.236***	−2.072***	−2.460***	−2.234***	−0.730	−0.736***	−1.660***	−1.833***	4.215***	−2.725***	−2.951***	−2.654***	5.429***
	(−7.408)	(−7.262)	(−7.024)	(−7.603)	(−8.711)	(−7.382)	(−1.321)	(−3.486)	(−5.339)	(−5.323)	(4.315)	(−5.191)	(−5.394)	(−6.258)	(5.665)
No of obs.	3,428	3,310	3,428	3,427	3,310	3,428	3,398	3,310	3,310	3,310	3,211	2,413	2,329	2,413	3,050
Adj. R-Sq (%)	33.83	41.18	34.94	34.98	42.86	34.52	35.05	51.67	46.86	46.97	52.77	50.22	51.00	58.40	49.23

Table 2.3 also reveals the relative importance of firm characteristics in determining the volume share of a host market. First, our results provide mixed evidence in support of the visibility argument. The estimated coefficients on firm age are positive as we expected that a firm with a longer history on the market will have more trading in the host market. However it is marginally significant at 10 percent in Model 15. Foreign sales are positively significant at the 1 percent level in Models 12–14 which is consistent with the argument that firms with more foreign sales are more visible to foreign investors and results in higher trading volume on the foreign markets. The estimated coefficients on firm size are negative and statistically significant in Models 11 and 15. The higher portion of trading share in host markets for small firms may be due to the lure of some popular trading venue like NASDAQ. As a comparison, *Halling et al.* (2008) documents a similar negative association between firm size and trading share of the U.S. (host) market.

Second, we find strong evidence that trading volume distribution between a host and its home markets is affected by its level of sensitivity to private information. The estimated coefficients on asset growth, high-tech firm indicator and stock return volatility are all positive and statistically significant at the 5 percent level, which shows that opaque cross-listed firms, typically featured by high growth rate, from the high-tech sector, and high stock return volatility, have more trading in the host market relative to the home market. This may result from the fact that the most of our sample host markets require more information disclosure when firms cross-list. The investors in the host market have access to readily information so that they are more comfortable with trading shares in the host markets. The multi-cross-listing dummy accounts for the impact on host market volume share if firms cross-listed on more than one host market simultaneously. Models 1–15 show that the multi-cross-listing dummy coefficients are consistently negative and significant at 1 percent, which agrees with our expectation. Multi-cross-listing behavior will reduce the firm's

trading volume share of one host market.

Table 2.4: Multivariate regressions with fixed effects

The table reports the results from multivariate regressions with different fixed effects at home, host country, and regional level. Panel A reports the results based on $\log(\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i} + \text{Vol}_{HM}))$ as dependent variable. Panel B reports the results based on the alternative measure $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$. Independent variables are measured as we defined in Table 2.2. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Variable	Panel A: $\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$ as dependent variable					
	(1)	(2)	(3)	(4)	(5)	(6)
Information factor	0.055*	0.048	0.050*	0.099***	0.070**	0.089***
	(2.114)	(1.571)	(1.827)	(3.192)	(2.705)	(3.144)
Time zone difference	−0.029	−1.275**	−0.136	−0.017	−0.954**	−0.217
	(−0.360)	(−2.506)	(−0.647)	(−0.329)	(−2.383)	(−1.428)
Trading cost difference	−0.018***	−0.014***	−0.017***	−0.020***	−0.016***	−0.019***
	(−4.770)	(−4.251)	(−4.669)	(−4.723)	(−4.537)	(−4.704)
Shareholder protection difference	0.501***	−1.568	0.467***			
	(4.212)	(−1.392)	(3.294)			
Insider trading law difference				0.686**	−0.051	0.244
				(2.624)	(−0.112)	(0.708)
Domestic financial development				−0.004***	−0.000	−0.003**
				(−3.193)	(−0.561)	(−2.382)
Domestic economy class	1.762***	1.574	2.389***			
	(4.762)	(0.625)	(5.505)			
Legal origin difference				−0.666***	−0.512**	−0.627**
				(−3.319)	(−2.338)	(−2.869)
Language difference	−2.008***	−0.993	−1.721***			
	(−6.797)	(−1.745)	(−5.488)			
Foreign sales	0.161	−0.000	0.002			
	(0.632)	(−0.001)	(0.007)			
Firm size				−0.244***	−0.222***	−0.224***
				(−4.789)	(−4.454)	(−4.599)
Firm age				−0.003	0.025**	0.004
				(−0.263)	(2.396)	(0.390)
Firm growth				0.546***	0.281**	0.443***
				(6.589)	(2.372)	(4.708)
Return Volatility	7.328**	6.007**	7.243**			
	(2.310)	(2.583)	(2.370)			
High-tech sector	0.320	0.361	0.382			
	(1.280)	(1.504)	(1.524)			
Multiple Cross-listings	−1.461***	−1.359***	−1.573***	−1.020***	−0.974***	−1.133***
	(−6.015)	(−5.686)	(−6.488)	(−4.108)	(−4.715)	(−4.441)
Constant	−1.710***	−2.906**	−3.423***	3.215***	−0.536	3.104***
	(−4.965)	(−2.569)	(−4.832)	(4.466)	(−0.444)	(4.668)
Host country fixed-effects?	Yes	Yes	Yes	Yes	Yes	Yes
Home country fixed-effects?	No	Yes	No	No	Yes	No
Home region fixed-effects?	No	No	Yes	No	No	Yes
Number of company-years	2,413	2,413	2,413	3,050	3,050	3,050
Adj. R-square (%)	72.63	77.80	73.75	71.82	78.48	73.04

Table 2.4 (Cont'd)

Variable	Panel B: $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$ as dependent variable					
	(1)	(2)	(3)	(4)	(5)	(6)
Information factor	0.077**	0.075*	0.073*	0.140***	0.108***	0.130***
	(2.126)	(1.867)	(1.930)	(4.071)	(3.521)	(3.979)
Time zone difference	−0.009	−1.633**	−0.122	0.039	−1.222**	−0.177
	(−0.087)	(−2.649)	(−0.505)	(0.622)	(−2.304)	(−1.123)
Trading cost difference	−0.019***	−0.015***	−0.019***	−0.022***	−0.018***	−0.021***
	(−4.680)	(−4.112)	(−4.565)	(−4.669)	(−4.450)	(−4.637)
Shareholder protection difference	0.543***	−2.305	0.530***			
	(4.228)	(−1.695)	(3.395)			
Insider trading law difference				0.754**	0.111	0.293
				(2.265)	(0.234)	(0.629)
Domestic financial development				−0.005***	−0.001	−0.005***
				(−3.821)	(−0.861)	(−3.051)
Domestic economy class	2.306***	3.612	2.781***			
	(5.314)	(1.176)	(5.524)			
Legal origin difference				−0.598**	−0.453*	−0.575**
				(−2.649)	(−1.870)	(−2.349)
Language difference	−2.414***	−1.095*	−2.084***			
	(−6.753)	(−1.762)	(−5.348)			
Foreign sales	0.484	0.366	0.339			
	(1.515)	(1.132)	(1.034)			
Firm size				−0.381***	−0.327***	−0.347***
				(−6.370)	(−5.445)	(−5.902)
Firm age				0.017	0.046**	0.025
				(0.980)	(2.842)	(1.459)
Firm growth				0.834***	0.517***	0.682***
				(6.280)	(3.156)	(4.225)
Return Volatility	11.198**	9.002***	10.602**			
	(2.867)	(3.039)	(2.817)			
High-tech sector	0.495	0.602	0.563			
	(1.407)	(1.687)	(1.613)			
Multiple Cross-listings	−1.581***	−1.456***	−1.701***	−0.986***	−0.966***	−1.131***
	(−5.204)	(−4.690)	(−5.652)	(−3.236)	(−3.493)	(−3.621)
Constant	−1.293***	−2.878**	−2.901***	6.083***	0.603	5.867***
	(−3.057)	(−2.293)	(−3.577)	(7.097)	(0.419)	(6.804)
Host country fixed-effects?	Yes	Yes	Yes	Yes	Yes	Yes
Home country fixed-effects?	No	Yes	No	No	Yes	No
Home region fixed-effects?	No	No	Yes	No	No	Yes
Number of company-years	2,413	2,413	2,413	3,050	3,050	3,050
Adj. R-square (%)	67.71	73.19	68.56	67.25	74.06	68.50

Table 2.4 reports the estimation results from six different models that adopt the model specifications from Models 14 and 15 in Table 2.3 but with different fixed effects. In both Panels A and B, Models 1–3 use the same model specification as Model 14 in Table 2.3. Models 4–6 are in line with Table 2.3 Model 15. The estimation results are similar when we use different combinations of variables in two groups. Models 1 and 4 include the host country fixed effect to account for residuals correlation across firms that share the same cross-listing destination; Models 2 and 5 add both host and home country fixed effects; and Models 3 and 6 control for host country fixed effect and home market regional effect measured by regional dummies. Again, our discussion will using the result in Panel A as an example since the results in two panels are similar. The coefficient estimates are consistent with the findings in Table 2.3. After controlling for different fixed effects, both the economics significance and statistics significance are reduced for some independent variables. For example, information factor remains positively significant at conventional levels in all models expect Model 2, even though the sizes of the coefficients are reduced by 50 percent compared to those in Models 14 and 15 in Table 2.3. As expected, time zone and trading cost differences show a negatively significant relationship with trading volume share. Shareholder protection and insider trading law proxies are only statistically significant in three out of six models. Domestic development and culture difference proxies show expected sign and have consistently significant results. In terms of firm level characteristics, firm size, asset growth, return volatility and multi-cross-listing indicator show the same strongly significant results as what we find in Table 2.3. After controlling for home and/or host fixed effects, foreign sales, firm age and high-tech sectors no longer show the pronounced impacts as those in Table 2.3, although their coefficients keep expected signs, confirming the relationship to trading volume share as we discussed previously.

2.4 Robustness checks

2.4.1 Alternative measures of volume share

As we mentioned in previous sections, we use volume share ($\text{Vol}_{HT_i}/(\sum_{i=1}^{n} \text{Vol}_{HT_i} + \text{Vol}_{HM})$) to document the trading volume distribution between host and home market in our main analysis. The advantage of this method is that it takes into account those cross-listed firms with multiple host markets. As a robustness check, we also conduct the analysis using the traditional volume share approach (*Baruch et al.*, 2007; *Halling et al.*, 2008) to calculate volume share of host market i to its counterpart home market ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$); $i = 1, ..., n$; $n \geq 1$; n is the total number of firm's host markets). The results associated with the second trading volume measure are reported in Panel B of Tables **??**–2.4. The results are comparable with those associated with the first measurement of volume share. Information factor, geographic proximity, trading costs, legal protection proxies, domestic development, and cultural difference continue to have significant impacts on trading volume share. Firm level characteristics are still crucial in determining the trading volume distribution and multi-cross-listing behavior will significantly reduce the volume share for one host market versus the counterpart home market. All of these confirm what we found using our improved version of volume share.

2.4.2 The U.S. dollar as a common currency

Regression results presented in Tables **??**–2.4 are estimated using information factors and some firm level characteristics such as asset growth and stock return volatility, denominated in host markets' currencies. As a robustness check of the previously reported results, we convert all the values into the U.S. dollar as a common currency. We re-estimate all aforementioned models and report the regression results in Table 2.5. We continue to measure trading volume share using two meth-

ods and report estimation results in Panels A ($\text{Vol}_{HT_i}/(\sum_{i=1}^{n}\text{Vol}_{HT_i}+\text{Vol}_{HM})$) and B ($\text{Vol}_{HT,i}/\text{Vol}_{HM}$), respectively. Models 1 and 5 adopt the specification of Models 14 and 15 in Table 2.3. Models 2 and 6 include the host country fixed effect; Models 3 and 7 add both host and home country fixed effects; and Models 4 and 8 control for host country fixed effect and home market regional effect measured by regional dummies. The signs and levels of statistical significance of all independent variables in both panels are similar to those reported in Table 2.4. The estimated coefficients on the information factor, shareholder protection index difference, insider trading law difference and domestic economy class dummies are all positive and statistically significant at conventional levels, confirming that these factors boost the volume share of the host market. The estimated coefficients on time zone difference, trading cost difference, domestic financial development, difference in legal origin, and difference in language are all negative and statistically significant at least at 5 percent, confirming that the above trading frictions reduce relative trading in the host market. Regarding firm characteristic variables, we continue to observe a negative association between volume share and firm size and a positive association between trading volume and asset growth as well as return volatility. Estimated coefficients on high-tech indicator, foreign sales and firm age do not offer conclusive results.

Table 2.5: Determinants of global trading volume distribution – The U.S. dollar as a common currency

This table reports the results of multivariate models estimated by independent variables denominated in the U.S. dollar as a common currency. Panel A reports the results based on $\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$ as dependent variable. Panel B reports the results based on the alternative measure $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Variable	Panel A: $\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$ as dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information factor	0.160***	0.066**	0.055*	0.062**	0.186***	0.127***	0.084***	0.112***
	(4.794)	(2.464)	(1.895)	(2.343)	(5.135)	(4.393)	(3.293)	(4.298)
Time zone difference	−0.332***	−0.028	−1.246**	−0.114	−0.356***	−0.018	−0.904**	−0.176
	(−3.896)	(−0.355)	(−2.467)	(−0.536)	(−5.002)	(−0.354)	(−2.267)	(−1.168)
Trading cost difference	−0.018***	−0.018***	−0.014***	−0.017***	−0.026***	−0.019***	−0.016***	−0.019***
	(−4.698)	(−4.789)	(−4.269)	(−4.685)	(−5.026)	(−4.737)	(−4.543)	(−4.708)
Shareholder protection difference	0.375***	0.493***	−1.520	0.467***				
	(5.536)	(4.132)	(−1.385)	(3.292)				
Insider trading law difference					0.571**	0.715**	−0.016	0.253
					(2.511)	(2.735)	(−0.037)	(0.752)
Domestic financial development					−0.005***	−0.004***	−0.000	−0.003**
					(−4.303)	(−3.097)	(−0.520)	(−2.362)
Domestic economy class	2.348***	1.774***	1.536	2.398***				
	(6.226)	(4.792)	(0.624)	(5.476)				
Legal origin difference					−1.045***	−0.606***	−0.477**	−0.577**
					(−3.817)	(−2.970)	(−2.133)	(−2.607)
Language difference	−2.713***	−1.981***	−0.944	−1.686***				
	(−11.261)	(−6.765)	(−1.665)	(−5.432)				
Foreign sales	0.715**	0.176	0.007	0.017				
	(2.137)	(0.704)	(0.028)	(0.066)				
Firm size					−0.321***	−0.257***	−0.229***	−0.236***
					(−4.399)	(−5.066)	(−4.611)	(−4.907)
Firm age					0.024	−0.003	0.025**	0.004
					(1.742)	(−0.301)	(2.322)	(0.327)
Firm growth					1.027***	0.559***	0.295**	0.458***
					(3.145)	(6.559)	(2.407)	(4.656)
Return volatility	10.108***	6.305*	5.583**	6.165*				
	(3.599)	(2.071)	(2.465)	(2.091)				
High-tech sector	0.646**	0.323	0.364	0.384				
	(2.310)	(1.303)	(1.530)	(1.548)				
Multiple cross-listings	−2.105***	−1.464***	−1.359***	−1.577***	−2.311***	−0.993***	−0.956***	−1.107***
	(−7.124)	(−6.017)	(−5.686)	(−6.506)	(−7.491)	(−4.030)	(−4.729)	(−4.394)
Constant	−2.965***	−1.725***	−2.945**	−3.480***	2.819***	3.277***	−0.354	3.160***
	(−8.599)	(−5.055)	(−2.749)	(−4.947)	(3.449)	(4.511)	(−0.295)	(4.722)
Host country fixed-effects?	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Home country fixed-effects?	No	No	Yes	No	No	No	Yes	No
Home region fixed-effects?	No	No	No	Yes	No	No	No	Yes
Number of company-years	2,412	2,412	2,412	2,412	3,044	3,044	3,044	3,044
Adj. R-square (%)	62.15	72.63	77.82	73.74	52.64	72.05	78.55	73.20

Table 2.5 (Cont'd)

Variable	Panel B: $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$ as dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information factor	0.202***	0.100**	0.096*	0.097**	0.240***	0.177***	0.134***	0.162***
	(4.610)	(2.404)	(2.072)	(2.283)	(5.784)	(4.823)	(3.621)	(4.443)
Time zone difference	−0.324***	−0.008	−1.576**	−0.086	−0.331***	0.038	−1.140**	−0.118
	(−3.498)	(−0.083)	(−2.591)	(−0.353)	(−4.218)	(0.605)	(−2.173)	(−0.749)
Trading cost difference	−0.020***	−0.019***	−0.015***	−0.019***	−0.028***	−0.021***	−0.017***	−0.021***
	(−4.653)	(−4.708)	(−4.141)	(−4.591)	(−5.007)	(−4.690)	(−4.467)	(−4.653)
Shareholder protection difference	0.404***	0.531***	−2.202	0.529***				
	(4.915)	(4.103)	(−1.678)	(3.382)				
Insider trading law difference					0.661**	0.793**	0.168	0.302
					(2.316)	(2.389)	(0.355)	(0.662)
Domestic financial development					−0.007***	−0.005***	−0.001	−0.005***
					(−4.564)	(−3.677)	(−0.765)	(−3.017)
Domestic economy class	2.927***	2.321***	3.500	2.794***				
	(6.448)	(5.325)	(1.181)	(5.597)				
Legal origin difference					−0.979***	−0.511**	−0.397	−0.502*
					(−3.053)	(−2.219)	(−1.595)	(−2.029)
Language difference	−3.061***	−2.372***	−1.004	−2.026***				
	(−10.869)	(−6.735)	(−1.644)	(−5.344)				
Foreign sales	1.066**	0.504	0.376	0.359				
	(2.746)	(1.614)	(1.183)	(1.111)				
Firm size					−0.465***	−0.399***	−0.340***	−0.364***
					(−5.589)	(−6.677)	(−5.645)	(−6.254)
Firm age					0.047**	0.016	0.045**	0.024
					(2.577)	(0.947)	(2.824)	(1.414)
Firm growth					1.367***	0.858***	0.544***	0.709***
					(3.895)	(6.023)	(3.162)	(4.136)
Return volatility	13.941***	9.849**	8.455**	9.240**				
	(3.914)	(2.584)	(2.846)	(2.491)				
High-tech sector	0.864**	0.500	0.607	0.564				
	(2.416)	(1.435)	(1.716)	(1.640)				
Multiple cross-listings	−2.273***	−1.584***	−1.456***	−1.706***	−2.441***	−0.949***	−0.936***	−1.093***
	(−6.554)	(−5.194)	(−4.691)	(−5.661)	(−6.865)	(−3.160)	(−3.496)	(−3.577)
Constant	−2.738***	−1.344***	−2.988**	−3.015***	5.551***	6.178***	0.896	5.972***
	(−6.598)	(−3.074)	(−2.535)	(−3.769)	(5.780)	(7.143)	(0.627)	(6.843)
Host country fixed-effects?	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Home country fixed-effects?	No	No	Yes	No	No	No	Yes	No
Home region fixed-effects?	No	No	No	Yes	No	No	No	Yes
Number of company-years	2,412	2,412	2,412	2,412	3,044	3,044	3,044	3,044
Adj. R-square (%)	58.51	67.74	73.28	68.60	49.55	67.60	74.23	68.77

2.4.3 Excluding cross-listed firms in the U.S.

Our overall sample contains 771 global cross-listings from 39 home markets on 10 major financial markets. Those cross-listed in the U.S. represent 42.80 percent (=330/771) of our sample. One concern is that the results presented above are driven by firms that cross-list in the U.S. To alleviate this concern, we re-estimate the regression models used in Tables 2.4 by excluding firms that are cross-listed in the U.S. The two panels in Table 2.6 report the re-estimated results regarding the impact of firm and market characteristics on two measures of trading volume distribution. We continue to observe a significant impact from most firm and market characteristics on the volume share that a host market receives. Host markets with a higher information factor, lower trading cost, and stronger legal protection receive a higher share of trading volume. We continue to find that smaller firms from the high-tech sector with higher asset growth rate observe a greater share of order flow executed in foreign host markets rather than in their domestic home markets.

Table 2.6: Determinants of global trading volume distribution – Excluding firms listed in the U.S.

This table reports the results of the re-estimation with the sample firms that cross-list outside of the U.S.. The dependent variable is log of volume share, which is calculated in two ways. Panel A reports the results based on $\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$. Panel B reports the results based on the alternative measure $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Variable	Panel A: $\log(\text{Vol}_{HT,i}/(\sum \text{Vol}_{HT} + \text{Vol}_{HM}))$ as the dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information factor	0.205***	0.064	0.066	0.064	0.253***	0.163***	0.106**	0.138***
	(3.156)	(1.282)	(1.248)	(1.285)	(5.006)	(3.467)	(2.425)	(3.120)
Time zone difference	−0.212*	0.034	−1.170*	0.063	−0.084	−0.148	−1.463**	−0.257
	(−1.818)	(0.278)	(−1.793)	(0.241)	(−0.780)	(−1.234)	(−2.672)	(−1.038)
Trading cost difference	−0.017***	−0.017***	−0.013***	−0.015***	−0.018***	−0.018***	−0.015***	−0.017***
	(−4.695)	(−4.749)	(−4.229)	(−4.646)	(−4.534)	(−4.462)	(−4.351)	(−4.557)
Shareholder protection difference	0.248**	0.642***	2.451	0.460**				
	(2.789)	(4.804)	(1.487)	(2.882)				
Insider trading law difference					0.677**	1.196***	−0.274	0.767
					(2.239)	(3.278)	(−0.639)	(1.137)
Domestic financial development					−0.005**	−0.006**	−0.000	−0.004
					(−2.198)	(−2.567)	(−0.052)	(−1.448)
Domestic economy class	2.260***	2.949***	−6.570*	2.656***				
	(3.286)	(5.294)	(−1.976)	(2.993)				
Legal origin difference					−0.954**	−0.455	−0.124	−0.266
					(−2.913)	(−1.251)	(−0.371)	(−0.710)
Language difference	−2.497***	−2.206*	−0.077	−1.479				
	(−5.357)	(−2.011)	(−0.054)	(−1.315)				
Foreign sales	1.129*	0.327	0.013	0.102				
	(1.877)	(0.650)	(0.027)	(0.198)				
Firm size					−0.559***	−0.361***	−0.310***	−0.321***
					(−6.757)	(−4.890)	(−3.889)	(−4.074)
Firm age					−0.055*	−0.022	0.010	−0.005
					(−2.123)	(−0.999)	(0.472)	(−0.238)
Firm growth					0.761***	0.444***	0.204	0.245*
					(3.617)	(4.001)	(1.292)	(1.932)
Return volatility	9.687	4.082	6.337	5.028				
	(1.711)	(0.833)	(1.574)	(1.120)				
High-tech sector	0.430	0.420	0.810	0.565				
	(0.731)	(0.855)	(1.740)	(1.110)				
Multiple cross-listings	−2.466***	−1.965***	−1.828***	−1.992***	−1.347***	−1.311***	−1.340***	−1.458***
	(−5.894)	(−5.567)	(−5.412)	(−5.776)	(−3.305)	(−3.474)	(−4.560)	(−3.913)
Constant	−3.673***	−2.936***	−7.719***	−3.894***	5.654***	3.269***	0.163	1.702
	(−6.771)	(−5.624)	(−3.223)	(−5.061)	(4.469)	(2.991)	(0.112)	(1.183)
Host country fixed-effects?	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Home country fixed-effects?	No	No	Yes	No	No	No	Yes	No
Home region fixed-effects?	No	No	No	Yes	No	No	No	Yes
Number of company-years	1,439	1,439	1,439	1,439	1,726	1,726	1,726	1,726
Adj. R-square (%)	46.80	60.67	67.98	62.80	53.50	61.25	70.70	63.58

Table 2.6 (Cont'd)

Variable	Panel B: $\log(\text{Vol}_{HT,i}/\text{Vol}_{HM})$ as the dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information factor	0.237***	0.096	0.093	0.098	0.291***	0.198***	0.137**	0.173***
	(3.143)	(1.493)	(1.351)	(1.525)	(5.023)	(3.664)	(2.499)	(3.196)
Time zone difference	−0.239*	−0.029	−1.115	0.057	−0.085	−0.206	−1.555**	−0.245
	(−1.776)	(−0.184)	(−1.425)	(0.199)	(−0.651)	(−1.448)	(−2.572)	(−0.982)
Trading cost difference	−0.018***	−0.018***	−0.014***	−0.017***	−0.019***	−0.020***	−0.017***	−0.019***
	(−4.633)	(−4.626)	(−4.082)	(−4.504)	(−4.536)	(−4.457)	(−4.285)	(−4.546)
Shareholder protection difference	0.259**	0.624***	2.512	0.456**				
	(2.572)	(4.023)	(1.439)	(2.425)				
Insider trading law difference					0.738*	1.301***	−0.175	0.852
					(2.109)	(3.069)	(−0.354)	(1.092)
Domestic financial development					−0.006*	−0.006**	0.000	−0.004
					(−2.090)	(−2.596)	(0.215)	(−1.390)
Domestic economy class	2.754***	3.427***	−6.418*	2.747**				
	(3.581)	(5.682)	(−1.836)	(2.713)				
Legal origin difference					−0.882**	−0.309	−0.033	−0.160
					(−2.187)	(−0.756)	(−0.088)	(−0.387)
Language difference	−2.648***	−2.637**	−0.560	−1.769				
	(−4.849)	(−2.133)	(−0.344)	(−1.415)				
Foreign sales	1.490**	0.621	0.424	0.403				
	(2.185)	(1.051)	(0.705)	(0.668)				
Firm size					−0.694***	−0.468***	−0.402***	−0.396***
					(−6.985)	(−5.414)	(−4.057)	(−4.111)
Firm age					−0.034	0.009	0.040	0.028
					(−1.030)	(0.288)	(1.429)	(0.939)
Firm growth					1.099***	0.754***	0.415**	0.453**
					(4.952)	(5.740)	(2.178)	(2.596)
Return volatility	12.406*	5.945	7.984	6.313				
	(1.877)	(1.074)	(1.637)	(1.241)				
High-tech sector	0.699	0.658	1.055	0.804				
	(0.949)	(0.975)	(1.565)	(1.188)				
Multiple cross-listings	−2.598***	−2.016***	−1.925***	−2.068***	−1.332**	−1.271**	−1.338***	−1.474***
	(−5.439)	(−4.796)	(−4.464)	(−5.015)	(−2.810)	(−2.913)	(−3.409)	(−3.320)
Constant	−3.598***	−2.773***	−7.781***	−3.865***	7.805***	4.953***	1.280	2.601
	(−5.901)	(−4.760)	(−3.083)	(−4.664)	(5.026)	(3.743)	(0.733)	(1.570)
Host country fixed-effects?	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Home country fixed-effects?	No	No	Yes	No	No	No	Yes	No
Home region fixed-effects?	No	No	No	Yes	No	No	No	Yes
Number of company-years	1,439	1,439	1,439	1,439	1,726	1,726	1,726	1,726
Adj. R-square (%)	42.95	55.19	61.48	57.21	49.13	56.91	65.43	59.44

2.5 Conclusion

While both asset prices and trading volume are the fundamental building blocks of all economic interactions in financial markets (*Karpoff*, 1986, 1987; *Lo and Wang*, 2006), much of the literature has been devoted to the behavior of stock prices. Studies of trading volume, especially of firms that cross-list their shares abroad, have been far fewer. In the past few decades, we have witnessed rapid growth of global cross-listings both in number of offerings and in number of origination (home) and destination (host) markets. However, there is a lack of understanding on the global distribution, and its determinants, of trading volume for globally cross-listed shares. Previous studies have drawn conclusions using sample firms that cross-list in the U.S. It is important to incorporate other important host markets into our study in order to reflect the changing landscape of cross-listing markets.

In this study, we attempt to fill the aforementioned gaps. Using a hand-collected sample of firms with foreign cross-listings on 10 major financial markets, we utilize the improved methods to measure the trading volume and information factor of each host market. Our methods are able to address the impacts from rival host markets for firms that cross-list on multiple host market. We document that the U.S., on average, attracts 36.563 percent of a firm's global trading volume, surpassing other host markets. Four countries (Belgium, France, Germany and Japan), on average, attract less than 8 percent of a cross-listed firm's global trading volume. The dispersion of volume share among the 10 host markets illustrates the difficulty in generalizing findings based on sample firms that cross-list shares only in the U.S.

We next systematically examine the impact of both information- and non-information-based variables on volume share in a regression framework. Our findings support the importance of information factor in attracting order flows in both U.S. and non-U.S. host markets. In addition, for the first time, we document that whether a host market shares the language or legal origin with the home markets plays an important role

in attracting order flows. Moreover, our results suggest that host markets with the following characteristics attract a greater portion of trading volume from the home market: closer proximity to home market in time zone, lower trading cost and stronger legal protection for inventors. Furthermore, small and mature high-tech firms from less-developed domestic markets, with high asset growth, high return volatility and more foreign sales observe a greater portion of their trading volume executed on foreign host markets, rather than on their respective home markets.

CHAPTER III

Essay II. Competition among trading venues: Evidence from the trading volume distribution of globally multiple cross-listed shares

Over the last few decades, there has been a substantial increase in the numbers of global cross-listings as well as home and host markets. Many firms cross-list their shares on multiple foreign markets in order to gain credibility and visibility and to facilitate marketing (*Doidge et al.*, 2009). Some firms have delisted their shares from abroad (*You et al.*, 2012). Previous studies (See, for example, *Sarkissian and Schill*, 2009; *Wang and Zhou*, 2014) have excluded such delisted firms from their samples largely due to the lack of a historical record of cross-listings. Our study fills the gap by constructing a comprehensive dataset of firms that list their shares on both domestic and foreign stock exchanges. Our sample is constructed directly from Datastream and consists of $1,118$ cross-listings in 50 host countries over the period between 1990 and 2012. Among them, there are 340 cross-listings listed on two or more stock exchanges. This subset of multiple cross-listings offers a unique opportunity to chronologize the distribution of such listings and to examine the dynamics of market competitiveness in attracting order flows among rival foreign markets, which has largely been ignored by the literature.

Specifically, we examine the importance of various market- and firm-level factors, suggested by *Baruch et al.* (2007), *Eun and Sabherwal* (2003), *Su and Chong* (2007), and *Wang and Zhou* (2014), in determining the distribution of trading volume among rival host markets. We find robust evidence that trading cost, firm age, host market legal protection, information disclosure, financial development, market liquidity, and legal origin consistently play a vital role for a host market to attract order flows from rival host markets. More specifically, host markets are better positioned to attract order flows from rival host markets when they have lower trading cost, foreign firms with a longer listing history, better legal protection and information disclosure, higher market liquidity and more advanced financial market. Interestingly, we consistently find that host countries with English common law origin are able to attract more trading volume while host countries with French civil-law origin attract significantly lower trading volume. Moreover, we find minimal evidence that information-based variables have a significant impact on the distribution of order flows.

Our study contributes to the literature in three ways. First, we construct a comprehensive dataset of global cross-listings directly from Datastream. With few exceptions, previous studies have largely examined firms that cross-list in one market only (See, for example, *Baruch et al.*, 2007). Studies that have constructed a dataset of global cross-listings mostly collected the listings from stock exchanges (See, for example, *Sarkissian and Schill*, 2009; *Wang and Zhou*, 2014). One limitation of such an approach is that most stock exchanges do not provide a complete list of historical listings but a snapshot of listings at a particular point of time, such as the end of calendar year 2012. Thus, datasets used in previous studies usually do not include delisted, merged or other firms that no longer actively listed on a market at the time when the dataset is constructed. Moreover, most stock exchanges only provide limited information about a firm, such as company name and stock ticker. Many firms change name or registration location during the listing's duration. The incomplete

information provided by stock exchanges makes it difficult to match with firms in research databases such as Datastream. We employ an innovative approach to identify cross-listings directly from Datastream; thus, our dataset is comprehensive and free from potential biases caused by the above mentioned limitations.

Second, to the best of our knowledge, we are the first to examine trading volume distribution among rival host markets. Our main analysis focuses on firms with multiple cross-listings, which allows us to examine competition among host markets and to identify factors that influence the competitiveness of the host market in attracting order flows from rival host markets. We conduct a comprehensive analysis and present robust results on the relative importance of firm- and market-level characteristics in determining market competitiveness. Our results are robust to different regression methods, variable measurements and subsamples.

Third, our findings have both important academic and practical implications. Investors may find our results useful in guiding them to place orders at markets with the most market liquidity, lower transaction cost and better shareholder protection, and therefore lower the liquidity and trading cost, reduce the global trading risk, ensure the feasibility of investors' trading strategies, and help them construct globally diversified portfolios (See, for example, *Baruch et al.*, 2007). Regulators and policymakers may adjust policies and improve market soundness in order to make a country's stock market more competitive in attracting order flows and foreign cross-listings and therefore enhance the development of domestic financial markets (See, for example, *Hargis and Ramanlal*, 1998; *Halling et al.*, 2008).

The remainder of the paper proceeds as follows: Section 3.1 details variable construction. Section 3.2 describes the hypotheses and sampling process and documents the distribution of foreign cross-listings across home and host markets. Sections 3.3 discusses our empirical findings. Section 4.6 presents results on robustness checks. Section 3.5 concludes our study.

3.1 Variable construction

In this section, we discuss various firm and market characteristics and their expected impact on volume share distribution among rival host markets.

3.1.1 Trading volume ratio

Baruch et al. (2007) and *Halling et al.* (2008) calculate the trading volume ratio for cross-listing i in a host market as the ratio of the trading volume in the host market to that in the firm's home market, $\text{Vol}_{HT,i}/\text{Vol}_{HM}$, where i represents an individual cross-listing. This definition provides information about the volume distribution between a host market and its counterpart home market. *Wang and Zhou* (2014) calculates the volume ratio of the host market as the ratio of trading volume in one host market i to the total global trading volume of each cross-listed firm, $\text{Vol}_{HT,i}/\sum_{k=1}^{n}(\text{Vol}_{HT,k} + \text{Vol}_{HM})$, and studies the trading volume distribution between a host market and its counterpart home market.

To examine the distribution of foreign trading volume among multiple rival host markets, we measure the trading volume ratio of a host market as the proportion of trading volume in host market i over the total foreign trading volume of each cross-listed firm,

$$\frac{\text{Vol}_{HT,i}}{\sum_{k=1}^{n}\text{Vol}_{HT,k}}, \tag{3.1}$$

where n is the total number of host markets for each sample cross-listed firm. We first obtain trading volume of each cross-listed share in each stock market as listed on Datastream. We download the American Depository Receipt (ADR) exchange ratio from the Worldsope database. To further verify the ADR bundle ratio, we collect ADR bundle ratios from Citi bank, J.P. Morgan Chase Bank and Bank of New York. We then adjust the number of shares trading volume in the host market by multiplying the bundle ratio for those ADRs in our sample. For robustness purpose, we measure

trading volume in two ways, number of shares traded and U.S. dollar denominated value traded, and thus have two measures of trading volume ratio — share volume ratio and dollar volume ratio, repectively.

3.1.2 Information factor

Baruch et al. (2007) proposes a theoretical model to explain the variations in volume ratio of internationally cross-listed stocks (henceforth, the BKL information factor). The BKL information factor is estimated as the correlation coefficient between cross-listed asset returns and the returns of other assets traded on that market. It represents the incremental information generated from the host market in addition to that from its counterpart home market. The BKL model predicts that trading volume ratio for the cross-listed stock is positively associated with the respective information factor. Using the sample of foreign firms that cross-list in U.S. markets, *Baruch et al.* (2007) and *Halling et al.* (2008) document evidence to support the BKL model's prediction that proportionally more volume takes place in the U.S. than in its counterpart home market if the cross-listed asset has a higher information factor. *Wang and Zhou* (2014) find a positive relationship between a revised version of the BKL information factor and trading volume ratio of globally cross-listed stocks. Following *Wang and Zhou* (2014), we adopt the BKL information factor to measure the incremental information provided by one host market in addition to that provided by its domestic home market. For every cross-listed stock in our sample, we first regress daily domestic market returns of stock i on the daily index return in the domestic market and obtain the R-square, R_r^2, in the restricted model:

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \epsilon_{i,t}, \tag{3.2}$$

where $\boldsymbol{\beta}^{home}_{i,t}$ is a 3×1 vector of asset i's loadings on index returns of the home

market, and $\boldsymbol{R}_{m,t}^{home}$ is a 3×1 vector of index returns (R_m) of the home market. We estimate the equation at every day t within a three-day window, from the previous day $(t-1)$ to the next day $(t+1)$; that is, $\boldsymbol{\beta}'^{home}_{i,t} = \left(\beta^{home}_{i,t-1}, \beta^{home}_{i,t}, \beta^{home}_{i,t+1}\right)'$ and $\boldsymbol{R}^{home}_{m,t} = \left(R^{home}_{m,t-1}, R^{home}_{m,t}, R^{home}_{m,t+1}\right)'$, to account for non-synchronous trading across markets in different time zones.

We next estimate the unrestricted model by adding daily index returns of a host market as additional regressors and obtain the new R-square, R^2_{ur}, in the unrestricted model:

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \boldsymbol{\beta}'^{host}_{i,t} \boldsymbol{R}^{host}_{m,t} + \xi_{i,t}, \tag{3.3}$$

where $\boldsymbol{\beta}^{host}_{i,t}$ is a 3×1 vector of asset i's loadings on index returns of the host market, and $\boldsymbol{R}^{host}_{m,t}$ is a 3×1 vector of index returns of the host market from $t-1$ to $t+1$, with $\boldsymbol{\beta}^{host}_{i,t} = \left(\beta^{host}_{i,t-1}, \beta^{host}_{i,t}, \beta^{host}_{i,t+1}\right)'$ and $\boldsymbol{R}^{host}_{m,t} = \left(R^{host}_{m,t-1}, R^{host}_{m,t}, R^{host}_{m,t+1}\right)'$.

We calculate the incremental information provided by the host market j regarding the price of stock i in Year T as the following:

$$\text{Information factor}_{i,j,T} = \frac{\left(R^2_{ur} - R^2_r\right)/3}{\left(1 - R^2_{ur}\right)/\left(n-6\right)} \tag{3.4}$$

where n is the number of daily returns used in both restricted and unrestricted models.

We calculate the *difference in information factor* as the difference between the information factor of a host market and the average information factor of all host markets. That is, for each cross-listed firm i in host market j and year T, (Information factor$_{i,j,T}$)$-$ ($\bar{X}$), where $\bar{X}$= Average of Information factor$_{i,HT^n_j,T}$, for cross-listed firm i listing its shares in host market j, where $j = 1, 2, ..., n$. We expect that a host market attracts more trading from rival host markets if it provides more incremental information to the stock price than the rival host markets.

To construct the information factor, we first obtain from Datastream the domestic market daily stock prices for each cross-listed share and daily market index for both home and host markets. All data series are converted to the U.S. dollar as a common currency. We adjust the host market share price by dividing the ADR bundle ratio. For each stock, we first calculate daily stock returns and corresponding market index returns, and then we run a pair of time series regressions for each cross-listing in every sample year based on data from the past 48 months. If the available data is less than 36 months, we exclude the firm-year observation from our sample to prevent biased estimates.

3.1.3 Trading cost

Eun and Sabherwal (2003) and *Pulatkonak and Sofianos* (1999) suggest that relative trading cost of the host market, compared to the domestic market, influences the distribution of trading volume between the U.S. (host) and its domestic market. We expect that the volume ratio of a host market is inversely associated with the relative bid-ask spread of that host market compared to its rival host markets. Following *Eun and Sabherwal* (2003) and *Foerster and Karolyi* (1998), we define trading cost as the ratio of bid-ask spread to bid-ask midpoint. We first calculate the market-level average trading cost for all cross-listings in a host market. In our regression analysis, we include the *difference in trading cost*, which is calculated as the difference in average market-level trading cost between a host market and its rival host market(s).

3.1.4 Firm age

Usually, firms with longer presence in a foreign market are better known to foreign investors and thus may attract a higher volume ratio in a foreign host market. *Eun and Sabherwal* (2003) shows a positive association between the years listed in the U.S. (the host) market and the trading volume in the host market. As a proxy for

firm age, we use the number of years since each cross-listed stock's first trading data in the host market was recorded on Datastream. We further calculate the *difference in firm age* by subtracting the average firm age in all host markets from the firm age in a host market.

3.1.5 Time zone

The geographic proximity of a host market to its counterpart home market may affect information flow between the markets and thus sway the distribution of trading volume (*Davis and Henderson*, 2008; *Pirinsky and Wang*, 2006; *Sarkissian and Schill*, 2004; *Coval and Moskowitz*, 2001; *Pulatkonak and Sofianos*, 1999). When a host market is located further away from its counterpart home market, as measured by time zone difference, information flow is hindered. We expect to see a decreasing volume ratio for a host market when it is located further away in time zone from the cross-listing's home market, relative to rival host markets. Investors in host markets far away are at an information disadvantage and thus shy away from trading based on stale information.

We obtain the standard time zone for each stock exchange from WorldClock's website.[1] For example, Frankfurt is located in time zone "UTC/GMT+1" and is recorded as "+1"; New York is located in time zone "UTC/GMT−5" and is recorded as "−5". We then calculate the difference between the time zone of the host market and its counterpart home market and define time zone difference as the integer portion of the ratio of the difference over 3. In the above example, the time zone difference is 2 $(= (+1 - (-5))/3)$. To examine the competitiveness between rival host markets, we further calculate the *difference in time zone* by subtracting the average time zone difference of its rival host market(s) from the time zone difference of a host market.

[1]The URL is `www.timeanddate.com/worldclock/`.

3.1.6 Legal protection for shareholders

Previous studies have shown that the fraction of trading in the U.S. (host market) is higher due to the benefit of better legal protection for shareholders (*Halling et al.*, 2008; *Pulatkonak and Sofianos*, 1999). Investors prefer to become company shareholders in a country that provides stronger legal protection. Accordingly, we expect that host markets with better legal protection have higher trading volume ratio than rival host markets.

Our first measure of legal protection for shareholders is the *anti-director rights index* from *La Porta et al.* (1998), which has been used in numerous articles. The index is the sum of six anti-director rights scores ranging from 0 for Belgium to 5 for Canada and the U.S. A higher index value indicates better legal protection for minority shareholders. Our second measure is the information disclosure requirement of each financial market, the *disclosure index* from *La Porta et al.* (2006), which is estimated from the average of six variables of information disclosure.[2] The last measure is the legal protection of minority shareholders against expropriation by corporate insiders, the *anti-self-dealing index* from *Djankov et al.* (2008), which is the average of the *ex ante* and *ex post* controls of self-dealing for each country.[3] In our regression models, we use the difference in the above-mentioned indicators between a host market and the average level of all host markets. We expect a positive association between the volume ratio of a host market and its aforementioned three measures of legal protection for shareholders.

[2]The *disclosure index*, ranging from 0 to 1, is constructed from six factors: prospectus, compensation of directors and key officers, ownership structure, inside ownership, contracts outside the ordinary course of business, and transitions between he issuer and its directors, officers, and/or large shareholders. A higher index value indicates a more extensive disclosure requirement (*La Porta et al.*, 2006).

[3]The *anti-self-dealing index* is constructed based on laws and regulations applicable to publicly traded firms in May 2003, and summarizes the protection of minority shareholders in the corporate decision-making process (*Djankov et al.*, 2008).

3.1.7 Country/market development

Previous studies suggest that an advanced financial market in the home country will help domestic investors to acquire foreign assets and simultaneously facilitate foreign investors to acquire domestic assets (*Lane and Milesi-Ferretti*, 2008; *Martin and Rey*, 2006). *Halling et al.* (2008) shows that the fraction of trading in the U.S. (host market) is negatively related to financial development in the counterpart home market. We measure *financial development* as the ratio of the sum of stock market capitalization and private credit to GDP (*Beck et al.*, 2000). We expect that one country's volume ratio of a cross-listed firm is positively correlated to financial development in that market. In the regression analysis, we employ the difference in financial development between a host market and the average level of all host markets.

Some studies find different trading patterns for stock markets from developing and developed countries (See, for example, *Halling et al.*, 2008; *Lane and Milesi-Ferretti*, 2008). It is expected that a developed country will extract more foreign trading if the competing host markets are developing markets. Certain market characteristics may better facilitate trading activities. For example, *Claessens et al.* (2002) finds that developed countries with higher per capita income, better macroeconomic policies, better legal protection and more advanced financial markets tend to attract more trading activity. Therefore, we control for *economic development* of the host market using country classifications from World Bank. Development indicator equals 1 if the host country is a developing economy and 0 otherwise.

3.1.8 Market liquidity

Previous research demonstrates that illiquidity is a source of risk that is priced by the market (*Amihud*, 2002; *Pástor and Stambaugh*, 2003; *Acharya and Pedersen*, 2005). *Roll et al.* (2007) finds that liquidity facilitates trading and arbitrage opportunities. We expect that the host market with a higher level of market depth and

breadth will attract more foreign trading. We measure stock market liquidity using stock market turnover and the ratio of stock market value (calculated as total shares traded on the stock market exchange to GDP). The data are obtained from *Beck et al.* (2009), which was updated in 2012 and is available on the World Bank website.

3.1.9 Market correlation

Foreign markets with low correlation with the cross-listed firm's domestic market appeal to arbitrageurs due to the benefit of greater diversification. *Berger et al.* (2011) studies frontier markets (small, illiquid, developing markets) and find that frontier markets have low integration with the world market and thereby offer significant diversification benefits. This implies that, other things being equal, foreign trading volume should be higher in the market with a lower correlation to its domestic market. For each sample cross-listed share, we construct the *market correlation* as the correlation coefficient between a home market's daily market index returns and those of its counterpart host market.

3.1.10 Legal origin

La Porta et al. (1998) documents the influence of a country's legal origin on many aspects of economic development through financial development, government regulation and property rights, and contract enforcement, among others. Firms in common law countries typically have better minority shareholder protection. *La Porta et al.* (2008) summarizes that legal origin influences different aspects of investor protection such as ownership dispersion, dividend payout, and creditor rights. The results are largely in favor of a common law system, since it is associated with better investor protection and a more developed financial market. *Djankov et al.* (2008) shows that a common law system is associated with more efficient debt enforcement in insolvency cases. We create a set of indicator variables based on a country's legal origin from one

of the four main legal families – English common law, German law, French civil-law or Scandinavian law. The legal origin data is available from *La Porta et al.* (1998).

3.2 Sample construction and data description

3.2.1 Initial sample construction

To construct our dataset of cross-listings with multiple host markets, we begin by compiling a complete list of global cross-listings on Datastream at any time between January 1, 1990, and December 31, 2012. Our dataset of cross-listings only includes firms that list both on its domestic and at least one foreign stock exchange, subject to the following filtering process:

1. We exclude firms that only list aboard but not in their domestic country;

2. We limit sample listings to ordinary shares and depositary receipts and exclude preferred shares, warrants, derivatives, and indices.

3. We exclude financial services (SIC 4000-4999) and utilities (SIC 6000-6999) firms from our sample (*Sarkissian and Schill*, 2009).

4. We exclude firms originating from tax havens, such as Bermuda, the Cayman Islands, Jersey, or the Netherlands Antilles because those firms do not have operations in those registered "domestic" locations.

5. We exclude stocks listed on over-the-counter (OTC) markets from our analysis.

6. Germany is excluded from our sample because we are unable to separate shares traded in Germany's regulated stock exchange from over 5,000 open market shares. Palestine is excluded from the sample due to missing country level data from external sources.

7. If cross-listed firms trade on more than one exchange within a country, volumes and prices are taken from the country's primary exchange.

8. We require non-zero daily stock price and available trading volume data on both the home and host markets.

After the filtering process, our initial sample includes 934 cross-listed companies with 1,118 foreign listings.

Because our sample is constructed directly from Datastream and includes all historical listings, such as delisted firms, it provides a complete chronology of cross-listings on major stock exchanges. Our sample is also free from the potential biases caused by sampling or identification difficulties encountered in previous studies. For example, *Sarkissian and Schill* (2009) and *Wang and Zhou* (2014) both construct their datasets of foreign equity listings by soliciting from every stock exchange for all foreign shares listed on their exchange as of December 1998 and December 2010, respectively. Both lists are comprehensive and extend previous literature to include foreign shares listed on all major stock exchanges. However, a major drawback of their approaches is that the constructed datasets are static and do not capture the complete picture of historical listings, such as delisted or merged foreign stocks. Besides, previous studies started the process by collecting a list of company names and listing dates, which is inaccurate in many cases and is difficult to match with major databases, such as CRSP and Datastream. Our dataset is free from such difficulties because our dataset is constructed directly from Datastream.

3.2.2 Distribution of the initial sample of global cross-listings

In Panel A of Table 3.1, we present the distribution of a number of cross-listings grouped by home and host markets. Sample cross-listings represent 61 home markets and 50 host markets. Among them, there are 31 developed countries and 19 developing countries. Overall, most companies cross-list their shares in developed

markets. Out of 1,118 foreign cross-listings, 987 (88% of the sample) cross-listings are listed in developed host markets while 131 cross-listings (12%) favor developing host markets. In particular, the U.S. is the largest host country with 302 (27.01% of the sample) foreign cross-listings, followed by the U.K. with 229 cross-listings (20.48% of the sample). Hong Kong and Canada develop into popular foreign listing venues and attract 79 (7.07%) and 70 (6.26%) cross-listings, respectively. However, both markets are less diversified in terms of originating home markets. Sixty-four out of 79 cross-listings in Hong Kong' are originated from Mainland China, and half of the cross-listings in Canada are originated from Australia. The domestic markets from which most cross-listings originate are Canada (171), the U.S. (155), Australia (110), China (82) and the U.K. (81).

Panel B of Table 3.1 summarizes the number of cross-listings grouped by home markets. In our sample, 72.81% (= 814/1,118) of cross-listings list only on one host market and 27.19% (304) of the sample have multiple cross-listing destinations. Among multiple cross-listings, 10.38% (= 166/1,118), 6.44% (= 72/1,118), 1.79% (= 20/1,118), 2.24% (= 25/1,118), 1.07% (= 12/1,118) and 0.81% (= 9/1,118) of the sample cross-list on 2, 3, 4, 5, 6 and 9 foreign markets, respectively.

Table 3.1: Distribution of global cross-listings

Panel A: Distribution of cross-listings by host and home markets

			Host market																																															
Home market	# Firms	# Listings	Australia	Austria	Bahrain	Belgium	Botswana	Brazil	Canada	Chile	China	Colombia	Denmark	Egypt	Finland	France	Ghana	Hong Kong	Hungary	Iceland	Ireland	Israel	Italy	Japan	South Korea	Kuwait	Luxembourg	Malaysia	Mexico	Morocco	Namibia	Netherlands	New Zealand	Norway	Peru	Poland	Portugal	Romania	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Tanzania	Turkey	Uganda	UAE	U.K.	U.S.	Zambia	Zimbabwe
Argentina	5	6																																													1	5		
Australia	99	110					3		34									1													4		14						1	6			1						37	9		
Austria	4	4																																		2		1								1						
Bahrain	1	1																																													1			
Belgium	2	2																				1																										1		
Brazil	22	29																2											2												4									21		
Bulgaria	1	1																																		1																
Canada	162	171				2	3					3					1														1		1	2	10					6		3	1						24	114		
Chile	5	5																																							1									4		
China	67	82																64																					9										2	7		
Colombia	1	2							1																																									1		
Croatia	1	1																																															1			
Czech	1	1																																		1																
Denmark	3	3																		1																														2		
Egypt	1	1																								1																										
Estonia	1	1																																															1			
Finland	5	6																	1																							3							2			
France	18	26							1										1				11													1		2					3						2	5		
Hong Kong	31	33	1						1		1														1			1											13					10					1	4		
Hungary	1	2																																		1													1			
Iceland	1	1											1																																							
India	19	20																																					1										14	5		
Indonesia	2	2																																					1										1			
Ireland	37	40																																															36	4		
Israel	28	28																																															2	26		
Italy	6	8																	1													3									1								1	2		
Japan	14	19							1																														2				1	1					3	11		
Kenya	4	5																																											3		1		1			
South Korea	7	9																						1															2										2	4		
Kuwait	1	1																																														1				
Lithuania	1	1																																		1																
Luxembourg	2	2				2																																														
Malaysia	4	4											1																										2										1			
Mexico	27	37																																							8								8	21		
Morocco	1	1														1																																				
Netherlands	13	15																					3											1				1					2						1	7		
New Zealand	17	17	16																																				1													
Nigeria	1	1																																						1												
Norway	25	28														1																			1							22							3	1		
Oman	1	1			1																																															
Peru	2	2																																															1	1		
Philippines	1	2																																																2		
Poland	3	3																																															3			
Qatar	1	2																																														1	1			
Russia	23	28																																															25	3		
Singapore	9	9																3																										6								
Slovakia	1	1																																		1																
Slovenia	1	1																																		1																
South Africa	22	35				4	1									2	2														6												1	1					11	5	1	1
Spain	8	17						1											1				1	1					1			1			1		2												4	4		
Sweden	11	13				1			1						1																	1		3									2						2	2		
Switzerland	9	9				1								1		1							1																1	1										3		
Taiwan	17	20																									1																						14	5		
Thailand	3	3																																										3								
Tunisia	1	1																												1																						
Turkey	3	3																																															2	1		
UAE	3	3																								3																										
United Kingdom	71	81	1	1		1	3		14				1			5		1			5	1										4	1	3	1	1				12		3	1							22		
United States	100	155		1		8			17	9		6				4		8				7	1	2					1			13			21			7				3	28						19			
Zambia	1	1																																															1			
Zimbabwe	2	2																																						2												
Total	934	1,118	18	2	1	19	10	1	70	9	1	9	3	1	1	14	3	79	4	1	5	9	17	4	1	4	1	1	4	1	11	22	16	9	34	10	2	11	33	28	14	34	40	21	3	1	1	2	229	302	1	1

Table 3.1 (Cont'd)

Panel B: Number of foreign cross-listings by home markets

		Number of a firm's foreign cross-listings						
Home market	Total	1	2	3	4	5	6	9
Argentina	6	4	2					
Australia	110	88	22					
Austria	4	4						
Bahrain	1	1						
Belgium	2	2						
Brazil	29	19	2	3		5		
Bulgaria	1	1						
Canada	171	153	18					
Chile	5	5						
China	82	57	10	15				
Colombia	2		2					
Croatia	1	1						
Czech	1	1						
Denmark	3	3						
Egypt	1	1						
Estonia	1	1						
Finland	6	4	2					
France	26	12	8	6				
Hong Kong	33	29	4					
Hungary	2		2					
Iceland	1	1						
India	20	18	2					
Indonesia	2	2						
Ireland	40	35	2	3				
Israel	28	28						
Italy	8	4	4					
Japan	19	10	6	3				
Kenya	5	3	2					
South Korea	9	6		3				
Kuwait	1	1						
Lithuania	1	1						
Luxembourg	2	2						
Malaysia	4	4						
Mexico	37	21	6	6	4			
Morocco	1	1						
Netherlands	15	11	4					
New Zealand	17	17						
Nigeria	1	1						
Norway	28	23	2	3				
Oman	1	1						
Peru	2	2						
Philippines	2		2					
Poland	3	3						
Qatar	2		2					
Russia	28	19	6	3				
Singapore	9	9						
Slovakia	1	1						
Slovenia	1	1						
South Africa	35	16	6	3	4		6	
Spain	17	6	2					9
Sweden	13	10		3				
Switzerland	9	9						
Taiwan	20	14	6					
Thailand	3	3						
Tunisia	1	1						
Turkey	3	3						
UAE	3	3						
United Kingdom	81	63	12	6				
United States	155	72	30	15	12	20	6	
Zambia	1	1						
Zimbabwe	2	2						
Total	1,118	814	166	72	20	25	12	9

Table 3.1 (Cont'd)

Panel C: Time-series summary of cross-listings by host markets

		Host Market																																																	
Year	# of Cross-Listings	Australia	Austria	Bahrain	Belgium	Botswana	Brazil	Canada	Chile	China	Colombia	Denmark	Egypt	Finland	France	Ghana	Hong Kong	Hungary	Iceland	Ireland	Israel	Italy	Japan	South Korea	Kuwait	Luxembourg	Malaysia	Mexico	Morocco	Namibia	Netherlands	New Zealand	Norway	Peru	Poland	Portugal	Romania	Singapore	South Africa	Spain	Sweden	Switzerland	Taiwan	Tanzania	Turkey	Uganda	UAE	United Kingdom	United States	Zambia	Zimbabwe
1990	48				10							1											2								3								1										31		
1991	68	2			10			2				1			8								2								3	1						1	2										36		
1992	104	1			10			2				1			8								2								3	1						1	2			32							41		
1993	114	1			10			1				1			8		3						2								3	1						1	2			32							49		
1994	129	1			14			1				1			8		6						2								3	1						1	2			32							57		
1995	160	1			14							1			8		11						2								3	1						3	2			32						20	62		
1996	184	2			14			2				1			10		13						2								6	1		1				5	2		1	32						19	73		
1997	197	3			15			2				1			10		16						2								12	2						5	3		1	32						2	91		
1998	220	3			15			2				1			10		17						2								12	2		1				5	4	1	3	32						3	107		
1999	258	5			17			4				1			10		18						2								15	2	1	8				9	5	1	5	32						3	120		
2000	323	7			18			6				1			10		25			2		1	2							2	14	2	1	13				10	5	2	5	32						15	150		
2001	395	11			19			6				1			11		29			3		1	2			1				4	15	2	2	14				12	5	4	5	32	1					47	168		
2002	432	12			19			5				1		1	11		31			2	1	1	2							4	13	4	2	17				13	5	7	5	34	1					53	188		
2003	473	12			19			7				1		1	11		33			1	1	1	2		1					4	9	4	2	21				13	5	9	7	35	3				1	61	209		
2004	507	12			19			8				2		1	11		34			1	2	2	2		2					4	9	7	2	20	1	1		13	6	10	7	35	3				1	73	219		
2005	561	12	1		19	1		15				2		1	11	1	34			1	2	2	3		4					5	12	8	4	18	2	1		12	7	11	7	36	3				2	90	234		
2006	642	12	1	1	18	4		22				2		1	11	2	36		1	1	4	9	4		4			1		4	14	11	4	18	3	1		13	11	11	8	36	3				2	123	246		
2007	729	13	1	1	18	5	1	31				2		1	12	1	45		1	2	4	17	4		4			1		4	15	10	4	20	4	2		16	15	13	8	37	3				2	155	257		
2008	747	13	1		18	5	1	37				2	1	1	13	3	49		1	2	4	17	4	1	4		1	2		4	14	10	4	12	5	2		15	19	13	10	38	3				2	153	263		
2009	803	14	1	1	18	5	1	40			1	3	1	1	13	2	54		1	2	5	17	4	1	4		1	3		9	12	11	7	14	5	2		13	25	13	27	36	8	1			2	154	270		1
2010	829	14	1		18	6	1	46			3	3		1	12	3	61		1	2	7	17	4	1	4		1	3	1	9	11	11	7	18	4	2		24	24	13	31	32	14	1	1		2	141	273		1
2011	854	15	2		18	8	1	53			8	3		1	7	3	65	2	1	2	7	17	4	1	4		1	4	1	10	10	13	7	19	6			27	25	11	31	28	20	3	1		2	138	273	1	1
2012	872	17	2		17	10		50	9	1	6	3		1	4	2	76	4	1	3	7	17	3	1	4		1	4	1	9	12	13	4	15	9	1	11	26	24	11	32	23	20	1	1	1	2	138	273	1	1

Panel C of Table 3.1 reports the evolution of cross-listing programs over the sample period. Consistent with findings in previous studies (See, for example, *Halling et al.*, 2008), the number of cross-listings increased from 48 global cross-listings in 1990 to 872 in 2012. However, the growth rate of cross-listings fluctuates over time. It peaked during earlier years 1991-1992 (41.67% in 1991 and 52.94% in 1992) and stayed at a low ebb in recent years, e.g. 2008 (2.47%) and 2010-2012 (around 3%). The growth of foreign listings in the U.K. and the U.S. have stagnated since 2010.

Panel C also demonstrates the completeness of our dataset. At the end of 2012, there were 872 global cross-listings. However, our dataset includes a total of $1,118$ cross-listings, including 246 cross-listings that no longer actively traded. In other words, if one contacted stock exchanges to obtain a list of foreign shares as of the end of 2012, these 246 cross-listings wouldn't be included.

Our sample also confirms the declining importance of the U.S. in attracting foreign cross-listings (See, for example, *Wang and Zhou*, 2014; *Sarkissian and Schill*, 2009). In 1990, cross-listings in the U.S. accounted for 65% of global cross-listings. Although the U.S. continues to lead all countries in the number of cross-listings, its weight has gradually declined, from 65% in 1990 to 38% in 1995, 46% in 2000, 42% in 2005, 33% in 2010, and 31% in 2012. The literature has contributed such decline to both the emergence of other cross-listing destinations (e.g., Hong Kong, Singapore and Canada) and the passage of the SarbanesOxley Act (SOX) (See, for example, *Fernandes et al.*, 2010; *Marosi and Massoud*, 2008; *Doidge et al.*, 2010).

3.2.3 Sample of cross-listings with multiple host markets and distribution of trading volume

When we examine the research question that the distribution of trading volume across multiple competing host markets, we use our multi-cross-listing subsample, which includes 120 companies with 304 home-host paired cross-listings. The unique-

ness of this sub-dataset is that every sample firm cross-lists in two or more foreign markets simultaneously, which offers a unique opportunity to analyze the distribution of trading volume and competition for order flows among host markets.

We first calculate the trading volume ratio in every host market and document the distribution of order flows among foreign markets. For each cross-listed firm, we calculate volume ratio as the proportion of host market i's trading volume over the total trading volume in all host markets:

$$\frac{\text{Vol}_{HT,i}}{\sum_{k=1}^{n} \text{Vol}_{HT}}, \tag{3.5}$$

where $i = 1, 2, ..., n$, and n is the total number of host markets for each cross-listed firm.

To check robustness, we use two different measures of trading volume to calculate volume ratio. First, we measure trading volume as the total number of shares traded, that is, the share trading volume. We collect the daily number of shares traded for all sample firms in both home and host markets from Datastream for the sample period January 1990 to December 2012.[4] We also collect the bundle ratios from Worldscope and ADR lists from Bank of New York, Citi Bank, and J.P. Morgan Chase Bank. We adjust the trading volume by dividing by the bundle ratios.[5]

Second, We measure trading volume as the total value of traded shares, calculated as the daily number of shares traded in every foreign market times the closing price of that stock in the respective foreign market, converted to U.S. dollars. As pointed out in *Halling et al.* (2011), the benefit of converting all currencies to the U.S. dollar

[4]We use datatype "VO" in Datastream which shows the number of shares traded for a stock on a particular time frequency. The figure is expressed in thousands. Daily figures are adjusted for capital changes. For stocks that are traded on more than one exchange within a country, default volumes are taken from the primary exchange of that country.

[5]ADR Exchange Ratio represents the relationship between the American Depositary Receipt and the common share represented by the ADR. For example, an ADR ratio of 1:5 (or 0.2) represents that one ADR is equivalent to five outstanding shares.

is that it automatically adjusts for any ADR ratio.[6] For brevity purpose, we report only the results based on the dollar volume ratio. The results from the share volume ratio are quantitatively similar. Table 3.2 reports the trading volume distribution of firms with multiple cross-listings.

[6]We cross check with data type "VA" in Datastream which shows the value of all trades for a stock on a particular day. The figure is expressed in thousands, except for Korean and Indonesian securities where the value is expressed in millions. Daily figures are adjusted for capital changes.

Table 3.2: Trading volume distribution of global cross-listings with multiple host markets.

This table presents summary statistics on trading volume ratio across home and host pairs as well as over time. The sample is restricted to 120 companies that lists on multiple host markets, including a total of 304 pairs of home-host cross-listings. Panel A reports the average trading volume ratio grouped by home and host markets and Panel B presents time-series summary of trading volume ratio grouped by host market.

Panel A: Average trading volume ratios grouped by home and host markets

	Host Market																										
Home Country	Belgium	Botswana	Brazil	Canada	Chile	Colombia	Finland	France	Ghana	Hong Kong	Hungary	Ireland	Italy	Japan	Mexico	Namibia	Netherlands	Peru	Poland	Romania	Singapore	South Africa	Spain	Sweden	Switzerland	UAE	U.K.	U.S.	Zambia
Argentina																											4.20	95.80	
Australia		16.31		19.83												22.84						11.75			9.93		83.42	91.38	
Brazil										0.48													0.30					99.81	
Canada	1.68								0.03									55.26				31.30					53.45	83.68	
China										80.82											0.89						2.02	19.42	
Colombia				0.24																								99.76	
France											22.09		15.40												30.32		81.16	99.22	
Hong Kong																					0.35							99.65	
Hungary																			26.06								73.94		
India																											2.86	97.14	
Ireland																											59.63	40.37	
Italy																	1.00											99.00	
Japan				0.09																	1.54						30.65	74.61	
South Korea														1.52							0.21							98.49	
Mexico																							0.22				7.23	99.26	
Netherlands													0.17															99.83	
Norway								21.11																26.31			78.89	73.69	
Qatar																										28.75	71.25		
Russian Federation																											3.44	96.56	
South Africa	10.35							11.00	0.08							63.13									7.08		0.62	84.95	36.87
Spain			0.19								0.02		0.87	13.04			1.30	1.34									17.60	87.33	
Sweden							0.02																				0.01	99.98	
Taiwan																											8.23	91.77	
United Kingdom	3.20	19.79		40.76				7.43				0.22						50.65				76.42		57.88				65.23	
United States	33.13				23.48	20.96		35.93		10.05				33.99	57.12		21.73	22.12		42.78				38.04	66.87		19.15		
Sample average	19.05	17.86	0.19	23.34	23.48	20.96	0.02	15.23	0.07	74.95	6.26	0.22	8.37	15.79	57.12	32.92	12.97	20.21	26.06	42.78	0.76	43.11	0.27	46.41	49.96	28.75	46.12	70.48	36.87

Panel B: Time-series summary of trading volume ratio by host market

	Host Market																												
Year	Belgium	Botswana	Brazil	Canada	Chile	Colombia	Finland	France	Ghana	Hong Kong	Hungary	Ireland	Italy	Japan	Mexico	Namibia	Netherlands	Peru	Poland	Romania	Singapore	South Africa	Spain	Sweden	Switzerland	UAE	U.K.	U.S.	Zambia
1990	42.57													87.16			38.37											63.99	
1991	39.65			0.31				32.56						56.49			34.19											57.86	
1992	33.04			0.19				22.27						53.01			28.94								51.93			67.73	
1993	32.54			0.65				18.50		80.94				47.22			22.97								50.87			73.76	
1994	32.87			0.78				14.89		68.00				51.62			16.46								48.15			71.38	
1995	30.66							18.77		66.16				6.33			21.94								57.21		44.51	68.52	
1996	25.03							19.32		79.24				7.54			23.35								61.05		53.51	67.04	
1997	24.50							27.16		84.11				5.62			15.09					99.46			60.90		77.46	66.55	
1998	22.61							27.27		55.21				6.37			17.10					97.19			59.73			69.23	
1999	20.42			0.06				18.25		79.17				6.23			17.59	1.31				98.92		83.94	60.44			62.29	
2000	19.83			0.04				11.79		78.73		0.28		4.22			9.65	6.09				96.58		76.75	62.38		97.54	63.69	
2001	17.11			0.04				13.17		68.62		0.16		5.06			11.19	7.91				98.66	0.19	67.47	55.82		40.70	68.47	
2002	12.52			0.07			0.00	10.43		75.27		0.17		10.29			2.69	15.43				99.07	0.66	58.20	54.75		31.08	72.51	
2003	11.13			0.04			0.02	9.39		76.33				6.22			2.68	12.20				98.80	0.64	49.19	51.15		28.56	71.78	
2004	11.52			0.97			0.02	11.87		80.60				6.39			8.79	9.83	38.89			95.58	0.36	45.60	46.31		25.05	72.89	
2005	12.87	30.79		1.76			0.02	9.39	0.00	82.99				13.50			10.50	2.67	8.65			59.19	0.23	50.98	45.67		36.33	72.76	
2006	13.55	32.10		25.01			0.03	8.64	0.01	83.29			7.80	4.01			8.44	1.99	16.89			50.53	0.15	51.93	45.26	89.17	38.13	75.04	
2007	12.95	21.76	0.37	36.28			0.03	9.56	0.00	74.57			14.94	2.19			5.14	1.11	35.86			38.95	0.07	52.01	40.51		39.08	76.88	
2008	7.90	23.19	0.18	26.55			0.02	7.80	0.00	68.06			15.18	2.65			2.18	5.35	51.96			30.62	0.04	47.58	33.15	16.64	48.78	75.45	
2009	8.48	14.99	0.17	28.89			0.02	9.87	0.68	77.44			10.63	16.60	52.83	38.79	1.02	7.99	46.75			31.55	0.04	37.81	30.05		54.08	71.44	
2010	10.08	6.76	0.17	17.36			0.01	14.47	0.02	78.14			1.84	5.05	62.06	16.61	3.56	38.03	56.11		1.66	28.45	0.03	34.83	39.61	1.76	64.12	68.45	
2011	9.55	7.49	0.06	25.95		20.71	0.02	10.80	0.00	71.22	41.40		3.06	9.95	85.94	30.79	2.60	42.19	39.63		0.56	32.71	0.36	34.06	35.58	0.98	58.97	67.79	43.20
2012	12.28	4.82		26.26	23.48	21.94	0.01	46.33	0.00	72.86	0.98		3.01	7.45		62.37	2.03	39.04	67.85	42.78	0.19	44.61	0.54	35.77	35.37		50.53	64.44	5.19

Panel A of Table 3.2 summarizes the cross-sectional distribution of the volume ratio grouped by home and host markets. Overall, the U.S. leads other host markets in attracting foreign order flows. On average, the U.S. accounts for 70.48% of total trading volume of a cross-listed firm while its rival host markets account for 29.52% of the total trading volume. The U.S. attracts cross-listings from 22 countries. Of those, firms from 15 countries observe over 90% of their total foreign trading is executed in the U.S. Trailing the U.S., most competitive host markets are Switzerland (49.96%), Sweden (46.41%), the U.K. (46.12%), South Africa (43.11%) and Romania (42.78%). We note that Switzerland, Sweden and South Africa only attract foreign firms from three home countries. At the other end of the spectrum, some host markets are uncompetitive in attracting foreign trading. They include Finland (0.02%), Ghana (0.07%), Brazil (0.19%), Italy (0.22%) and Spain (0.27%).

The 20-year time span in our dataset enables us to examine the trading volume ratio over time in each host market. Panel B of Table 3.2 provides information on the average volume ratio by host country for each calendar year. It reveals that market competitiveness evolves over time. Some host markets, such as Hong Kong, the U.S., the U.K., South Africa, Sweden, and Switzerland, maintain high levels of foreign trading volume ratio over time. Hong Kong attracts a significant proportion of a firm's foreign trading, ranging from 55.21% in 1998 to 83.29% in 2006. The U.S. attracts a large proportion as well, ranging from 57.86% in 1991 to 76.88% in 2007. At the other extreme, countries such as Spain, Ireland, Ghana, Finland, and Brazil account for less than 1% of the foreign trading of cross-listed firms. The market competitiveness of countries such as Japan, Netherland and Belgium have declined over time. For example, the Netherlands attracted 38.37% of foreign trading in 1990 and its share dropped to about 2% in 2012. On the other hand, Canada has become a more popular trading venue in recent years. It attracted less than 1% of foreign trading before 2005, but its market share increased to more than 25% after

2006. Likewise, Peru's proportion of foreign trading increased from less than 10% before 2001 to between 38% and 42.19% in recent years. The findings on this table are consistent with the one from Panel C of Table 3.1 in that the U.S. leads other countries as one of the most popular and most competitive host markets. The decline in the U.S. from 76.88% in 2007 to 64.44% in 2012 coincides with the passage of the SOX in 2007.

3.2.4 Summary statistics of cross-listings with multiple host markets

Our main empirical analysis examines the impacts of firm- and market-level variables on the trading volume ratio of multiple cross-listed firms. Our sample in this part of the study consists of 304 cross-listings with multiple host markets. Panel A of Table 3.3 summarizes the mean values of firm- and market-level variables grouped by host markets. Mean values are calculated first by averaging the variables over time for each cross-listing and then averaging within each host market. We report the summary statistics for 29 host markets. We first report the average trading volume ratio calculated based on both value traded and the number of shares. The statistics are very close. The average volume ratio across all host markets is 43.37% for dollar volume ratio and 43.34% for share volume ratio.[7] There is a substantial variation in volume ratio across host markets.

We also observe substantial variations across 18 host markets in the information factors estimated from Equation 4.10, which measures the incremental information contribution of a host market in addition to that of the home market.[8] The cross-sectional average of all host markets is 4.50. South Africa and Brazil provide the most incremental information in price discovery of cross-listed stocks, by having the highest information factor, 33.89 and 11.49, respectively. Canada (5.67), the U.K.

[7]The ratio is below 50% because our sample includes firms with more than 1 foreign cross-listing.

[8]We only calculated the information factor for 18 markets because insufficient data limits our ability to estimate the information factor for other markets.

(5.51), the United State (4.52) and Italy (4.53) also provide relatively high level of information in price discovery. Hong Kong (1.42) ranks the last in information factor. The average trading cost is 0.04 scross all sample markets. The U.S. has the lowest average trading cost, which is rounded to 0. Hong Kong, Singapore and Sweden also have low trading cost at 0.01. On the other hand, Finland (0.13), Hungary (0.16), Netherland (0.11), Romania (0.14), United Arab Emirates (0.10) and Zambia (0.10) have relatively higher trading cost in our sample. We observe a negative correlation between trading cost and volume ratio, that is, countries with high trading cost tend to have low volume ratios. On average, our sample firms have listed in a host market for 10.51 years at the end of 2012 or when the cross-listed shares were delisted. Cross-listings on the exchanges of developing host markets on average have a shorter listing history than those listed on exchanges of developed host markets. For example, the average listing history of foreign shares cross-listed in Chile, Colombia, Hungary, Romania, Singapore and Zambia is less than a year. On the other hand, developed countries, such as the U.S. (14.35 years), Switzerland (12.60 years), Ireland (13.00 years), France (12.15 years) and Belgium (14.64 years) have foreign firms listed longer than the average of the overall sample.

Table 3.3: Summary of firm and market characteristics.

This table reports summary statistics of firm and market characteristics for the sample of 304 cross-listings with multiple host markets in 29 host markets. Panel A reports the averages of firm and market characteristics in each host market. Panel B presents the correlation coefficients of the mean-differenced series of all characteristic variables. We generate the mean-differenced series as the difference between the value of each host market to the average value of its rival host markets, which is $X_i - \bar{X}$, where X_i is the market factor for host country i, and $\bar{X}$ is the mean value of X across all rival host markets.

Panel A: Firm and market characteristics (average at host market level)

	Firm characteristics					Market characteristics									
Host country	Dollar vol ratio (%)	Share vol ratio (%)	Info factor (Eqn. 4.10)	Trading cost	Firm age	Stk mkt turnover	Stk mkt value	Fin devlp	Econ devlp	Anti-dir -rights	Anti-self -dealing	Disclosure index	Time zone distance	Market correlation	Legal origin
Belgium	23.22	21.64	3.03	0.05	14.64	32.32	20.16	132.90	0.00	0.00	0.54	0.42	1.26	0.46	French/Civil
Botswana	19.03	18.71	3.42	0.10	2.82	3.48	0.80	52.55	1.00				−1.09	−0.06	English/Common
Brazil	0.19	0.06	11.49	0.06	2.00	76.92	38.03	113.92	1.00	3.00	0.29	0.25	−1.00	0.70	French/Civil
Canada	28.07	28.06	5.67	0.06	4.93	73.69	78.74	238.11	0.00	4.00	0.65	0.92	−3.33	0.55	English/Common
Chile	32.00	31.97			0.00				1.00	3.00	0.63	0.58	0.00	0.24	French/Civil
Colombia	22.73	22.47			0.33				1.00	1.00	0.58	0.42	0.00	−1.00	French/Civil
Finland	0.02	0.00	3.93	0.13	5.00	124.48	126.89	171.84	0.00	2.00	0.46	0.50	0.00	0.85	Scand./Civil
France	19.87	15.30	3.47	0.03	12.15	76.48	55.11	156.18	0.00	2.00	0.38	0.75	0.68	0.62	French/Civil
Ghana	0.06	0.18		0.02	3.31	5.18	0.36	24.22	1.00		0.73		0.18		English/Common
Hong Kong	66.66	75.75	1.42	0.01	7.76	88.46	335.30	556.90	0.00	4.00	0.96	0.92	1.06	0.38	English/Common
Hungary	15.65	15.66		0.16	0.33				0.00		0.20		0.00	0.75	German/Civil
Ireland	0.20	0.04			13.00	28.68	23.51	167.91	0.00	3.00	0.79	0.67	0.00	0.59	English/Common
Italy	15.59	15.28	4.53	0.04	2.85	153.02	55.20	136.68	0.00	0.00	0.39	0.67	0.00	0.93	French/Civil
Japan	19.55	16.09	2.09	0.04	9.85	81.68	66.05	269.55	0.00	3.00	0.48	0.75	2.54	0.36	German/Civil
Mexico	66.94	66.76			1.00	33.85	9.31	57.25	1.00	0.00	0.18	0.58	0.00	0.86	French/Civil
Namibia	32.31	31.63			2.36	3.11	0.21	53.41	1.00				−2.45	0.94	English/Common
Netherlands	20.16	19.66	3.45	0.11	10.08	114.89	121.56	241.47	0.00	2.00	0.21	0.50	0.78	0.59	French/Civil
Peru	27.66	27.50	2.63	0.05	4.53	7.75	2.72	58.96	1.00	2.00	0.41	0.33	−0.32	0.34	French/Civil
Poland	40.29	13.01	2.63	0.02	4.00	44.91	12.25	64.99	0.00		0.30		0.00	0.85	German/Civil
Romania	39.32	39.16		0.14	0.00				1.00		0.41		2.00	0.57	French/Civil
Singapore	0.83	0.42		0.01	0.89	91.12	129.77	264.09	0.00	3.00	1.00	1.00	0.00	0.51	English/Common
South Africa	44.62	32.81	33.89	0.03	4.35	57.12	103.31	354.79	1.00	4.00	0.81	0.83	0.04	0.72	English/Common
Spain	0.31	0.17	3.59	0.02	4.92	162.44	134.29	234.54	0.00	2.00	0.37	0.50	1.39	0.55	French/Civil
Sweden	46.50	17.83	2.77	0.01	5.07	120.00	121.49	208.52	0.00	2.00	0.34	0.58	0.71	0.69	Scand./Civil
Switzerland	55.42	53.39	3.19	0.05	12.60	91.01	197.91	374.03	0.00	1.00	0.27	0.67	1.34	0.42	German/Civil
UAE	27.14	27.98		0.10	5.75				0.00				0.00		English/Common
U.K.	36.60	34.57	5.51	0.04	7.30	153.76	178.94	292.87	0.00	4.00	0.93	0.83	−0.55	0.57	English/Common
U.S.	74.07	79.43	4.52	0.00	14.35	192.22	224.52	295.96	0.00	5.00	0.65	1.00	−2.07	0.38	English/Common
Zambia	24.20	27.04		0.10	0.50				1.00				0.00	0.39	English/Common
Sample average	43.37	43.34	4.50	0.04	10.51	111.33	145.60	267.32	0.10	2.81	0.57	0.74	−0.12	0.48	

Table 3.3 (Cont'd)

Panel B: Correlation coefficients of mean-differenced firm and market characteristics

Variable	Dollar vol ratio	Share vol ratio	Info factor dif	Trading cost dif	Firm age	Stk mkt turnover	Stk mkt value	Fin devlp dif	Econ devlp dif	Time zone dif	Anti-dir -rights dif	Anti-self -dealing dif	Disclosure index dif	Market correlation
Share volume ratio	0.949													
Info factor dif	0.129	0.026												
Trading cost dif	−0.292	−0.277	0.002											
Firm age dif	0.440	0.483	0.053	−0.106										
Stk mkt turnover dif	0.385	0.401	−0.155	−0.194	0.302									
Stk mkt value dif	0.524	0.566	−0.065	−0.139	0.327	0.636								
Fin development dif	0.454	0.483	0.093	−0.056	0.227	0.232	0.768							
Econ development dif	−0.159	−0.184	0.345	0.056	−0.245	−0.414	−0.371	−0.386						
Time zone dif	−0.261	−0.262	0.006	0.120	−0.236	−0.458	−0.115	0.275	−0.089					
Anti-dir-rights dif	0.492	0.547	0.025	−0.216	0.343	0.575	0.507	0.327	−0.060	−0.541				
Anti-self-dealing dif	0.183	0.244	0.061	−0.129	0.089	0.037	0.107	0.142	−0.048	0.127	0.399			
Disclosure dif	0.537	0.587	0.013	−0.252	0.315	0.596	0.622	0.548	−0.319	−0.345	0.858	0.331		
Market corr	−0.098	−0.115	0.067	0.132	−0.122	−0.104	−0.025	0.049	−0.125	0.189	−0.144	−0.015	−0.083	
Common law	0.355	0.399	0.045	−0.144	0.208	0.306	0.326	0.256	−0.116	−0.229	0.565	0.482	0.569	−0.093

The country-level characteristics summary shows that the U.S., the U.K., Canada, Hong Kong, Ireland, Singapore and South Africa offer a higher-than-average degree of legal protection for shareholders, as shown by the higher anti-director rights and anti-director dealing indices. Similarly, the U.S., the U.K., Canada, Hong Kong, France, Singapore and South Africa provide better information disclosure, as shown by a higher-than-average disclosure index. We measure distance between host and home markets as their time zone difference divided by 3. Canada (-3.33), Japan (2.54), Namibia (-2.45), the U.S. (-2.07) and Romania (2.00) tend to attract foreign firms from time zones far away. However, many countries, such as Chile, Colombia, Finland, Hungary, Ireland, Italy, Mexico, Poland, Singapore, United Arab Emirates and Zambia, have an average time zone difference of 0, which means they attract mainly foreign firms from neighbouring time zones. The average market correlation, measured as the correlation coefficient between daily market index returns of the home market and the counterpart host market, is 0.48, indicating a relatively high diversification benefits achieved from the cross-listings. We observe that Botswana and Colombia are negatively correlated with the cross-listed firms' home markets, -0.06 and -1, respectively. Namibia (0.94) has the highest positive correlation with its counterpart domestic countries. Finland (0.85), Mexico (0.86), Poland (0.85) and South Africa (0.72) have a higher-than-average positive correlation as well. On the other hand, Chile (0.24), Peru (0.34), Japan (0.36), the U.S. (0.38), Hong Kong (0.38) and Zambia (0.39) have a lower-than-average positive correlation with counterpart home countries. Among the 29 host countries, there are 11 developing countries and 18 developed countries. Among them, 12 countries have English common law origin and others are civil law countries.[9]

In terms of financial market development proxied by the sum of stock market

[9]French civil-law countries include Belgium, Brazil, Chile, Colombia, France, Italy, Mexico, Netherland, Peru, Romania and Spain. German civil law countries include Hungary, Japan, Poland and Switzerland. Scandinavian civil law countries include Finland and Sweden.

capitalization and private credit as a ratio of GDP, Hong Kong has the highest level of financial development at 556.90, followed by Switzerland (374.03). The U.S., the U.K., Japan and Singapore also have higher-than-average level of financial development, at 295.96, 292.87, 269.55 and 264.09, respectively. It is worth noticing that South Africa is the only developing country with a higher-than-average level of financial development at 354.79. Among the countries with valid data to calculate financial development, Ghana (24.22) has the lowest level of financial development. Other less-developed financial markets include Brazil (52.55), Mexico (57.25), Namibia (53.41) and Peru (58.96). Consistent with financial market development, we observe that in most cases, more-developed financial markets are more liquid. Our two proxies of stock market liquidity (stock market turnover and stock market value) reveal a similar pattern. On average, the sample stock market turnover is 111.33 and the stock value is 145.60. The U.S. (192.22, 224.52), the U.K. (153.76, 178.94), Sweden (120.00, 121.49) and Spain (162.44, 134.29) have higher-than-average liquidity in terms of both measurements. On the other hand, Botswana (3.48, 0.80), Ghana (5.18, 0.36), Namibia (3.11, 0.21) and Peru (7.75, 2.72) have the lowest market liquidity.

In our regression analysis, we use the mean-differenced series to measure the relative level of information factor, trading cost, firm age, stock market liquidity, financial/economics development, shareholder protection and disclosure. More specifically, we calculate the difference between the value of each host market to the average value of its rival host markets, which is $X_i - \bar{X}$, where X_i is the market factor for host country i, and $\bar{X}$ is the mean value of X across all rival host markets. The estimated correlation coefficients of mean-differenced series are reported in Panel B of Table 3.3. As we have expected, two measures of volume ratio are highly correlated (95%). Information factor, firm age, stock market liquidity proxies, shareholder protection proxies, disclosure index differences and English common law origin are positively correlated with volume ratio. Time zone and trading cost differences as

well as market correlation are negatively correlated with volume ratio. High linear correlation (over 50%) exists among anti-director rights index, disclosure index, stock market turnover and stock market value. Financial development is highly correlated with stock market value (76.8%) and disclosure index (54.8%). Common law origin is highly correlated with shareholder protection proxies and disclosure index, which is consistent with the findings from the previous literature that common law countries tend to have better legal protection than civil law countries (*Djankov et al.*, 2008). The correlation coefficients for other market level explanatory variables are below 50%.

3.3 Regression analysis

We utilize panel regression to examine the impact of various firm- and market-level characteristics on volume distribution among rival host markets. The dependent variable is the logistically transformed volume ratio $\text{Vol}_{HT,i}/\sum_{k=1}^{n}\text{Vol}_{HT_k}$, which is the trading volume in one host market divided by the total foreign trading volume of a firm.[10] Tables 3.4 and 3.5 report the regression results, where Panels A (B) report the results estimated using dollar (share) volume ratio as the dependent variable. The information factor is estimated using Equation 4.10. Other market characteristics are calculated as mean-differential series $X_{HT,i} - \bar{X}_{HT}$, where $X_{HT,i}$ is a market characteristic in host country i and $\bar{X}_{HT}$ is the average of that market characteristic across all applicable host markets of each sample cross-listed firm. We winsorize the top and bottom 1% for information factor and trading cost.

[10]Because volume ratio is a [0,1] bounded variable which violates OLS assumption, we apply the logistically transformation Y=log(Volume ratio/(1-Volume ratio)) to reflect the bounded value to the entire range of real numbers.

3.3.1 Univariate regression analysis

To examine the impact of each firm- and market-level variable on trading volume distribution, we run a regression analysis for each explanatory variable against the logistically transformed dollar (share) volume ratio and report the results in Panel A (B) of Table 3.4. The standard errors are robust to heteroscedasticity and are adjusted for clustering by firm and by year. Because the results in Panel A and Panel B are very close, we focus our discussion on the results based on the models using logistically transformed dollar volume ratio as the dependent variable (in Panel A).

Table 3.4: Determinants of competitiveness in attracting trading volume – univariate regression analysis.

The table reports the univariate regression results by including only one independent variable in each regression model. The dependent variable is the logistic transformed trading volume ratio. Panel A (B) reports the results of dollar (share) volume ratio as the dependent variable. All characteristic variables are mean-differenced series, which are the difference between the value of each host market to the average value of its rival host markets, which is $X_i - \bar{X}$, where X_i is the market factor for host country i, and $\bar{X}$ is the mean value of X across all rival host markets. Each column reports panel regression results across firm-years. Standard errors are robust to heteroscedasticity and are adjusted for two-way clustering by firm and by year. R^2 is adjusted for degrees of freedom. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logistic transformed dollar volume ratio as the dependent variable

	Info factor	Trading cost diff	Firm age diff	Mkt Corr	Time zone diff	Anti-dir -rights diff	Anti-self -dealing diff	Disclose diff	Fin devlp	Econ devlp	Mkt turnover	Mkt Trd value	English Common law	French Civil law	German Civil law	Scand. Civil law
Estimates	0.168*	−50.264***	0.374***	−1.735**	−1.318***	1.547***	4.622**	12.646***	0.016***	−1.567**	0.027***	0.022***	2.553***	−2.879***	0.240	−2.023
t-statistics	(1.749)	(−5.083)	(7.420)	(−2.515)	(−3.458)	(7.175)	(2.651)	(7.748)	(5.994)	(−2.218)	(5.875)	(7.651)	(4.880)	(−5.956)	(0.493)	(−0.987)
Obs	1,144	1,528	2,055	2,001	2,079	2,020	2,051	2,020	1,689	2,079	1,761	1,761	2,079	2,079	2,079	2,079
Adj. R^2 (%)	1.51	14.64	27.74	1.86	11.68	29.87	3.59	30.35	15.62	1.57	19.31	26.36	11.97	13.38	0.06	0.55

Panel B: Logistic transformed share volume ratio as the dependent variable

	Info factor	Trading cost diff	Firm age diff	Mkt Corr	Time zone diff	Anti-dir -rights diff	Anti-self -dealing diff	Disclose diff	Fin devlp	Econ devlp	Mkt turnover	Mkt Trd value	English Common law	French Civil law	German Civil law	Scand. Civil law
Estimates	0.177	−60.549***	0.518***	−2.354**	−1.694***	2.210***	7.785***	17.474***	0.021***	−1.810***	0.034***	0.030***	3.640***	−3.637***	−0.235	−4.331*
t-statistics	(1.330)	(−4.804)	(9.189)	(−2.739)	(−3.008)	(8.950)	(3.440)	(8.869)	(5.910)	(−3.025)	(5.947)	(8.808)	(5.388)	(−5.909)	(−0.370)	(−1.842)
Obs	1,144	1,528	2,055	2,001	2,079	2,020	2,051	2,020	1,689	2,079	1,761	1,761	2,079	2,079	2,079	2,079
Adj. R^2 (%)	1.02	13.59	33.86	2.18	12.43	38.51	6.54	36.64	17.32	1.35	20.22	29.88	15.67	13.75	0.03	1.63

In line with our initial predictions, results show that additional price-relevant information contributed by a host market, which is measured by the information factor, increases the share of trading volume executed on that host market. A host market with a higher relative trading cost is shown to significantly decrease its proportion of global trading volume. Higher market correlation between host and home market will reduce the cross-listed trading in that host market compared to rival host markets. Consistent with the arbitrage theory, investors prefer to trade shares in a market that is less correlated with the domestic market in order to maximize the hedging benefit. Geographic proximity, measured by host-home market time zone difference, can influence information flow between the host market and the home market and thus impact the share of global volume executed on the host market. As expected, we observe that farther distance in time zone between the host market and the home market than irval host markets will reduce the volume retio of the host market. Better legal protection for investors in a host market relative to rival host markets increases the share of global trading volume in that host market, as evident from the highly significant positive coefficients on anti-director rights index, anti-self-dealing index and disclosure index. A more developed foreign market tend to attract more trading than the less developed competing host market, evident from the positive coefficients on financial development and negative coefficients on the developing economy dummy. As we expected, a host market with more market depth and breadth is more competitive in attracting foreign order flow, shown as the significant positive coefficients of market turnover and market traded value.

Four legal origin indicators reveal some interesting findings as well. More shares of foreign order flows traded on English common law host countries. Civil law host countries are less competitive. The significant negative coefficient of French civil-law shows that less foreign trading occurs in French civil-law countries. The estimated coefficients on the German and Scandinavian civil law countries indicator show lack of

statistical significance. Among all of the statistically significant variables, it is shown that disclosure index (Adj. R^2 30.35%), anti-director rights index (Adj. R^2 29.87%), firm age (Adj. R^2 27.74%), market liquidity proxies (market turnover with Adj. R^2 19.31% and market traded value with Adj. R^2 26.36%), financial development (Adj. R^2 15.62%) and trading cost (Adj. R^2 14.64%) have higher explanatory power in determining the volume ratio. On the other hand, information factor, market correlation, economic development and anti-self-dealing index have less power (Adj. R^2 less than 5%) in explaining the volume distribution among competing host markets.

3.3.2 Multivariate regression analysis

We next examine the relative importance of market- and firm-level characteristics in determining the distribution of trading volume by performing a series of panel regressions. Table 3.5 presents the estimated coefficients from the two sets of pooled OLS regressions. Models (1)-(4) present the baseline results from pooled OLS regressions. The standard errors are robust to heteroscedasticity and are adjusted for clustering by firm and by year. Models (5)-(8) apply pooled OLS with firm and year two way cluster and home country fixed effects, allowing for the possibility of time-invariant differences in investment levels among domestic countries.

To avoid the issue of multicollinearity, we first group independent variables into categories, such as legal protection and stock market liquidity, and then we include highly correlated independent variables, identified in Panel B of Table 3.3, from each category one at a time. Except for market correlation and legal origin indicators, all independent variables are mean-differenced by subtracting the mean across all applicable host markets from the respective market characteristic variable in each host market (i.e., $X_{HT,i} - \bar{X}_{HT}$, where X is a market characteristic). The information factor, trading cost, stock market turnover, stock market traded value and financial development are lagged by one period to control for any potential correlation between

those variables and volume ratios in the same year (See, for example, *Baruch et al.*, 2007; *Halling et al.*, 2008). The number of observations in each model varies due to data availability. Panels A and B report the regression results using two measures of volume ratio. For the purpose of brevity, our discussion will focus on the results reported in Panel A, which is based on the dollar volume ratio.

Table 3.5: Determinants of trading volume distribution among rival host markets.

This table reports the regression results on the impacts of firm and market characteristics in determining the trading volume distribution among rival host markets. The dependent variable is the logistic transformed trading volume ratio. Panel A (B) reports the regression estimation results when the dependent variable is the logistic transformation of dollar (share) volume ratio. Information factor and trading cost are winsorized at the top and bottom 1%. All market characteristic variables are mean-differenced series. The information factor, trading cost, stock market turnover, stock market traded value and financial development are lagged by one period. Each column reports panel regression results across firm-years with/ without domestic county fixed effects. Standard errors are robust to heteroscedasticity and are adjusted for clustering by firm and by year. R^2 is adjusted for degrees of freedom. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logistic transformation of dollar volume ratio as the dependent variable

	OLS				Fixed Effects			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	0.019	−0.023	0.012	−0.027	0.045	0.028	0.033	0.001
	(0.204)	(−0.214)	(0.187)	(−0.378)	(0.526)	(0.301)	(0.570)	(0.024)
Trading cost dif (T-1)	−19.702**	−20.767**	−21.852**	−19.708**	−16.712**	−17.975**	−20.707**	−17.204*
	(−2.380)	(−2.627)	(−2.680)	(−2.323)	(−2.312)	(−2.308)	(−2.674)	(−2.092)
Firm age dif	0.228***	0.212***	0.245***	0.220***	0.227***	0.238***	0.263***	0.245***
	(3.630)	(3.234)	(3.644)	(3.096)	(4.103)	(4.118)	(4.596)	(4.193)
Legal protection								
Anti-director-rights index dif		0.893**				1.035***		
		(2.790)				(3.628)		
Anti-self-dealing index dif			5.695***				5.712**	
			(3.148)				(2.885)	
Disclosure index dif				11.978***				12.477***
				(5.039)				(5.890)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.012***				0.011***			
	(4.132)				(3.712)			
Stk mkt traded value dif (T-1)			0.010***				0.011***	
			(4.385)				(4.092)	
Host country development								
Fin development dif (T-1)	0.010***	0.012***			0.009***	0.010***		
	(4.730)	(4.781)			(5.884)	(4.898)		
Econ development (HT)			0.393	1.309			1.156	1.898
			(0.289)	(1.064)			(0.935)	(1.440)
Distance and correlation								
Market corr (HM vs HT)	−1.247		−0.642		−1.249		−0.252	
	(−1.308)		(−0.724)		(−1.512)		(−0.338)	
Time zone dif (HM vs HT)		−0.777		−0.226		−0.477		−0.033
		(−1.545)		(−0.453)		(−1.275)		(−0.089)
Legal orgin								
English common law origin	2.201***				3.304***			
	(4.009)				(3.352)			
French civil law origin			−2.365***				−2.300***	
			(−3.709)				(−2.979)	
Intercept	−0.741	−0.331	0.719*	−0.411**	−0.291	−0.310	0.803	−0.377**
	(−1.103)	(−1.591)	(2.028)	(−2.124)	(−0.557)	(−1.609)	(1.378)	(−2.269)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	699	695	736	817	699	695	736	817
Adj. R^2	53.09	53.95	56.51	53.10	61.20	60.02	62.14	59.98

Table 3.5 (Cont'd)

Panel B: Logistic transformation of share volume ratio as the dependent variable

	OLS				Fixed Effects			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	−0.063	−0.096	−0.030	−0.090	−0.037	−0.038	−0.009	−0.059
	(−0.853)	(−1.326)	(−0.435)	(−1.488)	(−0.503)	(−0.551)	(−0.146)	(−1.170)
Trading cost dif (T-1)	−20.548**	−20.348**	−21.968**	−18.846**	−17.312**	−16.963*	−21.139**	−15.761*
	(−2.295)	(−2.412)	(−2.525)	(−2.141)	(−2.207)	(−2.007)	(−2.514)	(−1.835)
Firm age dif	0.374***	0.349***	0.370***	0.365***	0.364***	0.378***	0.389***	0.392***
	(4.997)	(4.475)	(4.621)	(4.271)	(5.843)	(5.643)	(5.694)	(5.603)
Legal protection								
Anti-director-rights index dif		1.344***				1.526***		
		(3.079)				(4.098)		
Anti-self-dealing index dif			8.418***				8.294***	
			(4.058)				(3.637)	
Disclosure index dif				16.239***				16.890***
				(5.110)				(6.033)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.014***				0.012***			
	(3.796)				(3.244)			
Stk mkt traded value dif (T-1)			0.017***				0.018***	
			(7.513)				(6.688)	
Host country development								
Fin development dif (T-1)	0.014***	0.015***			0.014***	0.013***		
	(4.589)	(4.526)			(5.220)	(4.668)		
Econ development (HT)			0.190	1.214			1.290	1.982*
			(0.204)	(1.407)			(1.321)	(1.872)
Distance and correlation								
Market corr (HM vs HT)	−0.876		−0.509		−0.754		0.295	
	(−0.774)		(−0.529)		(−0.757)		(0.386)	
Time zone dif (HM vs HT)		−0.587		0.036		−0.217		0.263
		(−0.735)		(0.046)		(−0.363)		(0.417)
Legal origin								
English common law origin	2.901***				4.482***			
	(4.526)				(4.079)			
French civil law origin			−2.239**				−2.033**	
			(−2.880)				(−2.181)	
Intercept	−1.241	−0.326	0.591	−0.427*	−0.679	−0.248	0.441	−0.369*
	(−1.527)	(−1.437)	(1.376)	(−1.932)	(−1.077)	(−1.256)	(0.618)	(−2.047)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	699	695	736	817	699	695	736	817
Adj. R^2	59.87	60.82	62.99	58.57	68.12	66.86	68.32	64.78

The regression results show that two firm-level variables and four categories of market-level variables have a robust impact on the competitiveness of a host market in attracting trading volume from rival host market(s): trading cost, firm age, legal protection, stock market liquidity, financial development and legal origin. The estimated coefficients on trading cost are all negative and statistically significant at conventional levels, which indicates that higher trading cost in a host market than its competing host markets drives down its relative trading volume ratio. Our findings are qualitatively similar to the negative impact of trading costs on trading volume documented in *Barclay et al.* (1998), *Pagano et al.* (2001), and *Wang and Zhou* (2014), although in a different setting.

Firm age proxies for firm visibility. Investors are more confident in trading shares of a more visible firm. *Wang and Zhou* (2014) documents that firms with higher visibility in the host market account for greater proportion of trading executed in the host market. We find similar evidence to support the firm visibility theory. A host market in which a firm has a longer listing history tends to account for a higher trading volume ratio of all trading executed outside of the home market. Taking Model (5) as an example, if a cross-listed firm has one year longer history on the host market than the average of rival host markets, the volume ratio of that host market will increase from 50% ($= \exp(0)/(\exp(0)+1)$) to 55.6% ($= \exp(0.227)/(\exp(0.227)+1)$).

Legal protection for investors is crucial to their decision on trading location. The estimated coefficients on difference in anti-director rights index, anti-self-dealing index and disclosure index are all positive and statistically significant at conventional levels. Investors are more likely to trade in a host market that offers a higher degree of legal protection. The impact of mean-differenced legal protection variables is sizable, too. Using Models (6)-(8) as examples, holding other factors constant, one unit higher in anti-director rights index of the host market than the average value of all host markets increases the trading volume ratio of the host market volume from 50%

$(= \exp(0)/(\exp(0)+1)$ to 73.8% $(= \exp(1.035)/(\exp(1.035)+1))$. One unit higher in anti-self dealing index and disclosure index than the average across all host markets results in a 50 percentage point increase in the trading volume ratio.

The estimated coefficients on stock market liquidity are consistently positive and statistically significant at 1%, which suggests that host markets that provide more liquidity attract a higher trading volume than rival host markets. Investors prefer to place orders in a market with depth and breadth. Using the coefficient estimates in Models (5) and (7) as examples, if the market turnover (or market traded value) of a host market is one unit higher than the average values across all host markets, its trading volume ratio increases from 50% to 50.3% $(= \exp(0.011)/(\exp(0.011)+1))$.

Consistent with the findings reported in Table 3.4, legal origin also has significant impact on trading volume ratio. English common law host countries attract a significantly higher volume ratio than rival host markets, and French civil-law host countries are less competitive.

The estimated coefficients on the information factor, time zone difference, market correlation and economic development exhibit the expected signs but are generally statistically insignificant. These findings are different than those reported in *Wang and Zhou* (2014), which shows that the four variables are important in explaining the domestic versus foreign market trading volume distribution. Information factor, time zone and market correlation can be classified as information-based variables, which affect information flow between the host market and the home market. Our results show that although information-based explanation is critical in explaining the host market volume ratio competing with the counterpart domestic market, it has limited power in determining the competitiveness among the competing host markets.

3.4 Robustness checks

3.4.1 Alternative dependent variables transformation

We use logarithm transformation of trading volume ratio as a dependent variable to re-run the analysis of volume distribution among rival host markets. The regression results are reported in Table 3.6. Models (1)-(8) utilize the same model specification and variable construction as in Table 3.5.

Estimation results continue to provide strong evidence of the importance of firm- and market-level characteristics in determining the distribution of order flows across host markets. Most results confirm what we found previously in Table 3.5. Host markets with lower trading cost attract more volume from competing host markets. Firm age, legal protection, liquidity variables and financial development are statistically significant, which confirms that more developed financial markets where firms have a longer listing history, better legal protection and higher liquidity attract higher volume ratio than rival host markets. The market correlation coefficients are negative and statistically significant, which confirms the arbitrage hypothesis that investors prefer to trade in a market that is less correlated with the home market in order to reap a higher hedging benefit.

Table 3.6: Determinants of trading volume distribution among rival host markets – logarithm transformation.

To check the robustness of the regression results reported in Table 3.5, we re-estimate the regression models using logarithm transformed volume ratio as the dependent variables. Model specification and variable construction are similar to those in Table 3.5. Panel A (B) reports the estimation results when logarithm transformed dollar (share) volume ratio. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logarithm transformed dollar volume ratio as the dependent variable

	OLS				Fixed Effects			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	0.024	−0.023	0.014	−0.021	0.038	0.018	0.017	−0.002
	(0.518)	(−0.442)	(0.415)	(−0.555)	(0.891)	(0.406)	(0.442)	(−0.053)
Trading cost dif (T-1)	−10.657*	−11.374*	−10.939*	−12.355*	−9.320*	−10.474*	−11.257**	−10.835*
	(−1.910)	(−1.927)	(−1.980)	(−1.842)	(−2.021)	(−2.085)	(−2.311)	(−1.954)
Firm age dif	0.123***	0.115**	0.124**	0.117**	0.129***	0.133***	0.145***	0.136***
	(2.941)	(2.665)	(2.905)	(2.513)	(4.072)	(3.967)	(4.503)	(3.950)
Legal protection								
Anti-director-rights index dif		0.450**				0.498***		
		(2.431)				(3.695)		
Anti-self-dealing index dif			2.650**				2.490**	
			(2.878)				(2.519)	
Disclosure index dif				6.435***				6.462***
				(5.043)				(6.698)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.006***				0.006***			
	(3.732)				(3.576)			
Stk mkt traded value dif (T-1)			0.006***				0.006***	
			(3.153)				(2.995)	
Host country development								
Fin development dif (T-1)	0.006***	0.007***			0.005***	0.006***		
	(4.690)	(4.556)			(6.137)	(5.271)		
Econ development (HT)			0.385	0.744			1.074	1.461
			(0.493)	(0.959)			(1.309)	(1.678)
Distance and correlation								
Market corr (HM vs HT)	−2.470***		−2.090***		−1.449**		−0.981	
	(−4.497)		(−3.625)		(−2.327)		(−1.443)	
Time zone dif (HM vs HT)		−0.438		−0.082		−0.297		−0.014
		(−1.424)		(−0.287)		(−1.611)		(−0.078)
Legal orgin								
English common law origin	0.648*				1.301**			
	(1.769)				(2.336)			
French civil law origin			−1.137**				−1.194**	
			(−2.422)				(−2.193)	
Intercept	−0.871*	−1.798***	−0.353	−1.846***	−0.931**	−1.401***	−0.384	−1.449***
	(−2.041)	(−8.095)	(−1.331)	(−8.722)	(−2.616)	(−6.315)	(−1.072)	(−6.831)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	699	695	736	817	699	695	736	817
Adj. R^2	42.99	41.18	47.16	40.51	57.72	57.74	59.94	57.40

Table 3.6 (Cont'd)

Panel B: Logarithm transformed share volume ratio as the dependent variable

Variable	OLS				Fixed Effects			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	0.005	−0.043	0.003	−0.047	0.020	0.010	0.007	−0.022
	(0.099)	(−0.920)	(0.058)	(−1.245)	(0.398)	(0.220)	(0.131)	(−0.513)
Trading cost dif (T-1)	−11.902*	−11.443	−10.753	−12.813	−9.455*	−9.662	−10.825*	−10.047
	(−1.760)	(−1.605)	(−1.684)	(−1.603)	(−1.750)	(−1.698)	(−1.985)	(−1.607)
Firm age dif	0.194***	0.178***	0.178***	0.187***	0.196***	0.201***	0.204***	0.209***
	(3.729)	(3.541)	(3.545)	(3.425)	(5.921)	(5.520)	(5.945)	(5.433)
Legal protection								
Anti-director-rights index dif		0.609**				0.691***		
		(2.451)				(3.982)		
Anti-self-dealing index dif			3.867***				3.600***	
			(3.698)				(3.214)	
Disclosure index dif				8.069***				8.228***
				(4.787)				(6.505)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.007***				0.006***			
	(3.341)				(3.063)			
Stk mkt traded value dif (T-1)			0.010***				0.009***	
			(5.033)				(4.631)	
Host country development								
Fin development dif (T-1)	0.008***	0.008***			0.007***	0.007***		
	(4.364)	(4.296)			(5.312)	(4.870)		
Econ development (HT)			0.979	1.174			1.880**	2.088**
			(1.453)	(1.710)			(2.618)	(2.788)
Distance and correlation								
Market corr (HM vs HT)	−2.589***		−2.439***		−1.381		−0.867	
	(−3.703)		(−3.780)		(−1.650)		(−1.063)	
Time zone dif (HM vs HT)		−0.381		0.022		−0.178		0.115
		(−0.811)		(0.050)		(−0.584)		(0.367)
Legal origin								
English common law origin	0.635				1.784***			
	(1.363)				(2.928)			
French civil law origin			−0.769				−0.937	
			(−1.413)				(−1.495)	
Intercept	−1.188*	−2.158***	−0.699*	−2.245***	−1.184**	−1.541***	−0.718	−1.632***
	(−2.081)	(−7.773)	(−1.913)	(−8.397)	(−2.515)	(−5.563)	(−1.586)	(−5.820)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	699	695	736	817	699	695	736	817
Adj. R^2	42.87	43.59	48.24	42.93	60.10	60.85	62.98	59.57

Similar to Table 3.5, the estimated coefficients on information factor, economic development and time zone continue to be statistically insignificant across all model specifications. However, the coefficients on market correlation are all negative and mostly statistically significant.

3.4.2 Excluding firms cross-listed in the U.S.

Based on the summary statistics reported in Tables 3.1 and 3.2, the U.S. leads other host markets in attracting order flows from foreign firms and accounts for about 27% of global cross-listings. When a firm simultaneously lists in the U.S. and another host market, the Unite States on average attracts about 70.48% of a firm's total foreign trading volume. One potential concern is that the results presented in Tables 3.5 and 3.6 are dominated by firms that cross-list in the U.S. To alleviate this concern, we test the robustness of our main results by excluding firms that cross-listed in the U.S. and reestimate the regression models reported in Table 3.5. The estimated coefficients are reported in Table 3.7. Again, we report results on two measures of volume ratio (dollar volume ratio and number of shares volume ratio) separately in Panels A and B. We also apply logistic transformation to the volume ratio.

Table 3.7: Determinants of trading volume distribution among rival host markets – subsample analysis.

As a cross-listing destination, the U.S. accounts for 27% of the sample of cross-listings with multiple host markets. To check the robustness of the results reported in Table 3.5, we re-estimate the regression models by excluding firms that cross-list in the U.S. Model specification and variable construction are consistent with Table 3.5. Panel A (B) reports the results of logistic transformed dollar (share) volume ratio. Each column reports panel regression results across firm-years with and without home county fixed effects. Standard errors are robust to heteroscedasticity and are adjusted for clustering by firm and by year. R^2 is adjusted for degrees of freedom. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logistic transformation of dollar volume ratio as the dependent variable

	OLS				Fixed Effects			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	0.104	0.029	0.074	0.028	0.166**	0.124	0.097	0.102*
	(1.250)	(0.282)	(1.202)	(0.449)	(2.246)	(1.354)	(1.520)	(2.077)
Trading cost dif (T-1)	−12.286*	−17.851**	−14.131**	−17.304*	−9.242*	−14.782**	−11.859**	−13.857*
	(−2.013)	(−2.360)	(−2.418)	(−2.070)	(−2.026)	(−2.256)	(−2.439)	(−2.092)
Firm age dif	0.200***	0.223***	0.206**	0.209**	0.246***	0.245***	0.257***	0.211***
	(3.204)	(3.378)	(2.794)	(2.890)	(3.866)	(4.200)	(3.656)	(3.673)
Legal protection								
Anti-director-rights index dif		0.743**				0.465**		
		(2.431)				(2.791)		
Anti-self-dealing index dif			3.452**				0.813	
			(2.218)				(0.498)	
Disclosure index dif				10.145***				6.674***
				(5.108)				(6.239)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.015***				0.016***			
	(4.025)				(5.433)			
Stk mkt traded value dif (T-1)			0.008**				0.005*	
			(2.376)				(1.823)	
Host country development								
Fin development dif (T-1)	0.006***	0.011***			0.005**	0.008***		
	(2.992)	(4.419)			(2.737)	(4.050)		
Econ development (HT)			0.617	1.010			1.591	1.422
			(0.474)	(0.852)			(1.188)	(0.998)
Distance and correlation								
Market corr (HM vs HT)	−3.764***		−2.689***		−1.907**		−1.473*	
	(−4.435)		(−3.185)		(−2.244)		(−1.918)	
Time zone dif (HM vs HT)		−0.783		−0.300		−1.288***		−1.242***
		(−1.304)		(−0.499)		(−4.180)		(−4.188)
Legal origin								
English common law origin	1.930***				1.271			
	(3.421)				(1.574)			
French civil law origin			−1.859**				−1.565**	
			(−2.555)				(−2.192)	
Intercept	0.613	−0.500*	1.178**	−0.583**	0.316	−0.261	0.854	−0.304
	(1.320)	(−2.065)	(2.400)	(−2.368)	(0.723)	(−1.304)	(1.558)	(−1.634)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	574	570	611	662	574	570	611	662
Adj. R^2	46.12	39.14	47.87	36.49	67.62	66.90	66.29	66.87

Table 3.7 (Cont'd)

Panel B: Logistic transformation of number of shares volume ratio as the dependent variable

Variable	OLS				Fixed Effects			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm level characteristics								
Info factor dif (T-1)	0.037	−0.035	0.041	−0.023	0.146**	0.099	0.095	0.080*
	(0.582)	(−0.489)	(0.669)	(−0.437)	(2.337)	(1.345)	(1.462)	(1.968)
Trading cost dif (T-1)	−12.355*	−17.333**	−13.385*	−17.115*	−8.820	−15.357**	−11.734*	−14.560*
	(−1.844)	(−2.155)	(−2.092)	(−1.861)	(−1.694)	(−2.164)	(−2.045)	(−1.954)
Firm age dif	0.316***	0.336***	0.295***	0.324***	0.311***	0.299***	0.312***	0.266***
	(3.907)	(4.335)	(3.357)	(3.713)	(4.142)	(4.670)	(3.780)	(4.277)
Legal protection								
Anti-director-rights index dif		1.017**				0.573***		
		(2.557)				(3.644)		
Anti-self-dealing index dif			5.830***				1.667	
			(3.203)				(0.904)	
Disclosure index dif				12.659***				7.627***
				(4.862)				(6.583)
Stock market liquidity								
Stk mkt turnover dif (T-1)	0.014***				0.018***			
	(3.096)				(6.653)			
Stk mkt traded value dif (T-1)			0.013***				0.009**	
			(4.136)				(2.619)	
Host country development								
Fin development dif (T-1)	0.009***	0.014***			0.005**	0.008***		
	(3.635)	(4.395)			(2.587)	(4.148)		
Econ development (HT)			0.612	0.962			1.855*	1.425
			(0.745)	(1.166)			(1.844)	(1.222)
Distance and correlation								
Market corr (HM vs HT)	−4.199***		−2.883***		−1.830*		−1.366	
	(−4.195)		(−2.976)		(−1.916)		(−1.649)	
Time zone dif (HM vs HT)		−0.597		−0.063		−1.856***		−1.944***
		(−0.641)		(−0.067)		(−5.688)		(−5.568)
Legal origin								
English common law origin	2.377***				1.653**			
	(3.685)				(2.174)			
French civil law origin			−1.520*				−1.183	
			(−1.761)				(−1.547)	
Intercept	0.470	−0.709**	0.943	−0.825**	0.138	−0.240	0.484	−0.287
	(0.799)	(−2.575)	(1.406)	(−2.785)	(0.286)	(−1.106)	(0.779)	(−1.398)
Home country fixed-effects?	No	No	No	No	Yes	Yes	Yes	Yes
Number of company years	574	570	611	662	574	570	611	662
Adj. R^2	49.29	43.63	51.38	39.69	75.37	77.48	72.85	77.34

Overall, the results are consistent with our previous findings that host markets with lower trading cost, stronger investor protection, higher market liquidity and less correlation with their domestic market grab a greater proportion of trading volume from their rival host markets. In addition, the English common law host market with better developed financial market, where the foreign firms listed for a longer history have greater proportion of foreign trading. However, we also document some results that were not present in Table 3.5. The positive estimated coefficients from Models (5) and (8) on the information factor indicate that a host market that provides price information attracts a greater proportion of foreign trading. Estimated coefficients on time zone difference are negative and significant in Models (6) and (8), which supports the information flow hypothesis that a host market attracts more order flows if it is located closer to the home market. Market correlation coefficients are consistently negative and significant in three out of four models. Economic development is positive and statistically significant in Model (6). These two variables together provide the support for the arbitrage theory that investors prefer to place orders in developing markets and markets with less correlation to firm origination in order to diversify their global portfolio.

3.5 Conclusion

In this study, we attempt to fill the gap in the literature by examining the distribution of order flow among rival host markets for multi-market cross-listed shares and evaluating the relative importance of firm- and market-level characteristic variables in determining such distribution. We construct a comprehensive dataset of global cross-listed stocks directly from Datastream, which consists of $1,118$ global cross-listings from 61 home (domestic) countries, listed in 50 host (foreign) countries over the period 1990-2012. Among $1,118$ sample cross-listings, there are 304 listings with multiple host markets.

We present the cross-sectional and chronological distribution of global cross-listings and trading volume. We document that the U.S. is not only the largest host market in attracting foreign listings but is also the most competitive market in attracting trading volume from other foreign markets. The U.S. market continues to lead all global markets during and after the 2002 dot-com bubble crisis and the 2008 financial crisis. Several host markets, such as the U.K. and Hong Kong, also developed as popular trading venues for foreign firms.

We provide robust evidence that host markets are more successful in attracting trading volume from competing markets when they have lower bid-ask spreads, better legal protection, more market liquidity, a higher level of financial development and firms with a longer listing history. Interestingly, we consistently find that host countries with English common law origins are able to attract trading volume while French civil-law origin host countries attract less trading activity. Additionally, companies prefer to trade in a host market that provides more stock price information, less stock price correlation with its home market and closer proximity in time zone to its home market; however, these factors become secondary in importance in determining market competitiveness.

CHAPTER IV

Essay III. Price discovery process in the multi-market trading

International cross-listings activities provide a natural laboratory to study the law of one price (*Lamont and Thaler*, 2003). It is common to observe that the price of cross-listed share differs from the price of its domestic share. Many previous studies documented the significant amount of price disparity. For example, *Froot and Dabora* (1999) found a large deviation from arbitrage parity by investigating the pricing of two dual-listed companies, Royal Dutch & Shell, and Unilever N.V. & Unilever PLC. *Gagnon and Karolyi* (2004) quantified sizable price deviations from the arbitrage-free pricing between ADRs and their underlying assets. *Suarez* (2005) revealed that large deviation from the law of one price is in presence in French ADR-underlying pairs. *Gagnon and Karolyi* (2010) documented the arbitrage opportunities by comparing the intraday prices and quotes of ADRs in the U.S. markets with synchronous prices of their home market shares. Because the cross-listed firms' shares in different markets claim on the same underlying cash flows, we can expect that the stock prices of one firm in different markets have some comovement trends and possibly achieve certain equilibrium level in long run. This study is to examine the price discovery process of non-U.S. cross-listings from 36 different origination countries and traded on the U.S. stock exchanges.

Considering the existence of the price disparity, the topic - "where the price discovery takes place?" - has been widely discussed in previous literature since 1986, when *Schreiber and Schwartz* (1986) claimed "Price discovery as the search for an equilibrium price is a key function of a stock exchange.", but findings have never reached the consistency. *Bacidore and Sofianos* (2002) suggested that price discovery should mostly take place in the home market. *Harris et al.* (1995) applied synchronous transactions data for IBM in the error correction model to investigate how each exchange contributing to the price discovery process. They found that error-correcting price adjustment took place on all three exchanges - the New York, Pacific and Midwest Stock Exchanges. *Hasbrouck* (1995) developed an econometric approach based on an implicit unobservable efficient price common to all markets based on a sample of U.S. stocks in NYSE and regional exchanges. He found that price discovery occurred primarily on the NYSE. Similar findings were revealed in *Lee* (1993) and *Blume and Goldstein* (1991). Therefore, the New York Stock Exchange has been characterized as information dominant and plays an important role in the price discovery process. *Eun and Sabherwal* (2003) used 6 months intraday trading data to construct the linear error correction model and studied the price discovery for 62 Canadian shares cross-listed in the NYSE. They found that the stock prices on TSE and U.S. exchanges for the same firm were mutually adjusting but the U.S. share of price discovery are significantly larger than the Canada portion. The U.S. share are directly related to the U.S. share of trading, informative trades and the bid-ask spreads. Similarly, *Koumkwa and Susmel* (2008) investigated the convergence between the prices of ADRs and the associated Mexican traded shares using non-linear convergence and arbitrage models a sample of 21 dually listed shares. *Grammig et al.* (2005) used three German firms and the intraday data in 6 months and found a significant feedback from the NYSE to Frankfurt that the majority of the price discovery happened at home (Germany) market.

Most aforementioned studies used synchronous stock prices of a small number of firms during a short time period to test the price discovery process so that their results have some limitations. First, the results are regional and limited to certain economic condition. Second, they are unable to test the market-/country- level determinant factors of price discovery if their samples are listed to one country. Third, their results are constrained by the degree of freedom when they explore the determinants of price discovery. In this study, we examine 497 non-U.S. cross-listed common shares from 36 different home countries listed in the U.S. markets of the NYSE, AMEX and NASDAQ. We collect daily trading data from 1994 to 2011. In order to overcome the obstacles of non-synchronous trading and time zone differences issues among global markets, we collect stock exchanges trading hours, domestic stock market location and time zone. We use the U.S. intraday mid-point of bid-ask prices to match with the closing price of the same company's stock in its domestic market. The long term sample period enable us to capture the annual/quarterly firm-, market- and country- level characteristics change. Accordingly, this study enable us not only to observe where the price discovery occur globally, but also to test the determinants of the price discovery process. To my knowledge, this is the first study to use long term intraday data to examine the dynamic price discovery process in cross-listing literature.

The objective of this study is first to document where the price discovery takes place - domestic market versus the U.S. stock exchanges (NYSE/AMEX/NASDAQ). To quantify the price discovery process, we construct error correction models for each cross-listed firm in every quarter and document the "speed of adjustment" coefficients for both the domestic and the U.S. share price. In order to construct the error correction model, we first conduct the unit root test and the cointegration test for the domestic share price, the U.S. share price, the associated home and U.S. stock market index prices of every cross-listed firm. Within every quarter, we require that

four price series of every sample firm are non-stationary and they are cointegrated at order 1, which ensures the error correction representation. We further construct the error correction model and extract the error correction term parameters alpha, the speed of adjustment, to quantify the speed of price adjusting to the long run equilibrium. We summarize the style fact of the price discovery by home market and reveal where the error-correcting price adjustment takes place. We find that when there is a price deviation from the equilibrium, the domestic and the U.S. prices will mutually adjust to restore the equality. For most of our sample home countries, the majority of the price discovery happened in the domestic markets. On average, U.S. share price adjust toward the domestic prices significantly with the speed of adjustment 0.700. On the other hand, we also observe a statistically significant amount of price adjustment from domestic side to the U.S. share prices, with the speed of adjustment -0.280, which confirms our expectation that as a host market, U.S. markets also play an important role in price discovery mechanism.

The second objective of this study is to analyze the determining factors for the U.S. relative contribution to the price discovery. We measure the U.S. relative contribution to the price discovery as the domestic proportion of speed of adjustment, $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right)$. The idea is that if the U.S. trading has strong effect, the U.S. price will be dominant and the domestic share price will adjust toward the U.S. prices. Therefore, larger ratio of $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right)$ indicates more contribution from the U.S. market in price discovery process. We utilize the panel regression method to investigate the determining factors and we find that a cross-listed firm with a larger U.S. proportion of its total trading volume, more informative share price provided in the U.S. market, longer listing history in the U.S. market, more liquidity in the U.S. market than the domestic market, the domestic price adjust more toward the U.S. price and the U.S. market contribute more in the price discovery. In addition, comparing the counterpart domestic market, if the U.S. market provides

more market depth and breath, better shareholder protection and financial information disclosure enforcement, it will contribute more in the price discovery and the proportion of domestic price adjustment will be higher. We also observe that larger capitalization foreign firm from a lower economic growth home country usually has higher domestic price adjustment toward the U.S. price.

The remainder of the paper proceeds as follows: Section 4.1 describes the sampling process and documents the distribution of U.S. cross-listed foreign shares by home markets and by year. Section 4.2 details the error correction model and documents the magnitude of price discovery across home and the U.S. markets. Section 4.3 explains the variable construction and their associated hypotheses about price discovery process. Section 4.4 summaries the sample statistics of the variables in the empirical analysis. Sections 4.5 discusses the regression method and our empirical findings. Section 4.6 presents results on robustness checks. Section 4.7 concludes our study.

4.1 Data and Sample

We start with the list of foreign stocks listed in the U.S. stock markets as of November 2011. We identify American Depository Receipts (SHRCD=30 and 31) and U.S. listed foreign firms (SHRCD=12) from the CRSP database. We also include those companies shown as U.S. firm in CRSP (SHRCD of 10 or 11) but recorded as incorporating in a foreign country in Compustat database (state=99). The original list includes 917 foreign firms listed in the U.S. markets. Because this study focuses on the exchange-listed ordinary shares, we excluded preferred shares, funds, warrants, derivatives, indices due to the specific characteristics. For ADRs, we keep exchange listed Level II and Level III ADRs while exclude the OTC issued level I ADRs, SEC Regulation S shares and SEC Rule 144a issues. We also exclude firms originated from tax havens, such as Bermuda, the Cayman Islands, Jersey, or the Netherlands Antilles

because those firms do not have operation in those registered "domestic" locations.

We collect the domestic daily stock price, daily volume, daily market index price[1] and daily market capitalization from Datasteam and accordingly the sample stocks without home market information in datastream are dropped from our sample. We obtain the ADR bundle ratios from Worldscope and fill the missing ratios using the ADR lists from Citi bank, J.P. Morgan Chase Bank and Bank of New York. We adjust the domestic price by multiplying the ADR bundle ratio for those ADRs in our sample. The U.S. markets trading data are collected from the NYSE's Trade and Quote (TAQ) database, which includes cross-listings' U.S. market intraday bid-ask price, intraday bid-ask volume and bid-ask quotes for SP500 Depository Receipts (ticker: SPY) as U.S. market index price. Following the sample construction method in *Gagnon and Karolyi* (2010), when the home and the U.S. market are close at the same time, e.g. Canada, we will use both the U.S. and home daily closing prices/volume series. When home and the U.S. market are not synchronous, we use the midpoint of bid and ask prices in the U.S. market for each cross-listed share observed at its domestic stock exchange close time. When the price at that matched point of time is not available, we take the first available midpoint quote in the U.S. market within 10 minutes after the home market close. For those foreign markets which have completely non-overlapping trading hours with the U.S. market, e.g. Hong Kong, we employ the first available bid-ask quotes after the U.S. market open at the same date. We discard issues with missing or invalid price, volume or market capitalization data over the sample period. We filter the prices with errors, missing and zeros. Further more, we exclude closing quotes flagged as odd lots, pre-open, or halted in Datastream and exclude the intraday quotes flagged as closing quotes, trading halts, non-firm quotes, and pre-opening indications in TAQ. Following the *Eun and Sabherwal* (2003)'s method, we require sample cross-listings have non-zero trading volume in both the home and the U.S.

[1]We use datatype "LI" as associated local market price index for a given stock from Datastream

markets on two consecutive days and we exclude those thinly traded stocks with fewer than 2,000 trades in 6 months on either the home market or the U.S. market. Because the U.S. high frequency data from TAQ starts from the beginning of 1993 and the records of SPY initiate from February 1, 1993. Our sample covers the U.S. cross-listing historical data from January 1, 1994 to December 31, 2011. After the filtering process, our initial sample include 537 U.S. cross-listed foreign companies. As we detailed later in Section 4.2, the purpose of this study is investigate the price discovery process. We will require the pairs cross-listed stock home and U.S. price series with valid "speed of adjustment" estimates from the U.S. and/or domestic side(s). Our final model includes 497 U.S. cross-listed foreign companies with with valid trading data in both domestic and the U.S. market as well as significant U.S. and domestic "speed of adjustment" coefficients estimates.

Table 4.1 reports the sample description by home country (Panel A) and by year (Panel B). The final sample includes 497 foreign common shares listed in the U.S. markets from 36 domestic countries. 59 companies (11.87%) are domiciled in 11 developing countries and 438 (88.13%) are from 25 developed countries. Canada is the largest issuer with 211 commons shares listed in the U.S. markets, which counts for 42.45% of the sample. The U.K. and Israel is the second largest domestic country with 35 cross-listings in the U.S. markets (7.04%), respectively, followed by Japan (29), France (21). Panel B summarizes the number of U.S. cross-listings over time as well as the annual growth rate from 1994 to 2011. With the enhanced globalization of financial markets, the number of non-U.S. firms cross-listed in the U.S. markets had been substantially increased over the sample period expect 2007-2009. Our sample starts with 13 cross-listings in 1993 and keeps increasing to 326 in 2006. The peak of the growth rate happened in the year of 1997 (72.22%) and kept at a high level during 1998-2000 (1998: 41.94%, 1999: 47.73%, 2000: 58.46%). In 2001, the foreign cross-listing programs still increased but the growth rate was down to 6.80%. After

then, the growth of cross-listing programs back to the high levels in 2002 (54.44%) but the growth rate decreasing over years, which mostly results from the development of other global markets. Markets like Hong Kong and London become popular cross-listing trading venues in last decades *Wang and Zhou* (2014). In 2007, the number of foreign cross-listings suffered a large drop in 2007 (-6.75%) and kept decreasing after 2007. It drops from 326 cross-listings in 2006 to 281 in 2011. The drops in/after 2001 and 2007 can be explained by the doc come crisis (2000-2002) and financial crisis (2008-2009). In addition, recent studies have revealed that small foreign firms with low trading volume have been exited the U.S. market, because the bonding costs of continued U.S. registration outweigh the benefits, especially after the passage of SOX in 2007. (See, for example, *Fernandes et al.*, 2010; *Marosi and Massoud*, 2008; *Doidge et al.*, 2010).

Table 4.1: Distribution of U.S. cross-listings sample by domestic country and by year

In this table we present the distribution of 605 U.S. listed firms from 39 home markets. Panel A reports the cross sectional distribution of cross-listings by home countries. Panel B reports distribution of sample U.S. cross-listings by year, grouped by year.

Panel A: By country			Panel B: By year		
Domestic Country	Number	Percent	Year	Number	% Change
Argentina	7	1.41%	1994	13	
Australia	13	2.62%	1995	13	0.00%
Austria	1	0.20%	1996	18	38.46%
Belgium	3	0.60%	1997	31	72.22%
Brazil	5	1.01%	1998	44	41.94%
Canada	211	42.45%	1999	65	47.73%
Chile	7	1.41%	2000	103	58.46%
China	10	2.01%	2001	110	6.80%
Denmark	1	0.20%	2002	170	54.55%
Finland	4	0.80%	2003	221	30.00%
France	21	4.23%	2004	271	22.62%
Germany	12	2.41%	2005	301	11.07%
Greece	3	0.60%	2006	326	8.31%
Hong Kong	6	1.21%	2007	304	−6.75%
Hungary	1	0.20%	2008	285	−6.25%
India	8	1.61%	2009	281	−1.40%
Indonesia	2	0.40%	2010	293	4.27%
Ireland	6	1.21%	2011	297	1.37%
Israel	35	7.04%			
Italy	3	0.60%			
Japan	29	5.84%			
Korea	9	1.81%			
Mexico	6	1.21%			
Netherlands	14	2.82%			
Norway	2	0.40%			
Portugal	2	0.40%			
Russia	5	1.01%			
Singapore	2	0.40%			
South Africa	7	1.41%			
Spain	7	1.41%			
Sweden	2	0.40%			
Switzerland	10	2.01%			
Taiwan	6	1.21%			
Turkey	1	0.20%			
United Kingdom	35	7.04%			
Venezuela	1	0.20%			
Total	497	100.00%			

4.2 Error correction and price discovery

Price discovery is the process by which stock markets attempt to identify permanent changes in equilibrium transaction prices. In this section, we apply methods of *Eun and Sabherwal* (2003) and *Johansen* (1988) to construct the error correction model using the cross-listed firm's domestic share price, home market index, synchronized U.S. share price and synchronized U.S. market index prices. Those four price series of the same cross-listed company are matched at the same trading time following the method we described in Section 4.1. We retrieve the speed of adjustment coefficients of the error correction models as the magnitude of price convergency. The error correction equation is established for every cross-listed firm within each quarter under two conditions: first, four price series associated with every cross-listed firm in every quarter are integrated of order one, i.e. I(1), (see Section 4.2.1). Second, price series of the same cross-listed firm are cointegrated, (see Section 4.2.2).

4.2.1 Unit root test (Augmented Dickey-Fuller test)

In this section, we determine the order of integration and the optimal lag length for the equations of the trading price series. We perform the Dickey-Fuller unique root test to check if the price series of the same firm are integrated of order one, denoted as I(1), (see, *Dickey and Fuller* (1979)). More specifically, the domestic share price, U.S. share price, domestic market index price and the U.S. market index price of the same cross-listed firm are non-stationary but their changes are stationary. For every price series x_t within every sample quarter, we run the time series stationary test and confirm that the level of price series is non-stationary. Then, we apply Augmented Dickey-Fuller Test to construct the three regressions as below (see, equation 4.1, equation 4.2 and equation 4.3), which test if the first difference of each price series Δx_t is concerned with the presence of a drift term and/or a linear time trend. We expect that the null hypothesis of the absence of unit root cannot be rejected in all

three equations, which means the first difference of the price series are stationary. We use minimum Bayesian Information Criterion (BIC) (*Schwarz* (1978)) to determine the optimal p, which is the number of lag to be included in the model.

$$\Delta x_t = \delta x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-i} + e_t \tag{4.1}$$

$$\Delta x_t = C_0 + \delta x_{t-1} + \sum_{i=1}^{p} \phi_i \Delta x_{t-i} + e_t \tag{4.2}$$

$$\Delta x_t = C_0 - \delta x_{t-1} + C_1 t + \sum_{i=1}^{p} \phi_i \Delta x_{t-i} + e_t \tag{4.3}$$

We run equation 4.1 - 4.3 within every sample firm-quarter on four synchronized series: the domestic price, the U.S. price, the domestic market index price and the U.S. market index price. At 5% confident interval level, the null hypothesis of I(1) cannot be rejected for 97% of the sample, which confirms that 524 (out of 537) sample companies with 10,627 firm-quarter observations meet the requirement that all four price series associated with each sample firm - the domestic and the U.S. share price as well as the domestic and U.S. market index prices - are I(1) in that sample quarter. One or two lags are indicated by the Bayesian Information Criterion (BIC) in the estimation of the VARs for different stocks.

4.2.2 Cointegration test

Within every firm-quarter, we test if four price series as a vector, $\boldsymbol{P}_{i,t} = \left(P_{i,t}^{HM}, P_{i,t}^{US}, P_{i,t}^{LI}, P_{i,t}^{SPY}\right)$ of the same cross-listed firm i within quarter t are cointegrated with single cointegrating vector. They are cointegrated if we can find a vector $\boldsymbol{\beta}_{i,t} = \left(\beta_{i,t}^{HM}, \beta_{i,t}^{US}, \beta_{i,t}^{LI}, \beta_{i,t}^{SPY}\right)$ such that $\boldsymbol{\beta'}_{i,t} * \boldsymbol{P}_{i,t}$ is stationary, I(0), on condition of that $\left(P_{i,t}^{HM}, P_{i,t}^{US}, P_{i,t}^{LI}, P_{i,t}^{SPY}\right)$ are I(1). If we can find one vector $\boldsymbol{\beta}_{i,t}$ to meet this requirement, then four prices of each sample stock are cointegrated with single cointegrating vector, denoted as

rank=1. If we find more than one cointegrating vectors $\boldsymbol{\beta}_{i,t}$, i.e. $rank > 1$, theoretically we need to construct different vector autoregressive models and include all of them as error correction terms in the error correction model for the same cross-listed company. However, few firms in our sample cointegrate with rank higher than 1. We will not address this issue in this study and simply exclude those special cases with rank higher than 1.

Within every sample firm-quarter, we run Johansen cointegration test (See more details at *Johansen*, 1988) on the four price series with the optimal lags p determined by minimized Bayesian Information Criterion (BIC). To determine the number of cointegrating vectors, we conduct the trace test of equation 4.4 and equation 4.5. The null hypothesis is that the number of cointegrating vectors is at most r and the alternative is that the maximum number of vectors is $(r + 1)$. We expect to reject null hypothesis when r=0 and fail to reject null hypothesis when r=1. Using the critical value of *Johansen and Juselius* (1990) at 5% confident interval level, we find that 95.23% (499 out of 524) sample cross-listed companies having four price series cointegrated within a quarter with a single cointegrating vector, resulting in 8,685 firm-quarters observations.

$$\lambda_{trace}(r) = -T \sum_{i=t+1}^{n} \ln(1 + \hat{\lambda}_t) \tag{4.4}$$

$$\lambda_{trace}(r, r+1) = -T \ln(1 - \lambda_{t+1}) \tag{4.5}$$

4.2.3 Error correction model

Using the sample of 499 cross-listed stocks which meet the requirement that one cointegrating vector can be found for the four price series of the same cross-listing firm by quarter, we establish the error correction model by firm-quarter and obtain the long-run price equilibrium term and the speed of adjustment for every firm - quarter.

Our method is in line with *Harris et al.* (1995), *Harris et al.* (2002) and *Eun and Sabherwal* (2003). For each sample stock i in every quarter, we estimate the Error Correction Models of equation 4.6 and equation 4.7. The optimal lag p is determined by lowest BIC as one or two for our sample firms and set uniformly across equation 4.6 and equation 4.7. As we describe in section 4.2.2, we use Johansen methodology to estimate the cointegrating vector $\boldsymbol{\beta}_{i,t} = \left(\beta_{i,t}^{HM}, \beta_{i,t}^{US}, \beta_{i,t}^{LI}, \beta_{i,t}^{SPY}\right)$ for each sample firm by quarter. We normalize the estimates by setting β^{HM} equals to 1 and the cointegrating vector in the Error Correction Model is $\boldsymbol{\beta}_{i,t} = \left(1, \beta_{i,t}^{US}, \beta_{i,t}^{LI}, \beta_{i,t}^{SPY}\right)$. Accordingly, the long run equilibrium can be calculated by $\left(P_{t-1}^{HM} + \beta^{US} P_{t-1}^{US} + \beta^{LI} P_{t-1}^{LI} + \beta^{SPY} P_{t-1}^{SPY}\right)$. The focuses of this study are coefficients $\alpha_{i,t}^{HM}$ and $\alpha_{i,t}^{US}$, representing the extent to which the price series respond to the deviation from the equilibrium relationship. We document the "speed of adjustment" from both the domestic side ($\alpha_{i,t}^{HM}$) and the U.S. side of trading ($\alpha_{i,t}^{US}$) respectively. The summary of the error correction model estimates are shown in Table 4.2.

$$\begin{aligned}\Delta P_{i,t}^{HM} = {} & a_{i,t}^{HM} + \alpha_{i,t}^{HM}\left(P_{t-1}^{HM} + \beta^{US} P_{t-1}^{US} + \beta^{LI} P_{t-1}^{LI} + \beta^{SPY} P_{t-1}^{SPY}\right) \\ & + \sum_{j=1}^{p} \gamma_j \Delta P_{t-j}^{HM} + \sum_{j=1}^{p} \delta_j \Delta P_{t-j}^{US} + \sum_{j=1}^{p} \nu_j \Delta P_{t-j}^{LI} + \sum_{j=1}^{p} \zeta_j \Delta P_{t-j}^{SPY} + \epsilon_{i,t}^{HM} \qquad (4.6)\end{aligned}$$

$$\begin{aligned}\Delta P_{i,t}^{US} = {} & a_{i,t}^{US} + \alpha_{i,t}^{US}\left(P_{t-1}^{HM} + \beta^{US} P_{t-1}^{US} + \beta^{LI} P_{t-1}^{LI} + \beta^{SPY} P_{t-1}^{SPY}\right) \\ & + \sum_{j=1}^{p} \gamma_j \Delta P_{t-j}^{HM} + \sum_{j=1}^{p} \delta_j \Delta P_{t-j}^{US} + \sum_{j=1}^{p} \nu_j \Delta P_{t-j}^{LI} + \sum_{j=1}^{p} \zeta_j \Delta P_{t-j}^{SPY} + \epsilon_{i,t}^{US} \qquad (4.7)\end{aligned}$$

Our main interests of price discovery proxies are $\alpha_{i,t}^{US}$ and $\alpha_{i,t}^{HM}$. Domestic market is the foreign firms' origination, we expect the U.S. share price adjust to the domestic share price. On the other hand, as claimed in many previous studies, the U.S. market is the information dominant, the largest global trading venue and leading financial center. We can also expect that the domestic share prices of cross-listed firms to response to the U.S. share price. Our hypothesis is that both the firm's

domestic share price $P_{i,t}^{HM}$ and its U.S. share price $P_{i,t}^{US}$ response to the short-term departure from the price equilibrium and the gap of domestic and U.S. prices could reduce quickly, which is the price discovery process. Both domestic stock markets and the U.S. markets will contribute to the price discovery process. In most cases, $\alpha_{i,t}^{US}$ and $\alpha_{i,t}^{HM}$ have opposite signs. For one cross-listed stock, if the domestic price is higher than the U.S. price at time t-1, we expect to observe that $P_{i,t}^{HM}$ decrease while $P_{i,t}^{US}$ increases to adjust toward the equilibrium. Accordingly, we expect $\alpha_{i,t}^{HM}$ to be negative and $\alpha_{i,t}^{HM}$ to be positive. If its domestic share price is cheaper than the U.S. price at time t, the relationship would be opposite. A less likely possibility is that both $P_{i,t}^{US}$ and $P_{i,t}^{HM}$ increase (decrease) but one increases (decreases) much more than the other share price till they achieve the equilibrium. The larger of the absolute value of α is, the faster that share price would adjust to the equilibrium. It takes (Departure from price equality(D))/$|\alpha|$ days[2] for the respective share price to converge to the long run equilibrium. Accordingly, $\left|\alpha_{i,t}^{HM}\right|$ proxies the speed of domestic price adjusts to the U.S. price and $\left|\alpha_{i,t}^{US}\right|$ proxies the U.S. share price converge toward the domestic share price. To put it another way, after one day of price movement, the domestic share price will adjust to the U.S. share price by $\left|\alpha_{i,t}^{HM}\right|$ dollar amount and the U.S. share price will move toward the domestic share price by $\left|\alpha_{i,t}^{US}\right|$ dollar amount.

[2]We use daily data to run the Error Correct Models, so the unit is "day".

Table 4.2: Error correction models: estimated values of α

We estimate the error correction model (Equations 4.6 and 4.7) for each cross-listing firm within every quarter. This table reports the mean of the estimated $|\alpha_{i,t}^{HM}|$ and $|\alpha_{i,t}^{US}|$ by home country.

	All Sample firms				NYSE/AMEX		NASDQA	
	No. of firms	Firm-quarter Obs.	α_{US}	α_{HM}	α_{US}	α_{HM}	α_{US}	α_{HM}
Argentina	7	131	0.594	−0.322	0.608	−0.334	0.551	−0.340
Australia	13	159	0.559	−0.324	0.609	−0.328	0.563	−0.315
Austria	1	11	0.871	−0.086	0.871	−0.086		
Belgium	3	42	0.784	−0.194	0.795	−0.175	1.186	0.063
Brazil	5	25	0.349	−0.515	0.266	−0.543		
Canada	211	3466	0.735	−0.293	0.703	−0.336	0.678	−0.349
Chile	7	103	0.525	−0.400	0.530	−0.400		
China	10	44	0.319	−0.074	0.333	−0.071		
Denmark	1	12	0.367	−0.660	0.367	−0.660		
Finland	4	77	0.727	−0.332	0.708	−0.334	1.076	−0.303
France	21	336	0.761	−0.198	0.748	−0.222	0.811	−0.108
Germany	12	260	0.483	−0.486	0.507	−0.470	0.252	−0.687
Greece	3	68	0.808	−0.101	0.808	−0.101		
Hong Kong	6	150	0.661	−0.295	0.684	−0.296	0.575	−0.290
Hungary	1	30	0.697	−0.219	0.697	−0.219		
India	8	96	0.688	−0.118	0.699	−0.094		
Indonesia	2	51	0.616	−0.288	0.616	−0.288		
Ireland	6	64	0.409	−0.559	0.568	−0.468	0.124	−0.720
Israel	35	542	0.894	−0.042	1.081	−0.022	0.884	−0.037
Italy	3	66	0.736	−0.251	0.736	−0.251		
Japan	29	571	0.672	−0.276	0.679	−0.270	0.656	−0.291
Korea	9	190	0.679	−0.175	0.689	−0.176	0.180	−0.133
Mexico	6	120	0.684	−0.315	0.680	−0.326		
Netherlands	14	256	0.430	−0.540	0.493	−0.475	0.352	−0.622
Norway	2	35	0.530	−0.482	0.510	−0.498	0.742	−0.310
Portugal	2	45	0.564	−0.350	0.564	−0.350		
Russia	5	53	0.796	−0.096	0.857	−0.085		
Singapore	2	43	0.924	−0.177			0.924	−0.177
South Africa	7	131	0.511	−0.470	0.488	−0.506	0.762	−0.074
Spain	7	138	0.744	−0.190	0.763	−0.169	0.529	−0.431
Sweden	2	18	0.622	−0.397			0.622	−0.397
Switzerland	10	149	0.684	−0.295	0.668	−0.313	0.832	−0.135
Taiwan	6	98	0.776	−0.203	0.785	−0.225	0.754	−0.146
Turkey	1	18	0.821	−0.181	0.821	−0.181		
United Kingdom	35	734	0.719	−0.261	0.751	−0.242	0.583	−0.345
Venezuela	1	12	0.288	−0.733	0.288	−0.733		
Total	497	8344	0.700	−0.280	0.681	−0.301	0.689	−0.282

The results in Table 4.2 summarizes the coefficients estimates of speed of adjustment (SOA). As we expected, $\left|\alpha_{i,t}^{HM}\right|$ and $\left|\alpha_{i,t}^{US}\right|$ have opposite signs. In most cases across 36 domestic countries, the estimated values of $\left|\alpha_{i}^{HM}\right|$ are negative and $\left|\alpha_{i}^{US}\right|$ are positive[3]. We exclude 2 firms with insignificant ECM model estimates and inflated SOA coefficients. The sample of 497 cross-listed firms with 8,360 firm-quarter observations are statistically significant. This reveals that the U.S. share price responds to deviations from the cross-listed firms' domestic share price. On the other hand, the domestic market provides some feedback and adjusts to the U.S. share price as well. This finding is consistent with the evidence from *Eun and Sabherwal* (2003) that both Canadian (home) and U.S. markets contribute to the price discovery process and share prices from both sides respond to the departure from equality. The untabulated results show that $\alpha_{i,t}^{SPY}$ and $\alpha_{i,t}^{LI}$ are either close to zero or statistically insignificant, which makes sense, because there is no reason to expect that any market index price response to the individual stock price.

Comparing the price adjustment from the U.S. and domestic sides, on average, the U.S. share price responses to the domestic share price by 0.700 while the domestic share price will response to U.S. share price by 0.280. Comparing the averages (mean) of $\left|\alpha^{HM}\right|$ and $\left|\alpha^{US}\right|$ by home countries, majority of the home countries (32 out of 36) have the absolute value of α^{US} larger than the absolute value of α^{HM}. The expectations are found for Brazil, Ireland and Venezuela, where domestic share prices adjust fasters than the U.S. share prices. The evidence indicates that for most of our sample home countries, domestic markets are dominant for the cross-listing firms and U.S. share price adjust toward to the domestic share prices significantly. On the other hand, we also observe a statistically significant amount of price adjustment from domestic side to the U.S. share prices, which confirms our expectation that as a host market, U.S. markets also play an important role in price discovery mechanism.

[3]Using USD as a common currency of measurement, the home shares are more expensive than the U.S. shares in most cases

The speed of price adjustment varies considerably across different domestic markets. It depends on the interaction between the domestic and the U.S. market. One likely way in which the gap between the two prices could reduce is that, on average, the U.S share prices response to the departure and adjust toward the domestic price quickly while the domestic share adjust to U.S. price slowly. Some evidences can be found in Singapore (U.S. 0.924; home -0.177), Israel (U.S. 0.894; home -0.042), Austria (U.S. 0.871; home -0.086), Turkey (U.S. 0.821; home -0.181), Greece (U.S. 0.808; home -0.101), and Russia (U.S. 0.796; home -0.096). Other less likely possibilities include (a) the U.S. share response slowly to domestic markets like Venezuela - the U.S. share price adjust to the price departure by 0.288 while the domestic share adjust to the price departure by -0.733. Denmark (U.S. 0.367; home -0.660), Brazil (U.S. 0.349; home -0.515) and Netherlands (U.S. 0.349; home -0.515) are other examples that domestic share price responses faster toward the U.S. listed share prices. (b) The price discovery processes slowly from both side. China is an example that the U.S. listed Chinese share price adjust by 0.319 and the Chinese domestic share price adjust by -0.074 to the equilibrium. (c) The U.S. side speed of adjustment and the domestic side are comparable. For example, Germany (U.S. 0.483; home -0.486), Norway (U.S. 0.53; home -0.482) and South Africa (U.S. 0.511; home -0.47) domestic shares and U.S. shares response to the price departure at similar speeds toward to the equilibrium prices.

We also split the sample by foreign cross-listed firms in NYSE/AMEX versus NASDQA. On average, NYSE/AMEX listed share prices response to the price departure by 0.681 and their domestic share prices response by -0.301. NASDAQ listed foreign share prices response by 0.689 while their domestic share prices response toward the U.S. prices by -0.282. The proportion of domestic speed of adjustment for NYSE/AMEX listed firms are slightly higher than those in NASDQA. *Hasbrouck* (1995) used a sample of U.S. stocks trading on the NYSE and regional exchanges

to show that price discovery occurs primarily on the NYSE. Similar findings are revealed in *Lee* (1993) and *Blume and Goldstein* (1991). Therefore, the NYSE has been characterized as information dominant. The findings in Table 4.2 are in line with the findings in previous literature that NYSE, as information dominant, contributes more in the price discovery than NASDQA. The foreign share prices will adjust toward NYSE more than NASDAQ.

4.3 Determinants of the price discovery

As per the above discussion, the contribution of price discovery and speed of price converge varies a lot across different domestic markets. The U.S. markets plays different roles in this process according to the counterpart home market of the cross-listing firms. We will analyze the determinants of this variation using regression analysis. In this section, we first discuss the variables construction and the associated hypothesis.

4.3.1 U.S. market relative contribution

We use the U.S. market relative contribution to price discovery as the dependent variable in the regression analysis in Section 4.5, which is proxied by the domestic portion of total speed of adjustment. Following the method from *Eun and Sabherwal* (2003), for each sample firm in every quarter, the proportion of the total price adjustment that occurs in the domestic market can be considered as the measure of price discovery that takes price due to the trading of the shares in the U.S. markets for the same firm. Accordingly, $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right)$ proxies the U.S. market impact on the process discovery mechanism. If U.S. trading has no effect at all, it is no need that the domestic share prices adjusts toward the U.S. prices, so that the $\left|\alpha_{i,t}^{HM}\right| = 0$ and $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right) = 0$. On the other hand, if the domestic market is unable to affect price adjustment and has no effect on the price discovery,

the U.S. shares will not response; $\left|\alpha_{i,t}^{US}\right| = 0$ and $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right) = 1$.

4.3.2 U.S. share of trading volume

Hasbrouck (1995) finds that NYSE's contribution to price discovery is positively correlated the NYSE market share by trading volume relative to the other U.S. regional exchanges. *Eun and Sabherwal* (2003) confirms this finding using U.S. - Canadian cross-listed stocks that the cross-listed stocks with more trading volume proportion in the U.S. market, its Canadian share price will adjust more toward the U.S. share price. According, the relative trading volume of the cross-listing stocks is a determination of price discovery process. The larger the U.S. trading volume of the cross-listed stock, the more informative of the U.S. trading; the more efficient of the U.S. market trading; the domestic market makers for the cross-listing stock would care more about the U.S. share price. Accordingly, if U.S. proportion of trading volume is larger, the domestic share price will response to the price disparity faster toward to the U.S. share price. The U.S. market will contribute more in the price discovery process.

We calculate the U.S. share of trading volume as the ratio of trading volume in the U.S. market i to the total of trading volume in both domestic market and the U.S. market, $(\text{Vol}_{US}/(\text{Vol}_{US} + \text{Vol}_{HM}))$. We first obtain the daily share of trading volume (VO) for each cross-listed share from DataStream and CRSP databases. We download the American Depository receipt (DR) exchange ratio from WorldScope database. To further verify the ADR bundle ratio, we collect ADR bundle ratios from WorldScope, Citi bank, J.P. Morgan Chase Bank and Bank of New York. Then we adjust the number of shares trading volume in the host market by multiplying the bundle ratio for those ADRs in our sample. We also measure the U.S. dollar denominated value trading volume (VA) calculated as the daily number of shares trading volume times the daily close price as a robustness check. The value based volume ratio avoids the

inaccuracy measurement caused by missing/error ADR bundle ratio.

4.3.3 Information factor

One of the prevalent findings from previous price discovery literature is that information trading contributes to the discovery of one price by the other price in a cointegrated time-series system of prices. *Eun and Sabherwal* (2003) uses the medium-size trades as a proxy of informed trading and finds that the ratio of shares traded in the U.S. and in Canada in medium sized lots is positively correlated with the U.S. relative contribution to the price discovery. Many previous papers characterize NYSE (comparing to other stock exchanges in the U.S.) or primary exchanges (comparing other regional stock exchanges in a country) as information dominant. For example, *Hasbrouck* (1995) uses a sample of U.S. stocks trading on the NYSE and regional exchanges and find that price discovery occurs primarily on the NYSE because the trading on the NYSE is more informative. Similar findings are revealed in *Lee* (1993) and *Blume and Goldstein* (1991).

Baruch et al. (2007) proposes a theoretical model to explain the variations in volume shares of internationally cross-listed stocks (henceforth, the BKL information factor). The BKL information factor is estimated by the correlation between cross-listed asset returns and the returns of other assets traded on that market. It represents the incremental information generated from the host (U.S.) market in addition to that from its home market. Using the sample of foreign firms that cross-list in U.S. markets, *Baruch et al.* (2007) and *Halling et al.* (2008) document evidences to support the prediction of the BKL model that proportionally more volume takes place in the U.S. than its counterpart home market if the cross-listed asset has a higher information factor. In this paper, we adopt the BKL information factor to measure the incremental information provided by the U.S. market in addition to that provided by its domestic home market for each stock. For every cross-listed stock

in our sample, we first regress daily domestic market returns of stock i on the daily index return in the domestic market and obtain the R-square, R_r^2, in the restricted model.

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \epsilon_{i,t}, \tag{4.8}$$

where $\boldsymbol{\beta}^{home}_{i,t}$ is a 3×1 vector of asset i's loading on index returns of the home market, and $\boldsymbol{R}^{home}_{m,t}$ is a 3×1 vector of index returns (R_m) of the home market. We estimate the equation at every day t within a three-day window, from the previous day $(t-1)$ to the next day $(t+1)$; that is, $\boldsymbol{\beta}'^{home}_{i,t} = \left(\beta^{home}_{i,t-1}, \beta^{home}_{i,t}, \beta^{home}_{i,t+1}\right)'$ and $\boldsymbol{R}^{home}_{m,t} = \left(R^{home}_{m,t-1}, R^{home}_{m,t}, R^{home}_{m,t+1}\right)'$, to account for non-synchronous trading across markets in different time zones.

We next estimate the unrestricted model by adding daily index returns of a host market as additional regressors, and obtain the new R-square, R_{ur}^2, in the unrestricted model:

$$R_{i,t} = \alpha_{i,t} + \boldsymbol{\beta}'^{home}_{i,t} \boldsymbol{R}^{home}_{m,t} + \boldsymbol{\beta}'^{host}_{i,t} \boldsymbol{R}^{host}_{m,t} + \xi_{i,t}, \tag{4.9}$$

where $\boldsymbol{\beta}^{host}_{i,t}$ is a 3×1 vector of asset i's loadings on index returns of the host market, and $\boldsymbol{R}^{host}_{m,t}$ is a 3×1 vector of index returns of the host market from $t-1$ to $t+1$, with $\boldsymbol{\beta}^{host}_{i,t} = \left(\beta^{host}_{i,t-1}, \beta^{host}_{i,t}, \beta^{host}_{i,t+1}\right)'$ and $\boldsymbol{R}^{host}_{m,t} = \left(R^{host}_{m,t-1}, R^{host}_{m,t}, R^{host}_{m,t+1}\right)'$.

We calculate the incremental information provided by the host market j regarding the price of stock i in year T as the following:

$$\text{Information factor}_{i,j,T} = \frac{\left(R_{ur}^2 - R_r^2\right)/3}{\left(1 - R_{ur}^2\right)/\left(n-6\right)} \tag{4.10}$$

where n is the number of daily returns used in both restricted and unrestricted models.

As we detailed in Section 4.1, we obtain the domestic market daily stock prices for

each cross-listed share and daily market index prices from Datastream and the U.S. daily trading data[4] from TAQ and CRSP. All data series are converted to the U.S. dollar as a common currency. We adjust the host market share price by dividing the DR bundle ratio for those DRs (ADR, GDR, etc.) in our sample. For each stock, we first calculate daily stock returns and corresponding market index returns. We run a pair of time series regressions simultaneously for each cross-listing in every sample year based on data from the past 48 months of every observation. If the available data is less than 36 months, we drop that firm-year observation to avoid biased estimates.

We expect a positive correlation between the information factor and the U.S. market relative contribution in price discovery. The more price information the U.S. market providing, the more information trading will execute in the U.S. market comparing to the counterpart home market *Wang and Zhou* (2014), and accordingly, the more U.S. stock exchange will contribute in stock price discovery relative to the counterpart domestic market.

4.3.4 Domestic country distance to U.S.

The geographic distance of the home market to the U.S. market may affect information flow between the markets and thus sway the trading activities. When a home market is located further away from the U.S. market, the information flow is hindered. Investors in the U.S. host markets far away to the home country are at an information disadvantage too and thus shy away from trading based on the stale information. Less (informed) trading will be executed in the U.S. host market. If a domestic market locate closer to the U.S. market, more trading are expected, like Canada which treats U.S. stock market as a "satellite" trading venue. We expect that the U.S. market contributes less in price discovery for those cross-listed firms from a

[4]We use SPY as the U.S. market index in the information factor calculation. As a robustness, we also calculate the information factor using SP500 as the U.S. market index. The two measures of information factor are very close. (see Section 4.5)

domestic country far away.

We construct two proxies for the distance: the time zone distance and the mileage distance between domestic major stock exchange location and the New York. For the time zone distance, we obtain the standard time zone for each stock exchange from WorldClock's website[5]. For example, Frankfurt is located in time zone "UTC/GMT+1" and is recorded as "+1"; New York is located in time zone "UTC/GMT−5" and is recorded as "−5". For the mileage distance, we measure the natural logarithm of the mileage distance between two cities on Google Map.

4.3.5 Listing duration

Firms with longer presence in the U.S. market usually are better known to the U.S. investors and thus have more U.S. trading activities. *Eun and Sabherwal* (2003) shows a positive association between the years listed in the U.S. and the foreign share of total adjustment in price. The longer the firms listed in the U.S. market, the U.S. share price will be more influential and the foreign share price will adjust more toward the U.S. share price. We measure the duration that a foreign firm listed in the U.S. market using the "Begin of Stock Data" in CRSP and count the number of days since the begin date. We us the natural logarithm of number of days since the share listed in the regression analysis.

4.3.6 Liquidity

(i) Amihud illiquidity

Previous research (e.g. *Amihud* (2002), *Pástor and Stambaugh* (2003) and *Acharya and Pedersen* (2005)) demonstrate that illiquidity is a source of risk which is priced by the market. Liquid market associate with higher trading efficiency, lower trading cost. We can expect that cross-listed stock accesses the higher level of liquidity in the U.S.

[5]The URL is `www.timeanddate.com/worldclock/`.

market relative to its domestic market, its U.S. market price to be more influential in the price discovery process and the domestic share of total prices adjustment in repones to the price deviations to be higher.

Using the method from *Amihud* (2002), we measure illiquidity as the average ratio of the daily absolute return to the dollar value of trading volume on that day. We compute separately for the domestic traded shares and the U.S. traded shares and calculate the ratio of U.S. illiquidity to the domestic illiquidity for the same cross-listed stock. We expect that the higher illiquidity ratio, the lower domestic share of total price adjustment, the less contribution from the U.S. market in the price discovery process.

(ii) Market depth

Koumkwa and Susmel (2008) shows that the market average daily volume, market capitalization, and float are positively and significantly correlated to the speed of transition between regimes. Similar findings are reported in *Rabinovitch et al.* (2003) where low market volume is associated with higher transaction costs. We collect stock market turnover data from *Beck et al.* (2009), which was updated in 2012 and is available on the World Bank website. We construct the ratio of stock market turnover of U.S. market to domestic market turnover. It proxies the relative market depth and breath. We expect that higher the U.S. to domestic stock market turnover ratio; the more domestic share price adjusts toward the U.S. share price; the more U.S. relative contribution to the price discovery.

4.3.7 Financial market legal protection

Many previous studies find that the market/country legal environment and regulation soundness influence the trading activities a lot. Previous studies have shown that the foreign stocks' trading in the U.S. is high due to the benefit of better legal protection for shareholders in the U.S. (*Halling et al.*, 2008; *Pulatkonak and Sofianos*, 1999).

Investors prefer to become shareholders of a company in a country where stronger legal investor protection is provided. *Melvin* (2003) and *Auguste et al.* (2005) finds that capital movement restrictions can seriously affect the cross-listing price disparity, especially during economic and currency crisis. *Claessens et al.* (2002) finds that countries with higher income per capita, better macro policies, more efficient legal systems, better shareholder protection, and more open financial markets tend to attract more trading activity. As we discussed in essay 1 (*Wang and Zhou* (2014)) and essay 2, better legal protection and financial market development can better facilitate trading activities. In this research, we measure three legal protection proxies below as the difference between the U.S. index to the domestic market index. The higher legal protection difference indicates the lower level of legal protection of the domestic market relative to the level of U.S.; in this case, we expect the more trading will flow to the U.S. market and domestic share price will adjust toward U.S. share price too. Therefore there is a positive relation between the legal protection ratio of U.S. to home markets and the domestic share of price adjustment.

(i) Financial disclosure

Following the method from *La Porta et al.* (2006), *Disclosure index* is estimated from the arithmetic mean of six variables of information disclosure. Information disclosure index is measured from six perspectives: prospectus, compensation, shareholders, inside ownership, contracts irregular and transactions for each country (*La Porta et al.*, 2006). A higher index indicates higher quality of financial disclosure.

(ii) Shareholder protection

We use the *anti-director rights index* from *La Porta et al.* (1998), which has been widely used in numerous articles as a measure of shareholder protection. The index is the sum of six anti-director rights scores ranging from 0 (e.g., Belgium in our sample) to 5 (e.g. Canada and the U.S. in our sample). A higher index indicates better legal protection for minority shareholders. *Djankov et al.* (2008) revise the La Porta

anti-director rights index. We test this *revised anti-director rights index* as one of the proxies of the shareholder protection in this study as well.

(iii) Anti-self-dealing index

Djankov et al. (2008) present another measure of legal protection of minority shareholders against expropriation by corporate insiders: the anti-self-dealing index. It is the average of the ex ante and ex post control of self-dealing for each country.The principal components of "control of self-dealing" measurement include (1) approval by disinterested shareholders; (2) disclosures by buyer; (3) disclosures by Mr. James; (4) independent review; (5) each of the elements in the index of disclosure in periodic filings; (6) standing to sue; (7) rescission; (8) ease of holding Mr. James liable; (9) ease of holding the approving body liable; and (10) access to evidence (*Djankov et al.*, 2008).

4.3.8 Control variables

To ensure that our results are not driven by any possible effects from firm size, home country region and industries effect, we measure control variables as below.

(i) Firm size: We measure the natural logarithm of each cross-listed firm's domestic market capitalization as a proxy of firm size.

(ii) Home market economic development: We obtain the *gross domestic product growth* from Datasteam. We use annual percentage growth rate of gross GDP as an indicator of the level of domestic economic development to control the impacts from the domestic country economic development. We expect a negative relationship between domestic GDP growth and the domestic share of price adjustment. If the cross-listed stock from a less developed home country, then more trading activities of the stock will be executed in the U.S. market. The domestic share price will converge toward U.S. share price.

(iii) Region dummy: We construct six domestic regional dummies - Europe and

Israel; Canada and the U.S.; South America and Mexico; Asia, Australia and New Zealand - for home markets in order to control for variation clustered by region.

(iv) Industry dummy: Some domestic country may have superior access to information for firms in a particular industry. We control for the industry effect through four industry dummies categorized by SIC code, mining ($1000 \leq SIC < 1500$), manufacturing ($2000 <= SIC < 4000$), utilities ($4000 <= SIC < 5000$) and financial services ($6000 <= SIC < 7000$).

4.4 Descriptive statistics

Table 4.3 Panel A reports the sample summary statistics for variables we discussed in Section 4.3. The speed of adjustment, trading volume and information factor variables are winsorized at top and bottom 1%. Overall, the sample includes 497 foreign firms cross-listed in U.S. markets. Canada is the largest domestic country with 211 firms cross-listed in U.S., followed by the U.K. (35), Israel (35) and Japan (29). Some sample home countries share a small slice of the sample. For example, Austria, Denmark, Hungary, Turkey and Venezuela only have one cross-listing in the U.S. from each of them. SOA (HM/TOT) is the domestic portion of the total speed of adjustment representing the U.S. market relative contribution to price discovery. Consistent with the finding in Table 4.2, majority of the sample firms' domestic share prices adjust slowly and U.S. share prices adjust faster toward the domestic prices. On average, 31.51% of the total speed of adjustment is for domestic share prices converging to the U.S. prices, which indicate the U.S. market relative contribution to the price discovery. Although the domestic markets still play a major role (68.49%) in the price discovery process. the U.S. market as a host market also has a significant amount of contribution in the price discovery. Three out of 36 home countries have firms listed in U.S. with larger U.S. relative contribution in the price discovery, which are Brazil (56.388%) Ireland (56.45%) and Venezuela (71.225%). In those three coun-

tries, the domestic share prices adjust toward U.S. prices more than the other way around. In some home countries like South Africa (49,164%) and Norway (46.773%), the domestic and the U.S. sides of contribution are similar to the price discovery. The U.S. proportion of trading volume are estimated in two ways - the share volume measure (VO) and the U.S. dollar volume measure (VA). The two measurements are very close to each other. Because the value based measure of trading volume is more robust and avoid the inaccuracy caused by missing/errorance ADR ratio, We focus on the VA measured trading volume ratio in our discussion in this section. On average, 96.613% of the cross-listed trading volume are executed in the U.S. market. 29 out of 36 domestic markets firms have over 90% trading volume shares executed in the U.S. markets. Chinese firms have the lowest trading volume portion in the U.S. market, which is 69.685%. For robustness check purpose, we estimate the information factor in two ways - one is estimated using the synchronized SPY as the U.S. market index and the other one is estimated using the daily SP500 index close price as the U.S. market index in the regression model. Both measurements provide similar results. We will focus our discussion on the synchronized SPY measured information factor. On average, the U.S market provides additional price information as 7.356 across all sample firms. It provides more than average information to the shares from Austria (info factor: 56.728), Germany (info factor: 17.582), Norway (15.898) and Switzerland (13.063) as well as China, Finland, Italy, Mexico, Netherland and South Africa. On the other extreme, the U.S. market provide minimal additional information to shares from Turkey (1.233) and Belgium (1.226). Duration is a indicator of foreign firms history and visibility in the U.S. market. It measures how many days the firm has been listed in the U.S. market. On average, the sample firms listed in the U.S. market for 4,422 days which is about 12 years. It ranges from the shortest listing duration for one Austrian firm (1599 days, about 4.4 years) to the longest listing duration for the Swedish firms (11,430 days, about 31.3 years). The average sample firm size

is 16.73 million measured by domestic market capitalization. Large firms are from Norway (51.794), Switzerland (49.432) and Hong Kong (47.299), while smaller firms are from Venezuela (1.116), Singapore (1.843), Mexico (2.519) and Israel (2.024). Overall, the illiquid ratio indicate that U.S. shares are more liquid (less than 1 in illiquid ratio) than its domestic shares. On average, for the same cross-listed firm, its U.S. share is more liquid than the domestic share in 25 out of 36 home countries, shown by a liquidity ratio of U.S. to Home Amihud illiquid measurement less than 1. Looking at the market liquidity measured by market turnover, the U.S. market is 3 times as liquid as the counterpart home market on average. Especially, the U.S. market has market turnover 45.375 times of the market turnover in Venezuela, and 24.506 times of the market turnover in Argentina. We measure the counterpart home market GDP growth rate as an indicator of the cross-listed firms' origination country economic development. China has a highest GDP growth as 10.739% per year on average while Denmark has the lowest GDP annual growth as -0.628% on average. The anti-director rights index (ADRI), anti-self-dealing index (ASDI), disclosure index show that the U.S. market on average is better in legal protection and financial disclosure enforcement than the counterpart domestic market. However, the revised anti-director rights index (RADRI) shows that the U.S. shareholder protection is 1 level less than the counterpart domestic market on sample average. It is mainly driven by the increased RADRI in European countries and some Asian countries (Japan, Korean, Hong Kong and Singapore). The countries like Venezuela and China still remain a low level of shareholder protection. We measure the distance from the counterpart domestic market to New York for both geographic distance and the time zone distance. The geographically farthest home country is Indonesia - 10,057 miles away. The farther country in time zone is Australia which is 15 hours ahead of New York time. Canada is the closet country in both geography (343 miles) and time zone (0 hour difference).

The estimated correlation coefficients, reported in Panel B of Table 4.3. As we expected, two measures of U.S. trading volume ratio are highly correlated (65%); two measures of information factor are highly correlated (89%); Geographical distance and time zone distance are highly correlated (94%). Higher linear correlation among four proxies of legal protection - anti-director rights index, revised anti-director rights index, anti-self-dealing index and disclosure index. We will try to avoid those highly correlated variables included in the same regression model in the analysis.

Table 4.3: Summary statistics on sample of U.S. cross-listings by home country

The table reports summary statistics for firm and market characteristics in this study. The sample includes all U.S. cross-listed companies from 35 host markets. We measure domestic share of price adjustment as the ratio of the absolute value of domestic speed of adjustment to the total of the absolute value of domestic and U.S. speed of adjustment in response to the price deviation from the equilibrium. U.S. share of total trading volume for each stock are measured by dollar volume (VA) and share volume (VO). The information factor is estimated using Equation 4.10. The information factor are measure by SPY as U.S.market index (F_{SPY}) and SP500 as U.S. market index (F_{SP500}) for robustness check. Other firm and market level variables are measured as we stated in Section refsec:var. Panel A summarizes cross sectional mean values of firm and market characteristics for each home market as well as the overall sample. Mean values are calculated by averaging the variables over time for each cross-listing, and then by averaging firm means within each host country. Panel B presents the correlation coefficients of the all characteristic variables used in the regression analysis.

Panel A: Firm and market characteristics

Home	No of firms	SOA (HM/TOT) (%)	VO (US/TOT) (%)	VA (US/TOT) (%)	Info factor (SPY)	Info factor (SP500)	Duration (days)	MV HM (mil)	Illiquid (US/HM)	Turnover (US/HM)	GDP_{chg} (HM)	ADRI (US-HM)	RADRI (US-HM)	ASDI (US-HM)	Discl Ind (US-HM)	DtoNY (miles)	TZ (HM-US)
Argentina	7	31.434	99.948	99.601	2.957	2.884	3364	3.389	0.111	24.506	6.851	1	1	0.313	19	5305	2
Australia	13	39.392	97.803	91.413	3.175	3.317	4978	20.432	0.925	2.350	3.297	1	−1	−0.103	20	9946	15
Austria	1	15.014	84.810	74.180	56.728	50.704	1599	9.042	1.828	4.508	2.530	3	1	0.442	15	4228	6
Belgium	3	26.688	98.771	98.767	1.226	0.960	2253	19.619	0.027	4.400	1.689	5	0	0.110	20	3660	6
Brazil	5	54.388	99.894	99.862	4.233	4.486	2372	19.953	0.006	3.233	4.196	2	−2	0.381	25	4794	2
Canada	211	30.728	99.582	99.561	8.284	8.974	4082	4.349	0.072	2.674	2.353	0	−1	0.013	20	343	0
Chile	7	44.074	99.765	89.966	6.774	7.126	4328	6.097	7.398	16.553	4.439	2	−1	0.029	20	5136	1
China	10	21.290	98.562	69.585	9.658	8.522	3960	24.632	3.840	1.886	10.739		2	−0.108	20	7383	13
Denmark	1	46.004	99.371	99.121	3.261	3.193	10258	37.228	0.037	3.632	−0.628	3	−1	0.192	17	3847	6
Finland	4	42.272	98.236	98.187	10.727	9.237	2880	44.548	0.132	1.741	2.717	2	−1	0.197	23	4113	7
France	21	29.381	96.375	96.658	5.238	3.241	2949	32.153	1.350	1.886	1.562	2	−1	0.275	20	3628	6
Germany	12	45.050	99.914	99.930	17.582	8.044	2841	36.229	0.008	1.485	0.864	4	−1	0.372	20	4017	6
Greece	3	21.198	96.011	97.894	3.394	3.018	2655	11.641	0.281	4.941	1.023	3	1	0.438	15	4927	7
Hong Kong	6	31.195	98.127	84.257	4.193	5.450	2570	47.299	10.339	2.793		0	−2	−0.308	11	8059	13
Hungary	1	26.073	98.716	93.965	2.667	1.113	2836	4.165	0.474		1.867		1	0.473	22	4359	6
India	8	18.705	99.656	99.332	7.668	5.788	2448	7.093	0.168	2.454	8.277	0	−2	0.075	22	7799	11
Indonesia	2	32.348	99.720	89.815	3.104	3.799	3315	9.676	1.235	4.095	4.782	3	−1	0.001	25	10057	12
Ireland	6	56.645	98.401	94.703	5.424	3.782	4438	9.912	0.143	4.922	2.305	1	−2	−0.135	24	3179	5
Israel	35	15.551	99.630	99.670	6.083	4.813	4293	2.024	0.089	3.839	4.212	2	−1	−0.071	20	5667	7
Italy	3	32.796	98.077	96.584	9.397	7.422	5782	30.388	0.241	1.750	0.324	4	1	0.233	22	4019	6
Japan	29	30.755	93.238	89.390	5.250	5.217	8486	32.833	1.733	1.754	0.894	1	−2	0.156	15	6744	14
Korea	9	25.242	98.436	96.241	3.103	3.370	2923	16.107	2.731	1.031	3.908	3	−2	0.185	15	6872	14
Mexico	6	29.583	99.735	98.957	9.432	8.828	4181	2.519	0.296	7.541	2.138	4	0	0.482	13	2094	1
Netherlands	14	46.716	97.226	97.133	8.454	6.320	4796	19.235	0.427	1.383	1.750	3	1	0.451	25	3645	5
Norway	2	46.773	97.375	96.874	15.898	11.163	2108	51.794	0.289	1.810	1.429	1	−1	0.233	23	3676	6
Portugal	2	34.467	96.117	87.660	2.877	0.632	3734	10.443	1.142	3.260	0.578	2	1	0.210	21	3371	5
Russia	5	25.763	99.345	95.805	6.768	3.801	2441	4.320	0.636	4.253	5.426		−1	0.214	22	4668	8
Singapore	2	21.974	99.295	99.069	4.673	5.160	3067	1.843	0.744	3.221	6.406	1	−2	−0.346	22	9539	13
South Africa	7	49.164	99.084	99.042	9.703	8.239	7131	8.717	0.281	3.874	3.702	0	−2	−0.158	23	7987	7
Spain	7	27.853	94.623	93.922	3.667	2.989	5499	43.564	0.707	1.168	2.610	1	−2	0.281	22	3587	6
Sweden	2	44.440	99.514	99.503	4.970	1.544	11430	43.720	0.039	2.086	1.924	2	−1	0.321	23	3927	6
Switzerland	10	39.546	98.337	99.019	13.063	8.610	2533	49.432	0.083	2.173	2.009	3	0	0.388	20	3931	6
Taiwan	6	24.411	98.878	93.993	3.582	5.557	2598	14.099	7.674		4.474	2	0	0.090	20	7797	13
Turkey	1	23.872	99.767	99.342	1.233	2.434	3099	13.409	0.043		4.094	3	0	0.225	23	5020	7
United Kingdom	35	32.606	96.108	91.614	6.071	4.127	5681	46.488	1.181	1.493	1.783	0	−2	−0.296	18	3463	5
Venezuela	1	71.225	99.992	99.947	2.151	1.919	2487	1.116	0.001	45.375	8.124	4	2	0.563	20	2136	1
Total	497	31.510	98.275	96.613	7.356	6.728	4422	16.732	0.888	3.103	2.560	1	−1	0.055	19	3193	5

Table 4.3 (Cont'd)
Panel B: Correlation coefficients

Variable	SOA (HM/TOT) (%)	VO (US/TOT) (%)	VA (US/TOT) (%)	Info factor (SPY)	Info factor (SP500)	Duration (days)	MV HM (mil)	Illiquid (US/HM) (%)	Turnover (US/HM)	GDP_{chg} (HM)	ADRI (US-HM)	RADRI (US-HM)	ADSD (US-HM)	Disclsr (US-HM)	DtoNY (miles)
VOUSR	0.06														
VAUSR	0.03	0.65													
F(SPY)	0.07	0.09	0.08												
F(SP500)	0.06	0.08	0.07	0.89											
Duration	0.05	−0.05	−0.09	0.03	0.07										
Firm size	0.10	−0.06	−0.03	0.11	0.05	0.17									
illiquidUSR	−0.02	−0.25	−0.40	−0.02	−0.02	−0.01	−0.03								
Mkt turnover(dif)	0.00	0.09	0.02	−0.03	−0.02	−0.03	−0.08	0.01							
GDP(growth)	−0.04	0.08	−0.05	−0.06	−0.05	−0.09	−0.12	0.04	−0.00						
ADRI(dif))	0.01	−0.10	−0.07	0.03	−0.13	−0.05	0.23	0.02	0.06	−0.03					
Revised ADRI(dif)	−0.01	0.05	0.04	0.05	−0.00	−0.12	−0.03	−0.05	0.29	0.10	0.42				
ASDI(dif)	0.05	−0.18	0.03	0.07	−0.05	−0.01	0.17	−0.05	0.11	−0.17	0.64	0.51			
Disclosure(dif)	0.04	0.26	0.27	0.07	0.06	−0.15	−0.22	−0.12	0.00	0.16	−0.14	0.19	−0.12		
Distance	−0.03	−0.27	−0.36	−0.13	−0.20	0.10	0.30	0.11	0.07	0.18	0.53	−0.06	0.11	−0.38	
TZ(dif)	−0.03	−0.36	−0.38	−0.12	−0.19	0.16	0.36	0.10	−0.11	0.04	0.46	−0.18	0.12	−0.50	0.94

4.5 Regression analysis and results

We perform panel regressions using the U.S. relative contribution to price discovery (domestic portion of speed of adjustment) as the dependent variable, which is calculated as $\left|\alpha_{i,t}^{HM}\right| / \left(\left|\alpha_{i,t}^{US}\right| + \left|\alpha_{i,t}^{HM}\right|\right)$ for every cross-listed firm in every quarter. Since the dependent variable is a ratio bounded within $(0, 1)$, we use the logistic transformation, $\ln(r/(r-1))$, where r is the U.S. relative contribution to price discovery (domestic portion of speed of adjustment), as the dependent variable and report the regression results in Panel A of Table 4.4, Table 4.5 and Table 4.6 in this section. As the robustness check, we also conduct a nature logarithm transformation, $\ln(r)$, and report the respective regression results in Panel B of Table 4.4, Table 4.5 and Table 4.6. The purpose of both transformations are to map a $(0, 1)$ dependent variable onto the whole real line and ensure the predicted dependent variable lies between $(0, 1)$. In general, the results support our expectations stated in Section 4.3.

4.5.1 Univariate regression

Table 4.4 reports the results from univariate regressions involving only one independent variable in every regression model. Each column reports panel regression with one independent variable results across firm-years. Standard errors are robust to heteroskedasticity and are adjusted for two-way clustering by firm and by year. R^2 is adjusted for degrees of freedom. Panel A reports the results of logistic transformed domestic speed of adjustment proportion as dependent variable. Panel B reports the results of natural log transformed domestic speed of adjustment proportion as dependent variable. All independent variables are defined in Section 4.3. Trading volume, information factor and market capitalization data are winsorized at the top and bottom 1%. Because the results in Panel A and Panel B are very close, we focus our discussion on the results based on the models using logistic transformed dependent variable (in panel A). In line with our initial predictions, results show that

higher U.S. portion of trading volume, proxied by share volume (VO) or value volume (VA), will make the U.S. share price more influential so that the domestic portion of speed of adjustment increases. In the other words, the U.S. market contribution is price discovery is larger. Additional price relevant information provided by the U.S. market, which is measured by the information factor (both the SPY measure and the SP500 measure), increases the U.S. relative contribution (domestic portion of speed of adjustment) in the price discovery too. A firm with a longer listing history in the U.S. market is shown to significantly increases its domestic proportion of speed of adjustment. The statistically negative coefficient on the illiquid ratio shows that if the U.S. share of the cross-listed firm is more liquid (less illiquid) than its domestic share, the U.S. share price is more influential and the domestic portion of speed of adjustment is higher. Better legal protection for investors in U.S. relative to the counterpart host markets of the cross-listed firms increases the share of domestic portion of speed of adjustment, evident from the positive coefficients on anti-director rights index (difference), revised anti-director rights index (difference), anti-self-dealing index (difference) and disclosure index (difference). A U.S. market tend to contribute more in price discovery for those firms from a less developed home market, evident from the negative coefficient on domestic GDP growth. As we expected, U.s. with more market depth and breadth relative to the counterpart home market will increase the domestic portion of speed of adjustment, shown as the positive coefficient of market turnover ratio of the U.S. to home market turnover. Geographic proximity, measured by both the geography distance and time zone difference, negatively influences the domestic portion of speed of adjustment but statistically insignificant in the univariate regression. As expected, farther distance between the domestic market and the U.S. will reduce the U.S. relative contribution in the price discovery.

Table 4.4: Univariate regression models

The table reports the results from univariate regressions involving only one independent variable in every regression model. Each column reports panel regression with one independent variable results across firm-years. Panel A reports the results of logistic transformed domestic speed of adjustment proportion as dependent variable. Panel B reports the results of natural log transformed domestic speed of adjustment proportion as dependent variable. The domestic speed of adjustment ratio is estimated as the absolute value of domestic speed of adjustment divided by the sum of the absolute values of the speed of adjustment of both home and U.S. markets for every cross-listed firm. The volume ratio, information factor and other independent variables are defined in Section 4.3. Trading volume, information factor and market capitalization data are winsorized at the top and bottom 1%. All market characteristic variables are mean-differenced series, that is, we subtract the mean across all applicable home markets from the U.S. market level of the characteristic variable. Standard errors are robust to heteroscedasticity and are adjusted for two-way clustering by firm and by year. R^2 is adjusted for degrees of freedom. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: Logistic transformed domestic SOA ratio as dependent variable															
	VORatio (US/TOT)	VARatio (US/TOT)	Info factor (SPY)	Info factor (SP500)	Duration (day)	Illq.Ratio (US/HM)	Anti-dir rights (US-HM)	Revised ADRI (US-HM)	Disclose (US-HM)	Anti-self dealing (US- HM)	GDP growth (HM)	StkMkt turnover (US/HM)	Geo. Distance (miles)	Time zone (HM-US)	Firm Size (MV,HM)
Estimates	4.735***	1.833**	0.015***	0.015**	0.108	−0.663**	0.046	0.065	0.069**	0.539**	−0.051**	0.009	−0.005	−0.013	0.098
t-statistics	(3.650)	(2.683)	(3.300)	(2.427)	(1.698)	(−2.187)	(0.720)	(0.835)	(2.336)	(2.643)	(−2.245)	(0.871)	(−0.045)	(−0.425)	(1.647)
Obs	7,916	7,916	6,309	6,309	7,916	7,916	8,217	8,344	8,344	8,344	8,194	7,275	8,344	8,344	8,344
Adj. R-sq (%)	0.86	0.61	0.49	0.36	0.22	0.08	0.08	0.05	0.69	0.25	0.40	0.05	0.00	0.09	1.02
Panel B: Log transformed domestic SOA ratio as dependent variable															
Estimates	3.151***	1.188**	0.010***	0.011**	0.063	−0.373*	0.022	0.039	0.044**	0.300**	−0.036**	0.005	−0.014	−0.010	0.052
t-statistics	(3.080)	(2.353)	(3.619)	(2.784)	(1.542)	(−1.836)	(0.532)	(0.768)	(2.267)	(2.472)	(−2.281)	(0.717)	(−0.191)	(−0.506)	(1.229)
Obs	7,916	7,916	6,309	6,309	7,916	7,916	8,217	8,344	8,344	8,344	8,194	7,275	8,344	8,344	8,344
Adj. R-sq (%)	0.81	0.55	0.45	0.39	0.16	0.05	0.04	0.04	0.59	0.17	0.42	0.03	0.02	0.12	0.60

4.5.2 Multivariate regression

In this section, we perform a series of panel regressions to evaluate the relative contribution of the U.S. market in price discovery and the firm and market level characteristics in determining the price discovery process. Table 4.5 presents the results of a set of regressions: model (1)-(3) is the baseline regression applying pooled OLS. Model (4) applies industry fixed effect using four industry dummies: finance, utility, manufacture and mining. Model (5) applies home region country fixed effects classified by 6 home region. Model (6) -(7) apply both the industry and the home region dummies. The fixed effects dummies are constructed as we defined in Section 4.3. The purpose of controlling for industry and home region fixed effects is to take into account the possibility that differences in investment levels among industry and domestic region may explain our results.

To avoid multicollinearity issue, we try to keep at least one proxy from each hypothesis and avoid including the highly correlated variables (shown in Table 4.3 Panel B) in the same models. Eventually, Models (1)-(5) are five combinations of variables that represent different theories in explaining the U.S. relative contribution in price discovery without causing any statistical issues. Considering that other independent variables, like information factor, legal protection, listing duration, etc., could be explained in the way that they impact the price discovery process through influencing the portion of trading volume in the U.S. market. In essay 1, we investigate the determinants of host market proportion of cross-listed firm's global trading volume and the U.S. market is one of the host market included in our study. Information factor, legal protection proxies, listing duration, time zone distance are shown to be an important determinant of host market proportion of trading volume. To avoid any possible multicollinearity between the U.S. portion of trading with any of other independent variable, we construct regression model (6) and (7) as robustness checks. Model (6) includes all independent variables representing different price discovery

arguments, expect the U.S. portion of trading volume. Model (7) includes only the U.S. trading volume ratio and industry as well as home fixed effect dummies. They both show consistent and robust results. The significance and the coefficients size are comparable to the results in model (1) - (5). Given that the results are similar for the two transformation of the dependent variables, our discussion will focus on the results generated by the logistic transformation as dependent variable in Panel A.[6]

In model (1), (2), (4), (5) and (7), the coefficients of U.S. portion of trading volume, measured either by share volume (VO) or value volume (VA), are positive and statistically significant at 1% level, implying that the greater the U.S. portion of total trading, the more domestic share price adjusting toward U.S. side, the greater the U.S. relative contribution in price discovery. In model (1), (2), (4), (5) and (6), the coefficients of the information factor, measured either by synchronized SPY or daily closing price of SP500, are positive and statistically significant at at least 5% level, which is consistent with the hypothesis that if the U.S. market provide more additional information of the share price, its price discovery contribution is greater. As we stated in the legal protection hypothesis, the higher standard of the legal protection in U.S. relative to the domestic country, the greater price adjustment by the domestic in response to the U.S. prices. For proxies of legal protection, anti-director-rights index (ADRI), revised ADRI, anti-self-dealing index and disclosure index, the differences between U.S. index and home index have consistently positive and statistically significant coefficients across model (1) - (6). The liquidity measures play an important role in determining the price discovery too. In model 3, the negative coefficient of illiquidity ratio of the U.S. to the home Amihud illiquid measurement is statistically significant at 5% level, indicating that the comparing to the U.S. shares, the more illiquid of the domestic shares of the cross-listed firm, the more influential of the U.S. share price, resulting a larger proportion of price adjustment by domestic

[6]The number of observations in model (1) - (7) varies depending on the data availability.

price toward the U.S. price. Market liquidity proxy of stock market turnover ratio of the U.S. to the home market turnover confirms the liquidity argument that a more liquid stock market contributes more in the price discovery process, shown by the positive and statistically significant coefficient of the liquidity ratio in model (4). The coefficients for the time zone difference between the home and the New York time are negative and statistically significant in model (2), (5) and (6), which confirms that the firms from a home country further from the U.S. in time zone, less domestic price adjustment toward the U.S. price. Geographic distance variables confirm this negative relationship between the home-U.S. markets distance and U.S. relative price discovery but lack of statistic significance in model (1) and (4).

To get an idea of the impact of the main variables of interest on the relative contributions of the U.S. market to price discovery, we use the coefficient estimates in model (6) and model (7) in Table 4.5 Panel A, which include all types of control variables and fixed effects in the models. If the U.S. proportion of trading volume increase 1% from 98% (sample mean) to 99%, the domestic share of speed of adjustment will increase from 97.895% (=exp(3.918*0.98)/(exp(3.918*0.98)+1)) to 97.970% (=exp(3.918*0.99)/(exp(3.918*0.99)+1)), where 3.918 is the coefficient estimate in model (8) from Table 4.5 Panel A. If the U.S. market provides more additional information to the stock price by 1 unit measured by information factor, from 7 (sample mean) to 8, the domestic share of speed of adjustment will increase from 51.225% (=exp(0.007*7)/(exp(0.007*7)+1)) to 51.400% (=exp(0.007*8)/(exp(0.007*8)+1)), where 0.007 is the coefficient estimate in model (5) and (7) from Table 4.5 Panel A. If the U.S. is 1 index higher than the domestic market in terms of the anti-director-rights index, the domestic share of speed of adjustment will increase from 50% (=exp(0.121*0)/(exp(0.121*0)+1)) to 53% (=exp(0.121*1)/(exp(0.121*1)+1)), where 0.121 is the coefficient estimate in model (6) from Table 4.5 Panel A.

Other control variables provide interesting findings as well. A firm with longer

listing history in the U.S. market results in a greater adjustment by the domestic prices in response to the U.S. prices, shown by significantly positive coefficients of "listing duration" in model (1) - (6). The coefficient for firm size are consistently positive and significant, suggesting that ceteris paribus, price discovery in the U.S. relative to the domestic is greater for larger firms. Those can be explained by the firm visibility argument that large firm will be more visible to the investor in the host market and therefore the shares of those foreign firms will be traded more active, resulting that the U.S. share price is more influential in price discovery. Domestic GDP growth shows a negative relationship with the domestic portion of speed of adjustment toward the U.S. price and the coefficients are statically significant at 1% level. A high GDP growth home country will have less price adjustment toward the U.S. price. The domestic share price will be dominant in the price discovery and the U.S. share price will adjust more toward the home price. More price discovery will happen in the high economic growth home market.

Table 4.5: Determinants of the distribution of trading volume among multiple host markets

This table summaries the results of multivariate regression with and without industry/home region fixed effects. Panel A reports the results of regressions based on logistic transformation of the domestic proportion of total price speed of adjustment (SOA) as dependent variable. Panel B reports the results of regressions based on natural logarithm transformation of the domestic proportion of total price speed of adjustment (SOA) as dependent variable. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: logistic tranformation of domestic portion of SOA as the dependent variable

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
US portion trading Vol(share)	6.090***			4.569***			3.918***
	(7.348)			(5.165)			(6.479)
US portion trading Vol(value)		2.177***			1.939***		
		(5.332)			(4.908)		
Info factor (SPY)		0.008***			0.007**	0.007**	
		(2.755)			(2.400)	(2.352)	
Info factor (SP500)	0.008**			0.008**			
	(2.481)			(2.140)			
Anti-dir-rights index(ADRI) (US-HM)		0.055**				0.121***	
		(2.323)				(4.028)	
Revised ADRI (US-HM)	0.080**		0.094***				
	(2.163)		(2.965)				
Anti-self-dealing index (US-HM)					0.543***		
					(3.512)		
Disclosure index (US-HM)				0.110***			
				(8.384)			
Illiquidity Ratio (US/HM)			−0.555**				
			(−2.054)				
Stk mkt turnover (US-HM)				0.015**			
				(2.130)			
Time zone (HM-US)		−0.028***			−0.106***	−0.083**	
		(−4.055)			(−2.636)	(−1.987)	
Distance to NY (miles)	−0.016			−0.033			
	(−0.673)			(−1.210)			
Listing duration	0.166***	0.200***	0.068**	0.128***	0.174***	0.136***	
	(4.116)	(4.917)	(2.547)	(2.940)	(4.316)	(3.255)	
Firm size	0.131***	0.131***	0.077***	0.158***	0.130***	0.169***	
	(8.855)	(9.031)	(6.794)	(9.166)	(8.477)	(10.369)	
Domestic GDP growth	−0.056***	−0.046***		−0.053***	−0.052***	−0.053***	
	(−5.473)	(−4.343)		(−4.751)	(−4.951)	(−4.886)	
Intercept	−9.448***	−6.000***	−2.285***	−9.749***	−5.217***	−3.161***	−4.816***
	(−10.356)	(−11.354)	(−10.805)	(−10.045)	(−9.840)	(−8.164)	(−7.807)
Industry fixed-effects?				No		Yes	Yes
Home region fixed-effects?					No	Yes	Yes
Number of firm-quarters	6028	5942	7916	5172	6028	5942	7916
Adj. R-square (%)	3.666	3.612	0.903	4.989	5.127	5.207	1.938

Table 4.5 (Cont'd)

Panel B: log transformation of domestic portion of SOA as the dependent variable

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
US portion trading Vol(share)	4.236***			3.234***			2.521***
	(7.387)			(5.283)			(6.077)
US portion trading Vol(value)		1.464***			1.309***		
		(5.188)			(4.772)		
Info factor (SPY)		0.005***			0.005**	0.005**	
		(2.704)			(2.443)	(2.322)	
Info factor (SP500)	0.006***			0.005**			
	(2.715)			(2.145)			
Anti-dir-rights index(ADRI) (US-HM)		0.033**				0.070***	
		(2.019)				(3.355)	
Revised ADRI (US-HM)	0.044*		0.054**				
	(1.714)		(2.492)				
Anti-self-dealing index (US-HM)					0.265**		
					(2.466)		
Disclosure index (US-HM)				0.070***			
				(7.704)			
Illiquidity Ratio (US/HM)			−0.316*				
			(−1.705)				
Stk mkt turnover (US-HM)				0.009*			
				(1.744)			
Time zone (HM-US)		−0.018***			−0.049*	−0.036	
		(−3.817)			(−1.756)	(−1.245)	
Distance to NY (miles)	−0.010			−0.021			
	(−0.599)			(−1.092)			
Listing duration	0.119***	0.143***	0.044**	0.097***	0.128***	0.103***	
	(4.284)	(5.090)	(2.392)	(3.231)	(4.560)	(3.545)	
Firm size	0.072***	0.073***	0.037***	0.090***	0.073***	0.099***	
	(7.090)	(7.257)	(4.757)	(7.514)	(6.865)	(8.736)	
Domestic GDP growth	−0.042***	−0.036***		−0.039***	−0.038***	−0.039***	
	(−5.865)	(−4.921)		(−5.101)	(−5.246)	(−5.164)	
Intercept	−7.446***	−4.972***	−2.409***	−7.595***	−4.513***	−3.120***	−4.155***
	(−11.795)	(−13.610)	(−16.591)	(−11.308)	(−12.260)	(−11.628)	(−9.820)
Industry fixed-effects?				No		Yes	Yes
Home region fixed-effects?					No	Yes	Yes
Number of firm-quarters	6028	5942	7916	5172	6028	5942	7916
Adj. R-square (%)	3.230	3.105	0.502	4.477	4.048	4.252	1.684

4.6 Robustness checks

4.6.1 Alternative measurement of variables

To ensure the robustness in our results, we use both the logistic and logarithm transformation of domestic proportion of price adjustment as dependent variable as we explained in Section 4.5. The results are very similar. We construct the variables in different manners. We measure trading volume using both the share volume and the dollar valued based measure. We construct information factor using either the synchronized SPY or the daily closing price of SP500 as U.S. market index. They show similar statistics and results.

4.6.2 Alternative regression method

According to *Petersen* (2009), when we have panel data and the regression residuals are serially correlated when we have persistent dependent and independent variables in finance/ economics research, standard errors clustered by firm provide much more accurate results than do other methods such as the Fama-MacBeth regression. Therefore, we re-run the regression models (1) - (7) using panel regression with 2-way (firm and year) clustered standard error. The results of clustered panel regression are presented in Table 4.6. The model (1) - (7) specifications are the same with the ones in Table 4.5. The standard errors are robust to heteroscedasticity and are adjusted for clustering by firm and by year in order to avoid biased t values. Clustering by firm accounts for the possible correlation between observations of same firm over different years and clustering by year accounts for the possible correlation between observations on different firms in the same year. Overall, the results confirm our main findings in Table 4.5.

Table 4.6: Determinants of the U.S. relative contribution of price discovery

This table summaries the results of multivariate regression models estimated with 2-way (firm- and year- level) cluster standard error and with/without industry-/home regional fixed effects. Panel A reports the results of regressions based on logistic transformation of the domestic proportion of total price speed of adjustment (SOA) as the dependent variable. Panel B reports the results of regressions based on natural logarithm transformation of the domestic proportion of total price speed of adjustment (SOA) as the dependent variable. * denotes statistical significance level at 1% or lower, ** denotes statistical significance level between 1% and 5%, and *** denotes statistical significance level between 5% and 10%.

Panel A: logistic tranformation of domestic portion of SOA as the dependent variable

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
US portion trading Vol(share)	6.090***			4.569***			3.918***
	(5.045)			(3.852)			(3.712)
US portion trading Vol(value)		2.177**			1.939**		
		(2.358)			(2.475)		
Info factor (SPY)		0.008			0.007	0.007	
		(1.728)			(1.564)	(1.595)	
Info factor (SP500)	0.008			0.008			
	(1.629)			(1.451)			
Anti-dir-rights index(ADRI) (US-HM)		0.055				0.121**	
		(1.223)				(2.320)	
Revised ADRI (US-HM)	0.080		0.094				
	(1.161)		(1.399)				
Anti-self-dealing index (US-HM)					0.543**		
					(2.772)		
Disclosure index (US-HM)				0.110***			
				(4.198)			
Illiquidity Ratio (US/HM)			−0.555*				
			(−1.804)				
Stk mkt turnover (US-HM)				0.015			
				(0.872)			
Time zone (HM-US)		−0.028			−0.106*	−0.083	
		(−0.997)			(−1.797)	(−1.359)	
Distance to NY (miles)	−0.016			−0.033			
	(−0.158)			(−0.337)			
Listing duration	0.166**	0.200***	0.068	0.128*	0.174***	0.136**	
	(2.575)	(2.977)	(1.043)	(1.892)	(3.047)	(2.295)	
Firm size	0.131***	0.131***	0.077	0.158***	0.130***	0.169***	
	(3.351)	(3.188)	(1.267)	(4.280)	(3.505)	(5.676)	
Domestic GDP growth	−0.056**	−0.046*		−0.053*	−0.052**	−0.053**	
	(−2.344)	(−1.967)		(−1.847)	(−2.378)	(−2.320)	
Intercept	−9.448***	−6.000***	−2.285***	−9.749***	−5.217***	−3.161***	−4.816***
	(−5.600)	(−6.311)	(−3.899)	(−5.517)	(−5.490)	(−5.457)	(−3.989)
Industry fixed-effects?	No	No	No	Yes	No	Yes	Yes
Home region fixed-effects?	No	No	No	No	Yes	Yes	Yes
Number of firm-quarters	6,028	5,942	7,916	5,172	6,028	5,942	7,916
Adj. R-square (%)	3.67	3.61	0.90	4.99	5.13	5.21	1.94

Table 4.6 (Cont'd)

Panel B: log transformation of domestic portion of SOA as the dependent variable

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
US portion trading Vol(share)	4.236***			3.234***			2.521***
	(4.852)			(3.764)			(3.043)
US portion trading Vol(value)		1.464*			1.309*		
		(2.008)			(2.102)		
Info factor (SPY)		0.005*			0.005*	0.005	
		(1.932)			(1.791)	(1.722)	
Info factor (SP500)	0.006*			0.005			
	(1.996)			(1.696)			
Anti-dir-rights index(ADRI) (US-HM)		0.033				0.070*	
		(1.065)				(1.834)	
Revised ADRI (US-HM)	0.044		0.054				
	(0.948)		(1.265)				
Anti-self-dealing index (US-HM)					0.265*		
					(1.973)		
Disclosure index (US-HM)				0.070***			
				(4.178)			
Illiquidity Ratio (US/HM)			−0.316				
			(−1.528)				
Stk mkt turnover (US-HM)				0.009			
				(0.790)			
Time zone (HM-US)		−0.018			−0.049	−0.036	
		(−0.950)			(−1.341)	(−0.944)	
Distance to NY (miles)	−0.010			−0.021			
	(−0.147)			(−0.317)			
Listing duration	0.119**	0.143***	0.044	0.097**	0.128***	0.103**	
	(2.816)	(3.221)	(1.010)	(2.321)	(3.192)	(2.644)	
Firm size	0.072**	0.073**	0.037	0.090***	0.073**	0.099***	
	(2.639)	(2.444)	(0.867)	(3.652)	(2.817)	(5.099)	
Domestic GDP growth	−0.042**	−0.036**		−0.039*	−0.038**	−0.039**	
	(−2.596)	(−2.343)		(−2.080)	(−2.749)	(−2.643)	
Intercept	−7.446***	−4.972***	−2.409***	−7.595***	−4.513***	−3.120***	−4.155***
	(−6.712)	(−7.074)	(−6.316)	(−6.361)	(−6.404)	(−8.799)	(−4.487)
Industry fixed-effects?	No	No	No	Yes	No	Yes	Yes
Home region fixed-effects?	No	No	No	No	Yes	Yes	Yes
Number of firm-quarters	6,028	5,942	7,916	5,172	6,028	5,942	7,916
Adj. R-square (%)	3.23	3.11	0.50	4.48	4.05	4.25	1.68

4.7 Conclusion

This study documents the speed of price adjustment using a sample of 497 foreign firms from 36 home countries cross-listed in the U.S. market. It is notable that out study overcome the obstacles of non-synchronous trading across global markets. We address the limitations in previous studies that concluded the findings based on a few ADRs/GDRs or a small sample of data from one or two markets. In this study, we are able to analyze how the U.S. contribution to price discovery varies across different countries and generalize those determinants of the U.S./domestic price adjustment in response to the price departure from the equilibrium in the global environment. In addition, our sample cover the time period from 1994-2011. We estimate the speed of price adjustment in every sample quarter for each cross-listed stock. In this way, we are able to observe the pattern of price discovery over time and utilize the panel regression to investigate the determinants of price discovery process.

Our empirical evidences indicate that the price adjustment in response to price disparity happened in both the home market and the U.S. (host) market. In most of our sample home countries, domestic prices are dominant for the price discovery and U.S. share price adjust toward to the domestic share prices significantly. However, we also observe a statistically significant amount of price adjustment from domestic side to the U.S. share prices. This reveals that, as a host market, the U.S. also plays an important role in price determination.

We further examine the determinants of the U.S. market relative contribution in the price discovery. The regression results show that the greater the competition offered by the U.S. market, the greater the U.S. contribution to the price discovery, the more price adjustment from domestic side toward the U.S. price. More specifically, we find that a cross-listed firm with a larger U.S. proportion of its total trading volume, more informative share price provided in the U.S. market, longer listing history in the U.S. market, more liquidity in the U.S. market than the domestic market, the

domestic price adjust more toward the U.S. price and the U.S. market contribute more in the price discovery. In addition, comparing the counterpart domestic market, if the U.S. market provides more market depth and breath, better shareholder protection and financial information disclosure enforcement, it will contribute more in the price discovery and the proportion of domestic price adjustment will be higher. We also observe that larger capitalization foreign firm from a lower economic growth home country usually has higher domestic price adjustment toward the U.S. price.

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