Home Bias and Market Liquidity

Wenjin Kang

Department of Finance and Accounting
NUS Business School
National University of Singapore
Email: bizkwj@nus.edu.sg

* Department of Finance and Accounting, NUS Business School, National University of Singapore, 1 Business Link, Singapore 117592, Tel: 65 – 68743194, Email: bizkwj@nus.edu.sg

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Abstract

In this paper, we examine the difference in liquidity between NYSE-listed U.S. and non-U.S. stocks. We construct a size-matched U.S. stock and a volume-matched U.S. stock for each non-U.S. stock and compare the Kyle's λ and spread between non-U.S. stocks and their U.S. matches. Our empirical results show that the average Kyle's λ and the average bid-ask spread of non-U.S. stocks are significantly larger than those of size-matched U.S. stocks. When non-U.S. stocks are compared with volume-matched U.S. stocks, the difference of spread width remains significant, although the magnitude of difference decreases. In contrast, the Kyle's λ difference between non-U.S. stocks and volume-matched U.S. stocks virtually disappears. Overall, our work suggests that the trading costs of non-U.S. stocks are significantly higher than those of size-matched U.S. stocks. They are also higher than the trading costs of volume-matched U.S. stocks, but the significance of the comparison result is tempered. The high trading costs of non-U.S. stocks may help explain why U.S. investors prefer holding domestic portfolios.

1. Introduction

The past decade has witnessed the accelerating growth in the number of non-U.S. firms listed on the New York Stock Exchange (NYSE). As demonstrated in Figure 1, from 1994 to 2001, the number of non-U.S. firms listed on the NYSE increased by more than 100%, while the number of U.S. listings fluctuated around the same level. Nevertheless, despite the trend that more and more non-U.S. stocks are available to be publicly traded on the U.S. stock market, and despite the well-known advantage of risk diversification through international investment demonstrated by Grubel (1968) and Levy and Sarnat (1970), the home bias of U.S. investors who favor the domestic portfolio has not weakened. Figures 2a and 2b show that, although the percentage of the number of non-U.S. listings on the NYSE grew from 8% to 16% from 1994 to 2001, the percentage of the aggregate dollar trading volume of these non-U.S. listings varied between 8% and 10%. This comparison implies that the globalization of financial markets in the past decade does not attract proportionally enough attention from domestic investors, at least in the U.S., to the increasing number of foreign stocks available to be traded on the domestic exchange.

There have been many explanations for the home bias phenomenon. Black (1974) and Stulz (1981) develop the international capital flow barrier theory. Adler and Dumas (1983) and Uppal (1993) derive models from the standpoint of purchasing power parity to explain how investors prefer domestic securities to hedge against inflation. It has also been noted that domestic investors may have an informational advantage over foreign investors. Shukla and Inwegen (1995) find that U.K. mutual funds investing in the U.S. perform worse than U.S. domestic funds because of the U.K. mutual fund manager's inferior market timing. Hau (2000) documents that traders located outside Germany in non-German speaking cities have lower trading profits in German markets. More recently, the research on market liquidity has been associated with the home bias literature. Bacidore and Sofianos (2002) show that specialists view non-U.S. stocks differently by investigating their closing inventory value, participation rate, and stabilization rate. They also compare the first moment of the spreads of U.S. and non-U.S. stocks and find that non-U.S. stocks have larger spreads than size-matched U.S. stocks.

In this paper, we conduct a comprehensive study on the market liquidity differences between U.S. stocks and non-U.S. stocks listed on the NYSE. On the NYSE both non-U.S. stocks and U.S. stocks are traded within the same trading hours, that is, from 9:30am to 4:00pm (ET). The prices and dividends of non-U.S. stocks are denominated in U.S. dollars. However, many differences of trading mechanism and regulation rules exist between U.S. and non-U.S. stocks. Most non-U.S. stocks are traded in the form of American Depositary Receipts (ADRs) as derivative instruments representing claims on the ordinary shares in their home market. ADRs are not fungible. One cannot buy an ADR of a non-U.S. stock in the U.S. market and sell it in the foreign home market. This nonfungibility increases the risk of ADRs with respect to inventory holding. [Pulatkonak and Sofianos (1999)] The main exception to the ADR format is Canadian stocks, which are traded in the U.S. as ordinary stocks. For this reason, Canadian stocks are not included in the non-U.S. sample in this paper. The U.S. market and the home markets of non-U.S. stocks are not as tightly linked as the U.S. domestic markets. Domowitz et al. (1998) show that if the markets are not perfectly linked, arbitrage traders may enter and reduce market quality since the market maker's adverse selection risk increases. Also, insider trading rules are different for ADR stocks in the U.S. market compared with the rules for ordinary U.S. stocks. All these differences could potentially change the nature of liquidity provision for non-U.S. stocks relative to U.S. stocks.

The liquidity is measured in this paper via the price impact power and the bid-ask spread. The price impact power may be better known as the Kyle's λ (1985), which measures the market depth and the price sensitivity to the incoming order flow. It is estimated by both the Glosten-Harris (1988) method and the Hasbrouck (1991) method. We also compare the first moment and the second moment of the bid-ask spread between U.S. stocks and non-U.S. stocks as an extension of Bacidore and Sofianos (2002).

Before comparing the liquidity of non U.S. stocks to that of U.S. stocks, we need to construct matched sample of U.S stocks for non-U.S. stocks as the benchmark of comparison. Since non-U.S. stocks listed on the NYSE are likely to possess large global market value and relatively low U.S. trading volume, we need to choose to match either by global market value or by U.S. trading volume. The benefit of matching by market value is that the matched U.S. stock will be similar with the non-U.S. stock in terms of size, revenue, and media exposure. However, given that the average trading volume of U.S. size-matched stocks is dramatically higher than that of non-U.S. stocks, it raises the question whether all the liquidity difference, if there is any, is caused purely by the difference in trading volume. On the other hand, the market maker for a volume-matched U.S. stock could expect to turn around his positions approximately as quickly as the market maker for the corresponding non-U.S. stock. Thus, if we observe any liquidity difference between non-U.S. stocks and volume-matched U.S. stocks, it should be caused by reasons other than the difference in trading volume. In this paper we adopt both methods and find that the comparison results vary accordingly.

The empirical results show that both the average Kyle's λ and the average bid-ask spread of non-U.S. stocks are significantly larger than those of size-matched U.S. stocks. It indicates that the non-U.S. stocks listed on the NYSE are generally less liquid than the size-matched U.S. stocks and the information asymmetry of non-U.S. stocks is also more severe than that of size-matched U.S. stocks. When we shift to the volume-matching method, the difference in spread between non-U.S. stocks and volume-matched U.S. stocks remains significant, although the magnitude of the spread difference computed by the volume-matching method decreases to about one half of the magnitude of the spread difference under the size-matching method. In contrast, the Kyle's λ difference between non-U.S. stocks and volume-matched U.S. stocks virtually disappears; it becomes insignificant. This change of results implies that the information asymmetries and the adverse selection costs of non-U.S. stocks and U.S. stocks with comparable trading volume are about the same, and the remaining spread difference may be attributable to some other reasons, such as exchange rate risk.

In addition to the pair-to-pair spread and Kyle's λ comparisons, we also examine the intraday spread pattern of non-U.S. stocks on the NYSE. The intraday spread pattern of European stocks is particularly interesting. It does not comply with the typical intraday pattern for U.S. stocks as documented by McInish and Wood (1992) and Lee et al. (1993). We find that there is a significant increase of spread width for European stocks between 11:30am and 12:00pm at New York time. One possible explanation is that it is caused by the informational announcements European companies make after most major European stock exchanges close.

We should bear in mind that this paper compares the liquidity measures between the U.S. and non-U.S. stocks on the NYSE, and not between the NYSE and the home market for non-U.S. stocks. Regarding the latter topic, Chowdry and Nanda (1991) provide a multiple-market model in which the competition among markets induces market makers to take action such as making price information public and cracking down insider trading to attract liquidity traders, and liquidity traders intend to concentrate their orders on the market where the expected trading costs are the smallest. Huddart, Hughes, and Brunnermeier (1999) allow the exchanges to set their own disclosure standards and find that the exchanges will engage in a "race for the top", which causes disclosure requirements to increase and trading costs to fall. The related empirical studies are included in Kadiyala and Subrahmanyam (2003), which compares the return difference and liquidity difference of U.S. ADRs in U.S. markets and their home markets.

This paper is organized as follows: Section 2 describes the data and introduces the methodology. Section 3 compares the Kyle's λ and spread width between non-U.S. stocks and size-matched U.S. stocks. The liquidity difference between non-U.S. stocks and volume-matched U.S. stocks is examined in Section 4. Section 5 studies the intraday pattern of spread and Kyle's λ of non-U.S. stocks. Finally, Section 6 concludes this paper and discusses some topics for future research.

2. Data and Methodology

The non-U.S. sample includes all the ADR stocks listed on the NYSE with the following exceptions. All stocks with an average price less than $1 or larger than $500 are excluded. Inactive stocks traded less than five times per day are also excluded to ensure the precision of our results. We also eliminate stocks that have less than 200 trading days in year 2001. The sample period covers the full calendar year 2001.

The high-frequency transaction data are from NYSE Trade and Quote (TAQ) database. We compute the average price and trading volume using CRSP and access company market capitalization information from COMPUSTAT. The identification of non-U.S. stocks and their regional classification is done with the NYSE's non-U.S. company database. Some NYSE-listed stocks are incorporated in locales as "flag of convenience", such as Bermuda and Bahamas. They are excluded from our study because they do not have an active home market other than the U.S. and are traded almost exclusively in the U.S. (See Pulatkonak and Sofianos, 1999)

We construct a size-matched sample of U.S. stocks and a volume-matched sample of U.S. stocks for the remaining non-U.S. stocks. As the first step, we select all U.S. stocks that have the same first three digits of the Standard Industry Code (SIC). Then, for the size-matched sample, stocks in the same industry are matched on the basis of global market capitalization, price, intraday volatility, and overnight volatility. For the volume-matched sample, we replace global market capitalization with the U.S. trading volume as the matching criterion. The intraday volatility and overnight volatility are measured through the NYSE TAQ database. We need to match on both volatility measures because some non-U.S. stocks have a home market in a different time zone and thus may have significant overnight volatility.

We identify matching U.S. stock for non-U.S. stock following the method used by Huang and Stoll (1996) and Bacidore and Sofianos (2002). The matched U.S. stock should minimize the following:

$$\sum_{i=1}^{4}\left(\frac{X_i^{US} - X_i^{non-US}}{X_i^{US} + X_i^{non-US}}\right)^2,$$

where $X_i\,(i=1,2,3,4)$ is equal to global market capitalization, average price, intraday volatility, and overnight volatility for the size-matched U.S. stock. As stated above, for the volume-matched U.S. stock, X_1 will be the U.S. trading volume instead of global market capitalization. We also require that $\left|(X_i^{US} - X_i^{non-US})/(X_i^{US} + X_i^{non-US})\right| < 2/3$ in order to ensure that the matched U.S. stock is sufficiently similar to the corresponding non-U.S. stock in terms of the matching criterions. To be included into the sample, the non-U.S. stock must have both a valid size-matched U.S. stock and a valid volume-matched U.S. stock. After all these filtering, there are 182 non-U.S. stocks left in the sample. Table 1a provides the summary statistics for non-U.S. stocks and their size-matched U.S. sample. Table 1b includes the summary statistics for non-U.S. stocks and their volume-matched U.S. sample. The similarity between the matching variables proves that our matching work is effective.

3. non-U.S. stocks *Vs.* size-matched U.S. stocks.

In this section we compare the market liquidity between non-U.S. stocks and size-matched U.S. stocks. Liquidity is interpreted in the context of trading cost and information asymmetry in this paper. The trading cost includes a fixed component, which is a constant proportion of the transaction value, and a variable component, which varies with the value of the transaction.

The fixed cost component is measured by the proportional quote and effective spreads. The quoted spread is the ask price minus the bid price and the effective spread is two times the difference between the execution price and the midpoint of the prevailing bid and ask prices. The proportional spread is the spread width divided by the average of the bid and ask prices. The variable component is estimated by the price impact power, which may be better known as Kyle's λ (1985). We should note that both spread and Kyle's λ are imperfect measures of the fixed and the variable trading-cost components, respectively. Spread is the precise measure of the fixed trading cost only when the maker maker's quote depth is sufficiently large to cover the incoming market order. The marginal transaction cost per dollar is affected not only by the Kyle's λ but also by the trade size. However, these imperfections should not prevent spread and Kyle's λ from being efficient trading-cost indicators. Also, Kyle's λ measures information asymmetry. A large Kyle's λ implies high adverse selection cost and a thin market.

3.1 Kyle's λ Comparison

In this part we examine the information asymmetry, which is measured by the Kyle's λ as the relation between trade size and the corresponding price movement, for both non-U.S. stocks and size-matched U.S. stocks. To ensure the robustness of our results, we use both the Glosten-Harris (1988) method and the Hasbrouck (1991) method.

(3.1a) The Glosten-Harris method

Let p_t and q_t denote the price and quantity of the order fulfilled at time t. q_t is positive if the trade is a purchase (buyer-initiated) and negative if the trade is a sale (seller-initiated). We also assume that m_t is the expected value of the stock conditional on the market maker's information set and y_t is the public information signal. According to Kyle's (1985) model, we have $m_t = m_{t-1} + \lambda q_t + y_t$, where λ is the (inverse) market depth parameter. We use D_t denoting the sign of the order and obtain $p_t = m_t + \Psi D_t$ $= m_{t-1} + \lambda q_t + y_t + \Psi D_t$. The value of D_t is assigned by the Lee and Ready (1991) algorithm. The first-order difference of price is $\Delta p_t = \lambda q_t + \Psi \Delta D_t + y_t$. The regression of Δp_t on q_t and ΔD_t will provide estimates for λ and Ψ. In practice we define $\Delta p_t = (p_t - p_{t-1}) / p_{t-1}$ in order to ensure that price levels will not affect our comparison of the price impact power between different stocks. Table 2 shows the Glosten-Harris estimates of Kyle's λ for non-U.S. stocks and size-matched U.S. stocks.

From Table 2 we can observe substantial difference in the Kyle's λ between non-U.S. stocks and size-matched U.S. stocks. The average Kyle's λ of non-U.S. stocks estimated by the Glosten-Harris approach is 1.90[1], and it is about three times the average Kyle's λ

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*1. The unit of the Kyle's λ in this paper is 10^{-5} percent/dollar. For example, the average Kyle's λ of non-U.S. stock is 1.90×10^{-5} percent/dollar and it means that if the there is a 100,000 dollar market buy (sell) order, the price will increase (decrease) by 1.90% on average.

of size-matched U.S. stocks (0.66). This result indicates that the market for the U.S. stock is much deeper than the market for the non-U.S. stock with comparable size. The trade on a non-U.S. stock has a substantially stronger price impact power than that on the corresponding size-matched U.S. stock. In other words, the market maker attaches a larger weight to the informational content of the incoming orders for non-U.S. stocks and revises his expectation according to the order flow more aggressively compared with size-matched U.S. stocks.

We also conduct a regional study on the Kyle's λ difference. The result that the Kyle's λ of non-U.S. stocks is larger than that of size-matched U.S. stocks is significant across all the geographic regions. Within the framework of the Glosten-Harris model, the regional comparisons show that stocks from Latin America and Asia both have higher Kyle's λ value than that of stocks from Europe. It indicates that the asymmetric information concern is more severe for Latin American and Asian stocks. This result is qualitatively similar with the result from our later work in the following section using the Hasbrouck estimation method.

(3.1b) Hasbrouck Method:

In this part we apply the Hasbrouck method to examine the difference between the price impact power of trade on U.S. stocks and that on non-U.S. stocks listed on the NYSE. Following Hasbrouck (1991), the regression model can be written as

$$r_t = a_1 r_{t-1} + a_2 r_{t-2} + \ldots + b_0 x_t + b_1 x_{t-1} + b_2 x_{t-2} \ldots + v_{1,t}$$
$$x_t = c_1 r_{t-1} + c_2 r_{t-2} + \ldots + d_1 x_{t-1} + d_2 x_{t-2} \ldots + v_{2,t}.$$

We assume that the market maker posts ask and bid quotes, q_t^a and q_t^b, after the trade order has been submitted at time t. Hence, the quotes prevailing before the agent presents his trade is q_{t-1}^a and q_{t-1}^b. x_t is the trade size at time t. It is positive if the trade is a purchase (buyer-initiated) and negative if the trade is a sale (seller-initiated). r_t is the quote-midpoint change in percentage scale. In other words, $r_t = (p_t - p_{t-1}) / p_{t-1}$. Here we interpret p_t as the quote-midpoint instead of actual trade price to avoid the negative autocorrelation of price caused by the ask-bid spread. As before, we prefer to use percentage instead of dollar-amount to measure the change in prices so that the price level will not affect our comparison of the price impact power.

We assume that the residual $v_{2,t}$ captures the unanticipated trade innovation where the private information resides. We should notice that $v_{2,t}$ is not a deterministic function of the private information, since the liquidity traders will introduce a noise component of $v_{2,t}$ that is uncorrelated with private information. The residual $v_{1,t}$ comes from the public new information. In this model we assume it arrives after the trade order has been submitted and before the market maker revises his quotes. We also assume that these two disturbances have zero means and are jointly and serially uncorrelated. In other words, we have $E(v_{1,t}) = E(v_{2,t}) = 0$ and $E(v_{1,t}v_{1,s}) = E(v_{2,t}v_{2,s}) = E(v_{1,t}v_{2,s}) = 0$ for any $t \neq s$. In practice we follow the Hasbrouck (1991) paper and use ordinary least squares estimates of the multiple-equation system. Under the assumption of the disturbance structure above, multiple-equation OLS is consistent and efficient. We truncate the time lag to $t-5$. The regression results are reported in Tables 3 and 4 in the appendix.

The Hasbrouck method results confirm our previous result computed by the Glosten-Harris method. Table 3 shows that there exist substantial differences in the Hasbrouck model coefficients b0 and b1 between non-U.S. stocks and size-matched U.S. stocks. The magnitude and significance of theses differences are similar to our result from the Glosten-Harris model. Hence, our finding that the price impact power of the trade on non-U.S. stocks is larger than that on size-matched U.S. stocks should be robust. The difference in price impact power is less significant for the coefficients b2 and in fact disappears for any time lag more than two periods (b3~b5).

Previously, we observe that the information asymmetry of Latin American and Asian stocks are higher than that of European stocks using the Glosten-Harris method. In the Hasbrouck framework, we find the same pattern. As shown in Table 3, the estimates of b0 and b1 from the Latin American and Asian sample are higher than the estimates from the European sample.

There is a positive autocorrelation in trades reflected by the positive coefficients d_i. This is consistent with the results in Hasbrouck (1991). The positive autocorrelation structure applies to both non-U.S. and U.S. stocks. This positive-autocorrelation effect of non-U.S. stocks appears to be stronger than that of size-matched U.S. stocks on average. But we should be cautious since there is little difference between the sum from d1 to d5 of Latin American stocks and that of size-matched U.S. stocks. In our later work, we do not detect any significant difference in the sum from d1 to d5 between non-U.S. stocks and volume-matched U.S. stocks.

(3.2) Spread Comparison: First Moment and Second Moment

We first compute for each sample the daily percentage quoted spread (QSPR%) and obtain the mean and volatility of the daily QSPR% throughout the year. We then average the annual mean and volatility across the samples and get the final results in Table 5. Table 6 is constructed with the same method, except that we use effective spread instead of quoted spread.

Tables 5 and 6 show that the mean percentage quoted and effective spreads of non-U.S. stocks are significantly larger than those of sized-matched U.S. stocks. The average quoted spread of non-U.S. stocks is 0.88% relative to only 0.40% for the sized-matched U.S. stocks. Similarly, the average effective spread of non-U.S. stocks is 0.66%, which is more than two times the average effective spread of sized-matched U.S. stocks (0.28%). The differences between non-U.S. stocks and sized-matched U.S. stocks are significant at the 1% level for both spread measures. This result is consistent with Bacidore and Sofianos' (2002) result that non-U.S. stocks are generally less liquid than (size-matched) U.S. stocks in terms of spread.

As a natural extension, we also compare the second moment of spreads. The standard deviation of quoted (effective) spreads of non-U.S. stocks is 0.38% (0.33%). Compared with 0.17% (0.12%) for the standard deviation of quoted (effective) spreads of sized-matched U.S. stocks, the spread of non-U.S. stocks initially appears to be more volatile than that of sized-matched U.S. stocks. However, as shown in Tables 5 and 6, this difference will disappear after we control for the fact that the mean spread of non-U.S. stocks is also larger than that of sized-matched U.S. stocks. The fourth column in Table 5 (Table 6) shows that the standard deviation of non-U.S. stock quoted (effective) spreads is 0.437 (0.504) times of the mean, which is not significantly different with 0.419 (0.428) as the ratio of the standard deviation to the mean of sized-matched U.S. stocks.

We also compare spreads by region. We find that both the quoted spread and effective spread of non-U.S. stocks are significantly larger than those of sized-matched U.S. stocks across all regions. However, the magnitude of difference varies. The difference of quoted (effective) spread between the Latin American sample and the corresponding size-matched U.S. sample is the largest as 0.70% (0.53%). Also, non-U.S. stocks in the Latin American sample have the largest average quoted (effective) spread, which is 1.24% (0.91%). The Asian sample has the second largest average quoted (effective) spread, which is 0.97% (0.70%) and the European sample's average quoted (effective) spread is the smallest as 0.63% (0.50%). The quoted (effective) spread of Asia-Pacific stocks exceeds that of sized-matched U.S. stocks by 0.45% (0.33%). The quoted (effective) spread difference between European stocks and sized-matched U.S. stocks is 0.39% (0.33%).

In general, in this section we compare the Kyle's λ and spreads between non-U.S. stocks and size-matched U.S. stocks. The results show that non-U.S. stocks have a higher Kyle's λ and larger spreads compared with size-matched U.S. stocks. The difference is both statistically and economically significant. It implies that the variable component and the fixed component of transaction cost for non-U.S. stocks are much higher than those of sized-matched U.S. stocks.

We should bear in mind that there is a substantial difference between the average trading volume of non-U.S. stocks in U.S. market and that of size-matched U.S. stocks. As shown in Table 1, the average U.S. daily trading volume of non-U.S. stocks is 8.113 MM$, which is merely about 12.9% of the daily trading volume of size-matched U.S. stocks (62.859 MM$). Naturally, one question is whether non-U.S. stocks have larger spread and higher Kyle's λ than size-matched U.S. stocks only because they are traded much less frequently in the U.S. market. In the next section we explore the effect of trading volume by examining the liquidity difference between non-U.S. stocks and volume-matched U.S. stocks.

4. non-U.S. stocks Vs. volume-matched U.S. stocks.

Brennan and Subrahmanyam (1995) show that the effect of trading volume on the adverse selection cost, which is measured in this paper by Kyle's λ, is negative. The intuition is that an active market will be deep. Branch and Freed (1977) show that trading volume is negatively correlated with the width of bid-ask spread on both NYSE and AMEX. Hence, a natural question is whether all the spread and Kyle's λ differences we document in the section above are caused purely by the difference in trading volumes between non-U.S. stocks and size-matched U.S. stocks, and have nothing to do with the characteristics of non-U.S. stocks themselves. To answer this question, we design a comparison study using the volume-matching method. We match non-U.S. stocks and U.S.-stocks based on U.S. trading volume, average price, intraday volatility, and overnight volatility. Then, we compare the spread and Kyle's λ between non-U.S. stocks and corresponding volume-matched U.S. stocks. The econometrics method to estimate the Kyle's λ is exactly the same as what we have used in the previous section.

Table 7 shows that the difference of Kyle's λ estimated by the Glosten and Harris (1988) method between non-U.S. stocks and volume-matched U.S. stocks is insignificant. The mean difference is 0.16 with a t-statistics of merely 0.48. The regional comparison shows that in the Asia-Pacific and Latin America samples the differences of Kyle's λ between non-U.S. stocks and volume-matched U.S. stocks are only 0.37 and 0.41, with t-statistics of 0.70 and 0.67 respectively. For the European sample, the Kyle's λ of non-U.S. stocks is even less than that of volume-matched U.S. stocks by 0.09. This result indicates that the information asymmetry of European stocks is, at most, the same as U.S. stocks after we control for the trading volume. The Asia-Pacific and Latin America stocks may have higher adverse selection cost than volume-matched U.S. stocks, but the significance of this result is weak.

The comparison result of the estimates for the price impact power using the Hasbrouck (1991) method is shown in Tables 8 and 9. The estimated coefficients b0 and b1 for non-U.S. stocks are 1.347 (0.557), which is not significantly larger than 1.253 (0.476) as the estimated b0 and b1 for volume-matched U.S. stocks. The regional study also shows that there is little significant difference across all the continent regions.

In contrast to the Kyle's λ comparison result, the difference of spreads between non-U.S. stocks and volume-matched U.S. stocks remains significant, although the magnitude of the difference decreases substantially. Tables 11 and 12 show that the mean difference of the quoted (effective) spreads between non-U.S. stocks and volume-matched U.S. stocks is 0.23% (0.20%). Although this is only about one half of the difference between non-U.S. stocks and size-matched U.S. stocks, the result is still significant at the 1% level. The regional study shows that the spread difference between Latin American stocks and corresponding volume-matched U.S. stocks is still largest across the region.

The comparison result of the second moment of spreads under the volume-matching method is similar to the result in the previous section. Although the standard deviation of quoted (effective) spreads of non-U.S. stocks is larger than that of volume-matched U.S. stocks, the difference will disappear after we control for the larger spread mean of non-U.S. stocks. As shown in Tables 10 and 11, the standard-deviation-to-mean ratio of non-U.S. stock quoted (effective) spreads is 0.437 (0.504), which is close to 0.439 (0.458) as the ratio of standard deviation to mean of volume-matched U.S. stocks.

The market maker as the liquidity provider needs to earn from the bid-ask spread to compensate his standing in the exchange. He also uses the spread to cover his inventory-holding cost because of the stochastic security return. [See Amihud and Mendelson (1980), Stoll (1978), and Ho and Stoll (1983)] The third component is the adverse selection cost faced by the market maker when some traders are better informed. [See Golsten and Milgrom (1985) and Easley and O'Hara (1987)] In practice, these three components together determine the width of the bid-ask spread. Huang and Stoll (1995) provide the estimates of the percentages of these three components and find that on average the adverse selection component accounts for 9.6% of the spread, the inventory component is 28.7% of the spread, and the rest 61.7% of the spread is caused by the order processing cost according to the transaction data of the calendar year 1992.

In the previous section we find that there is a substantial difference in the Kyle's λ between non-U.S. stocks and size-matched U.S. stocks, and it implies that the average adverse selection cost of non-U.S. stocks should be much larger than that of size-matched U.S. stocks. It is consistent with Bacidore and Sofianos (2002) that find the adverse selection component is the primarily factor that drives the difference of spread between non-U.S. stocks and size-matched U.S. stocks. However, the Kyle's λ comparison result in this section shows that there is little difference in the adverse selection cost between non-U.S. stocks and volume-matched U.S. stocks. Thus, the remaining spread difference is unlikely to stem from higher adverse selection cost.

The market maker of non-U.S. stocks may face additional inventory-holding cost even though he could expect to turn around his positions approximately as quickly as the market maker for corresponding non-U.S. stocks. If the non-U.S. firm collects earnings in foreign currency and issues ADR with a price denominated with U.S. dollar, the exchange rate fluctuation, or the forecast on the exchange rate fluctuation, could make holding the inventory of ADR stock more risky. Thus, the market maker will ask a large spread to compensate his inventory risk. This conjecture can be supported by the observation that exchange risk crises occur most frequently in Latin America and the spread difference between Latin American stocks and volume-matched U.S. stocks is the largest across regions. To further test this hypothesis, we examine the correlation between the exchange rate volatility and the spread difference between non-U.S. stocks and volume-matched U.S. stocks. We find that, under the volume-matching method, the correlation between the exchange rate volatility and the country-average quoted (effective) spread difference is 0.472 (0.488) and the correlation between the exchange rate volatility and the individual quoted (effective) spread difference is 0.174 (0.180). The positive correlation between the exchange rate volatility and the spread differences indicates that the additional exchange risk contributes to the larger average spread of non-U.S. stocks.

5. The Intraday Pattern of Spread

This section describes our empirical results about the intraday pattern of bid-ask spread for non-U.S. stocks listed on the NYSE. McInish and Wood (1992), and Lee, Mucklow, and Ready (1993) show that the typical intraday pattern of the bid-ask spread width for NYSE stock is a U-shape curve, where spreads are widest right after the market opens and before the market closes. In this work, we divide non-U.S. stocks into three subsamples, Europe, Asia, and Latin America, and examine the intraday spread pattern in each subsample. This division captures the differences in geography and time zone. The results show that the intraday spread pattern of each group varies. Our work shows that the spread width of European stocks does not follow the typical intraday pattern for NYSE stocks.

The intraday spread pattern of European stocks is especially interesting, since there exists an overlap between the trading time of European markets and the NYSE. We compare the intraday pattern of the percentage quoted spread of European stocks with their U.S. size-matches in five-minute time frames. Figure 3 shows the results. As the control group, the spread of size-matched U.S. stocks is high immediately after the market opens, then decreases very fast in the first half hour, as the literature has documented. There are various models explaining this phenomenon. Some of them attribute this to the market power of specialists. For example, Brock and Kleidon (1992) believe specialists possess monopoly power and use it to exploit the relative inelastic demand of investors to trade at the market open. Other models link this to the adverse selection. Madhavan (1992) suggests that specialists first post a wide spread and then narrow their spreads since private information is impounded into the price as trading goes on.

However, this pattern of large spread after the market open is less pronounced for European stocks. We should notice that when the NYSE opens at 9:30am eastern time, most Europe exchanges have already opened for hours. At the open of the NYSE, a substantial part of price discovery could have already been done in the European markets. Hence the adverse selection concern for European stocks is less severe compared with the U.S. matches. Also, the specialists' monopoly power on European stocks might be undermined since the investors have the option to trade in either the NYSE or the European markets. It indicates that the competition and interaction between the NYSE and European markets actually help to reduce the spread width at the open of the NYSE.

From 11:30am to 12:00pm we observe an increase in the spread width for European stocks. The local peak value is close to the spread width after the market open. We are not aware of any previous literature documenting this anomaly in the intraday spread pattern. One possible cause is the informational announcements European companies make after most major European stock exchanges close. This conjecture is supported by the time conversion. The New York time 11:30 is 16:30 in London and 17:30 in Berlin and Paris. This new empirical finding provides the opportunity to further study how the major global stock exchanges interact with each other.

Figure 4 shows the intraday pattern of the percentage quoted spread of Asian stocks and the pattern of their U.S. matches in five-minute time frameworks. There is basically no time overlap between the operating hours of NYSE and Asian stock exchanges. Hence, the market makers in the home markets for Asian stocks and in NYSE will not compete head-to-head simultaneously. This might explain why the intraday spread pattern of Asian stocks is similar with the pattern of their U.S. matches.

Figure 5 shows the percentage quoted spread in five-minute time frameworks for Latin America stocks traded on the NYSE. The Latin American exchanges open and close at about the same time as NYSE. The intraday spread pattern of Latin America stocks is also similar with that of their U.S. matches.

Besides the intraday spread pattern, we also compare the intraday pattern of the Kyle's λ in half-hour time frameworks. We decide to use the Glosten-Harris method since it requires fewer lag observations than the Hasbrouck method. As we did in the intraday spread pattern study, we divide non-U.S. stocks into three geographical subsamples: Asian stocks, European stocks, and Latin American stocks. The corresponding results are shown in Figures 6, 7, and 8. There seems to be no clear intraday trend of the Glosten-Harris measure of price impact power for either the non-U.S stocks or their U.S. matches and we are able to draw few conclusions about the comparison results.

6. Conclusion

We compare liquidity and the trading costs between NYSE-listed U.S. and non-U.S. stocks in this paper. As the benchmark of the comparison we construct a size-matched U.S. sample and a volume-matched U.S. sample. Then we compare the Kyle's λ and spread between non-U.S. stocks and their U.S. matches. Our empirical work suggests that both the average Kyle's λ and the average quoted and effective spreads of non-U.S. stocks are significantly larger than those of size-matched U.S. stocks. It implies that for non-U.S. stocks the information asymmetry problem is more severe and the trading costs are much higher compared with size-matched U.S. stocks. The picture of the comparison between non-U.S. stocks and volume-matched U.S. stocks is somehow different. We find that the difference of spread width remains significant, although the magnitude of difference is only about one half of the spread difference using the size-matching method. There is little difference between the average Kyle's λ of non-U.S. stocks and that of volume-matched U.S. stocks. It suggests that the adverse selection costs for non-U.S. stocks and U.S. stocks with similar trading volumes are approximately the same. The trading costs of non-U.S. stocks are still higher than that of volume-matched U.S. stocks, because of their larger spreads. It is well known that U.S. investors prefer holding domestic portfolios. Our study indicates that the high trading cost of non-U.S. stocks listed on the NYSE may at least partially explain this home bias phenomenon. Brennan and Subrahmanyam (1996) find a significant return premium associated with both the variable element and the fixed element of transaction cost. Hence, how exactly these liquidity differences we find in this paper are priced into the returns of non-U.S. stocks listed in U.S. markets could serve as an interesting future research topic.

Besides examining the trading cost of non-U.S. stocks, we also study their intraday spread patterns. We find that for European stocks there is an increase in the spread width from 11:30am to 12:00pm. One possible explanation is that the spread width increases because European companies make informational announcements after major European stock exchanges close. In further research it would be interesting to study the intraday patterns of volatility and trading volume for the foreign stocks listed on the NYSE to compare whether it is different from the patterns of typical U.S. stocks. It should reveal more information about the intraday trading behavior for NYSE-listed foreign stocks.

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Appendix I: Tables

Table 1a: Summary Statistics for U.S. stocks and size-matched non-U.S. stocks listed on the NYSE

This table includes the summary statistics for the sample of NYSE listed non-U.S. stocks and the corresponding size-matched U.S. stocks. The sample period is year 2001. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. The price and U.S. trading volume are calculated from CRSP. The intraday volatility and overnight volatility are calculated from NYSE TAQ data. The (global) market capitalization is calculated from COMPUSTAT.

	Non-U.S. stocks	MV-matched U.S. stocks
Sample Size	182	182
Mean Value		
Market Capitalization (MM$)	17,688	16,602
Average Price ($)	24.0	27.4
Intraday Volatility (in %)	0.7%	0.8%
Overnight Volatility (in %)	2.2%	1.6%
U.S. trading volume (thousand $)	8,113.3	62,858.8
Median Value		
Market Capitalization (MM$)	4,295	3,889
Average Price ($)	19.1	22.9
Intraday Volatility (in %)	0.6%	0.7%
Overnight Volatility (in %)	2.0%	1.6%
U.S. trading volume (thousand $)	1,308.0	18,440.3
Min Value		
Market Capitalization (MM$)	34	23
Average Price ($)	1.9	1.8
Intraday Volatility (in %)	0.2%	0.4%
Overnight Volatility (in %)	0.4%	0.5%
U.S. trading volume (thousand $)	12.7	26.3
Max Value		
Market Capitalization (MM$)	173,886	267,594
Average Price ($)	124.1	87.4
Intraday Volatility (in %)	2.1%	2.4%
Overnight Volatility (in %)	4.9%	3.3%
U.S. trading volume (thousand $)	149,263.4	531,051.7

Table 1b: Summary Statistics for U.S. stocks
and volume-matched non-U.S. stocks listed on the NYSE

This table includes the summary statistics for the sample of NYSE listed non-U.S. stocks and the corresponding volume-matched U.S. stocks. The sample period is year 2001. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. The price and U.S. trading volume are calculated from CRSP. The intraday volatility and overnight volatility are calculated from NYSE TAQ data. The (global) market capitalization is calculated from COMPUSTAT.

	Non-U.S. stocks	Volume-matched U.S. stocks
Sample Size	182	182
Mean Value		
Market Capitalization (MM$)	17,688	2,299
Average Price ($)	24.0	22.5
Intraday Volatility (in %)	0.7%	0.8%
Overnight Volatility (in %)	2.2%	1.5%
U.S. trading volume (thousand $)	8,113.3	9,734.0
Median Value		
Market Capitalization (MM$)	4,295	831
Average Price ($)	19.1	19.3
Intraday Volatility (in %)	0.6%	0.8%
Overnight Volatility (in %)	2.0%	1.4%
U.S. trading volume (thousand $)	1,308.0	1,624.9
Min Value		
Market Capitalization (MM$)	34	17
Average Price ($)	1.9	2.0
Intraday Volatility (in %)	0.2%	0.3%
Overnight Volatility (in %)	0.4%	0.5%
U.S. trading volume (thousand $)	12.7	25.3
Max Value		
Market Capitalization (MM$)	173,886	71,608
Average Price ($)	124.1	73.6
Intraday Volatility (in %)	2.1%	1.9%
Overnight Volatility (in %)	4.9%	3.5%
U.S. trading volume (thousand $)	149,263.4	123,487.8

Table 2: Estimates of Kyle's λ by Glosten-Harris method of non-U.S. stocks and size-matched non-U.S. stocks.

The Glosten-Harris model is $\Delta p_t = \lambda x_t + \Psi \Delta D_t + y_t$, where Δp_t is the price change in percentage scale, x_t is the signed dollar-amount trade size at time t, and D_t is the sign of order. All coefficients in this table have been multiplied by 10^5. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	Kyle's lambda (Glosten-Harris method)
All non-U.S. stocks		
Non-U.S.	182	1.90
MV Matched U.S.	182	0.66
Non-U.S. - MV-matched U.S.	182	1.24
		(3.25)
Regional Comparisons		
Asia-Pacific		
Non-U.S.	48	2.31
MV Matched U.S.	48	0.90
Non-U.S. - MV-matched U.S.	48	1.42
		(2.32)
Europe		
Non-U.S.	84	1.40
MV Matched U.S.	84	0.30
Non-U.S. - MV-matched U.S.	84	1.09
		(1.91)
Latin America		
Non-U.S.	48	2.42
MV Matched U.S.	48	1.06
Non-U.S. - MV-matched U.S.	48	1.36
		(1.59)

Table 3: Estimates of the Hasbrouck VAR model
of non-U.S. stocks and size-matched non-U.S. stocks (I).

The Hasbrouck model is $r_t = \sum_{i=1}^{5} a_i r_{t-i} + \sum_{i=0}^{5} b_i x_{t-i} + v_{1,t}$, $x_t = \sum_{i=1}^{5} c_i r_{t-i} + \sum_{i=1}^{5} d_i x_{t-i} + v_{2,t}$, where r_t is the quote-midpoint change in percentage scale; x_t is the signed trade size at time t. This table shows the estimates of b_0~b_5. All coefficients in this table have been multiplied by10^5. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	b0	b1	b2	b3	b4	b5
All non-U.S. stocks							
Non-U.S.	182	1.347	0.557	0.476	0.021	-0.066	-0.023
MV Matched U.S.	182	0.516	0.204	0.124	0.052	-0.016	0.031
Non-U.S. - MV-matched U.S.	182	0.831	0.354	0.352	-0.031	-0.050	-0.054
		(3.14)	(4.86)	(2.17)	(-0.35)	(-0.53)	(-1.02)
Regional Comparisons							
Asia-Pacific							
Non-U.S.	48	1.748	0.802	0.139	0.224	0.024	0.067
MV Matched U.S.	48	0.629	0.262	0.099	0.088	-0.060	0.111
Non-U.S. - MV-matched U.S.	48	1.119	0.540	0.040	0.136	0.084	-0.045
		(2.05)	(3.38)	(0.19)	(0.84)	(0.88)	(-0.73)
Europe							
Non-U.S.	84	0.966	0.374	0.688	-0.139	-0.028	-0.083
MV Matched U.S.	84	0.262	0.121	0.103	0.024	-0.009	0.014
Non-U.S. - MV-matched U.S.	84	0.704	0.254	0.585	-0.164	-0.020	-0.096
		(2.22)	(2.78)	(1.96)	(-1.31)	(-0.39)	(-1.04)
Latin America							
Non-U.S.	48	1.710	0.654	0.470	0.097	-0.229	-0.011
MV Matched U.S.	48	0.880	0.299	0.190	0.067	0.014	-0.018
Non-U.S. - MV-matched U.S.	48	0.830	0.354	0.280	0.031	-0.243	0.006
		(1.26)	(2.18)	(1.05)	(0.15)	(-0.73)	(0.06)

Table 4: Estimates of the Hasbrouck VAR model
of non-U.S. stocks and size-matched non-U.S. stocks (II).

The Hasbrouck model is $r_t = \sum_{i=1}^{5} a_i r_{t-i} + \sum_{i=0}^{5} b_i x_{t-i} + v_{1,t}$, $x_t = \sum_{i=1}^{5} c_i r_{t-i} + \sum_{i=1}^{5} d_i x_{t-i} + v_{2,t}$, where r_t is the quote-midpoint change in percentage scale; x_t is the signed trade size at time t. This table shows the sum of a_i, b_i, c_i and d_i. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	Sum of a(i)	Sum of b(i)	Sum of c(i)	Sum of d(i)
All non-U.S. stocks					
Non-U.S.	182	-0.025	2.312	3.285	0.152
MV Matched U.S.	182	0.000	0.910	4.335	0.117
Non-U.S. - MV-matched U.S.	182	-0.025	1.402	-1.050	0.036
			(3.49)		(1.98)
Regional Comparisons					
Asia-Pacific					
Non-U.S.	48	-0.030	3.003	8.152	0.203
MV Matched U.S.	48	-0.016	1.129	3.369	0.133
Non-U.S. - MV-matched U.S.	48	-0.014	1.874	4.783	0.070
			(2.12)		(3.71)
Europe					
Non-U.S.	84	-0.029	1.778	2.430	0.138
MV Matched U.S.	84	0.004	0.515	6.390	0.106
Non-U.S. - MV-matched U.S.	84	-0.033	1.263	-3.960	0.033
			(2.54)		(1.86)
Latin America					
Non-U.S.	48	-0.007	2.690	0.772	0.122
MV Matched U.S.	48	0.012	1.432	1.734	0.121
Non-U.S. - MV-matched U.S.	48	-0.019	1.258	-0.962	0.002
			(1.36)		(0.03)

Table 5: Percentage Quoted Spread (QSPR%)
of non-U.S. stocks and size-matched non-U.S. stocks.

QSPR% is the annual mean of the daily percentage quoted spread. Volatility of QSPR% is the standard deviation of the daily percentage quoted spread throughout the year. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	QSPR%	Volatility of QSPR%	Volatility / Mean
All non-U.S. stocks				
Non-U.S.				
MV Matched U.S.	182	0.88%	0.38%	43.7%
Non-U.S. - MV-matched U.S.	182	0.40%	0.17%	41.9%
	182	0.48%	0.22%	
		(12.05)	(10.11)	
Regional Comparisons				
Asia-Pacific				
Non-U.S.	48	0.97%	0.43%	43.9%
MV Matched U.S.	48	0.52%	0.22%	41.3%
Non-U.S. - MV-matched U.S.	48	0.45%	0.21%	
		(6.95)	(7.00)	
Europe				
Non-U.S.	84	0.63%	0.25%	40.6%
MV Matched U.S.	84	0.24%	0.10%	41.5%
Non-U.S. - MV-matched U.S.	84	0.39%	0.15%	
		(9.59)	(7.33)	
Latin America				
Non-U.S.	48	1.24%	0.58%	46.4%
MV Matched U.S.	48	0.55%	0.23%	42.7%
Non-U.S. - MV-matched U.S.	48	0.70%	0.34%	
		(6.14)	(5.42)	

Table 6: Percentage Effective Spread (ESPR%)
of non-U.S. stocks and size-matched non-U.S. stocks.

ESPR% is the annual mean of the daily-averaged percentage effective spread. Volatility of ESPR% is the standard deviation of the daily percentage effective spread throughout the year. The size-matched U.S. stocks are matched to non-U.S. stocks by average price, global market capitalization, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	ESPR%	Volatility of ESPR%	Volatility / Mean
All non-U.S. stocks				
Non-U.S.				
MV Matched U.S.	182	0.66%	0.33%	50.4%
Non-U.S. - MV-matched U.S.	182	0.28%	0.12%	42.8%
	182	0.38%	0.21%	
		(12.48)	(11.07)	
Regional Comparisons				
Asia-Pacific				
Non-U.S.	48	0.70%	0.34%	47.5%
MV Matched U.S.	48	0.37%	0.17%	44.6%
Non-U.S. - MV-matched U.S.	48	0.33%	0.17%	
		(7.35)	(6.90)	
Europe				
Non-U.S.	84	0.50%	0.25%	50.1%
MV Matched U.S.	84	0.17%	0.07%	41.2%
Non-U.S. - MV-matched U.S.	84	0.33%	0.18%	
		(9.72)	(9.96)	
Latin America				
Non-U.S.	48	0.91%	0.49%	53.2%
MV Matched U.S.	48	0.38%	0.16%	42.3%
Non-U.S. - MV-matched U.S.	48	0.53%	0.32%	
		(6.15)	(5.49)	

Table 7: Estimates of Kyle's λ by Glosten-Harris method of non-U.S. stocks and volume-matched non-U.S. stocks..

The Glosten-Harris model is $\Delta p_t = \lambda x_t + \Psi \Delta D_t + y_t$, where Δp_t is the price change in percentage scale, x_t is the signed dollar-amount trade size at time t, and D_t is the sign of order. All coefficients in this table have been multiplied by 10^5. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	Glosten-Harris's lambda
All non-U.S. stocks		
Non-U.S.	182	1.90
Volume Matched U.S.	182	1.74
Non-U.S. - Volume-matched U.S.	182	0.16
		(0.48)
Regional Comparisons		
Asia-Pacific		
Non-U.S.	48	2.31
Volume Matched U.S.	48	1.94
Non-U.S. - Volume-matched U.S.	48	0.37
		(0.70)
Europe		
Non-U.S.	84	1.40
Volume Matched U.S.	84	1.49
Non-U.S. - Volume-matched U.S.	84	-0.09
		(-0.16)
Latin America		
Non-U.S.	48	2.42
Volume Matched U.S.	48	2.01
Non-U.S. - Volume-matched U.S.	48	0.41
		(0.67)

Table 8: Estimates of the Hasbrouck VAR model
of non-U.S. stocks and volume-matched non-U.S. stocks (I).

The Hasbrouck model is $r_t = \sum_{i=1}^{5} a_i r_{t-i} + \sum_{i=0}^{5} b_i x_{t-i} + v_{1,t}$, $x_t = \sum_{i=1}^{5} c_i r_{t-i} + \sum_{i=1}^{5} d_i x_{t-i} + v_{2,t}$,

where r_t is the quote-midpoint change in percentage scale; x_t is the signed trade size at time t. This table shows the estimates of b_0~b_5. All coefficients in this table have been multiplied by10^5. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	b0	b1	b2	b3	b4	b5
All non-U.S. stocks							
Non-U.S.	182	1.347	0.557	0.476	0.021	-0.066	-0.023
Volume Matched U.S.	182	1.253	0.449	0.334	0.046	-0.039	0.014
Non-U.S. - Volume-matched U.S.	182	0.094	0.108	0.142	-0.025	-0.027	-0.037
		(0.41)	(1.57)	(0.92)	(-0.28)	(-0.29)	(-0.68)
Regional Comparisons							
Asia-Pacific							
Non-U.S.	48	1.748	0.802	0.139	0.224	0.024	0.067
Volume Matched U.S.	48	1.580	0.550	0.425	0.125	-0.020	0.018
Non-U.S. - Volume-matched U.S.	48	0.168	0.252	-0.286	0.098	0.044	0.048
		(0.33)	(1.72)	(-2.28)	(0.60)	(0.47)	(0.52)
Europe							
Non-U.S.	84	0.966	0.374	0.688	-0.139	-0.028	-0.083
Volume Matched U.S.	84	0.960	0.374	0.319	-0.055	-0.046	-0.021
Non-U.S. - Volume-matched U.S.	84	0.006	0.001	0.369	-0.085	0.017	-0.062
		(0.02)	(0.00)	(1.25)	(-0.62)	(0.22)	(-0.68)
Latin America							
Non-U.S.	48	1.710	0.654	0.470	0.097	-0.229	-0.011
Volume Matched U.S.	48	1.500	0.478	0.282	0.140	-0.055	0.072
Non-U.S. - Volume-matched U.S.	48	0.210	0.176	0.187	-0.043	-0.174	-0.083
		(0.44)	(1.15)	(0.73)	(-0.22)	(-0.54)	(-0.85)

Table 9: Estimates of the Hasbrouck VAR model
of non-U.S. stocks and volume-matched non-U.S. stocks (II).

The Hasbrouck model is $r_t = \sum_{i=1}^{5} a_i r_{t-i} + \sum_{i=0}^{5} b_i x_{t-i} + v_{1,t}$, $x_t = \sum_{i=1}^{5} c_i r_{t-i} + \sum_{i=1}^{5} d_i x_{t-i} + v_{2,t}$,

where r_t is the quote-midpoint change in percentage scale; x_t is the signed trade size at time t. This table shows the sum of a_i, b_i, c_i and d_i. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	Sum of a(i)	Sum of b(i)	Sum of c(i)	Sum of d(i)
All non-U.S. stocks					
Non-U.S.	182	-0.025	2.312	3.285	0.152
Volume Matched U.S.	182	0.003	2.057	-0.538	0.159
Non-U.S. - Volume-matched U.S.	182	-0.029	0.255	3.823	-0.007
			(0.72)		(-0.22)
Regional Comparisons					
Asia-Pacific					
Non-U.S.	48	-0.030	3.003	8.152	0.203
Volume Matched U.S.	48	-0.001	2.678	-0.943	0.167
Non-U.S. - Volume-matched U.S.	48	-0.029	0.324	9.095	0.035
			(0.47)		(1.76)
Europe					
Non-U.S.	84	-0.029	1.778	2.430	0.138
Volume Matched U.S.	84	0.022	1.532	-0.210	0.152
Non-U.S. - Volume-matched U.S.	84	-0.051	0.246	2.640	-0.014
			(0.46)		(-0.25)
Latin America					
Non-U.S.	48	-0.007	2.690	0.772	0.122
Volume Matched U.S.	48	-0.018	2.417	-0.927	0.166
Non-U.S. - Volume-matched U.S.	48	0.011	0.274	1.699	-0.044
			(0.37)		(-0.84)

Table 10: Percentage Quoted Spread (QSPR%) of non-U.S. stocks and volume-matched non-U.S. stocks.

QSPR% is the annual mean of the daily percentage quoted spread. Volatility of QSPR% is the standard deviation of the daily percentage quoted spread throughout the year. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	QSPR%	Volatility of QSPR%	Volatility / Mean
All non-U.S. stocks				
Non-U.S.	182	0.88%	0.38%	43.7%
Volume Matched U.S.	182	0.65%	0.29%	43.9%
Non-U.S. - Volume-matched	182	0.23%	0.10%	
		(5.79)	(4.39)	
Regional Comparisons				
Asia-Pacific				
Non-U.S.	48	0.97%	0.43%	43.9%
Volume Matched U.S.	48	0.80%	0.35%	44.0%
Non-U.S. - Volume-matched	48	0.17%	0.07%	
		(2.17)	(1.52)	
Europe				
Non-U.S.	84	0.63%	0.25%	40.6%
Volume Matched U.S.	84	0.49%	0.21%	43.1%
Non-U.S. - Volume-matched U.S.	84	0.14%	0.04%	
		(3.88)	(1.94)	
Latin America				
Non-U.S.	48	1.24%	0.58%	46.4%
Volume Matched U.S.	48	0.79%	0.35%	44.4%
Non-U.S. - Volume-matched U.S.	48	0.45%	0.23%	
		(4.34)	(4.17)	

Table 11: Percentage Effective Spread (ESPR%)
of non-U.S. stocks and volume-matched non-U.S. stocks.

ESPR% is the annual mean of the daily-averaged percentage effective spread. Volatility of ESPR% is the standard deviation of the daily percentage effective spread throughout the year. The volume-matched U.S. stocks are matched to non-U.S. stocks by average price, U.S. trading volume, intraday volatility, and overnight volatility. In the parenthesis are the t-statistics.

	Number of Stocks	ESPR%	Volatility of ESPR%	Volatility / Mean
All non-U.S. stocks				
Non-U.S.	182	0.66%	0.33%	50.4%
Volume Matched U.S.	182	0.46%	0.21%	45.8%
Non-U.S. - Volume-matched	182	0.20%	0.12%	
		(6.85)	(6.24)	
Regional Comparisons				
Asia-Pacific				
Non-U.S.	48	0.70%	0.34%	47.5%
Volume Matched U.S.	48	0.57%	0.27%	47.0%
Non-U.S. - Volume-matched	48	0.14%	0.07%	
		(2.54)	(1.85)	
Europe				
Non-U.S.	84	0.50%	0.25%	50.1%
Volume Matched U.S.	84	0.35%	0.16%	44.6%
Non-U.S. - Volume-matched U.S.	84	0.15%	0.09%	
		(5.15)	(4.93)	
Latin America				
Non-U.S.	48	0.91%	0.49%	53.2%
Volume Matched U.S.	48	0.55%	0.25%	45.7%
Non-U.S. - Volume-matched U.S.	48	0.36%	0.23%	
		(4.60)	(4.46)	

Appendix II: Figures

Figure 1: The Growth Rate of the Numbers of U.S. and non-U.S. Stocks Listed on the NYSE

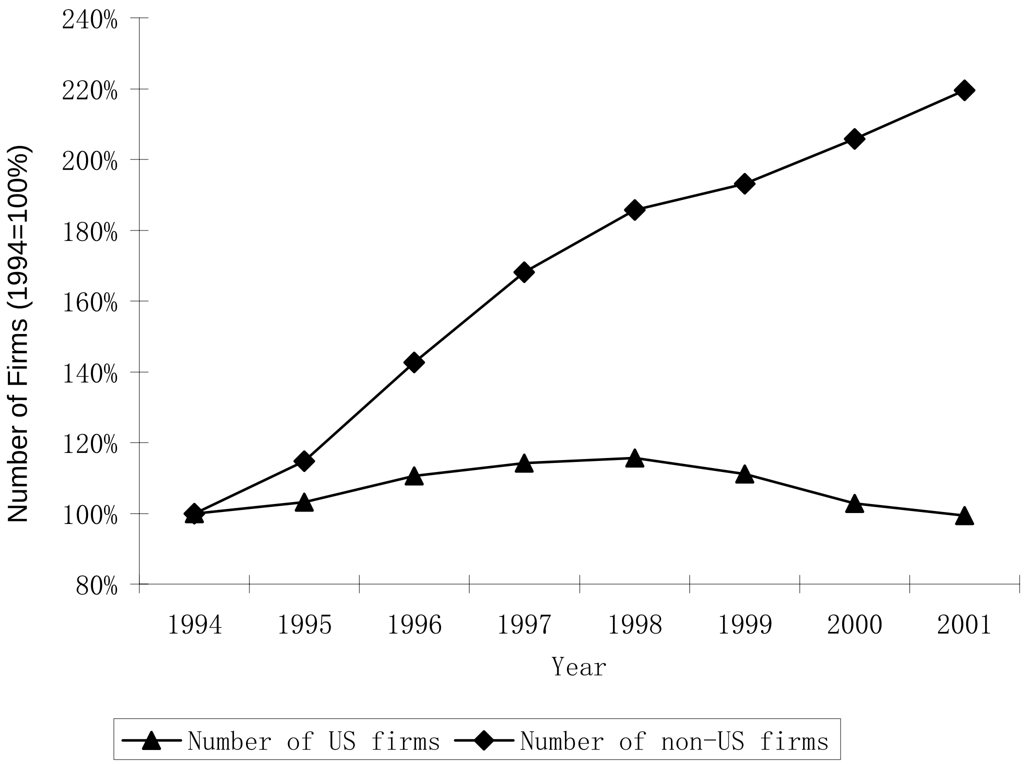

Figure 2a: The Percentage of Non-U.S. Stock Numbers on the NYSE

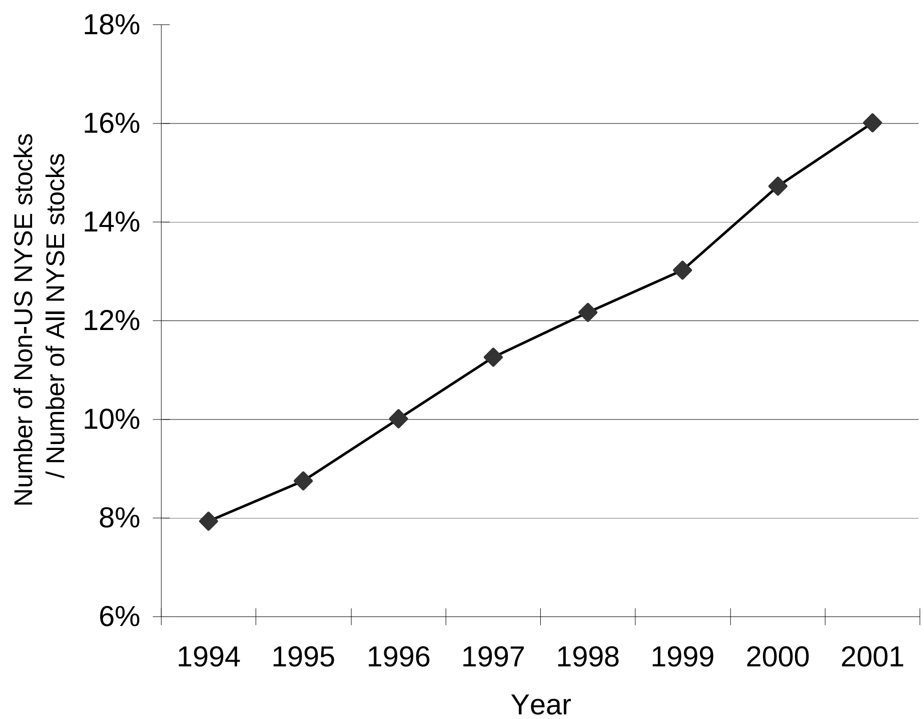

Figure 2b: The Percentage of Non-US Stock

Dollar Trading Volumes on the NYSE

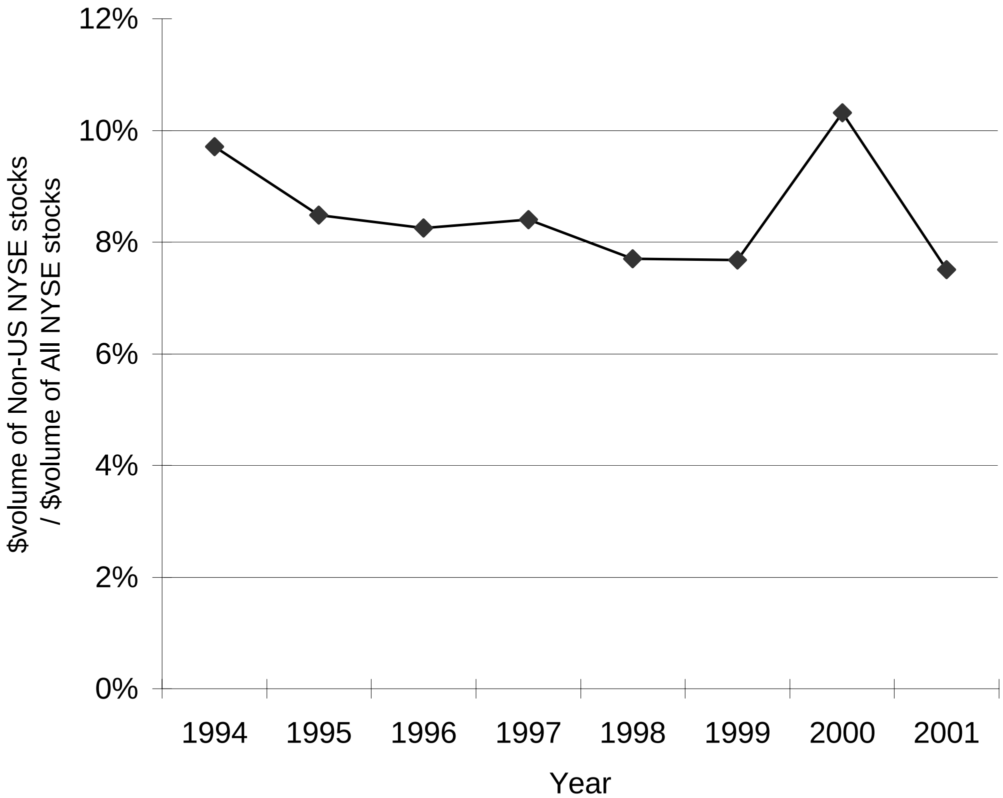

Figure 3: Intraday Pattern of Quoted Spread

for European stocks Listed on the NYSE

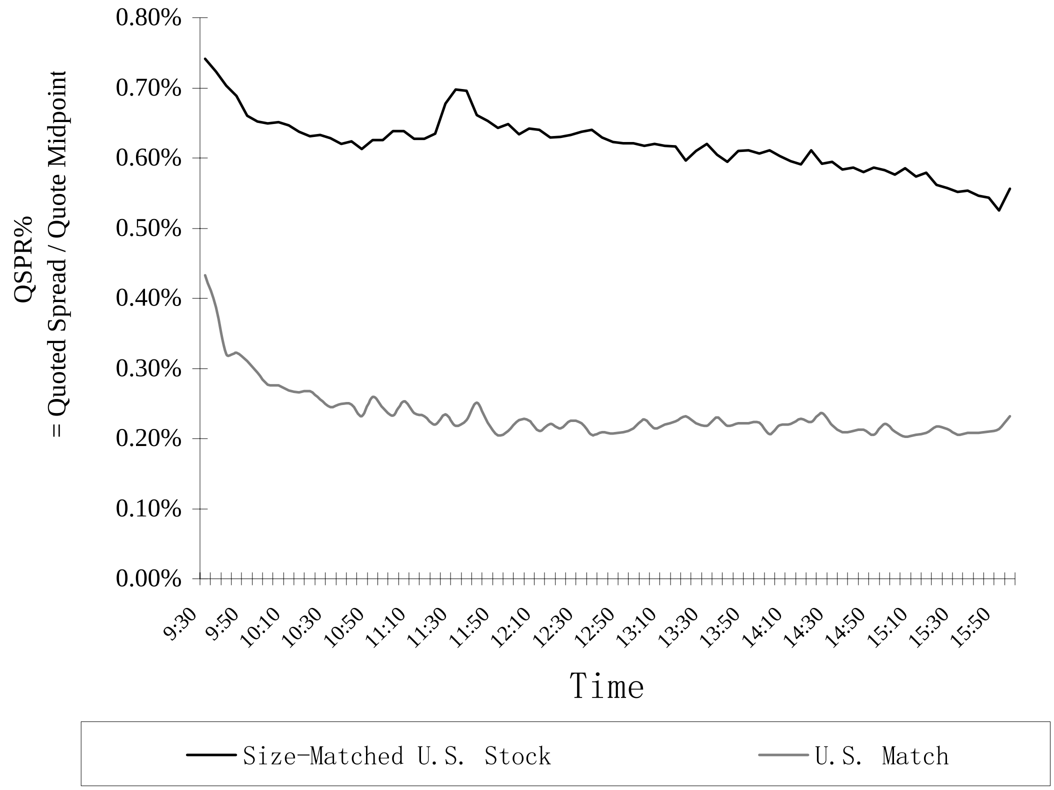

Figure 4: Intraday Pattern of Quoted Spread

for Asian stocks Listed on the NYSE

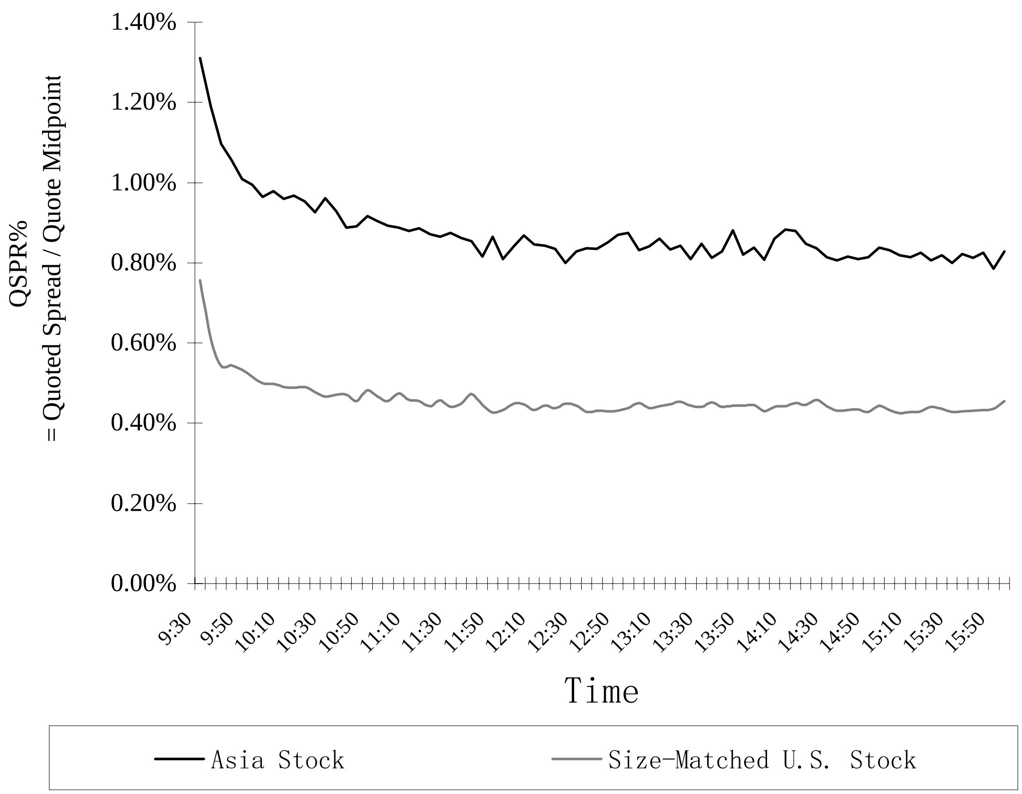

Figure 5: Intraday Pattern of Quoted Spread

for Latin American stocks Listed on the NYSE

Figure 6: Intraday Pattern of the Glosten-Harris Measure of Price Impact Power for Asian stocks Listed on the NYSE

Figure 7: Intraday Pattern of the Glosten-Harris Measure of Price Impact Power for European stocks Listed on the NYSE

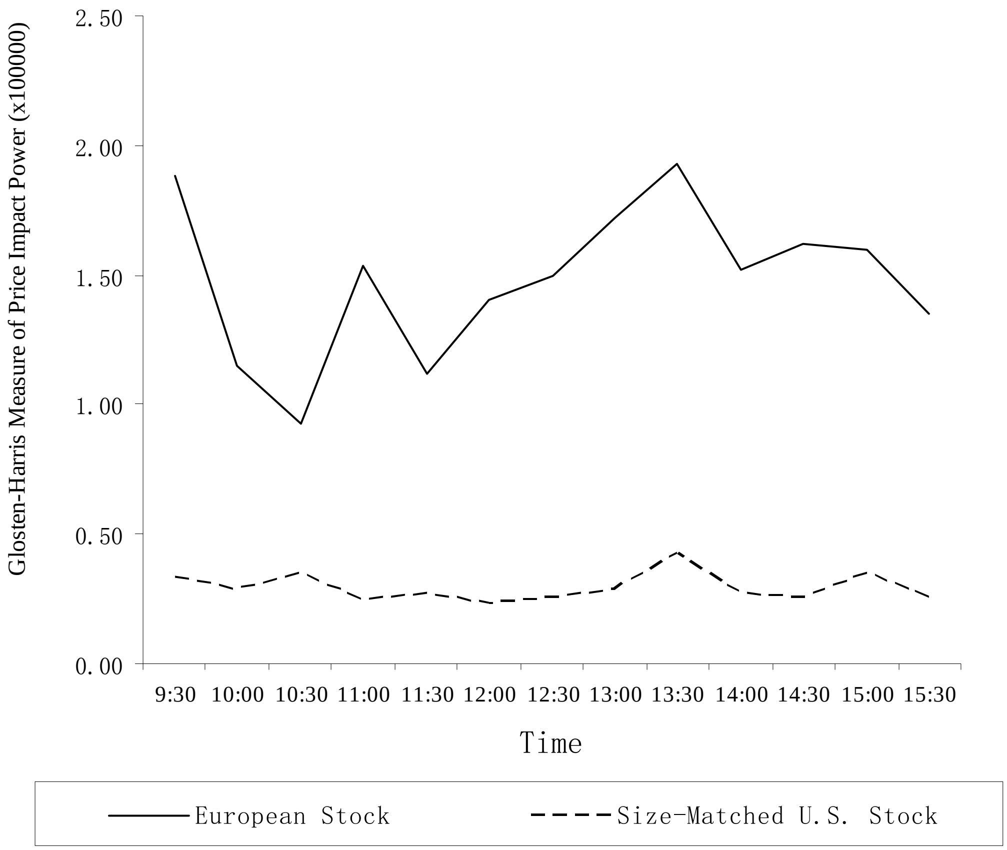

Figure 8: Intraday Pattern of the Glosten-Harris Measure of Price Impact Power for Latin American stocks Listed on the NYSE