Cross-Listing and Firm Liquidity on the Stock Exchange of Hong Kong

by *Paul Brockman* and *Dennis Y. Chung*

Abstract

The purpose of this paper is to investigate liquidity differences between Hong Kong companies that choose to cross list on the London Stock Exchange and those that list only on the local market, the Stock Exchange of Hong Kong. Each of these exchanges is among the ten largest in the world by market capitalization and represents a major source of new equity issuances within their respective regions of Europe and Asia. We compare the magnitudes of bid-ask spreads and depths for cross-listed and non-cross-listed firms over a 16-month period using a sample of 981,183 intra-day observations. Consistent with our hypotheses, relative bid-ask spreads are significantly lower and depths are significantly higher for the cross-listed sample, even after controlling for differences in price, volume, return variance, and inter-temporal patterns. This evidence strongly confirms the liquidity advantage of cross-listed firms and contributes to our understanding of the motivations for, and effects of, equity cross listings.

1. Introduction

The deepening globalization of capital markets and continuing reduction of regulatory constraints have fostered a highly competitive environment among the world's financial markets. Stock markets, in particular, compete intensely for the right to list actively traded multinational companies. With more and more firms electing to list their equity shares on multiple stock exchanges, it is increasingly important to understand the cause(s) and effect(s) of such cross listings. Survey results suggest that management is motivated by an anticipated improvement in firm liquidity, expansion in shareholder base, and reduction in the cost of capital. International listings are expected to increase the firm's visibility and elicit greater interest among market makers, financial analysts, and institutional investors such as pension and mutual funds. To date, most empirical research on cross-listing effects, particularly with respect to firm liquidity, has focused on U.S. firms listing on non-U.S. exchanges or non-U.S. firms listing on U.S. exchanges. The purpose of this paper is to analyze liquidity differences between Hong Kong companies that choose to cross list on the London Stock Exchange (LSE) and those that list only on the domestic market, the Stock Exchange of Hong Kong (SEHK).[1]

More specifically, this study compares the magnitudes of bid-ask spreads and depths for cross-listed and non-cross-listed firms over a 16-month period from May, 1996 to August, 1997. Using a sample of 981,183 intra-day observations, we test whether the cross-listed firms have higher liquidity than a (matched) portfolio of non-cross-listed firms. It is important to investigate both dimensions of liquidity (i.e., spreads and depths) before drawing conclusions from the empirical findings. A firm or portfolio is unambiguously more liquid than another only if it has lower relative spreads *and* higher depths. We therefore construct and test the following two hypotheses in order to provide empirical evidence with respect to the liquidity differences associated with cross listing:

Hypothesis 1: Cross-listed companies have lower relative bid-ask spreads than non-cross-listed companies, ceteris paribus.

Hypothesis 2: Cross-listed companies have higher depths than non-cross-listed companies, ceteris paribus.

The empirical results confirm both hypotheses and allow us to conclude, unambiguously, that cross-listed firms are more liquid than their non-cross-listed counterparts.

These findings are useful to corporate managers because of the inverse relationship between a firm's liquidity and its cost of capital (Amihud and Mendelson (1986)). Recent empirical evidence confirms that a corporation's required rate of return is significantly related to various liquidity proxies, such as amortized spreads (Chalmers and Kadlec (1998)), turnover rates (Datar, Naik, and Radcliffe (1998)), and adverse selection costs (Brennan and Subrahmanyam (1996)). Holding everything else constant, highly liquid firms are associated with relatively low costs of capital and, therefore, relatively high firm values. In making the decision to cross list, managers must weigh the benefits of improved liquidity and lower cost of capital against the costs of listing fees and additional disclosure. Our results are also relevant to the market microstructure literature by providing evidence on the effects of international competition among market markers. In an effort to maintain order flow, domestic market makers are expected to narrow their spreads (Stoll (1978)) or increase their depths (Noronha, Sarin, and Saudagaran (1996)) when domestic companies list abroad. The findings reported herein are consistent with both behaviors on the part of SEHK market makers.[2]

The remainder of the paper is organized as follows. Section 2 reviews the related literature on cross-listing effects and provides a brief review of intra- and inter-day liquidity patterns. Section 3 presents background information on the market making system of the SEHK and describes the intra-day spread and depth data. Section 4 discusses the method of analysis and analyzes the empirical results, and section 5 concludes the paper.

2. Previous Research

2.1. *Cross-Listing Effects*

Several reasons have been proposed as potential motivations for corporate managers to list their stock on more than one exchange. Merton (1987) develops a theoretical model of capital market equilibrium based on incomplete information (a violation of the standard CAPM set of assumptions) and shows that investors tend to invest only in companies with which they have good familiarity. His model suggests that managerial decisions designed to increase the size of the company's investor base will lead to a reduction in the cost of capital and an increase in firm value. Cross listing is an example of such a decision since it is expected to increase the investor base by adding a foreign investor component. In addition, Saudagaran (1988) and Mittoo (1992) show that the two major factors motivating the cross-listing decision are (1) greater access to sources of capital, and (2) enhanced visibility, particularly with respect to marketing.

The empirical evidence with respect to valuation effects caused by cross listing has been rather inconsistent across different studies.[3] According to Sundaram and Logue (1996, p.71), "... the totality of previous research appears to present a somewhat mixed picture with respect to the beneficial effects of cross-listing." Howe and Kelm (1987), for example, investigate 165 NYSE firms that cross list in Canada and Europe and report a negative 12.5 percent annualized return (statistically weak) during the first 40 days following listing. Lee (1991), Varela and Lee (1993), and Lau, Diltz, and Apilado (1994), on the other hand, re-

Table 1.
Selected market statistics on trading activities of sample companies over the 330 trading days in the period May 1996 to August 1997.[a] For each Hong Kong company that is cross-listed in London, a non-London-listed Hong Kong company with market capitalization that is closest to that of the London-listed company is identified and included in the matching sample. Each company's market capitalization is measured as the mean of the company's market capitalization on the last trading day of each month over the sample period.

	London-listed sample	Non-London-listed matching sample
Number of companies in the sample	33	33
Average market capitalization per company	$66,565,590,000	$11,468,220,000
Average daily trading volume per company in number of shares	4,577,917	6,410,162
Average daily trading volume per company in total dollar volume	$119,893,823	$35,607,293
Average percentage of trading days (over the sample period) with one or more shares traded	99.79%	98.76%
Average percentage of five-minute intra-day intervals (over the sample period) with one or more shares traded	78.11%	56.41%
Average share price in five-minute intervals	$32.700	$14.348
Average absolute bid-ask spread in five-minute intervals	$0.12227	$0.08303
Average relative bid-ask spread in five-minute intervals	0.00489	0.00728
Average dollar depth in five-minute intervals	$9,915,149	$2,860,914

[a] Two trading days (October 14, 1996 and December 12, 1996) are not included because data on the bid and ask quotes were not available from the SEHK on these two particular days.

port neutral or weakly positive valuation effects during the listing month. However, the preponderance of the evidence suggests that non-U.S. companies listing on U.S. exchanges experience positive valuation effects during the first few days after listing, but U.S. companies listing abroad experience insignificant effects. The real anomaly in this area of the literature is the almost universal tendency for significant declines in long run post-listing returns. Although some studies attribute these declines to optimal timing on the part of managers or to the fact that cross listing firms tend to be large, mature firms (i.e., less growth potential), this issue is far from settled.

Another line of research, and the primary focus of the current study, investigates liquidity effects associated with the cross-listing decision. Tinic and West (1974) show that 112 Canadian firms, simultaneously listed on the NYSE or AMEX, display narrower spreads than domestic firms even after controlling for differences in volume, volatility, and market capitalization. Other studies have employed a longitudinal approach by analyzing liquidity measures before and after cross listing. Foerster and Karolyi (1996) show that Canadian firms' bid-ask spreads decrease, on average, following dual listing on U.S. exchanges. On closer inspection, however, it is only those firms that experience an increase in home country (Canada) trading volume that receive the subsequent reduction in bid-ask spreads. For firms experiencing a decrease in home country trading volume, spreads actually widen following the cross listing. Noronha, Sam, and Saudagaran (1996) show that spreads do not change following the cross listings of U.S. firms onto the LSE and Tokyo Stock Exchange (TSE), although their quoted depths tend to increase.[4] Overall, these findings demonstrate the need for additional research in this area, particularly with respect to non-U.S.-related listings, and the importance of using both spreads and depths in drawing conclusions about firm liquidity.

2.2. *Inter- and Intra-day Liquidity Patterns*

Intra-day bid-ask spread patterns have been documented on the major U.S. stock and stock options exchanges, including the New York and American Stock Exchanges (NYSE and AMEX) (McInish and Wood (1992), Chan, Fong, Kho, and Stulz (1996)), the National Association of Securities Dealers Automated Quotation System (NASDAQ) (Chan, Christie, and Schultz (1995)), and the Chicago Board Options Exchange (CBOE) (Chan, Chung, and Johnson (1995)). Intra-day spread quotations have also been investigated on several European markets, including the LSE (Abhyankar, Ghosh, Levin, and Limmack (1997)) and the Paris Bourse (Biais, Hillion, and Spatt (1995)). Empirical evidence related to bid-ask spread patterns on major Asian exchanges, however, is still in its infancy with the noted exception of the "TSE" (Lehmann and Modest (1994) and Hamao and Hasbrouck (1995)).

Reported intra-day spread patterns can be classified into one of two categories: U-shaped and L-shaped. U-shaped patterns refer to intra-day bid-ask spreads that are relatively higher at the open and close of trading than during intermediate trading periods. L-shaped patterns refer to spreads that are relatively high at the open and either remain constant or slightly decline over the remainder of the trading period. In general, stock exchanges that rely on a specialist or designated dealer system for the provision of liquidity, such as the NYSE and AMEX, display U-shaped spread patterns while exchanges that rely on a multi-dealer system for the provision of liquidity, such as the NASDAQ and CBOE, display L-shaped spread patterns.

Inter-day theories and empirical results are not as plentiful as the extant intra-day literature. Many studies use inter-day data primarily for control purposes, such as Fortin's

(1990) investigation of the underlying cause(s) of the day-of-week effect in equity returns. In his study, NASDAQ bid-ask spread data are employed simply to test whether the returns pattern is a manifestation of spread variations. Fortin (1990) concludes that the weak inter-day pattern in bid-ask spreads could not be responsible for generating the strong day-of-week pattern in returns.

There currently exists very little evidence on inter- or intra-day depth patterns in the literature, probably due to data availability and less theoretical development in this area. Lee, Mucklow, and Ready (1993), however, stress the importance of analyzing both dimensions of liquidity (i.e., spreads and depths) whenever drawing conclusions from empirical results. Accordingly, they show that intra-day depths follow an inverse U-shaped pattern for a sample of firms traded on the NYSE. One of the contributions of this paper will be to provide preliminary results on inter- and intra-day depths for an order-driven market system.

3. Institutional Background and Data

The order-driven market making system of the SEHK is simple and straightforward. Unlike most other exchanges including those in the U.S. and Japan, the SEHK operates with minimal interference from third parties. There are no liquidity providers of last resort, no obligations to supply bid-ask quotations, no circuit breakers or other trading halts, no maximum price changes, and no exchange-designated order processors (i.e., *saitori).* Unlike the NYSE, AMEX, LSE, and TSE, the SEHK does not open with a call market and then switch to a continuous market; rather, it opens as a continuous market and remains a continuous market up to and including the close of trading.[5] All orders are placed through the public limit order book and this information is instantaneously displayed on the trading terminals of various market participants.[6] The only type of order permitted on the exchange is a limit order, so there are no "hidden orders" or complicated priority rules for market order execution as found on other automated exchanges such as the Paris Bourse (see Biais, Hillion, and Spatt (1995)). In this sense, the SEHK is a very open and competitive market, particularly with respect to the ease of entry and exit for liquidity suppliers.

Order entry and execution begins with the submission of a limit order. The order is entered into the Automatic Order Matching and Execution System (AMS) which prioritizes it by price and then by time. Although order sizes are posted for each bid or ask price level, trade size is not a priority in execution. Bid orders are arranged in priority from highest to lowest and ask orders are arranged from lowest to highest. Since it is not possible to place a buy (sell) order above (below) the currently-prevailing lowest ask (highest bid) price, the "best" price is the only one that can be executed at any given time. The quoted bid-ask spread, which is always equal to the effective bid-ask spread, is simply the difference between the prevailing lowest ask and highest bid price. Exchange members who trade on the floor of the Exchange, as well as non-members who have direct (real-time) access to the same information through data vendors, are free to post higher bids or lower offers as they see fit. Such an environment provides an interesting opportunity to investigate intra-day liquidity patterns since any observed patterns cannot be the result of monopolistic market making.

Our data set is obtained from the SEHK's Research and Planning Division and includes intra-day data for 33 cross-listed and 33 non-cross-listed firms covering the period from May 1, 1996 to August 29, 1997 (a total of 16 months).[7] Individual stock prices, bid-ask spreads, depths, and other transaction data are compiled at five-minute intervals

throughout the trading day. The first and last five-minute intervals for the morning trading session are from 10:00 to 10:05 a.m. and from 12:25 to 12:30 p.m., respectively; and the first and last five-minute intervals for the afternoon trading session are from 2:30 to 2:35 p.m. and from 3:50 to 3:55 p.m., respectively. In total, there are 47 five-minute intervals throughout the day broken up into 30 intervals for the morning session and 17 intervals for the afternoon session. The resulting data set consists of 981,183 observations.

4. Method of Analysis and Empirical Results

Table I presents summary statistics for the 33 cross-listed firms along with summary statistics for the non-cross-listed control sample. For each Hong Kong company that is cross-listed in London, a non-London-listed company with market capitalization closest to that of the London-listed company is identified and included in the control sample. As seen by comparing average capitalizations ($67 billion versus $11 billion), dollar volumes ($120 million versus $36 million), and prices per share ($33 versus $14), the cross-listed firms are substantially larger and more actively traded in terms of dollar amounts than their matched-sample counterparts. These differences can lead to confounded results whereby cross-listing effects (if any) cannot be disentangled from price, firm-size, and volume effects. In order to mitigate this possibility, subsequent testing includes control variables for price, volume, and volatility. Additional testing, based on a more restrictive matching rule (not reported herein), confirms that liquidity differences between cross-listed and non-cross-listed firms cannot be explained by differences in firm size or trading activity.[8]

Average daily trading volume for the cross-listed and control samples are 4.6 million and 6.4 million shares, respectively. The control sample firms have higher volumes but lower dollar volumes due to their relatively lower prices per share. The percentage of trading days with at least one trade and the percentage of five-minute intervals with at least one trade are 99.79 percent and 78.11 percent, respectively, for the cross-listed firms. The same statistics for control sample firms are 98.76 percent and 56.41 percent, respectively. These figures, along with average daily volumes, demonstrate that both portfolios are actively traded within the day (i.e., bid and ask prices are not stale).

Table I also provides summary statistics for spreads and depths. The average absolute bid-ask spread, defined as the ask price minus the bid price, is $0.12227 for cross-listed firms and $0.08303 for non-cross-listed firms. These figures show that absolute spreads are positively related to average price levels, consistent with previous research. The average relative bid-ask spread *(RBA)*, defined as the absolute spread divided by the spread midpoint, is 0.00489 for cross-listed firms and 0.00728 for non-cross-listed firms. Lower relative spreads suggest that London-listed firms are more liquid than the control sample, at least before the implementation of control variables. Average dollar depth *(DDepth)*, defined as the number of shares at the bid times price per share plus the number of shares at the ask times price per share, is also higher for the London-listed firms ($9.9 million) than for the control sample firms ($2.8 million). In summary, the London-listed firms appear to be more liquid than their non-cross-listed counterparts both in terms of relative bid-ask spreads and depths.

Next, we estimate pooled cross-sectional and time series regressions using 981,183 observations taken at five-minute intervals throughout the day. Two separate regressions, one for each liquidity measure, are estimated as follows:

Table 2.
Regression of liquidity measures on a matching sample (based on market capitalization) of London-listed and non-London-listed Hong Kong companies.

$$Liquidity_t = \alpha + \beta\ London_{i,t} + \varepsilon_t$$

where $Liquidity_t$ is measured by RBA_t or $DDepth_t$. RBA_t is the relative bid-ask spread of the individual firm at the end of time interval t. $DDepth_t$ is the dollar depth which is defined as the total bid price dollar value of all shares quoted at the highest bid price plus the total ask price dollar value of all shares quoted at the lowest ask price at the end of each interval. $London_{i,t}$ is a dummy variable assigned a value of one if the Hong Kong company is cross-listed in London, and zero otherwise. RBA_t and $DDepth_t$ are transformed by taking natural logarithms. The t-statistics are adjusted for heteroscedasticity using White's (1980) procedure. Significance at the 0.01 level is indicated by an asterisk.

		$Liquidity_t = RBA_t$		$Liquidity_t = DDepth_t$	
Variable		estimate of coefficient	t-statistic	estimate of coefficient	t-statistic
Intercept	α	-5.0754	-6414.06*	14.1662	8008.91*
London-listed	β	-0.4081	-376.60*	0.9944	372.91*
Overall model statistics (n = 981,183)[a]:					
adjusted R^2		0.1265		0.1235	
F-ratio (d.f. = 1 and 981,181)		142,086.14*		138,300.77*	

[a] The sample size represents the number of five-minute intervals with posted bid and ask prices (i.e., a valid bid-ask spread) for the matching sample of 33 London-listed Hong Kong companies and 33 non-London-listed Hong Kong companies over the 330 trading days in the period May 1996 to August 1997.

$$Liquidity = \alpha + \beta\, London_{i,t} + \varepsilon_t, \qquad (1)$$

where *Liquidity* is measured by RBA_t, or $DDepth_t$, $London_{i,t}$ is a dummy variable (1 if cross-listed, 0 otherwise), and ε_t is an error term. A negative and statistically significant β is supportive of hypothesis 1 when *RBA* is used as the dependent variable (i.e., London-listed firms have relatively lower spreads). A positive and statistically significant β is supportive of hypothesis 2 when *DDepth* is the dependent variable (i.e., London-listed firms have relatively higher depths). Cross-listed firms are unambiguously more liquid than non-cross-listed firms only if both results are obtained.

Table 2 reports the findings from testing model (1). *RBA* and *DDepth* are transformed by taking natural logarithms and all t-statistics are adjusted for heteroskedasticity using White's (1980) procedure. Consistent with hypothesis 1, the *RBA*-regression β (-0.4081) is negative and statistically significant, thus demonstrating that cross-listed spreads are lower than their non-cross-listed counterparts. And consistent with hypothesis 2, the *DDepth*-regression β (0.9944) is positive and statistically significant, showing that cross-listed depths are higher than non-cross-listed depths. Taken together, these results provide corroborating evidence of a significant liquidity difference between cross-listed and non-cross-listed firms.

Previous research demonstrates that variations in bid-ask spreads are a function of cross-sectional variations in volume, volatility, and price. It is therefore plausible that the significant liquidity differences reported above are due to variations in these three explanatory variables and not to cross-listing effects as hypothesized. Controlling for volume, volatility, and price differences is particularly important in this study because of the difficulty in constructing a matched portfolio of non-cross-listed firms. In order to mitigate the effects of a less-than-perfect control sample, the following regression model is estimated with volume, volatility, and price as additional explanatory variables:

$$Liquidity = \alpha + \beta\, London_{it} + \gamma_1\, vol_t + \gamma_2\, var_t + \gamma\, price_t + \varepsilon_t \qquad (2)$$

where *vol* is defined as the number of shares traded over a five-minute interval, and *price* is simply the stock price recorded at the end of that interval. *Var* is estimated for five-minute intervals and based on one-minute continuous returns which, in turn, are obtained by taking the logarithms of bid-ask midpoint relatives one minute apart. All non-dummy variables, *RBA, DDepth, vol, var,* and *price,* are transformed by taking their natural logarithms.[9]

Table 3 provides summary statistics for each of the (raw or non-transformed) control variables in panel A and a corresponding correlation matrix in panel B. The overall number of observations drops from the full sample of 981,183 as reported in table 2, to a reduced sample of 685,825 due to the additional requirement that a trade must occur during the five-minute interval to be included. This requirement is needed because the control variables are transaction-based measures. Although the relevant relationships among dependent and independent variables are discussed in the following section, it is interesting to note that the strongest correlation in panel B is between *price* and *DDepth* (0.643). In addition, the negative correlation between *RBA* and *DDepth* suggests that firms with relatively low spreads also tend to have relatively high depths.

Table 3.
Descriptive statistics and correlation matrix of variables on a matching sample (based on market capitalization) of London-listed and non-London-listed Hong Kong companies. *RBA* is the relative bid-ask spread at the end of each five-minute interval. *DDepth* is the dollar depth which is defined as the total bid price dollar value of all shares quoted at the highest bid price plus the total ask price dollar value of all shares quoted at the lowest ask price at the end of each five-minute interval. *Vol* is the number of shares traded during each five-minute interval. *Var* measures the variance of returns over each five-minute interval, and returns are calculated on a continuously compounded basis over one-minute intervals. *Price* is the recorded share price at the end of each five-minute interval.

Panel A: Descriptive statistics (n = 685,825)[a]

variable	minimum	maximum	mean	median
RBA	0.002	0.122	0.005	0.005
DDepth (x 10^3)	9.100	447,800.000	8,326.157	3,284.525
vol (x 10^3)	0.001	423,100.000	171.174	43.000
var (x 10^{-6})	0.000	753.000	2.679	0.000
price	1.060	279.000	26.042	13.600

Panel B: Correlation matrix (n = 685,825)[a]

	RBA	*DDepth*	*vol*	*var*
RBA	1.000			
DDepth	-0.123	1.000		
vol	0.046	0.003	1.000	
var	0.272	-0.078	0.117	1.000
price	-0.361	0.643	-0.047	-0.119

[a] n represents the number of five-minute intervals with posted bid and ask prices (i.e., a valid bid-ask spread) and recorded transaction for the matching sample of 33 London-listed Hong Kong companies and 33 non-London-listed Hong Kong companies over the 330 trading days in the period May 1996 to August 1997.

Table 4 presents the results from estimating equation (2). As anticipated, the inclusion of control variables increases the explanatory power (R^2) of the models from 12.65 percent to 48.07 percent, and from 12.35 percent to 25.65 percent, for the *RBA* and *DDepth* regressions, respectively. The signs of the control variables are consistent with theory and previous empirical findings. Higher trading volumes are expected to decrease relative bid-ask spreads (coefficient=-0.0135) and increase depths (coefficient=0.2636) as higher volume levels allow market makers to spread their fixed costs over more units. Higher return variance is expected to increase relative spreads (coefficient=0.2592) and decrease depths (coefficient = -0.9065) as greater volatility increases the costs of inventory control. Higher prices are associated with lower relative spreads (coefficient=-0.2823) because of a fixed cost component of the spread (i.e., there is less variation in market making costs than prices). And lastly, higher prices are associated with higher depths (coefficient=0.3761) since price is closely related to size and the level of trading activity. Overall, the estimated coefficients, in terms of signs, magnitudes, and levels of statistical significance, are consistent with theory-based expectations.

The most significant result in table 4, however, is that both regressions confirm the hypothesized effect of cross listing. The *RBA*-regression β (-0.1241) falls in magnitude from that estimated in model (1) but remains negative and statistically significant. The *DDepth*-regression β (0.4634) also falls in value from its model (1) counterpart but remains positive and statistically significant. Therefore, the inclusion of various (cross-sectional) control variables based on market microstructure theory does not alter the previous conclusion that the cross-listed firms are unambiguously more liquid than the non-cross-listed control sample.

Previous research has also shown that liquidity costs vary over time and display rather consistent inter- and intra-day patterns. It is therefore possible that significant liquidity differences attributed to cross listing may dissolve after controlling for inter-temporal patterns. Regression model (3) is estimated with day-of-week and time-of-day dummy variables in order to control for the effects of these inter-temporal variations. We estimate the following augmented model:

$$Liquidity = \alpha_0 + \sum_{i=1}^{3} \beta_i \, port_{i,t} + \gamma_1 \, vol_t + \gamma_2 \, var_t + \gamma_3 \, price_t$$

$$+ \sum_{j=1}^{4} \theta_j \, day_{j,t} + \sum_{k=1}^{46} \lambda_k \, time_{k,t} + \varepsilon_t \qquad (3)$$

where the additional dummy variables, *day* and *time,* represent the day-of-week (i.e., Monday, ..., Friday), and time-of-day (i.e., 10:00-10:05 a.m., ..., 3:50-3:55 p.m.), respectively. No dummy variable is included for Wednesday or the 36*th* time interval (i.e., 2:55-3:00pm) to avoid perfect collinearity within the sets of dummy variables.

The regression results for model (3) are presented in table *5.* Statistical significance and signs for the volume, variance, and price control variables are consistent with theory and previous results. Higher levels of trading volume tend to decrease spreads and increase depths due to a reduction in order-processing costs, and higher levels of volatility tend to increase spreads and decrease depths due to greater inventory-holding costs. As before, the

Table 4.
Regression of liquidity measures with the transaction data control variables on a matching sample (based on market capitalization) of London-listed and non-London-listed Hong Kong companies.

$$Liquidity_t = \alpha + \beta\ London_{i,t} + \gamma_1 vol_t + \gamma_2\ var_t + \gamma_3 price_t + \varepsilon_t$$

where $Liquidity_t$ is measured by RBA_t or $DDepth_t$. RBA_t is the relative bid-ask spread of the individual firm at the end of time interval t. $DDepth_t$ is the dollar depth which is defined as the total bid price dollar value of all shares quoted at the highest bid price plus the total ask price dollar value of all shares quoted at the lowest ask price at the end of each interval. $London_{i,t}$ is a dummy variable assigned a value of one if the Hong Kong company is cross-listed in London, and zero otherwise. Vol_t, var_t, and $price_t$ are the trading volume, return variance, and trading price of the individual firm at time interval t. All non-dummy variables, RBA_t, $DDepth_t$, vol_t, var_t, and $price_t$, are transformed by taking natural logarithms. The t-statistics are adjusted for heteroscedasticity using White's (1980) procedure. Significance at the 0.01 level is indicated by an asterisk.

		$Liquidity_t = RBA_t$		$Liquidity_t = DDepth_t$	
Variable		estimate of coefficient	t-statistic	estimate of coefficient	t-statistic
Intercept	α	-1.4546	-68.16 *	0.6553	10.69 *
London-listed	β	-0.1241	-108.12 *	0.4634	144.42 *
Trading volume	γ_1	-0.0135	-43.88 *	0.2636	284.63 *
Return variance	γ_2	0.2592	148.08 *	-0.9065	-178.09 *
Trading price	γ_3	-0.2823	-540.74 *	0.3761	239.19 *
Overall model statistics (n = 685,825)[a]:					
adjusted R^2			0.4807		0.2565
F-ratio (d.f. = 4 and 685,820)			158,715.00 *		59,157.88 *

[a] The sample size represents the number of five-minute intervals with posted bid and ask prices (i.e., a valid bid-ask spread) for the matching sample of 33 London-listed Hong Kong companies and 33 non-London-listed Hong Kong companies over the 330 trading days in the period May 1996 to August 1997.

Table 5.
Regression of liquidity measures with all the control variables on a matching sample (based on market capitalization) of London-listed and non-London-listed Hong Kong companies.

$$Liquidity_t = \alpha + \beta\ London_{i,t} + \gamma_1 vol_t + \gamma_2\ var_t + \gamma_3 price_t + \sum_{j=1}^{4} \theta_j day_{j,t} + \sum_{k=1}^{46} \lambda_k time_{k,t} + \varepsilon_t$$

where $Liquidity_t$ is measured by RBA_t or $DDepth_t$. RBA_t is the relative bid-ask spread of the individual firm at the end of time interval t. $DDepth_t$ is the dollar depth which is defined as the total bid price dollar value of all shares quoted at the highest bid price plus the total ask price dollar value of all shares quoted at the lowest ask price at the end of each interval. $London_{i,t}$ is a dummy variable assigned a value of one if the Hong Kong company is cross-listed in London, and zero otherwise. Vol_t, var_t, and $price_t$ are the trading volume, return variance, and trading price of the firm for time interval t. $Day_{j,t}$, and $time_{k,t}$ are dummy variables for the day-of-week (i.e., Monday, ..., Friday), and time-of-day (i.e., 10:00-10:05 a.m., ..., 3:50-3:55 p.m.), respectively. No dummy variable is included for Wednesday or for the 36th interval (i.e., 2:55-3:00 pm) to avoid perfect collinearity among each set of dummy variables. All non-dummy variables, RBA_t, $DDepth_t$, vol_t, var_t, and $price_t$, are transformed by taking natural logarithms. The t-statistics are adjusted for heteroscedasticity using White's (1980) procedure. Significance at the 0.01 level is indicated by an asterisk.

		$Liquidity_t = RBA_t$		$Liquidity_t = DDepth_t$	
Variable		estimate of coefficient	t-statistic	estimate of coefficient	t-statistic
Intercept	α	-1.6391	-75.23 *	1.9229	31.23 *
London-listed	β	-0.1252	-109.93 *	0.4697	148.88 *
Trading volume	γ_1	-0.0155	-49.51 *	0.2756	300.01 *
Return variance	γ_2	0.2434	137.55 *	-0.7982	-158.31 *
Trading price	γ_3	-0.2838	-545.19 *	0.3857	249.16 *
Monday	θ_1	0.0033	2.24	-0.0419	-9.37 *
Tuesday	θ_2	-0.0003	-0.22	0.0058	1.33
Thursday	θ_3	0.0015	1.04	-0.0395	-8.99 *
Friday	θ_4	0.0002	0.12	-0.0316	-7.30 *
1st interval (10:00-10:05)	λ_1	0.2711	41.88 *	-1.1400	-70.38 *
2nd interval (10:05-10:10)	λ_2	0.1403	27.20 *	-0.8530	-62.23 *
3rd Interval (10:10-10:15)	λ_3	0.1094	23.35 *	-0.7372	-56.39 *
4th interval (10:15-10:20)	λ_4	0.0906	19.73 *	-0.6455	-49.17 *
5th interval (10:20-10:25)	λ_5	0.0713	15.96 *	-0.5627	-43.04 *
6th interval (10:25-10:30)	λ_6	0.0579	13.02 *	-0.4931	-37.31 *

7th interval (10:30-10:35)	λ_{7}	0.0525	11.81*	-0.4313	-32.65*
8th interval (10:35-10:40)	λ_{8}	0.0453	10.27*	-0.3788	-28.63*
9th interval (10:40-10:45)	λ_{9}	0.0407	9.25*	-0.3465	-26.08*
10th interval (10:45-10:50)	λ_{10}	0.0353	8.03*	-0.3020	-22.51*
11th interval (10:50-10:55)	λ_{11}	0.0345	7.86*	-0.2698	-20.09*
12th interval (10:55-11:00)	λ_{12}	0.0289	6.63*	-0.2141	-15.98*
13th interval (11:00-11:05)	λ_{13}	0.0297	6.77*	-0.1833	-13.59*
14th interval (11:05-11:10)	λ_{14}	0.0240	5.49*	-0.1381	-10.19*
15th interval (11:10-11:15)	λ_{15}	0.0227	5.18*	-0.1268	-9.35*
16th interval (11:15-11:20)	λ_{16}	0.0219	5.01*	-0.1062	-7.83*
17th interval (11:20-11:25)	λ_{17}	0.0181	4.15*	-0.0812	-5.96*
18th interval (11:25-11:30)	λ_{18}	0.0215	4.90*	-0.0680	-4.98*
19th interval (11:30-11:35)	λ_{19}	0.0181	4.15*	-0.0503	-3.67*
20th interval (11:35-11:40)	λ_{20}	0.0144	3.30*	-0.0529	-3.85*
21st interval (11:40-11:45)	λ_{21}	0.0116	2.65*	-0.0303	-2.21
22nd interval (11:45-11:50)	λ_{22}	0.0100	2.29	-0.0086	-0.62
23rd interval (11:50-11:55)	λ_{23}	0.0118	2.70*	0.0025	0.18
24th interval (11:55-12:00)	λ_{24}	0.0139	3.15*	0.0306	2.21
25th interval (12:00-12:05)	λ_{25}	0.0110	2.51	0.0250	1.81
26th interval (12:05-12:10)	λ_{26}	0.0147	3.35*	0.0231	1.66
27th interval (12:10-12:15)	λ_{27}	0.0105	2.39	0.0309	2.20
28th interval (12:15-12:20)	λ_{28}	0.0150	3.40*	0.0462	3.31*
29th interval (12:20-12:25)	λ_{29}	0.0178	4.04*	0.0425	3.04*
30th interval (12:25-12:30)	λ_{30}	0.0273	6.12*	0.0117	0.84
31st interval (14:30-14:35)	λ_{31}	-0.0014	-0.33	-0.1475	-11.43*
32nd interval (14:35-14:40)	λ_{32}	0.0067	1.59	-0.0768	-5.82*
33rd interval (14:40-14:45)	λ_{33}	0.0060	1.42	-0.0611	-4.61*
34th interval (14:45-14:50)	λ_{34}	0.0053	1.24	-0.0299	-2.24
35th interval (14:50-14:55)	λ_{35}	0.0032	0.75	-0.0045	-0.33
37th interval (15:00-15:05)	λ_{36}	0.0007	0.18	0.0223	1.67
38th interval (15:05-15:10)	λ_{37}	-0.0009	-0.22	0.0158	1.18
39th interval (15:10-15:15)	λ_{38}	-0.0015	-0.36	0.0130	0.98
40th interval (15:15-15:20)	λ_{39}	-0.0008	-0.20	0.0022	0.16
41st interval (15:20-15:25)	λ_{40}	-0.0016	-0.38	-0.0067	-0.51
42nd interval (15:25-15:30)	λ_{41}	-0.0042	-1.00	-0.0352	-2.67*
43rd interval (15:30-15:35)	λ_{42}	-0.0019	-0.44	-0.0441	-3.37*
44th interval (15:35-15:40)	λ_{43}	0.0010	0.25	-0.0899	-6.90*
45th interval (15:40-15:45)	λ_{44}	0.0048	1.15	-0.1623	-12.60*

46th interval (15:45-15:50)	λ_{45}	0.0222	5.29 *	-0.2628	-20.65 *
47th interval (15:50-15:55)	λ_{46}	0.1459	32.44 *	-0.6888	-55.31 *
Overall model statistics (n = 685,825)[a]:					
adjusted R^2			0.4869		0.2886
F ratio (d.f. = 54 and 685,770)			12,053.74 *		5,152.55 *

[a] The sample size represents the number of five-minute intervals with posted bid and ask prices (i.e., a valid bid-ask spread) for the matching sample of 33 London-listed Hong Kong companies and 33 non-London-listed Hong Kong companies over the 330 trading days in the period May 1996 to August 1997.

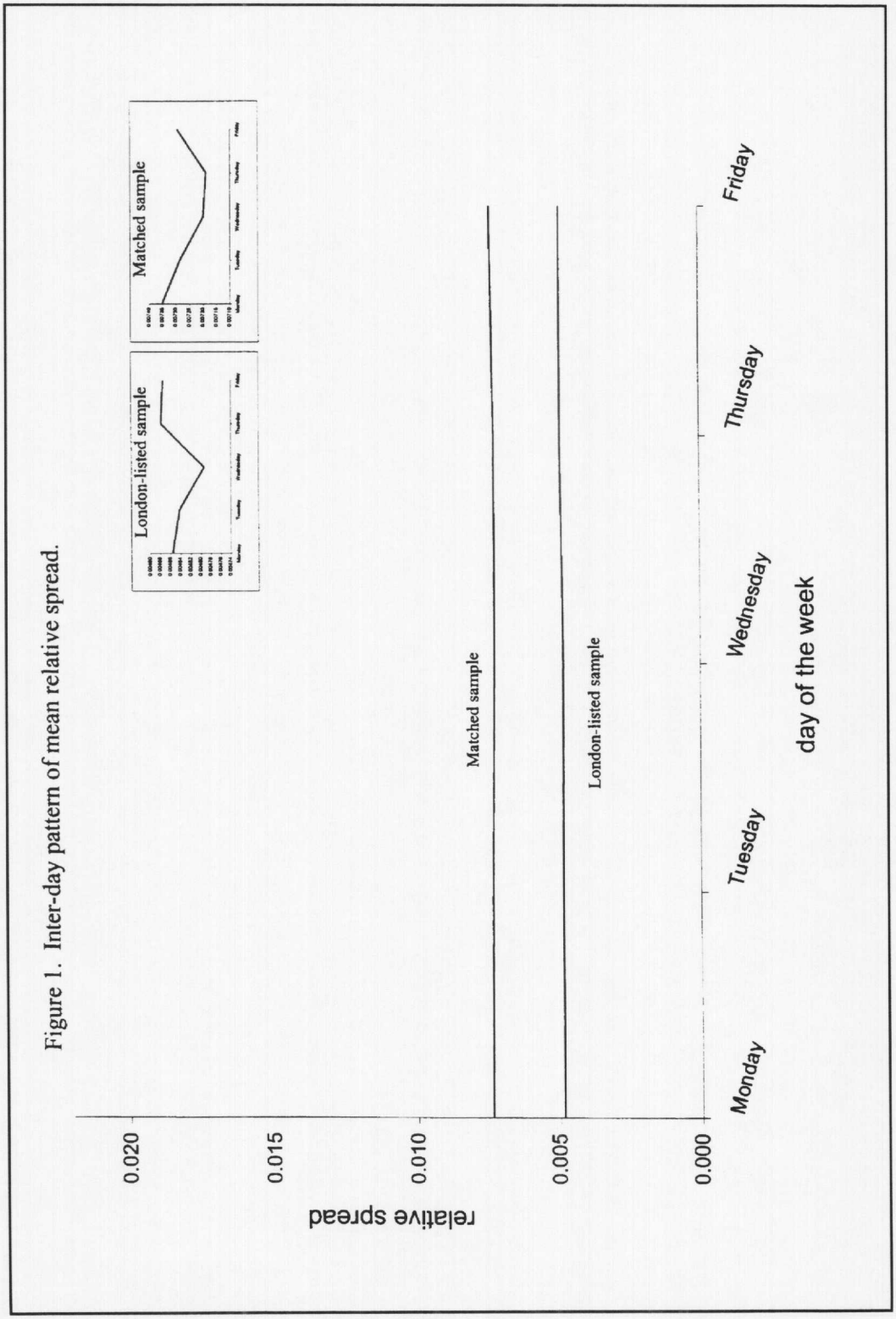

Figure 1. Inter-day pattern of mean relative spread.

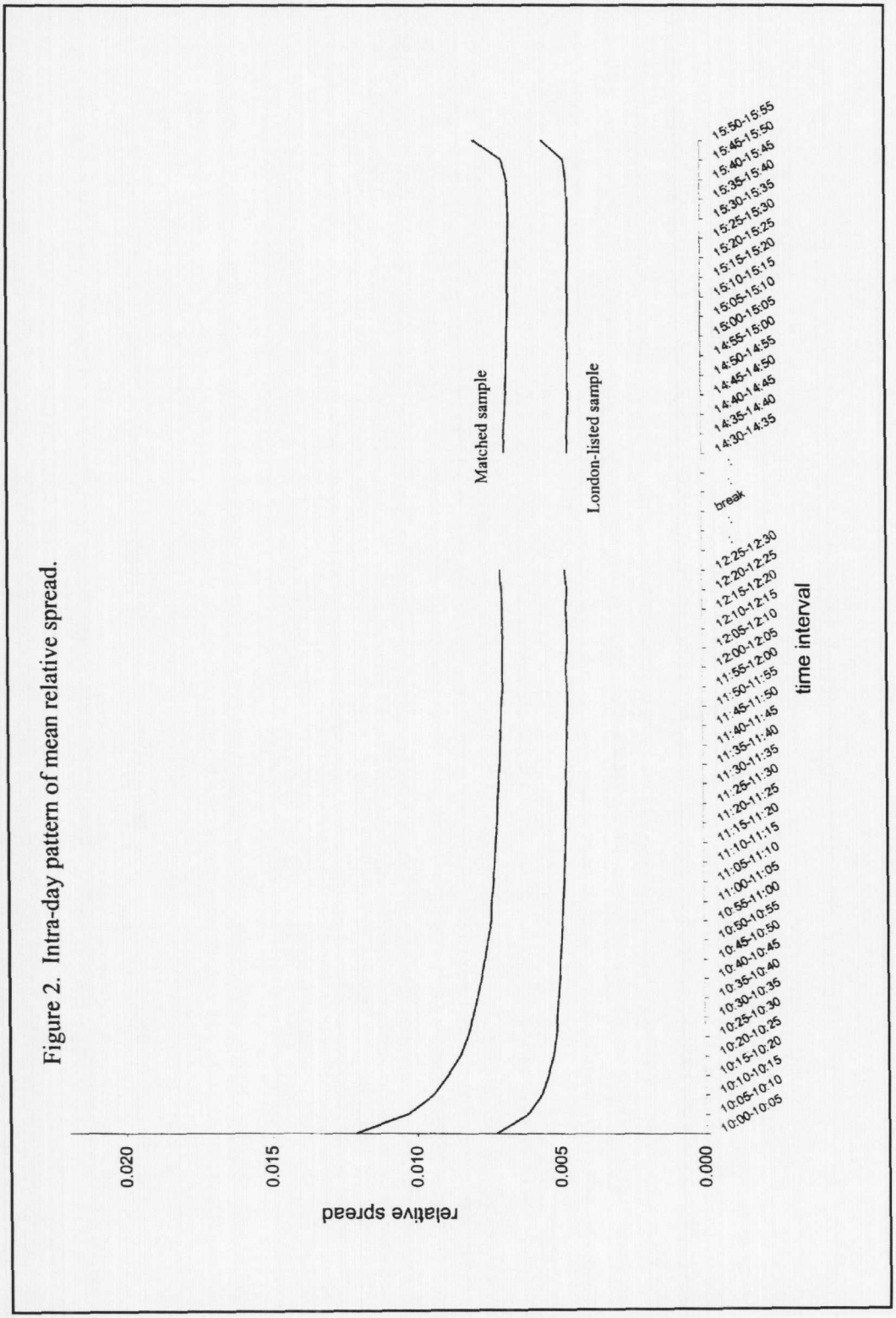

Figure 2. Intra-day pattern of mean relative spread.

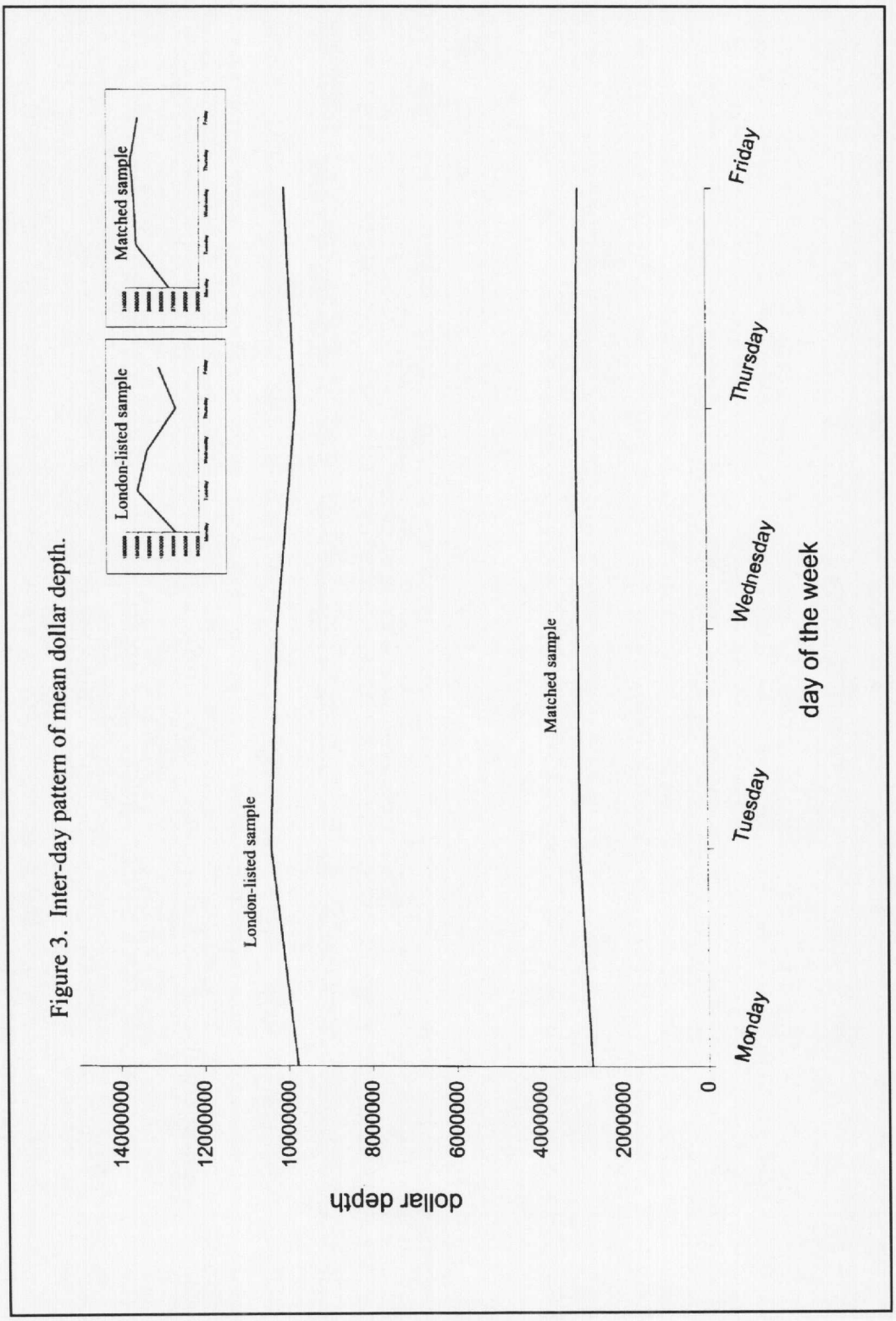

Figure 3. Inter-day pattern of mean dollar depth.

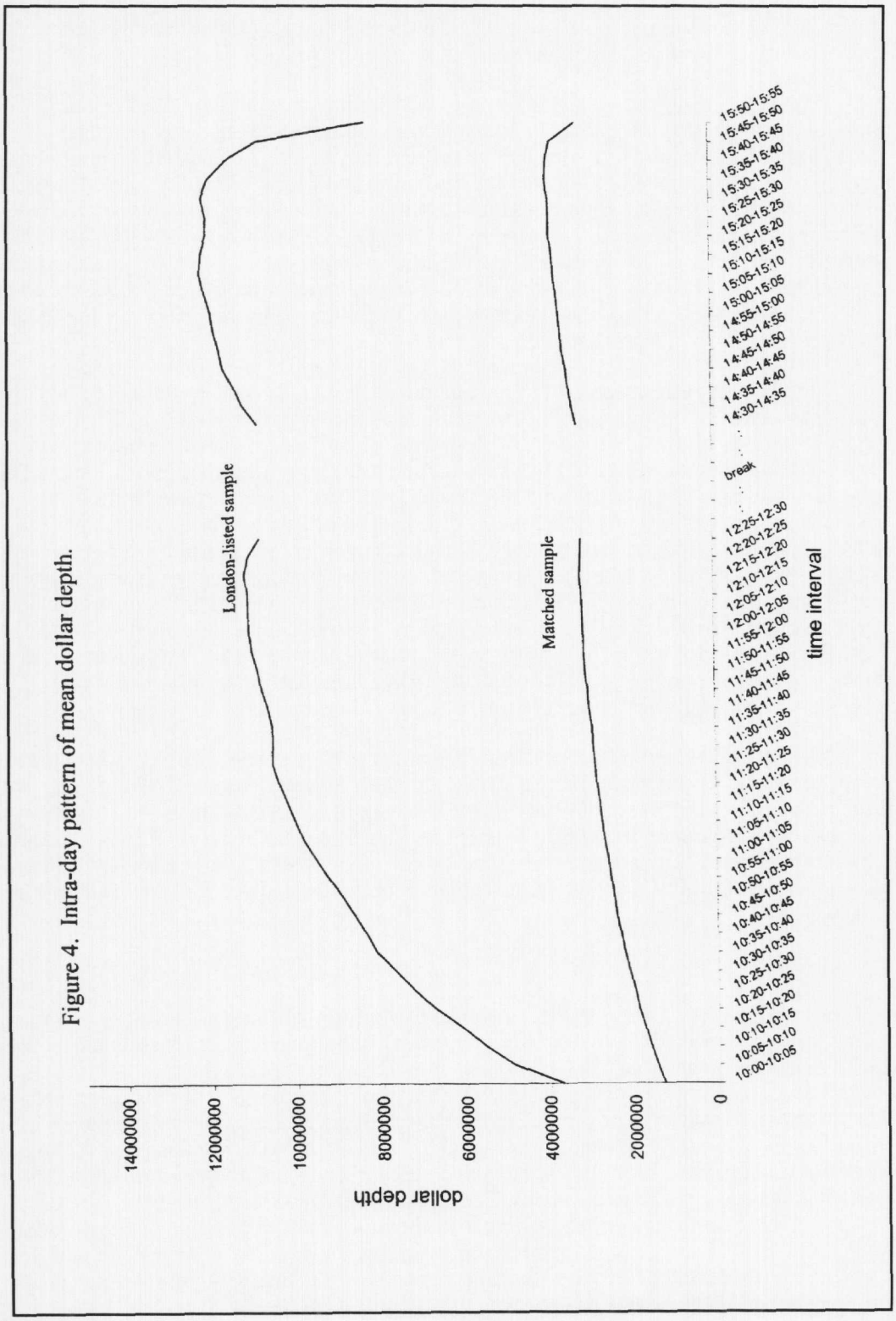

Figure 4. Intra-day pattern of mean dollar depth.

inverse (direct) relationship between price levels and spreads (dollar depths) is related to the presence of fixed costs in the cost structure of order processing.

Although the day-of-week and time-of-day dummy variables are used primarily for control purposes, it is interesting to note that intra- and inter-day spreads are generally U-shaped and that intra and inter-day depths are generally inverted U-shaped. Overall liquidity, therefore, is consistently lower at the beginning and ending of trading periods. Again, the most significant result in table 5 is that both regressions confirm the hypothesized effect of cross listing (i.e., lower spreads and higher depths). The *RBA*-regression β (-0.1252) is negative and statistically significant, and the *DDepth*-regression β (0.4697) is positive and statistically significant. The inclusion of cross-sectional and time-series control variables confirms the earlier findings that the cross-listed firms are unambiguously more liquid than the non-cross-listed control sample.

Finally, we present graphs of intra- and inter-day spreads and depths in order to compare inter-temporal properties. This section is designed to investigate whether there are specific periods of the day, or days of the week, when the liquidity differences between cross-listed and non-cross-listed firms are particularly large or small. Figures 1 and 2 display mean relative spreads for London-listed and matched sample firms over the five days of the week and 47 five-minute intervals of the day, respectively. The scales are held constant (i.e., relative spreads range from 0.00 to 0.02) in order to aid visual comparisons and smaller inserts are added where necessary to show patterns at higher magnification (see figures 1 and 3). Consistent with previous research, intra-day variations are more pronounced than inter-day variations. All inter- and intra-day patterns can be described as U-shaped, with the exception of the spike in Thursdays' London-listed spreads. The primary result in terms of inter-temporal patterns is that relative spreads are lower for cross-listed firms during every day of the week and every time interval (47) of the day.

Figures 3 and 4 report inter-and intra-day dollar depth patterns. Just as bid-ask spreads reveal consistent U-shaped patterns, depths show consistent inverted U-shaped patterns. Again, the only exception to this result is the behavior of cross-listed firms on Thursdays.[10] Consistent with the spread results in figures 1 and 2, the patterns in figures 3 and 4 show that depths are larger for cross-listed firms for each day of the week and for each of the 47 intra-day intervals. Liquidity is unambiguously higher for the cross-listed firms over all time periods.

5. Conclusion

As financial markets continue their advance toward global integration, more and more companies are expected to cross list their shares on multiple exchanges. Theoretical models and management survey results suggest that cross listing can reduce the firm's cost of capital by increasing the investor base, improving the firm's liquidity, and providing greater access to alternative sources of capital. To date, most empirical research has focused on U.S. firms listing on non-U.S. exchanges or non-U.S. firms listing on U.S. exchanges. Although previous findings have been somewhat mixed, researchers generally report favorable share price reactions to cross border listings. The liquidity of cross-listed firms improves, on average, but these results are quite sensitive to the home-country and foreign-listing locations (e.g., U.S. firms listing abroad experience insignificant liquidity changes). In addition, there is little empirical evidence with respect to non-North American intra-day spread and depth behavior due to a lack of data availability.

The purpose of this paper is to extend the literature by analyzing liquidity differences between Hong Kong companies that choose to cross list on the London Stock Exchange and those that list only on the local market, the Stock Exchange of Hong Kong. Both of these exchanges are among the ten largest in the world by market capitalization and major sources of new equity issuances within their respective regions of Europe and Asia. We compare the magnitudes of bid-ask spreads and depths for cross-listed and non-cross-listed firms over a 16-month period from May, 1996 to August, 1997 using a sample of 981,183 intra-day observations. Consistent with our hypotheses, relative bid-ask spreads are significantly lower and dollar depths are significantly higher for the cross-listed sample. After controlling for differences in price, volume, return variance, and intertemporal patterns (in addition to matching by market capitalization), the cross-listed firms continue to display significantly higher levels of liquidity. The evidence strongly confirms the liquidity advantage of cross-listed firms and suggests that such firms enjoy a lower cost of capital than their domestic counterparts.

The work described in this paper was partially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region (Project number 5004/97H).

Endnotes

1. The LSE operates the world's largest market for trading international securities and currently (May, 1998) lists over 530 international companies, more than any other stock exchange. International equities are traded on the LSE's electronic, screen-based quotation system referred to as the SEAQ (Stock Exchange Automated Quotations) International.

2. As explained below, the SEHK does not have formal, designated market makers. However, Exchange members and limit-order submitters fulfill the function of market makers by posting bid and ask prices against which buyers and sellers may trade. If order flow is migrating to the LSE due to cross listings, then we expect SEHK spreads to narrow and depths to increase in an effort to win back trading volume and profits.

3. For more complete reviews of this literature, see McConnell, Dybevik, Haushalter, and Lie (1996) and Karolyi (1996).

4. However, once the authors account for post-listing changes in price, volume, and return variance, the increase in depth disappears. Thus, cross listing does not appear to benefit U.S. firms' liquidity on average.

5. The SEHK does have an opening quotation rule that sets limits on the first bid and ask orders entered into the system at the start of the morning session. The first bid (ask) order must be greater (less) than or equal to the previous day's closing price less (plus) four spreads. The spread or tick size ranges from HK$ .001 to HK$ 2.5, depending on the stock price. The previous day's closing or nominal price is the median of five prices taken at 15-second intervals in the last minute of trading (i.e., 3:54:00, 3:54:15, 3:54:30, 3:54:45, 3:55:00 p.m.).

6. In conversations with an SEHK official, we learned of one exception to this rule. Under certain circumstances, such as the case of odd lots, Exchange members may execute "manual orders" that may be entered with a delay (instead of instantaneously) into the public limit order book. The SEHK official confirmed that manual orders represent no more than one or two percent of total volume.

7. Minor adjustments are made to the time-of-day for the first eight months of the sample period due to an internal clock misalignment in the original data capturing process. These adjustments are made based on information provided by SEHK's Research and Planning officials and verified by our program filters.

8. Specifically, each London-listed firm is matched to a non-London-listed firm only if the latter's market capitalization is within ten percent of the former's. This selection method reduces the overall sample size from 33 to 11 matched pairs but also produces closely-matched average market capitalizations ($14.2 million versus 13.7 million) and share prices ($13.995 versus $14.112). Regression results based on this control sample confirm the findings reported in tables 2, 4, and 5. In addition, we construct another control sample based on dollar volumes and apply the same ten percent rule as above. Regression results, based on 22 dollar-volume matched pairs, confirm those reported in tables 2, 4, and 5. Both sets of results are available upon request.

9. In order to avoid taking logarithms of zero values, a small constant of 0.00001 is added to each of the non-dummy variables following Bamber, Barron, and Stober (1997). Reported results are unaffected by using alternative constant values.

10. Combined with the previous evidence on cross-listed spreads (see figure 1), this result demonstrates that liquidity is particularly low for cross-listed firms on Thursdays.

References

Abhyankar, A., D. Ghosh, E. Levin, and R.J. Limmack, (1997), "Bid-Ask Spreads, Trading Volume and Volatility: Intra-Day Evidence from the London Stock Exchange," *Journal of Business Finance & Accounting* 24, pp. 343-362.

Amihud, Y., and H. Mendelson, (1986), "Asset Pricing and the Bid-Ask Spread," *Journal of Financial Economics* 17, pp.223-249.

Bamber, L.S., O.E. Barron, and T.L. Stober, (1997), "Trading Volume and Different Aspects of Disagreement Coincident with Earnings Announcements," *Accounting Review* 72, pp. 575-597.

Bias, B., P. Hillion, and C. Spatt, (1995), "An Empirical Analysis of the Limit Order Book and the Order Flow in the Paris Bourse," *Journal of Finance* 50, pp. 165 5-1689.

Brennan, M.J., and A. Subrahmanyam, (1996), "Market Microstructure and Asset Pricing: On the Compensation for Liquidity in Stock Returns," *Journal of Financial Economics* 41, pp. 441-464.

Chalmers, J.M.R., and G.B. Kadlec, (1998), "An Empirical Examination of the Amortized Spread," *Journal of Financial Economics* 48, pp. 159-188.

Chan, C., Y.P. Chung, and H. Johnson, (1995), "The Intraday Behavior of Bid-Ask Spreads for NYSE Stocks and CBOE Options," *Journal of Financial and Quantitative Analysis* 30, pp. 329-346.

Chan, K.C., W.G. Christie, and P.H. Schultz, *(1995),* "Market Structure and the Intraday Evolution of Bid-Ask Spreads for NASDAQ Securities," *Journal of Business* 68, pp. 35-60.

Chan, K.C., W. Fong, B Kho, and R.M. Stulz, (1996), "Information, Trading and Stock Returns: Lessons from Dually-Listed Securities," *Journal of Banking and Finance* 20, pp. 1161-1187.

Datar, V.T., N.Y. Naik, R. Radcliffe, (1998), "Liquidity and Stock Returns: An Alternative Test," *Journal of Financial Markets* 1, pp. 203-219.

Foerster, S.R., and GA. Karolyi, (1996), "The Effects of Market Segmentation and Liquidity on Asset Prices: Evidence from Foreign Listings in the U.S.," Working paper, Richard Ivey School of Business, University of Western Ontario.

Fortin, R., (1990), "Transaction Costs and Day-of-the-Week Effects in the OTC/NASDAQ Equity Market," *Journal of Financial Research* 13, pp. 243-248.

Hamao, Y., and J. Hasbrouck, (1995), "Securities Trading in the Absence of Dealers: Trades and Quotes on the Tokyo Stock Exchange," *Review of Financial Studies* 8, pp. 849-878.

Howe, J., and K. Kelm, (1987), "The Stock Price Impacts of Overseas Listings," *Financial Management* (Autumn), pp. 51-56.

Karolyi, G. A.. (1996), "What Happens to Stocks that List Shares Abroad? A Survey of the Evidence and its Managerial Implications," Working paper, Richard Ivey School of Business, University of Western Ontario.

Lau, S., D. Diltz, and V. Apilado, (1994), "Valuation Effects of International Stock Exchange Listings," *Journal of Banking and Finance* 18, pp. 743-755.

Lee, C., B. Mucklow, and M. Ready, (1993), "Spreads, Depths, and the Impact of Earnings Information: An Intraday Analysis," *Review of Financial Studies 6,* pp. 345-374.

Lee, I., (1991), "The Impact of Overseas Listings on Shareholder Wealth: The Case of the London and Toronto Stock Exchanges," *Journal of Business Finance and Accounting* 18, pp. 583-592.

Lehman, B.N., and D.M. Modest, (1994), "Trading and Liquidity on the Tokyo Stock Exchange: A Bird's Eye View," *Journal of Finance* 44, pp. 951-984.

McConnell, J.J., H.J. Dybevik, D. Haushalter, and E. Lie, (1996), "A Survey of Evidence on Domestic and International Stock Exchange Listings with Implications for Markets and Managers," *Pacific-Basin Finance Journal* 4, pp. 347-376.

Mclnish, T.H., and R.A. Wood, (1992), "An Analysis of Intraday Patterns in Bid/Ask Spreads for NYSE Stocks," *Journal of Finance* 47, pp. 345-374.

Merton, R.C., (1987), Presidential Address: "A Simple Model of Capital Market Equilibrium with Incomplete Information," *Journal of Finance* 42, pp. 333-350.

Mittoo, U., (1992), "Managerial Perceptions on the Net Benefits of Foreign Listing; Canadian Evidence," *Journal of International Financial Management and Accounting* 4, pp. 40-62.

Noronha, G., A. Sarin, and S. Saudagaran, (1996), "Testing for Liquidity Effects of International Dual Listings using Intraday Data," *Journal of Banking and Finance* 20, pp. 965-983.

Saudagaran, S., (1988), "An Empirical Study of Selected Factors Influencing the Decision to List on Foreign Stock Exchanges," *Journal of International Business Studies* 19, pp. 101-127.

Stoll, H.R., (1978), "The Pricing of Dealer Services: An Empirical Study of NASDAQ Stocks," *Journal of Finance* 33, pp. 1152-1173.

Sundaram, A., and D. Logue, (1996), "Valuation Effects of Foreign Company Listing on U.S. Exchanges," *Journal of International Business Studies* 27, pp. 67-88.

Tinic, S.M., and R.R. West, (1974), "Marketability of Common Stocks in Canada and the U.S.A.: A Comparison of Agent versus Dealer Dominated Markets," *Journal of Finance* 29, pp. 729-746.

Varela O., and S. Lee, (1993), "International Listings, the Security Market Line and Capital Market Integration: The Case of U.S. Listings on the London Stock Exchange," *Journal of Business Finance and Accounting* 20, pp. 843-863.

White, H., (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 48, pp. 817-838.