Available online at www.sciencedirect.com
SCIENCE DIRECT®
Journal of Financial Economics ▮ (▮▮▮▮) ▮▮▮–▮▮▮
JOURNAL OF Financial ECONOMICS
www.elsevier.com/locate/jfec

Liquidity of emerging markets ☆

David A. Lesmond*

A.B. Freeman School of Business, Tulane University, New Orleans, LA 70118-5698, USA

Received 30 May 2003; received in revised form 30 December 2003; accepted 26 January 2004

Abstract

Emerging markets are characterized by volatile, but substantial returns that can easily exceed 75% per annum. Balancing these lofty returns are liquidity costs that, using the bid–ask spread as a basis, range from 1% for the Taiwanese market to over 47% for the Russian market. However, the paucity of bid–ask spread information across countries and time requires the use of liquidity estimates in emerging markets even though little is known about the efficacy of these estimates in measuring bid–ask spread costs. Using firm-level quoted bid–ask spreads as a basis, I find that price-based liquidity measures of Lesmond et al. [Review of Financial Studies 12 (1999) 1113] and Roll [Journal of Finance 39 (1984) 1127] perform better at representing cross-country liquidity effects than do volume based liquidity measures. Within-country liquidity is best measured with the liquidity estimates of either Lesmond, Ogden, and Trzcinka or, to a lesser extent, Amihud (2002). Examining the impact of legal origin and political institutions on liquidity levels shows that countries with weak political and legal institutions have significantly higher liquidity costs than do countries with strong political and legal systems, even to the exclusion of legal origin or insider trading enforcement. Higher incremental political risk is associated with a 10 basis point increase in

☆This research was supported under a grant from the Quantitative Research Group in Finance (Q-Group). I especially acknowledge the comments of an anonymous referee and those of Warren Bailey, Rob Hansen, Craig Holden, Patrick Sandas, Hany Shawky, Charles Trzcinka, and participants of the Indiana University seminar series and the 13th Annual Conference on Financial Economics and Accounting held jointly with the 5th Maryland Finance Symposium who have improved this manuscript. I also wish to thank Alyssa Wilcox, Miroslav Stoev, Teresa Fong, Leonardo Serrano, and Kenneth Boris for their excellent research support. All errors remain my responsibility.

*Tel.: 1 504 865 5665; fax: 1 504 865 6751.
E-mail address: dlesmond@tulane.edu.

doi:10.1016/j.jfineco.2004.01.005

transaction costs, using the Lesmond, Ogden, and Trzcinka estimate, or a 1.9% increase in price impact costs, using the Amihud estimate.

JEL classification: G15; N20

Keywords: Liquidity costs; Liquidity determinants; Emerging markets

1. Introduction

Emerging markets are experiencing explosive growth. Not only did the total value of shares traded increase from $15 billion in 1991 to over $200 billion in 2000, but the total market capitalization also rose from $306 billion in 1991 to over $1.4 trillion in 2000. The growth in emerging markets is, in part, fueled by foreign investments that the World Bank estimates exceeded $47 billion in 2000 from a mere $0.1 billion in 1985 (World Bank, 2001). The increasing investment interest in emerging markets can yield spectacular returns that can easily exceed 90% in any given year. These returns, while substantial, are subject to increased risk and volatility; they are significantly reduced by the increased illiquidity of trading stocks in emerging markets relative to more developed markets. While risk, return, volatility, and correlation (Bekaert and Harvey, 1995, 1997; Harvey, 1995) have been analyzed for emerging markets, few studies have attempted to address the liquidity of emerging markets. The importance of estimating liquidity in emerging markets is underscored by Bekaert et al. (2003), who find that models that account for liquidity risk outperform other models that incorporate only market risk factors in predicting future returns. The substantial investment interest lured by equally substantial returns highlights the importance of addressing liquidity concerns and determinants of emerging markets.

Liquidity, by its very nature, is difficult to define and even more difficult to estimate. Kyle (1985) notes that "liquidity is a slippery and elusive concept, in part because it encompasses a number of transactional properties of markets. These include tightness, depth, and resiliency," (p. 1316). Empirical liquidity definitions span direct trading costs (tightness), measured by the bid–ask spread (quoted or effective), to indirect trading costs (depth and resiliency), measured by price impact. However, the lack of obtainable bid–ask quotes or intraday trading information makes the use of proxies standard procedure in estimating emerging market liquidity. But little consensus exists regarding the applicability or efficacy of any of the most commonly used liquidity proxies that span the Roll (1984) measure, the Amivest measure, and the ubiquitous turnover measure. Given the uncertainty surrounding liquidity estimation in emerging markets, these liquidity measures are augmented with the Amihud (2002) measure and the (Lesmond et al., 1999) LOT measure to provide a menu of liquidity measures. These five liquidity measures are tested against the quoted bid–ask spread, where available, to determine each measure's efficacy in estimating the underlying liquidity, in addition to analyzing the

time-series behavior of liquidity and analyzing the liquidity determinants for emerging markets.

The estimation and use of specific liquidity proxies is unusually varied. Bailey and Jagtiani (1994) use raw trading volume, while Amihud et al. (1997) and Berkman and Eleswarapu (1998) use trading volume scaled by the security return (the Amivest measure) as a liquidity proxy for market depth to explain return differentials in studies on the Thai, Israeli, and Indian stock exchanges, respectively. Domowitz et al. (1998) use a variant of the Roll (1984) model to assess liquidity effects in their study of cross listings and market segmentation for the Mexican stock market. Miller (1999) uses the abnormal return of the depository receipt as a liquidity proxy to test the joint hypothesis that illiquidity and investor recognition segment international markets. Finally, Rouwenhorst (1999), in examining emerging market return premiums, Bekaert et al. (2003), in predicting future returns, and Levine and Schmukler (2003), in investigating emerging market internationalization and domestic liquidity, use turnover as a liquidity proxy. However, little is known about the ability of any of these estimators to measure each market's underlying liquidity.

Some studies attempt to incorporate the actual institutional trades as compiled by Elkins/McSherry (Domowitz et al., 2000) or actual bid–ask quotes (Jain, 2002). However, because these data sources do not consistently follow the same firms or even the same countries, time series inferences become nearly impossible and the power of cross-sectional tests declines. Consequently, actual trade data, while important, do not provide a comprehensive and complete assessment of the liquidity costs in emerging markets.

In response to the potential problems with providing a consistent liquidity measure for all markets, Amihud (2002) introduces a price impact measure defined as the absolute value of stock returns scaled by dollar volume in assessing the relation between liquidity and ex ante returns. This paper augments this liquidity measure with estimates derived from a limited dependent variable model defined in Lesmond et al. (1999). Because the LOT model is predicated only on daily prices, estimates for any market can be easily calculated.

The maintained hypothesis of the LOT model is that the informed trader's reservation price must exceed the transaction costs of each stock before informed trade will occur. Zero returns are observed if the transaction costs exceed the information value for the informed trader.[1] A maximum likelihood procedure jointly estimates the liquidity costs for the marginal, informed investor. The LOT liquidity estimate, by considering the informed trader's reservation price, includes all relevant costs bearing on the informed trader's decision to trade. Principally, these include the explicit costs, such as taxes, fees, and commissions, and the implicit bid–ask

[1]Adding to the import of the zero returns, Bekaert et al. (2003) find that the zero return liquidity proxy significantly predicts future returns in emerging markets, whereas the commonly used turnover liquidity proxy does not.

spread, expected price impact, and potential opportunity costs of delayed or failed trades.[2]

Using 187,136 quarterly bid–ask spread estimates across 23 emerging markets, I find that liquidity costs are cross-sectionally disparate and appreciable, ranging from 1.0% for the Taiwanese market to over 47% for the Russian market. Within-country correlations report significant strength of association between the bid–ask spread and all of the liquidity measures, except turnover. Turnover and the bid–ask spread are negatively and significantly correlated in only 40% of the markets tested. Cross-country correlations between the bid–ask spread and the various liquidity measures show that price-based liquidity estimators (the LOT measure and the Roll measure) better represent cross-country differences in liquidity than volume based measures (the Amihud measure and the turnover measure.)

Model selection tests (Vuong, 1989) and regression tests show the LOT liquidity estimate to be more highly associated with the spread-plus-commission cost than any of the competing liquidity proxies in the majority of the 23 emerging markets or even the Stoll (2000) variables in ten of the 23 emerging markets with available spread data. Generalizing the results across all 31 emerging markets, a maximum likelihood factor analysis points to a single factor that explains much of the common variance of all of the liquidity measures. Amihud's measure and the LOT model's liquidity estimate appear to be more highly correlated with this single factor than are the competing liquidity measures.

Extending the analysis to liquidity determinants, the quality and scope of political institutions affects equity market liquidity more than does the French/civil and English/code law country classifications of La Porta et al. (1998), the level of insider trading enforcement (Bhattacharya and Daouk, 2002), or, to a lesser extent, the tradition for rule of law (La Porta et al., 1997). After controlling for firm-specific liquidity influences (Stoll, 2000) and country random effects, countries with weak political institutions have significantly higher liquidity costs than do countries with strong political institutions. Transaction costs are 10 basis points higher, using the LOT measure, and price impact costs are 1.7% higher, using Amihud's measure, for countries and times of reduced political stability. Political risk appears to be more dominant than is information risk engendered by legal institutions.

These results are important for a host of reasons. First, accurate measures of liquidity are necessary to more adequately assess market efficiency.[3] Rouwenhorst (1999) finds evidence that emerging markets experience price momentum, but the liquidity proxy of turnover that he employs does not explain the return premium.

[2] Lesmond et al. (2004) report an 80% correlation between the bid–ask spread and the LOT estimate. In addition, regression results show a high degree of association between the LOT liquidity estimate and the bid–ask spread with R^2 statistics that range from 31.6% for the largest NYSE firms to 78.3% for the smallest NYSE firms.

[3] Fama (1991) argues that "an economically more sensible version of the efficiency hypothesis says that prices reflect information to the point where the marginal benefits of acting on information (the profits to be made) do not exceed the marginal costs," (p. 1575). Lesmond et al. (2004) find that a LOT-based liquidity measure largely eclipses the trading profits from relative strength strategies in U.S. markets.

Presumably, with a more focused liquidity measure, implementable trading strategies can be more completely examined. Second, in a highly cited study, Obstfeld and Rogoff (2000) find that transaction costs explain why investors' equity portfolios are heavily dominated by their home country securities. Coval and Moskowitz (1999) find that asymmetric information (liquidity) could be driving the observed preference for geographically proximate firms. Kang and Stulz (1997) find that turnover (liquidity) is marginally related to foreign ownership for the Japanese market, while Dahlquist and Robertsson (2001) find stronger evidence of a turnover (liquidity) effect on foreign ownership for Swedish firms. Testing the home bias preference with a more comprehensive measure of liquidity will more adequately test the joint hypothesis of information asymmetry and liquidity for the home bias phenomenon.

Third, accurate measures of liquidity costs can be important for asset pricing models. Bekaert and Urias (1996) and De Roon et al. (2001) find that transaction costs in emerging markets alter the mean-variance spanning of benchmark and emerging market assets. De Roon et al. (2001) do not estimate the level of transaction costs. Instead, they assign the costs given the bounds of the mean-variance spanning levels. Bekaert and Harvey (1995) find, in an asset pricing context, that the level of liquidity in the market hinges on the probability of market integration. Bekaert et al. (2003) find that models incorporating local liquidity risks outperform all other models that use only market risk factors in predicting future returns. Better estimates of these costs will better isolate the limits of the mean-variance spanning in emerging market assets, determine the degree to which the markets are integrated, estimate the liquidity premium in emerging markets, and, in so doing, more properly assess equity cost of capital concerns (Amihud and Mendelson, 1986).

Fourth, loosely termed, market segmentation effects on the cross-listing decision (Domowitz et al., 1998; Foerster and Karolyi, 1999) rely on a transaction costs assessment to adequately test pricing differences or directly study liquidity effects (Levine and Schmukler, 2003). A more adaptable and tested liquidity measure would allow for more powerful tests of the liquidity issues. Fifth, studies of institutional design and liquidity of stock exchanges (Jain, 2002) rely extensively on a comprehensive measure of liquidity to adequately assess market performance. Issues such as decimalization, centralization, and automation can now be more adequately analyzed with a more rigorous liquidity measure. Finally, the power of empirical tests analyzing the importance of legal origin (La Porta et al., 1997, 1998) and the influence of political institutions (Bhattacharya and Daouk, 2002) on liquidity can be significantly improved and customized using local market liquidity measures (Eleswarapu and Venkataraman, 2003).

The paper is organized as follows. Section 2 outlines the various liquidity estimators. Section 3 reports the summary statistics for each of the 31 emerging markets, the time-series behavior of liquidity costs, and the cross-country and within-country correlation analysis. Section 4 presents the tests for each liquidity measure. Section 5 presents the liquidity determinant tests. Section 6 concludes.

2. Liquidity proxies and measures

The literature provides a menu of measures and proxies to consider for estimating emerging market liquidity. The first class of liquidity estimators measure trading costs directly. Jain (2002) estimates the daily bid–ask spread over a four-month interval and finds that the quotes are rough indicators of the underlying liquidity. The bid–ask quote is by far the most demonstrable indicator of overall liquidity, but closing prices often deviate from the quotes as trades are consummated at different prices from, or even outside, the quotes. In addition, quotes are not always available in all markets and for all time periods. In response to the lack of sufficient quote information, a second class of estimators is constructed from firm-level data. The benefits of these measures are the ease of construction and general applicability to either theory or practice. These volume based liquidity estimators are turnover and Amihud's measure (Amihud, 2002).[4]

Turnover is the ubiquitous liquidity measure. It is used in Rouwenhorst (1999), Bekaert et al. (2003), and Levine and Schmukler (2003) and spans a host of applications. Turnover captures trading frequency but fails to account for the cost per trade, which varies considerably across assets. Given the specific focus on only trading volume, turnover is likely to increase during liquidity crunches such as occurred during the Tequila Crisis, the Asian Crisis, and the Brazilian Crisis (Summers, 2000), rather than decrease to reflect the decline in market liquidity (Froot et al., 2001). Moreover, turnover is likely to be nonlinear with respect to the bid–ask spread, leading to scaling problems with this measure. However, turnover is easy to construct and has intuitive appeal. Turnover and the bid–ask spread are hypothesized to be inversely related because larger spreads should reduce the frequency of trade.

Amihud (2002) attempts to generalize the liquidity measure to make it more adaptable to markets around the world. Amihud's definition is the ratio of the daily absolute return to the dollar trading volume. This ratio more closely follows the Kyle (1985) price impact definition of liquidity, or the response of price to order flow. The advantage of this liquidity estimate is that it can be calculated for days when there is no price change, which is of particular concern in emerging markets and especially for the Amivest measure. However, zero volume days also occur, leaving this estimator undefined. Relating the estimator to the spread, this estimator should be positively related to the bid–ask spread because smaller spreads are associated with lower price impact.

The third class of liquidity estimators indirectly infers trading costs based on price behavior. The advantage of these approaches is that they require only price to estimate liquidity instead of trading volume. Roll (1984) proposes an estimator of implied effective spread based on measuring the negative autocorrelation produced

[4]I abstract from using the Amivest measure, defined as the ratio of the daily trading volume divided by the absolute value of the daily return, in the regression tests as this measure is not critical to the literature involving liquidity costs. However, I introduce this liquidity measure in the factor analysis to provide a comprehensive liquidity assessment across all 31 emerging markets.

by bounces between the bid and ask quotes. Particular to general liquidity, this estimator should be positively related to the bid–ask spread. However, the serial autocorrelation is, at times, positive, invalidating the estimate.

Finally, Lesmond et al. (1999) introduce an alternative indirect method for estimating liquidity based on the occurrence of zero returns. The LOT measure is a comprehensive estimate of liquidity by implicitly including not only the spread, but also commission costs, a portion of the expected price impact costs, and possible opportunity costs of informed trade. The maintained hypothesis is that the marginal, informed trader will trade only if the value of information exceeds the marginal costs of trading. If trading costs are sizable, Lesmond, Ogden, and Trzcinka argue that zero return days occur more frequently because new information must accumulate longer, on average, before informed trade affects price. However, this logic implies an almost one-to-one mapping between the zero return and the level of informed trade, which in turn implies assumptions about information flows, the type of trader(s) in the market, and the responsiveness of prices to liquidity trading. A practical limitation of the LOT measure is that it requires a sufficiently long period of time (i.e., more than one month) to estimate the parameters. Too many zero returns (i.e., greater than 80% over the estimation period) also makes this measure inestimable. As with the Roll measure, I anticipate that the LOT measure is directly related to the bid–ask spread.

Because of the strengths and weaknesses of each liquidity measure and proxy, I employ all four estimators to determine the efficiency and efficacy of each measure in representing emerging market liquidity. All liquidity parameters are estimated on a quarterly basis to match the frequency of the bid–ask spread data. I examine the period 1987–2000 for 31 emerging markets. The start date of 1987 is chosen so as to encapsulate the major events that occurred for the world markets (Summers, 2000). Little daily price data prior to 1987; only a few firms have complete information. The 31 emerging markets are selected from those that are listed as emerging markets by the *Emerging Markets Database*. The market capitalization is determined at the beginning of each quarter using the quarterly closing price as of the beginning of the quarter and number of shares outstanding as of the beginning of the year. The local currency is converted to $US using the beginning-of-quarter exchange rate derived from the *International Monetary Fund Database* to allow for a comparison of separate country liquidity results.

2.1. The bid–ask spread and commission cost

Data on the quarterly bid–ask quotes are hand-collected from the *Bloomberg Terminals*. (The exception is Portugal. Daily bid–ask quotes are available from *Datastream*.) Using the Stock Exchange Daily Official List (SEDOL) number based on the code established by the London Stock Exchange (LSE), I match the firms to those firms on the *Bloomberg Terminals*, then record quarterly bid and ask quotes. The range of dates for the bid–ask quotes varies from country to country. (Korean quotes are available from 1992, while Israeli quotes are available only for one quarter, September 2000). There are 187,136 separate bid and ask quotes. Bid–ask

quotes are unavailable for Chile, Cyprus, Egypt, Morocco, Pakistan, Sri Lanka, Turkey, and Zimbabwe. If quarterly bid prices exceed ask prices or if missing ask or bid quotes are recorded, that quarter's proportional spread is deleted from the average bid–ask spread calculation. The bid–ask spread is calculated using the average of the available quarterly quotes and incorporates at a minimum a single quarter's quote for that quarter. A single quarter minimum is established to include countries such as Israel for which only one quarter of quote data are available. The average bid–ask spread spanning the quarter is used for the estimate of the spread. This procedure minimizes outlier problems and averages out the recording of either quarterly highs or lows in quotes resulting from quarterly sampling. I trim bid–ask spreads that exceed 80% which could result from coding errors.

The quarterly quoted spread is defined as

$$\text{Quoted spread}_Q = 1/2\left[\left(\frac{(Ask_Q - Bid_Q)}{(Ask_Q + Bid_Q)/2} + \frac{(Ask_{Q-1} - Bid_{Q-1})}{(Ask_{Q-1} + Bid_{Q-1})/2}\right)\right]. \quad (1)$$

Finally, the commission cost is calculated from the separate country commission schedules in Appendix A. Where necessary, trade size statistics compiled by Meridian Securities for each year are used to calculate the commission costs. Coupled with the market trading characteristics and country-specific commission schedules, I calculate individual firm commission costs.

2.2. Turnover

Daily trading volume and shares outstanding for this study are obtained from *Datastream*. Daily trading volume varies for each country, with most countries having volume data beginning with, or a few years subsequent to, the recording of daily prices. The exception is Brazil, where daily trading volume becomes available only in 1999. I trim any turnover statistics that exceed 100% of the shares outstanding in any quarter. The shares outstanding is determined at the beginning of each year and kept constant for each of the four quarters of the year. The number of shares outstanding statistic is not available for all firms and for all time periods. I use the daily turnover measure defined as

$$1/D_Q \sum_{t=1}^{Q} volume_t/shares\ outstanding, \quad (2)$$

where D_Q is the number of days in the quarter, Q.

2.3. Amihud's measure

Daily prices and volume are obtained from *Datastream*. The daily security prices are scanned for data errors, omissions, and delistings. If a firm was delisted or began trading mid-quarter, then that firm-quarter is dropped from the estimation procedure. The remaining price data are used to calculate daily returns, controlling for splits and dividends, and following the same procedure as the Center for

Research into Security Prices (CRSP). To control for return outliers, a data error filter eliminates daily prices that are ±50% of the prior day's price; that day's price as well as the prior day's price are deleted. If zero volume occurs on day t, then that day is deleted from the average. I trim the upper and lower 1% of the distribution and multiply the measure by 10^6, as performed in Amihud (2002), to provide a common representation among all the measures. Amihud's measure is defined as

$$1/D_q \sum_{t=1}^{Q} |R_t|/(Price_t * Volume_t). \tag{3}$$

2.4. Roll's measure

The Roll (1984) measure uses the bid–ask bounce-induced negative serial autocorrelation in returns to estimate the effective spread. Roll's measure requires a negative autocovariance in the returns. If the serial autocovariance is positive, I force it negative and use the Roll estimate as if a negative serial autocovariance is estimated (Harris, 1989). Harris (1990) explains that positive autocovariance could result from closing prices that cluster at the ask, violating Roll's assumption of trade independence.

2.5. The LOT model

The LOT model requires a sufficient number of nonzero returns to properly estimate the liquidity cost parameters. If the number of missing daily data returns and zero returns exceeds 80% (or 51 missing prices out of 63 possible daily returns) of the quarterly trading pattern, that firm-quarter is dropped from the LOT estimation. To control for overcounting the zero return percentage, the daily returns are checked for days when the return is zero for all firms that are traded on that exchange. The return for that day is set to "missing" for all firms on that market. To estimate the LOT parameters, an equally weighted market return is constructed specific to each market using the procedure as performed by CRSP. (The LOT estimation results for transaction costs do not vary if a Morgan Stanley Capital International (MSCI) index is used. The MSCI index contains only the largest 50 stocks in each market.) I average all available non missing returns for each day for all firms on that exchange. This procedure utilizes all of the prior return filters.

This model, developed by Lesmond (1995), uses only daily security returns to endogenously estimate firm-level liquidity costs. If transaction costs inhibit more informed investors from trading, then more zero returns will be observed because no new information, on average, has been incorporated into the price. The higher the level of transaction costs, the more zero returns will be observed. In effect, the market model representation of security returns must be altered to incorporate the influence that transaction costs have on security returns, that is, zero returns.

The common market model regression of the return on firm j and time t, $R_{j,t}$, on the return of a market index, Rm_t, is given as

$$R^*_{j,t} = \beta_j \cdot Rm_t + \varepsilon_{j,t}. \tag{4}$$

In Eq. (4), the stock's return is assumed to be generated by price responses to market-wide and new firm-specific information through the terms $\beta_j \cdot Rm_t$ and $\varepsilon_{j,t}$, respectively. In a perfect market, devoid of all transaction costs, either index-wide or firm-specific information will be immediately reflected in the stock's price, regardless of the magnitude of the impact of the information on the stock's price. $R^*_{j,t}$ is the desired return, that is, the return that investors would desire if there were zero transaction costs.

Amihud and Mendelson (1986) show that actual returns require a liquidity premium over the desired return. The effect of liquidity costs on equity returns is stated as

$$R_{j,t} = R^*_{j,t} - \alpha_{i,j}, \tag{5}$$

where $R_{j,t}$ is the measured return. $\alpha_{2,j}$ is the effective buy-side cost, and $\alpha_{1,j}$ is the effective sell-side cost for firm j. Thus, the desired return and the measured return are related, but only after transaction costs are taken into account.

The general methodology for limited dependent variable models is detailed in Maddala (1983). The effect of liquidity on equity returns is then generally modeled by combining the objective function with the liquidity constraint and is given as

$$R^*_{j,t} = \beta_j \cdot Rm_t + \varepsilon_{j,t}, \tag{6}$$

where

$$\begin{aligned}
&R_{j,t} = R^*_{j,t} - \alpha_{1,j} \quad \text{if} \quad R^*_{j,t} < \alpha_{1,j} \quad \text{and} \quad \alpha_{1,j} < 0,\\
&R_{j,t} = 0 \quad \text{if} \quad \alpha_{1,j} \leqslant R^*_{j,t} \leqslant \alpha_{2,j}\\
&R_{j,t} = R^*_{j,t} - \alpha_{2j} \quad \text{if} \quad R^*_{j,t} > \alpha_{2,j} \quad \text{and} \quad \alpha_{2,j} > 0.
\end{aligned}$$

The estimates, $\alpha_2 - \alpha_1$, provide liquidity thresholds for informed trading. This does not assume that stocks capture only private information, as it would be impossible to assess whether information is public or private at the time of the trade. Unanticipated public information can affect price, but I assume that unanticipated public information flows are idiosyncratic in nature and hence captured by the residual term.

The informed trader is further assumed to incorporate any private information with any public information before deciding to trade relative to the expected liquidity costs. A more realistic assumption is that the marginal, informed trader could know only the firm-specific information with some noise, not the full realization of the market return in advance. Given informed trade, it is reasonable to assume that the market return will reflect at least a portion of the private information. If enough informed trade occurs, then the observed market return (scaled by systematic market risk) will signal if the liquidity threshold is exceeded, indicating informed trade has occurred. However, given that only a portion of the

full information signal is recognized, the LOT model will potentially underestimate the underlying liquidity costs of the informed trader.

I further assume that the marginal trader is the trader with the highest net difference between the value of information and transaction costs and that the value of information relative to the transaction costs is what causes price movements. The market maker could possess the most valuable information and adjust the price even if no buyers and sellers initiate the trade (changes in the idiosyncratic noise) or because of sustained buy-side or sell-side order flow (inventory effects). Neither the source of the trade, nor whether the trade is informed or liquidity based can be determined. It can only be assumed that the price, on average, should rationally reflect the costs of trade relative to the information value of the trade. Idiosyncratic noise that affects price averages to zero over time, as does sustained idiosyncratic trading by liquidity traders. The focus is not the actual trade, but the effect on prices over time from trades that, by assumption, will reflect the true information value relative to the costs of trading.

The resulting log-likelihood function[5] is stated as

$$\begin{aligned}\mathrm{LnL} = &\sum_{1} \mathrm{Ln}\frac{1}{(2\pi\sigma_j^2)^{1/2}} - \sum_{1}\frac{1}{2\sigma_j^2}(R_j + \alpha_{1,j} - \beta_j \cdot Rm_t)^2 \\ &+ \sum_{2} \mathrm{Ln}\frac{1}{(2\pi\sigma_j^2)^{1/2}} - \sum_{2}\frac{1}{2\sigma_j^2}(R_j + \alpha_{2,j} - \beta_j \cdot Rm_t)^2 \\ &+ \sum_{0} \mathrm{Ln}(\Phi_{2,j} - \Phi_{1,j}). \end{aligned} \tag{7}$$

For purposes of liquidity estimation, I focus on only the $\alpha_{2,j}$ and $\alpha_{1,j}$ estimates. Taken in difference form, $\alpha_{2,j} - \alpha_{1,j}$ represents the liquidity effects on equity returns because of round-trip transaction costs and is termed the LOT measure. $\Phi_{i,j}$ represents the cumulative distribution function for each firm-quarter evaluated at $(\alpha_{i,j} - \beta_j \cdot Rm_t)/\sigma_j$. $\sum_1$ (region 1) represents the nonzero measured returns when the market return is negative while $\sum_2$ (region 2) represents the non-zero measured returns when the market return is positive. $\sum_0$ (region 0) represents the zero measured returns. Maddala (1983) and Lesmond (1995) outline the estimation procedure.

3. Preliminary findings

In this section, I itemize the levels of each liquidity measure, the bid–ask spread, and related firm characteristics particular to each of the 31 emerging markets and

[5] Bekaert and Harvey (1997) show that, except for Argentina, Colombia, Greece, Korea, and Turkey, the distribution of monthly returns departs from normality. Presumably, the distribution of measured daily returns deviates more from a normal distribution. However, the likelihood function of the LOT model is based on the underlying distribution of true returns, not measured returns. The LOT model assumes that true returns are normally distributed. In addition, White (1982) argues that even when the true distribution is not normal, maximum likelihood carried out under the assumption of normality yields consistent estimates of the mean and variance of distributions for which these quantities are finite.

analyze the correlation between each liquidity measure and the bid–ask spread. Finally, I characterize the time-series behavior for each liquidity measure and the bid–ask spread across the 23 emerging markets with quote information.

3.1. Summary statistics for liquidity measures and liquidity proxies

Analysis of daily trading characteristics for firms that makeup emerging markets shows a number of stylized facts. First, the percentage of zero returns is a sizable proportion of the daily return pattern regardless of country but is most extreme for the Latin American and Middle Eastern/African markets compared with the Asian and European emerging markets (see Table 1). The average number of zero returns often approaches 40% of the total daily trading pattern for Latin American and Middle Eastern/African markets compared with the Asian and European markets. Bekaert and Harvey (1995) argue that the markets of Chile and Colombia are very illiquid and the markets of Korea and Taiwan are very liquid. Not surprisingly, Chilean and Colombian firms experience approximately 47% zero returns, and the Korean and Taiwanese firms experience approximately 13% zero returns. These percentages equate to more than 30 trading days (out of 63 trading days) for the Latin American markets but to only eight trading days for the Asian markets where no daily price changes are observed. Lesmond et al. (2004) report that NYSE and Amex firms have approximately 23.5% zero returns over an annual trading period that would equate to 15 days in each quarter without price changes.

While not presented, country-based ordinary least squares (OLS) regression tests using the bid–ask spread as a dependent variable and the percentage of zero returns as the independent variable show a high degree of association between the percentage zero returns and the proportional bid–ask spread, regardless of country, substantiating the primary hypothesis of a transaction costs effect on security returns for emerging markets. Similar results are also obtained using a fixed effects specification, which controls for omitted variables in cross-country effects.

The second feature is the wide cross-country dispersion of the four liquidity estimators. Using, as a benchmark, the high liquidity markets of Korea and Taiwan shows that the LOT model estimates fairly low transaction costs, Roll's estimate indicates fairly low effective spread costs, Amihud's measure estimates small price impact costs, and turnover predicts high (greater than 1% of the shares outstanding transacted per day) trading frequency. These are expected results. Comparing these results with the low liquidity markets of Chile and Colombia, the LOT model estimates larger transaction costs, Roll's estimate indicates lower effective spread costs, Amihud's measure estimates somewhat lower price impact costs, and turnover predicts reduced trading frequency. However, for both Amihud's and Roll's measure, the Colombian market appears to be more liquid than either the Korean or Taiwanese market, which is a result opposite to that expected.

The difference in liquidity recognition of these various measures could lie in the percentage of zero returns that could, in particular, affect Roll's measure and Amihud's measure. Trade clustering at the bid or ask quote, which results in a zero return, induces positive serial autocovariance (Harris, 1989) and causes Roll's

estimate to be downward biased. Too many zero returns could cause Amihud's measure to better reflect the informed trader's fixed costs than it does price impact costs, rendering it a more static than dynamic model. This can be seen for the Colombian market in which the percentage of zero returns exceeds 50% but price impact estimates are very low. As the percentage of zero returns falls, the more regular the trading pattern becomes (i.e., trading results in price changes), and the better each liquidity measure represents the market liquidity.

Considering variables such as firm size, price, volume, and volatility that are usually related to trade difficulty through the implicit and explicit costs of trade (Keim and Madhavan, 1997) or market quality (Harris, 1994), I find that, within each region, higher volatility, lower stock price ($US), and lower daily trading volume are generally associated with lower liquidity markets.

Price proxies for discreteness (Harris, 1994), risk, and the bid–ask spread (Benston and Hagerman, 1974). Volume reflects market depth (Pagano, 1989; Brennan and Subrahmanyam, 1995) and market capitalization is often related to the bid–ask spread (Stoll and Whaley, 1983). Volatility reflects liquidity because thin, speculative markets are more volatile than deep ones (Cohen et al., 1976). For example, the Chinese, Korean, and Taiwanese markets have lower median volatility, higher median price, and generally higher median trading volume than the rest of the markets within each region. Not surprisingly, they have better liquidity than peer markets within each region as evidenced by each of the four liquidity estimates. Conversely, Russia and Cyprus have higher median volatility, lower median price, and generally lower median trading volume than the rest of the markets within each region and consequently higher liquidity costs as evidenced by each of the four liquidity estimates.

3.2. Correlation analysis

To better assess the relation between the underlying liquidity of each market and of each liquidity measure, I present a correlation matrix, using as a basis the quarterly bid–ask quotes. The results are presented in Table 2. The most telling finding is the lack of correlation between turnover and the bid–ask spread. Turnover is negatively and significantly correlated with the bid–ask spread in only 40% of the 23 emerging markets. (Similar results are found by log scaling turnover.) The rather low correlation between the bid–ask spread and turnover is consistent with Bekaert et al. (2003), who use monthly sampling intervals. Turnover, surprisingly, has the lowest correlation, where significant, among any of the liquidity measures. These results cast doubt on a wide range of studies employing turnover as a principal liquidity proxy.

In terms of the magnitude of the correlation coefficient, the LOT model appears to have a stronger relationship than the other liquidity measures in representing the covariation with the bid–ask spread. Roll's model also appears to perform well at representing the bid–ask spread. Except for five of the 23 markets, Roll's model is significantly associated with the bid–ask spread. Amihud's measure is very highly (positively) correlated with the spread regardless of country. The results for

Table 1
Summary statistics

Thirty-one emerging markets are segregated by region as designated by the International Monetary Fund. *Datastream* provides the daily prices, volume, and market capitalization information. Start refers to the beginning date of the daily security return data up to the year 2000. Zero returns (percent) represent the number of zero returns over one quarter scaled by the total number of available trading days. Four liquidity cost estimates are presented. LOT, derived from Lesmond et al. (1999), is the liquidity measure based on $\alpha_2 - \alpha_1$ and provides an estimate of liquidity encapsulating spread effects, price impact effects, and market depth influences. Turnover is defined as $1/D_q \sum_{t=1}^{Q} volume_t/shares\ outstanding$ and provides a measure of the trading frequency. Amihud's measure is defined as $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$ and provides a measure of the price impact. Roll's measure is based on the serial autocorrelation of daily security returns and provides a measure of the effective spread. Price is the average of the daily prices over each quarter and is stated in the domestic currency (except for Russia where the $US are used to settle trades) and converted to $US using the average exchange rate for each quarter and country. Volume is the average of the daily trading volume over each quarter and is stated in thousands. Market capitalization is measured as of January 1 for each country and is the equity market value of the firm expressed in millions of local currency or $US currency. The $US market cap is derived using the end of quarter exchange rate for each country and quarter. Median values for each variable are given in braces.

			Liquidity cost measures				Local market				$US equivalent	
Country	Start	Zero return (%)	LOT (%)	Roll (%)	Turnover (%)	Amihud (%)	Price	Volume (thousands)	Volatility (%)	Capitalization (millions)	Price	Capitalization (millions)
Latin America												
Argentina	1989	30.939	6.082	2.280	0.141	1.262	13.549	312.263	0.138	815.550	14.022	817.257
		[25.00]	[3.970]	[1.790]	[0.084]	[0.282]	[2.249]	[64.766]	[0.076]	[195.99]	[2.297]	[197.97]
Brazil	1991	38.196	11.357	3.003	0.715	3.732	40.048	582.837	0.243	850.060	44.156	1634.271
		[38.71]	[7.123]	[2.400]	[0.109]	[0.545]	[6.629]	[31.543]	[0.148]	[77.590]	[7.626]	[70.146]
Chile	1989	42.271	6.275	1.614	0.284	0.154	2134.539	914.223	0.067	189503.300	5.541	433.973
		[42.860]	[4.671]	[1.340]	[0.039]	[0.003]	[216.423]	[101.503]	[0.038]	[61190.550]	[0.519]	[147.817]
Colombia	1992	50.941	8.189	1.855	0.057	0.002	3027.961	161.384	0.087	509051.110	2.778	438.492
		[53.770]	[6.509]	[1.540]	[0.026]	[0.000]	[2415.790]	[36.654]	[0.056]	[387309.900]	[2.215]	[304.924]
Mexico	1988	30.779	5.592	1.873	0.254	0.465	13.239	1984.340	0.091	7197.810	2.147	1055.260
		[23.440]	[3.532]	[1.560]	[0.159]	[0.032]	[8.448]	[384.754]	[0.058]	[2550.000]	[1.334]	[405.419]
Peru	1992	42.645	9.508	2.228	0.965	2.742	4.057	311.633	0.139	471.405	1.505	172.026
		[43.550]	[7.291]	[1.870]	[0.228]	[0.777]	[1.367]	[79.263]	[0.101]	[57.040]	[0.518]	[21.729]
Venezuela	1990	30.034	6.932	2.529	0.199	0.088	308.673	1333.37	0.161	96117.41	0.860	263.828
		[25.420]	[4.799]	[2.200]	[0.077]	[0.007]	[67.793]	[314.549]	[0.115]	[18592.550]	[0.310]	[74.697]
East Asia												
China	1991	9.139	2.683	2.039	0.758	0.394	8.296	5404.520	0.119	1940.24	1.014	236.394
		[4.690]	[1.538]	[1.740]	[0.508]	[0.003]	[7.270]	[1145.860]	[0.087]	[1291.180]	[0.888]	[157.488]

Korea	1987	15.331	4.161	2.744	1.582	0.007	21832.67	161.265	0.200	156403.13	26.356	172.483
		[11.670]	[3.084]	[2.120]	[0.664]	[0.001]	[11172.700]	[20.882]	[0.104]	[29700.000]	[13.019]	[33.927]
Philippines	1987	44.127	13.300	3.209	1.131	0.850	27.033	10344.470	0.265	9064.81	0.898	294.646
		[43.080]	[8.812]	[2.450]	[0.088]	[0.138]	[1.873]	[764.796]	[0.148]	[1650.000]	[0.063]	[52.230]
Taiwan	1988	11.568	2.346	1.981	1.208	0.035	27.601	5627.34	0.099	18747.37	0.878	608.357
		[9.680]	[2.110]	[1.700]	[0.726]	[0.001]	[21.025]	[2417.490]	[0.079]	[6713.860]	[0.678]	[213.696]
South Asia												
India	1990	25.244	7.618	3.263	0.168	2.580	174.073	138.854	0.245	8505.94	5.152	233.631
		[23.530]	[5.344]	[2.605]	[0.023]	[0.225]	[68.251]	[5.512]	[0.143]	[1592.850]	[2.155]	[49.552]
Indonesia	1990	46.590	15.038	3.748	0.328	0.009	1219.86	1884.36	0.349	1047405.95	0.397	278.268
		[47.580]	[10.145]	[2.700]	[0.119]	[0.001]	[653.788]	[429.465]	[0.152]	[214199.900]	[0.182]	[51.271]
Malaysia	1987	25.113	4.299	2.171	0.305	0.773	4.168	529.075	0.137	979.829	1.500	342.949
		[20.690]	[3.353]	[1.740]	[0.089]	[0.159]	[2.471]	[148.056]	[0.079]	[321.970]	[0.842]	[109.473]
Pakistan	1991	37.428	10.299	2.785	6.628	2.098	37.423	10323.790	0.206	3239.13	1.076	85.659
		[35.850]	[7.095]	[2.270]	[0.077]	[0.219]	[15.759]	[42.558]	[0.126]	[594.060]	[0.433]	[14.545]
Singapore	1987	36.506	6.647	2.110	0.229	2.083	2.083	736.597	0.121	1064.300	1.299	668.360
		[34.380]	[4.446]	[1.630]	[0.087]	[0.291]	[0.989]	[169.260]	[0.064]	[169.050]	[0.594]	[104.608]
Sri Lanka	1987	51.941	12.165	2.775	11.596	1.703	36.368	7490.660	0.175	958.744	0.695	17.882
		[55.560]	[10.089]	[2.180]	[0.125]	[0.180]	[24.233]	[40.856]	[0.108]	[409.630]	[0.458]	[7.731]
Thailand	1992	33.276	8.017	2.717	0.311	1.196	66.676	405.789	0.187	9050.11	2.481	319.899
		[29.030]	[5.193]	[2.200]	[0.095]	[0.066]	[36.980]	[50.129]	[0.101]	[1500.000]	[1.341]	[54.799]
Europe												
Cyprus	1993	33.362	7.806	3.361	1.043	4.456	1.729	167.063	0.232	122.810	0.981	71.187
		[30.650]	[5.569]	[2.500]	[0.196]	[0.318]	[1.021]	[50.045]	[0.144]	[23.800]	[0.554]	[11.954]
Czech	1993	32.275	5.808	2.369	1.249	0.432	1131.60	72.985	0.102	5009.01	37.765	159.277
Republic		[28.950]	[5.019]	[2.035]	[0.007]	[0.094]	[650.900]	[0.147]	[0.070]	[1519.830]	[21.853]	[51.329]
Greece	1988	22.572	4.746	2.685	0.465	5.347	6.913	73.300	0.130	174.579	0.022	0.559
		[15.380]	[3.181]	[2.230]	[0.214]	[0.790]	[2.877]	[24.357]	[0.100]	[26.230]	[0.011]	[0.102]
Hungary	1991	27.940	7.900	2.850	0.418	0.091	3897.710	159.586	0.178	53925.57	19.979	238.914
		[20.310]	[3.641]	[2.180]	[0.193]	[0.007]	[2394.140]	[5.262]	[0.091]	[6433.310]	[14.476]	[38.191]
Poland	1992	19.370	4.252	2.499	0.329	1.899	26.057	25.259	0.135	420.041	7.156	107.571
		[16.920]	[3.729]	[2.220]	[0.142]	[0.609]	[13.027]	[8.051]	[0.106]	[60.060]	[3.567]	[17.664]
Portugal	1988	38.549	6.578	1.926	0.184	5.453	11.959	37.299	0.082	202.142	0.076	1.226
		[39.060]	[4.757]	[1.605]	[0.087]	[1.843]	[7.698]	[5.800]	[0.049]	[40.200]	[0.049]	[0.255]
Russia	1994	41.553	17.992	4.673	0.222	4.882	11.378	2616.630	0.504	720.035	1.687	98.105
		[43.440]	[12.293]	[3.680]	[0.063]	[1.268]	[2.733]	[54.573]	[0.348]	[106.29]	[0.398]	[13.777]
Turkey	1988	20.593	5.627	3.243	1.740	0.002	18944.44	117253.81	0.242	10651192.60	0.161	78.769
		[18.415]	[4.844]	[2.930]	[0.582]	[0.000]	[941.945]	[20806.790]	[0.209]	[3018499.000]	[0.009]	[29.515]

Table 1 (*continued*)

Country	Start	Zero return (%)	Liquidity cost measures				Local market				$US equivalent	
			LOT (%)	Roll (%)	Turnover (%)	Amihud (%)	Price	Volume (thousands)	Volatility (%)	Capitalization (millions)	Price	Capitalization (millions)
Middle East/ Africa												
Egypt	1994	22.289	4.097	2.068	0.225	3.041	49.855	23.681	0.082	692.594	14.657	203.285
		[13.560]	[2.919]	[1.760]	[0.089]	[0.496]	[31.484]	[5.471]	[0.059]	[175.540]	[9.152]	[51.627]
Israel	1993	32.458	7.332	2.378	0.239	3.499	67.845	211.951	0.134	688.496	17.645	189.096
		[28.570]	[4.856]	[1.930]	[0.091]	[0.903]	[10.531]	[9.057]	[0.083]	[114.030]	[2.681]	[27.724]
Morocco	1993	43.926	4.481	1.232	0.051	0.147	695.860	1.797	0.036	3320.80	71.054	341.062
		[43.330]	[3.560]	[1.050]	[0.023]	[0.049]	[515.672]	[0.639]	[0.022]	[1948.900]	[52.463]	[203.791]
South	1987	40.333	11.003	2.812	0.209	3.656	16.978	309.954	0.247	2236.57	4.082	516.642
Africa		[40.000]	[7.090]	[1.960]	[0.085]	[0.441]	[4.349]	[78.525]	[0.099]	[401.620]	[0.914]	[84.643]
Zimbabwe	1993	51.560	14.621	3.473	0.387	6.570	6.816	112.673	0.267	1649.98	0.479	68.310
		[51.610]	[11.765]	[2.720]	[0.057]	[2.913]	[2.696]	[46.618]	[0.158]	[180.000]	[0.201]	[13.652]

Table 2
The bid–ask spread and alternative liquidity measure correlations
The bid–ask spread is the proportional spread using quarterly quotes and is stated in %. These are determined using quotes derived from the *Bloomberg terminals*. The quotes are available for 23 of the 31 emerging markets. A correlation coefficient shows the relation between the bid–ask spread and each liquidity measure. LOT, derived from Lesmond et al. (1999), is the liquidity measure based on $\alpha_2 - \alpha_1$. Turnover is defined as $1/D_q \sum_{t=1}^{Q} volume_t/shares\ outstanding$. Amihud's measure is defined as $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$. Roll's measure is based on the serial autocorrelation of daily security returns

Country	N	bid–ask	LOT	$\%\rho$	Roll	$\%\rho$	Turnover	$\%\rho$	Amihud	$\%\rho$
Argentina	189	0.0317	0.035	42.15*	0.019	−13.78	0.001	−21.29*	0.488	63.59*
Brazil	1,917	0.0943	0.095	48.61*	0.029	19.19*	0.004	−1.89	4.799	22.02*
China	10,689	0.0052	0.025	61.34*	0.018	33.35*	0.006	−13.41*	0.645	55.59*
Colombia	113	0.0452	0.093	29.41*	0.019	−4.05	0.001	23.22†	0.001	28.17*
Czech Republic	175	0.0815	0.085	34.27*	0.025	24.36*	0.001	−30.31*	0.884	22.89*
Greece	4,992	0.0300	0.037	24.46*	0.029	39.48*	0.005	9.63*	4.658	23.11*
Hungary	210	0.1114	0.074	69.93*	0.029	37.42*	0.005	−6.22	0.074	54.25*
India	1,673	0.0465	0.050	51.27*	0.032	32.17*	0.003	−10.36*	3.242	44.89*
Indonesia	3,733	0.0856	0.166	61.79*	0.042	38.84	0.003	−2.42	0.011	39.94*
Israel	81	0.1050	0.100	50.07*	0.023	19.84	0.001	−0.78	6.033	26.14†
Korea	15,580	0.0195	0.043	54.98*	0.035	15.69*	0.023	−10.74*	0.005	32.92*
Malaysia	10,121	0.0242	0.044	50.85*	0.023	8.89*	0.004	−10.13*	0.852	42.14*
Mexico	1,649	0.0527	0.051	49.18*	0.018	11.22*	0.002	−5.76†	0.287	22.10*
Peru	370	0.0492	0.088	54.65*	0.018	20.30*	0.007	1.04	1.040	51.85*
Philippines	3,826	0.0635	0.134	57.28*	0.032	26.94*	0.010	1.81	0.913	33.04*
Poland	908	0.0313	0.041	38.34*	0.024	26.24*	0.002	−5.79	2.765	19.46*
Portugal	1,439	0.0291	0.055	79.80*	0.019	37.11*	0.002	−4.09	6.540	57.63*
Russia	587	0.4722	0.216	47.47*	0.059	27.65*	0.001	−1.04	9.722	40.47*
Singapore	2,741	0.0337	0.076	46.50*	0.023	25.39*	0.003	−10.37*	3.355	36.60*
South Africa	6,361	0.0611	0.110	69.06*	0.029	44.90*	0.002	−0.98	5.136	49.54*
Taiwan	11,108	0.0109	0.023	19.29*	0.018	10.81*	0.012	−2.53*	0.025	18.46*
Thailand	2,334	0.0514	0.083	60.14*	0.027	29.54*	0.003	−11.88*	1.553	31.46*
Venezuela	194	0.0464	0.098	66.15*	0.025	12.15	0.003	−8.29	0.009	26.22*
All countries	81,002	0.0348	0.059	56.05*	0.027	29.51*	0.009	−6.51*	1.427	27.50*
Rank correlation (percent) - all countries				80.23*		49.61†		−27.57		30.54

* denotes significance of the correlation at the 1% level;
† denotes significance of the correlation at the 5% level.

Amihud's measure perhaps are surprising given that the bid–ask spread is not often associated with price impact costs. However, Jain (2002) notes that effective spreads are often larger than the quotes, making the bid–ask spread a lower bound for price impact costs.

Finally, each country's liquidity cost is ranked for each of the four liquidity estimators as well as for the bid–ask spread. The rank correlation is then performed to determine how well each measure matches the cross-sectional differences in each country's bid–ask spread. This procedure eliminates outlier effects that could cloud the inferences concerning cross-country liquidity comparisons. The results are presented in the final row of Table 2. The results indicate that price-based liquidity measures (the LOT and Roll's estimate) outperform volume-based liquidity measures (Amihud's measure or turnover) at representing cross-sectional ranking differences in the bid–ask spread. The rank of the LOT estimate is over 80% correlated with the rank of the bid–ask spread, while Roll's measure is almost 50% correlated, indicating that price-based liquidity models outperform volume-based models. Among the price based models, the LOT liquidity estimate more correctly matches the cross-country variations in the bid–ask spread.

3.3. Time-series liquidity behavior

Fig. 1 presents a matched sample of the quarterly based bid–ask spread and the four liquidity measures for all 23 emerging markets from 1993 to 2000. The most striking aspect of Fig. 1 is the significant time-series variation displayed by most of the liquidity measures over time. The LOT measure, Roll's measure, Amihud's measure, and the bid–ask spread all experience a sharp spike from the third quarter

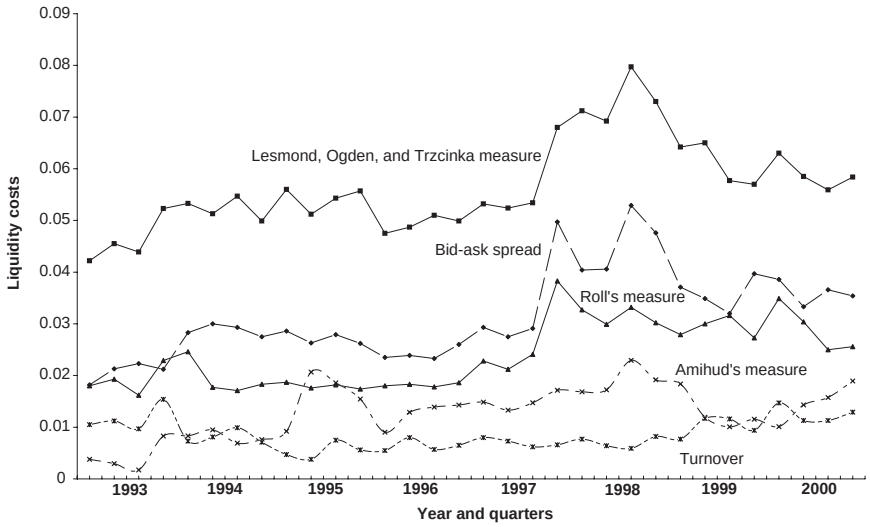

Fig. 1. Liquidity cost measures over time.

of 1997 to the third quarter of 1998. This period coincides with the Asian (Indonesia, Korea, and Thailand) and Russian financial crises as documented in Summers (2000) and Froot et al. (2001). The Asian markets' financial crisis occurred first in Thailand in July 1997, then spread to Indonesia in October 1997, and concluded with Korea in December 1997. Russia devalued the ruble in August 1998 and Long Term Capital Management (LTCM) failed in September 1998. For each of these financial crises, "investors (both domestic and foreign) decided to reduce the stock of their assets in the affected country in response to a change in the fundamentals" (Summers, 2000, p. 5). Froot et al. find similar attenuation in capital inflows for these emerging markets. Liquidity began to improve (transaction costs declined) after the financial crisis of 1998 as more capital inflows stabilized the markets.[6] Turnover demonstrates little movement during this financial crisis, although a sharp reduction in liquidity should have occurred because of the severe reduction in investor inflows.

4. Liquidity measure comparison tests

In this section, tests of association between the bid–ask spread and each liquidity measure are performed specific to each country as well as tests to determine which liquidity measure performs better at representing the underlying variation in the bid–ask spread or spread proxies. I conclude with commonality tests among all the liquidity measures using factor analysis.

4.1. Bid–ask spread plus commissions on liquidity proxies and measures

I now provide a direct test of the association between the bid–ask spread plus commission cost and the various liquidity proxies as well as market variables used to proxy for liquidity. These market variables include price, volume, volatility, and firm size (Stoll, 2000). Stoll argues that price proxies for risk, as lower priced stocks tend to be riskier, and controls for the effects of price discreteness. Volume and firm size proxy for order processing and inventory considerations. Increases in volume and firm size increase the probability of locating a trade counter party, which reduces inventory risk. Volatility measures the risk of adverse price changes because of stock put into inventory.

For each country, three regressions are presented. The first regresses the bid–ask spread plus commissions on the market liquidity proxies of price, volume, volatility, and firm size to provide a basis for comparing the separate liquidity measures. (Similar results are obtained using only the bid–ask spread.) The second set of regressions incorporates each of the four liquidity measures separately to assess the incremental explanatory power of each measure. The last set regresses the bid–ask

[6]Separate time-series plots particular to each region, except for the Middle Eastern/African markets, show a similar time-series trend.

spread-plus-commissions on the Stoll control variables and all four liquidity measures. In keeping with Stoll (2000), I log scale price, volume, and firm size. Also, I log scale turnover to remove significant skewness in this liquidity measure. (Using unscaled turnover reduces turnover to insignificance in almost every country.)

The results for the regression tests are reported in Table 3 for 23 emerging markets with bid–ask spread information. The Stoll (2000) variables of price, volatility, and volume are usually of the proper sign (negative for price and volume, and positive for volatility) and significantly associated with the spread plus commission. Surprisingly, firm size is inconsistently related to the spread plus commission cost. Overall, the results are roughly consistent with Stoll's results for the NYSE and Amex and Nasdaq markets, except for firm size. The R-square statistic is relatively robust, ranging from 5% for Taiwan to 53% for China, which would suggest that, for some markets, almost half of the cross-sectional variation in the spread plus commission costs is explained by these market proxies. For comparison purposes, Stoll reports an R^2 of between 65% for the Nasdaq and 79% for the NYSE and Amex markets.

Including the four liquidity measures sequentially reveals that each measure, with the exception of Roll's measure, remains significantly related to the spread plus commission cost for the majority of the 23 markets.[7] The poor performance of Roll's measure is somewhat surprising given the correlation results of Table 2. More telling is the effect on the R^2 statistic, which shows the LOT liquidity measure explaining more of the cross-sectional variation in the spread plus commission costs than does Amihud's measure or turnover. The largest percentage increases in the R^2 are noted for the Brazilian market, increasing from 13% to 20%; for the Malaysian market, increasing from 25% to 35%; and for the Portuguese market, increasing from 44% to 70%. This implies that the LOT liquidity estimate adds almost half of the explanatory power in explaining the cross-sectional variation in the bid–ask spread plus commission cost. More modest increases in the R^2 statistic are realized for Amihud's measure and turnover, with increased explanatory power exhibited by Amihud's measure.

The grand regressions, including the Stoll (2000) variables and each of the four liquidity measures, show surprising resiliency for all of the liquidity measures, again except for Roll's estimator. The LOT measure is significant in 20 of the 23 markets, while Amihud's measure is significant in 12 markets and turnover is significant in 13 markets. The liquidity coefficients of the prior regressions are relatively invariant with those of the grand regressions. For instance, the LOT coefficient for Brazil is relatively constant at approximately 0.50, while for India the LOT coefficient is relatively constant at approximately 0.16. Similar results are obtained for Amihud's measure. These results indicate that the LOT measure and Amihud's measure, where significant, are robust liquidity estimators when used within each country.

[7]While not reported, the log-scaled Amivest measure is significantly related to the spread plus commission costs in only one market.

Table 3
Total costs on liquidity proxies and measures
The results of the regression tests are based on a firm-quarter basis using bid–ask spread plus commission costs as the dependent variable. Turnover is defined as $1/D_q \sum_{t=1}^{Q} volume_t/shares\ outstanding$. Amihud's measure is defined as $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$. Roll's measure is based on the serial autocorrelation of daily security returns. The LOT liquidity measure, derived from Lesmond et al. (1999), is defined by $\alpha_2 - \alpha_1$. The proportional bid–ask spread is calculated using the quarterly closing quotes. Commissions and fees are the applicable commission costs and related fees particular to each market. The spread is added to two times the commission cost to arrive at total costs. The total cost is the dependent variable in the regressions. Firm size is determined from the first day of each quarter. Volatility is the average daily stock return variance and price and volume measure the average price (local currency) and trading volume over an annual trading period. Turnover, price, volume, and market capitalization are log scaled. N is the sample size in firm-quarters. The White (1980) t- statistics are in parentheses

Country	N	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
Argentina	189	0.128*	−0.008*	−0.008	−0.009*	0.001					39.05
		(6.76)	(4.93)	(0.01)	(8.17)	(0.92)					
		0.100*	−0.006*	−0.971	−0.007*	0.001	**0.164***				41.60
		(4.76)	(3.52)	(0.67)	(6.41)	(1.14)	(2.92)				
		0.127*	−0.008*	1.362	−0.009*	0.001		−0.121			39.01
		(6.67)	(4.93)	(0.63)	(8.11)	(0.98)		(1.06)			
		0.097*	−0.005*	−0.534	−0.005*	0.001			**0.009***		44.76
		(4.48)	(3.26)	(0.39)	(4.24)	(0.25)			(4.25)		
		0.165*	0.001	2.051	0.001	−0.009†				**−0.010***	41.25
		(7.31)	(0.37)	(1.25)	(0.26)	(2.39)				(2.88)	
		0.112*	−0.001	1.911	−0.001	−0.004	0.053	−0.151	**0.007†**	−0.004	45.20
		(3.99)	(0.24)	(0.93)	(0.34)	(1.03)	(0.88)	(1.35)	(2.98)	(1.25)	
Brazil	1,230	0.313*	−0.011*	7.279*	−0.015*	−0.001					12.58
		(8.17)	(4.78)	(4.35)	(8.57)	(0.51)					
		0.162*	0.002	−2.838	−0.006*	−0.001	**0.515***				20.46
		(4.13)	(0.78)	(1.75)	(2.82)	(0.18)	(7.32)				
		0.320*	−0.012*	9.995*	−0.015*	−0.001		−0.388			12.73
		(8.13)	(4.86)	(4.78)	(8.55)	(0.55)		(1.90)			
		0.289*	−0.009*	6.554*	−0.013*	−0.001			**0.001***		13.01
		(7.70)	(3.31)	(3.76)	(7.11)	(0.59)			(3.24)		
		0.370*	0.026*	7.710*	0.024*	−0.035*				**−0.039***	15.84
		(9.64)	(3.49)	(4.82)	(3.15)	(5.05)				(5.04)	
		0.212*	0.015†	0.594	0.012	−0.017*	**0.456***	−0.299	0.000	**−0.019***	21.14
		(5.79)	(2.29)	(0.27)	(1.80)	(2.86)	(6.43)	(1.47)	(0.06)	(2.75)	
China	9,447	0.085*	−0.004*	3.353*	−0.003*	−0.001*					53.33
		(39.11)	(25.67)	(16.16)	(20.90)	(5.64)					
		0.078*	−0.003*	2.579*	−0.003*	−0.001	**0.047***				54.44
		(31.59)	(15.20)	(11.19)	(18.99)	(4.63)	(6.19)				
		0.085*	−0.004*	3.126*	−0.003*	−0.001*		0.020			53.35
		(39.05)	(25.84)	(12.68)	(20.94)	(5.70)		(1.71)			
		0.076*	−0.003*	2.338*	−0.002*	−0.001*			**0.001***		57.96
		(40.79)	(20.47)	(11.75)	(17.38)	(7.29)			(9.04)		
		0.089*	−0.001*	3.494*	−0.000	−0.003*				**−0.003***	53.80
		(37.63)	(4.29)	(16.39)	(1.11)	(8.77)				(7.67)	
		0.074*	−0.001*	1.895*	−0.001	−0.002*	**0.032***	0.005	**0.001***	**−0.002***	59.47
		(30.42)	(3.43)	(7.44)	(1.50)	(6.20)	(4.03)	(0.31)	(7.31)	(4.54)	
Colombia	113	0.376*	−0.007†	−0.302	0.001	−0.010†					13.91
		(3.44)	(2.22)	(0.13)	(0.07)	(2.39)					
		0.282†	−0.005	−4.841	0.002	−0.008	**0.123†**				16.96

Table 3 (*continued*)

Country	*N*	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
		(2.58)	(1.49)	(1.77)	(0.60)	(1.87)	(2.27)				
		0.364*	−0.007†	1.207	0.001	−0.010†		−0.154			13.36
		(3.18)	(2.04)	(0.30)	(0.13)	(2.25)		(0.55)			
		0.294*	−0.004	−3.336	0.003	−0.009†			**9.403**†		17.23
		(3.14)	(1.07)	(1.63)	(1.07)	(2.51)			(2.09)		
		0.377*	−0.008	−0.358	−0.001	−0.010				0.001*	13.12
		(3.21)	(0.62)	(0.16)	(0.06)	(1.09)				(0.07)	
		0.237†	−0.014	−8.627	−0.010	0.003	0.117	0.056	8.262	0.014	18.16
		(2.82)	(1.29)	(1.59)	(0.79)	(0.33)	(1.65)	(0.19)	(1.49)	(1.09)	
Czech Republic	143	0.058	−0.023*	28.988*	−0.012*	0.011†					27.10
		(0.78)	(4.14)	(2.72)	(5.47)	(2.54)					
		0.031	−0.022*	26.244†	−0.010*	0.011†	0.182				27.03
		(0.37)	(4.00)	(2.26)	(3.51)	(2.49)	(0.82)				
		0.066	−0.023*	31.512†	−0.012*	0.111†		−0.173			26.65
		(0.83)	(4.46)	(2.74)	(5.54)	(2.42)		(0.40)			
		0.063	−0.024*	29.627†	−0.012*	0.012†			−0.001		26.61
		(0.82)	(3.44)	(2.50)	(5.14)	(2.54)			(0.17)		
		0.159	−0.002	31.159*	0.014	−0.013				−0.026	27.67
		(1.32)	(0.11)	(2.92)	(0.70)	(0.65)				(1.29)	
		0.139	−0.002	31.031†	0.014	−0.013	0.181	−0.161	−0.001	−0.025	26.59
		(1.14)	(0.09)	(2.47)	(0.66)	(0.58)	(0.82)	(0.36)	(0.08)	(1.19)	
Greece	4,475	0.127*	0.004*	14.501*	−0.003*	−0.004*					19.74
		(18.59)	(4.65)	(17.41)	(7.19)	(7.16)					
		0.092*	0.007*	12.966*	−0.0025*	−0.004*	**0.256***				22.42
		(11.78)	(8.20)	(14.71)	(2.95)	(6.63)	(8.26)				
		0.115*	0.002*	9.470*	−0.004*	−0.003*		**0.368***			20.98
		(17.17)	(3.23)	(9.75)	(9.07)	(5.63)		(7.28)			
		0.090*	0.006*	13.084*	−0.001	−0.004*			**0.001***		22.79
		(12.59)	(7.55)	(15.35)	(0.67)	(7.07)			(11.39)		
		0.112*	0.011*	16.432*	0.008*	−0.012*				**−0.015***	24.44
		(17.50)	(10.11)	(18.94)	(7.02)	(12.22)				(12.05)	
		0.077*	0.011*	11.349*	0.006*	−0.009*	**0.082***	**0.234***	**0.001***	**−0.010***	26.51
		(9.91)	(9.80)	(10.14)	(5.84)	(8.65)	(2.56)	(4.76)	(7.37)	(8.02)	
Hungary	201	0.493*	−0.006	27.584*	−0.015*	−0.010					29.39
		(4.21)	(0.39)	(3.25)	(2.73)	(0.96)					
		0.191†	0.007	−6.396	0.006	−0.011	**1.219***				49.27
		(2.07)	(0.50)	(0.62)	(0.91)	(1.17)	(4.43)				
		0.499*	−0.006	30.356†	−0.015*	−0.010		−0.301			29.09
		(4.38)	(0.41)	(2.54)	(2.67)	(0.92)		(0.29)			
		0.412*	0.021	13.444	−0.001	−0.022†			**0.364***		35.44
		(3.55)	(1.66)	(1.59)	(0.10)	(2.36)			(2.92)		
		0.532*	0.043	25.324*	0.038	−0.054†				−0.056	31.19
		(4.33)	(1.59)	(2.96)	(1.32)	(2.13)				(1.79)	
		0.139	0.002	−15.610	−0.007	−0.000	**1.196***	0.532	0.151	0.020	49.58
		(1.58)	(0.11)	(1.41)	(0.35)	(0.02)	(3.16)	(0.63)	(0.93)	(0.79)	
India	1,361	0.202*	−0.022*	8.879*	−0.007*	0.001					41.88
		(8.73)	(14.94)	(6.06)	(9.46)	(1.00)					
		0.183*	−0.021*	7.281*	−0.006*	0.001	**0.152**†				42.33
		(7.61)	(13.17)	(4.66)	(6.90)	(0.99)	(2.06)				
		0.203*	−0.022*	9.288*	−0.007*	0.001		−0.051			41.85
		(8.56)	(14.86)	(4.52)	(9.48)	(0.99)		(0.34)			
		0.199*	−0.021*	7.764*	−0.007*	0.001*			0.001		41.97

Table 3 (*continued*)

Country	*N*	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
		(8.68)	(12.55)	(4.56)	(8.90)	(0.86)			(1.04)		
		0.202*	−0.020*	8.861*	−0.005*	−0.000				−0.002	41.87
		(7.60)	(6.12)	(6.32)	(2.92)	(0.40)				(0.51)	
		0.183*	−0.021*	7.745*	−0.007	0.002	**0.172**†	−0.026	−0.001	0.000	42.22
		(7.52)	(9.82)	(3.56)	(3.26)	(0.84)	(2.16)	(0.19)	(0.40)	(0.11)	
Indonesia	3,721	0.425*	−0.021*	7.922*	−0.021*	0.002					36.75
		(18.41)	(12.17)	(23.77)	(20.89)	(1.47)					
		0.229	−0.009*	1.557*	−0.012*	0.001	**0.309***				42.06
		(9.12)	(4.88)	(3.14)	(11.86)	(1.09)	(14.87)				
		0.426*	−0.021*	8.083*	−0.021*	0.002		−0.033			36.75
		(18.27)	(12.10)	(17.27)	(20.89)	(1.48)		(0.50)			
		0.404*	−0.019*	7.129*	−0.018*	0.001			**0.268***		37.44
		(17.61)	(11.16)	(18.99)	(18.04)	(0.93)			(3.55)		
		0.423*	−0.005	8.099*	−0.000	−0.015*				**−0.022***	37.98
		(18.56)	(1.93)	(24.15)	(0.06)	(6.31)				(7.74)	
		0.235*	0.001	2.330*	0.002	−0.010*	**0.288***	**−0.122**†	**0.129**†	**−0.015***	42.82
		(9.39)	(0.49)	(4.15)	(0.79)	(4.73)	(13.62)	(1.98)	(2.00)	(5.63)	
Israel	78	0.34*	−0.038*	26.855	−0.029*	0.005					23.54
		(1.53)	(2.59)	(1.51)	(2.91)	(0.35)					
		0.216	−0.025	14.438	−0.016	0.003	**0.705***				29.70
		(1.11)	(1.86)	(0.64)	(1.59)	(0.24)	(2.65)				
		0.402*	−0.0389	34.500†	−0.030*	0.003		−1.185			23.75
		(1.80)	(2.67)	(2.31)	(3.07)	(0.21)		(1.06)			
		0.337	−0.033†	16.329	−0.025†	0.003			0.002		23.00
		(1.54)	(1.98)	(0.69)	(2.12)	(0.19)			(0.48)		
		0.283	0.002	26.051	0.016	0.028				−0.047	25.59
		(1.26)	(0.07)	(1.55)	(0.56)	(1.21)				(1.50)	
		0.263	−0.029	−10.498	−0.020	0.004	**0.697**†	−0.775	0.000	0.004	27.20
		(1.29)	(0.88)	(0.38)	(0.62)	(0.17)	(2.13)	(0.73)	(0.12)	(0.11)	
Korea	15,319	0.146*	−0.006*	2.872*	−0.008*	0.001*					35.31
		(38.72)	(21.64)	(19.54)	(39.54)	(4.81)					
		0.106*	−0.005*	1.220*	−0.006*	0.001*	**0.279***				42.49
		(27.96)	(18.19)	(9.42)	(32.24)	(5.19)	(16.99)				
		0.146*	−0.006*	2.859*	−0.008*	0.001*		0.002			35.30
		(38.74)	(21.62)	(15.34)	(39.54)	(4.81)		(0.13)			
		0.137*	−0.005*	2.518*	−0.008*	0.001*			**0.105***		37.01
		(30.22)	(14.98)	(16.47)	(30.14)	(3.55)			(3.17)		
		0.163*	−0.001†	3.127*	−0.003*	−0.004*				**−0.007***	36.50
		(40.27)	(2.19)	(20.49)	(5.27)	(8.53)				(12.09)	
		0.115*	−0.002*	1.293*	−0.003*	−0.002*	**0.252***	0.014	0.034	**−0.004***	42.95
		(28.97)	(4.47)	(7.94)	(7.31)	(4.43)	(14.39)	(1.11)	(1.19)	(7.87)	
Malaysia	10,076	0.167*	−0.006*	2.990*	−0.009*	−0.001*					25.06
		(27.87)	(12.77)	(14.31)	(36.77)	(4.15)					
		0.110*	−0.006*	0.300	−0.006*	−0.006†	**0.366***				36.13
		(19.25)	(14.85)	(1.44)	(25.56)	(2.08)	(16.70)				
		0.167*	−0.006*	2.300*	−0.009*	−0.001*		**0.100***			25.19
		(27.44)	(12.78)	(8.16)	(36.92)	(3.98)		(3.87)			
		0.134*	−0.003*	1.874*	−0.0056	−0.001*			**0.004***		30.43
		(20.68)	(6.08)	(9.20)	(22.64)	(4.37)			(10.59)		
		0.187*	0.007*	3.375*	0.007*	−0.014*				**−0.016***	28.12
		(29.61)	(6.85)	(15.64)	(6.16)	(13.96)				(13.39)	
		0.111*	0.001	0.576†	0.001	−0.006*	**0.289***	−0.022	**0.002***	**−0.007***	37.88
		(18.63)	(0.82)	(2.40)	(1.47)	(7.38)	(11.76)	(0.84)	(6.19)	(6.63)	

Table 3 (*continued*)

Country	N	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
Mexico	1,597	0.319*	−0.014*	15.178*	−0.017*	0.000					15.98
		(9.47)	(5.31)	(3.78)	(10.59)	(0.03)					
		0.111*	−0.004	0.609	−0.006*	0.002	**0.627***				24.81
		(3.25)	(1.38)	(0.19)	(3.18)	(0.91)	(7.50)				
		0.325*	−0.014*	18.364*	−0.017*	−0.001		0.353			16.09
		(9.46)	(5.30)	(3.21)	(10.56)	(0.15)		(1.24)			
		0.298*	−0.011*	14.625*	−0.015*	−0.000			**0.005***		17.01
		(8.93)	(4.28)	(3.66)	(9.66)	(0.12)			(4.89)		
		0.338*	0.007	17.929*	0.007*	−0.021				**−0.024***	17.34
		(9.78)	(1.05)	(4.28)	(1.10)	(3.31)				(3.75)	
		0.096*	−0.008	2.589	−0.011†	0.007	**0.639***	−0.368	**0.004†**	0.006	25.34
		(2.76)	(1.46)	(0.55)	(2.02)	(1.30)	(7.20)	(1.43)	(2.39)	(0.34)	
Peru	367	0.217*	−0.012*	10.068*	−0.012*	−0.001					29.75
		(7.58)	(6.29)	(4.14)	(6.48)	(0.76)					
		0.137*	−0.007*	−2.776	−0.006*	−0.002	**0.288***				40.29
		(4.69)	(3.59)	(0.75)	(2.79)	(1.34)	(5.55)				
		0.212*	−0.012*	9.280*	−0.012*	−0.001		0.142			29.57
		(7.37)	(6.32)	(3.27)	(6.51)	(0.63)		(0.62)			
		0.161*	−0.008*	4.021	−0.007*	−0.002			**0.009***		35.31
		(5.19)	(3.99)	(1.54)	(2.95)	(1.35)			(4.03)		
		0.253*	0.010	9.357†	0.0134†	−0.023*				**−0.024***	35.36
		(8.91)	(1.68)	(3.57)	(2.04)	(4.08)				(4.21)	
		0.148*	0.003	−3.032	0.006	−0.011†	**0.199***	0.227	0.004	**−0.011†**	41.66
		(4.52)	(0.54)	(0.72)	(1.14)	(2.25)	(3.17)	(1.00)	(1.87)	(2.09)	
Philippines	3,779	0.340*	−0.018	6.454*	−0.018*	−0.001					39.50
		(29.19)	(25.15)	(12.62)	(26.73)	(1.55)					
		0.198*	−0.011*	1.257*	−0.011*	0.000	**0.280***				47.35
		(14.94)	(14.11)	(2.65)	(16.72)	(0.09)	(14.62)				
		0.348*	−0.018*	7.533*	−0.018*	−0.001†		**−0.193†**			39.68
		(29.46)	(25.39)	(9.99)	(26.89)	(1.96)		(2.51)			
		0.309*	−0.016*	5.195*	−0.015*	−0.001*			**0.006***		41.68
		(24.66)	(19.12)	(10.49)	(19.18)	(2.35)			(4.72)		
		0.353*	−0.009*	6.176*	−0.008*	−0.010				**−0.010***	40.09
		(28.57)	(4.40)	(12.04)	(3.65)	(5.07)				(5.12)	
		0.211*	−0.007*	2.303*	−0.007*	−0.003†	**0.258***	**−0.217***	**0.002***	−0.003	47.94
		(15.07)	(4.30)	(3.68)	(4.08)	(1.99)	(12.95)	(3.22)	(2.18)	(1.91)	
Poland	901	0.142*	−0.012*	6.464*	−0.006*	−0.001					30.51
		(13.34)	(11.60)	(6.78)	(8.71)	(0.49)					
		0.125*	−0.011*	3.324	−0.005*	−0.001	**0.253***				32.56
		(10.76)	(10.71)	(2.67)	(6.07)	(0.77)	(4.13)				
		0.137*	−0.012*	5.415*	−0.006*	−0.000		0.213			30.64
		(12.55)	(11.41)	(5.13)	(8.13)	(0.52)		(1.49)			
		0.144*	−0.012*	6.613*	−0.006*	−0.000			−0.001		30.48
		(13.23)	(11.78)	(6.74)	(8.45)	(0.38)			(0.72)		
		0.1815*	−0.003	6.928*	0.005	−0.011*				**−0.121***	32.12
		(12.09)	(0.92)	(6.91)	(1.76)	(3.79)				(3.89)	
		0.153*	−0.006†	3.888*	0.002	−0.007†	**0.196***	0.092	−0.001	**−0.008†**	33.11
		(8.50)	(2.09)	(2.68)	(0.59)	(2.26)	(2.99)	(0.99)	(1.24)	(2.26)	
Portugal	1,754	0.108*	−0.001	3.477*	−0.005*	−0.002*					40.46
		(19.18)	(0.56)	(3.32)	(13.02)	(3.19)					
		0.055*	0.001	−1.443†	−0.003*	−0.001†	**0.345***				67.70
		(12.35)	(1.93)	(2.16)	(6.97)	(2.11)	(16.06)				

Table 3 (*continued*)

Country	*N*	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
		0.105*	−0.001	2.461†	−0.005*	−0.002*		**0.114**†			40.66
		(19.71)	(0.53)	(2.09)	(12.85)	(3.14)		(2.34)			
		0.076*	0.003*	1.765*	−0.003*	−0.001*			**0.001***		49.24
		(15.73)	(4.86)	(3.24)	(9.12)	(3.11)			(12.56)		
		0.147*	0.014*	3.621*	0.013*	−0.018*				**−0.018***	50.27
		(22.55)	(7.41)	(4.66)	(6.01)	(9.07)				(8.16)	
		0.066*	0.006*	−1.061†	0.003†	−0.005*	**0.299***	−0.006	**0.001***	**−0.005***	68.61
		(11.85)	(5.26)	(1.32)	(2.11)	(4.52)	(12.09)	(0.17)	(2.99)	(4.78)	
Russia	209	0.931*	−0.102*	29.359*	−0.103*	0.028					49.61
		(3.87)	(3.45)	(5.54)	(4.33)	(1.31)					
		0.560†	−0.066†	20.101*	−0.102*	0.042	**0.749***				55.14
		(2.05)	(2.50)	(3.99)	(4.85)	(1.76)	(3.51)				
		0.935*	−0.102	29.855*	−0.104*	0.028		−0.114			49.37
		(3.85)	(3.41)	(4.81)	(4.30)	(1.13)		(0.14)			
		0.817*	−0.087*	28.409*	−0.092*	0.026			0.004		50.11
		(3.10)	(2.78)	(5.21)	(3.61)	(1.02)			(1.13)		
		0.363	0.003	31.668*	0.013	−0.040				**−0.108***	55.05
		(1.71)	(0.08)	(6.08)	(0.38)	(1.37)				(4.19)	
		−0.079	0.049	22.636†	0.023	−0.028*	**0.758***	−0.213	0.003	**−0.109***	60.78
		(0.26)	(1.38)	(3.51)	(0.74)	(1.06)	(3.77)	(0.29)	(0.81)	(4.47)	
Singapore	2,693	0.012	−0.007*	7.617*	0.001	0.002†					12.21
		(0.62)	(5.68)	(7.67)	(0.75)	(2.02)					
		−0.003	0.001	1.182	0.004*	0.000	**0.284***				19.01
		(0.15)	(0.92)	(1.01)	(6.67)	(0.12)	(8.29)				
		0.012	−0.007*	7.580*	0.001	0.002†		0.005			12.17
		(0.62)	(5.38)	(6.79)	(0.75)	(2.00)		(0.06)			
		−0.028	−0.003*	4.494*	0.005*	0.002			**0.002***		17.22
		(1.40)	(2.79)	(4.54)	(6.89)	(1.50)			(7.63)		
		0.012	0.004	7.760*	0.014*	−0.009†				**−0.014***	13.40
		(0.59)	(1.05)	(7.78)	(3.59)	(2.35)				(3.61)	
		−0.028	0.008†	1.149†	0.014*	−0.006	**0.231***	−0.115	**0.002***	**−0.008**†	68.61
		(1.46)	(2.29)	(0.96)	(3.68)	(1.64)	(7.27)	(1.28)	(5.77)	(2.14)	
South Africa	5,919	3.245*	−0.017*	6.155*	−0.010*	−0.003†					31.08
		(210.62)	(12.53)	(14.02)	(10.56)	(2.31)					
		3.121*	−0.0101*	0.628	−0.003*	−0.002	**0.363***				36.53
		(209.95)	(6.89)	(1.34)	(3.02)	(1.69)	(12.74)				
		3.244	−0.017*	6.012*	−0.010*	−0.003†		0.026			31.07
		(210.28)	(12.54)	(10.62)	(10.50)	(2.30)		(0.36)			
		3.201*	−0.012*	4.483*	−0.006*	−0.003*			**0.002***		33.77
		(217.48)	(8.55)	(10.51)	(6.20)	(2.83)			(9.84)		
		3.244*	−0.010*	6.446*	−0.001*	−0.009*				**−0.009***	31.34
		(212.78)	(3.25)	(13.65)	(0.40)	(3.24)				(3.16)	
		3.112*	−0.009*	0.068	−0.003	−0.002	**0.314***	0.063	**0.001***	0.001	37.24
		(205.09)	(3.17)	(0.11)	(0.99)	(0.57)	(11.27)	(0.91)	(5.65)	(0.38)	
Taiwan	10,927	0.060*	−0.005*	4.728*	−0.002*	0.001					5.58
		(15.75)	(9.15)	(7.34)	(8.94)	(0.92)					
		0.050*	−0.005*	2.880*	−0.001*	0.001	**0.227***				6.78
		(12.85)	(9.45)	(3.86)	(5.81)	(0.68)	(3.98)				
		0.060*	−0.005*	4.190*	−0.002*	0.001		0.039			5.59
		(15.70)	(9.18)	(6.08)	(8.88)	(0.89)		(1.16)			
		0.060*	−0.004*	3.998*	−0.002*	−0.001			**0.006***		7.65
		(16.03)	(8.14)	(6.69)	(8.04)	(0.43)			(10.17)		

Table 3 (*continued*)

Country	N	Intercept	Price	Volatility	Volume	Size	LOT	Roll	Amihud	Turnover	R^2
		0.072*	−0.002	4.665*	0.002	−0.003†				**−0.004***	5.80
		(10.12)	(1.68)	(7.30)	(1.11)	(2.22)				(2.61)	
		0.061*	−0.002	2.429*	0.001	−0.003	**0.156***	0.025	**0.005***	**−0.003†**	8.36
		(9.73)	(1.93)	(3.59)	(0.93)	(1.91)	(2.78)	(0.71)	(9.65)	(2.01)	
Thailand	2,295	0.121*	−0.017*	8.987*	−0.015*	0.007*					36.10
		(7.95)	(14.23)	(12.29)	(19.92)	(6.59)					
		0.054*	−0.007*	0.917	−0.006*	0.003*	**0.452***				51.34
		(3.65)	(6.52)	(1.52)	(8.09)	(2.91)	(15.92)				
		0.117*	−0.016*	8.149*	−0.015*	0.007*		0.141			36.19
		(7.71)	(13.89)	(8.66)	(19.76)	(6.58)		(1.45)			
		0.105*	−0.014*	6.762*	−0.013*	0.006			**0.003***		38.67
		(6.97)	(12.08)	(8.91)	(16.94)	(5.93)			(5.17)		
		0.177*	0.006†	7.978*	0.013*	−0.017*				**−0.028***	41.11
		(11.67)	(2.39)	(11.85)	(4.75)	(6.91)				(10.08)	
		0.080*	0.001	0.949	0.005†	−0.006	**0.392***	−0.038	**0.001†**	**−0.011***	52.19
		(5.02)	(0.58)	(1.36)	(1.97)	(2.79)	(12.36)	(0.48)	(2.26)	(4.16)	
Venezuela	189	0.294*	−0.014*	5.801†	−0.014*	0.000					29.75
		(7.41)	(5.26)	(2.37)	(6.23)	(0.13)					
		0.076	−0.006†	0.991	−0.005†	0.002	**0.318***				46.97
		(1.72)	(2.42)	(0.43)	(2.41)	(0.97)	(5.65)				
		0.293*	−0.014*	5.905	−0.014*	0.000		−0.015			29.37
		(7.42)	(5.26)	(1.93)	(6.24)	(0.14)		(0.07)			
		0.235*	−0.013*	4.699†	−0.013*	0.001			**1.144†**		32.40
		(5.32)	(4.71)	(2.06)	(5.52)	(0.56)			(2.04)		
		0.321*	0.005†	7.714*	−0.005	−0.009*				−0.011	30.59
		(6.62)	(0.91)	(2.85)	(0.72)	(1.42)				(1.66)	
		0.086	0.001	3.494	0.002	−0.004	**0.307***	−0.195	0.331	−0.007	47.27
		(1.58)	(0.20)	(1.27)	(0.35)	(0.81)	(5.18)	(1.08)	(0.71)	(1.31)	

* denotes significance at the 1% level;
† denotes significance at the 5% level.

4.2. Direct model comparison tests

The regression tests appear to indicate that the LOT measure and Amihud's measure have increased explanatory power over the other market proxies and liquidity estimators. Because the dependent variable, the spread plus commissions, in the prior regressions is the same, I can provide a direct test of the explanatory power of using only the LOT liquidity estimate versus Roll's, Amihud's, or the turnover measure, or separately, the Stoll (2000) liquidity determinants. In addition, given the relatively similar explanatory power exhibited by Amihud's measure, I test this measure against turnover and Roll's measure as well as against the Stoll determinants. However, simply comparing an R^2 statistic in a regression context does not provide reliable evidence of which liquidity measure is more highly associated with the spread plus commission costs.

Vuong (1989) provides a likelihood ratio test for model selection without specifying a null hypothesis that either model is true. Instead, the null hypothesis is that either model is equally efficient at explaining the data generating process against the alternative that one model is better.[8] Vuong's likelihood ratio Z-score test statistic indicates whether the reference model is better at explaining the comparison model with a one-sided probability. The reference models are either the LOT liquidity estimate or Amihud's measure, and the comparison models are the Stoll (2000) variables and separately Roll's estimate, and turnover. Amihud's measure is a comparison model in the LOT reference model tests, while the LOT measure is a comparison model in the Amihud reference model tests. A positive and significant one-sided probability indicates that the LOT estimate or Amihud's measure is more highly associated, or statistically superior to the competing liquidity estimators. Generally, a positive sign for the Z-score test statistic indicates the reference model has a higher R^2 regression statistic than the competing models. Appendix B. provides more complete details for the Vuong test statistic.

The results are presented in Table 4 with the rejection of either the Stoll (2000) variables or the competing liquidity measures in favor of the reference LOT measure or Amihud's measure shown in bold type.

For 10 of the 23 emerging markets, the LOT is more highly associated with the spread plus commission costs than are the Stoll variables as evidenced by significant one-sided probabilities. The Stoll variables are better at explaining the spread plus commission costs than the LOT measure in only nine markets. Both the Stoll variables and the LOT measure do equally well at explaining the bid–ask spread plus commission cost for the remaining markets.

Comparisons between the LOT measure and each of the other liquidity estimators reveals that, for the vast majority of emerging markets, the LOT model is superior to the competing liquidity measures at explaining the bid–ask spread plus commission cost. Turnover is never preferred over the LOT model, and Roll's measure is preferred in only the Grecian market. Amihud's measure is superior in only two markets (Argentina and Greece). In reference to Amihud's measure, neither the LOT measure nor Amihud's measure is superior in eight markets.

Combining the Roll, Amihud, and turnover measures does not appreciably reduce the ability of the LOT model, by itself, to explain the bid–ask spread plus commission cost. In 12 markets, the LOT measure dominates the other liquidity proxies taken together. In only two markets (Argentina and Greece) are the competing measures superior to the LOT measure.

Directly comparing Amihud's measure with the other liquidity measures shows that Amihud's measure dominates turnover and Roll's measure. Amihud's measure is superior to turnover in 15 of the 23 markets and superior to Roll's measure in 14 of

[8]The commonly used J-test lacks power in discriminating between models and competing hypotheses. This is particularly true when competing liquidity measures have incremental explanatory power as evidenced in Table 3.

Table 4
Likelihood ratio test
A likelihood ratio test, developed by Vuong (1989) for non-nested model selection, is presented for each country. The models compared are based on the regressions of the bid–ask spread and the LOT measure, derived from Lesmond et al. (1999), the variables of Stoll (2000), turnover defined as $1/D_q \sum_{t=1}^{Q} volume_t/shares\ outstanding$, Amihud's measure defined as $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$, and Roll's measure based on the serial autocorrelation of daily security returns. Turnover, price, volume, and market capitalization are natural log scaled. Each regression uses the proportional bid–ask spread as the dependent variable. The reference regression uses either the LOT liquidity estimate, $\alpha_2 - \alpha_1$, or Amihud's liquidity measure. A Z-statistic, using a one-sided probability, is the basis of determining if the LOT estimate or Amihud's estimate (the reference model) is better at explaining the true bid–ask spread generating process than the alternative liquidity proxies, or the comparison models tested either singly or as a group. The group combines all the competing liquidity measures excluding the reference estimate. A positive and significant Z-statistic indicates that the comparison models are rejected in favor of the reference model. These cases are in bold type. N is the sample size

Country	N	LOT versus					Amihud versus			
		Stoll	Roll	Turnover	Amihud	Group	Stoll	Roll	Turnover	Group
Argentina	189	−2.79*	**3.36***	1.44	−2.51*	−2.64*	−0.58	**4.99***	**3.63***	1.19
Brazil	1,230	**2.62***	**4.86***	**4.09***	**3.84***	**3.98***	−3.61*	**2.55***	1.22	−4.03*
China	9,447	−9.91*	**13.65***	**14.11***	**3.11***	1.22	−9.53*	**6.99***	**9.44***	−3.90*
Colombia	113	−1.09	1.26	1.13	0.08	−0.80	−1.12	1.02	0.87	−0.53
Czech Republic	143	−2.02†	**2.57***	−0.47	0.91	0.13	−2.88*	0.86	−1.24	−1.02
Greece	4,475	−9.08*	−5.64*	**4.62***	−3.26*	−11.45*	−8.55*	−4.81*	**6.29***	−8.95*
Hungary	201	**2.41***	**3.53***	**5.61***	**1.82†**	**1.74†**	−0.09	1.37	**2.12†**	−1.83†
India	1,364	−8.24*	**3.86***	1.04	0.87	−0.57	−9.21*	**3.76***	0.59	−2.61*
Indonesia	3,721	**1.99†**	**12.06***	**10.86***	**8.84***	**8.63***	−9.02*	0.38	**5.50***	−9.09*
Israel	78	0.43	**2.12†**	**2.37***	1.47	1.49	−1.52	1.59	1.08	−1.40
Korea	15,319	−4.01*	**14.79***	**11.43***	**8.30***	**6.24***	−10.65*	**3.45***	1.10	−8.36*
Malaysia	10,076	0.53	**14.47***	**8.01***	**1.93†**	**1.67†**	−2.26*	**10.76***	**5.87***	−2.50*
Mexico	1,597	**2.95***	**5.63***	**4.69***	**5.06***	**4.96***	−5.16*	**2.48***	−0.62	−5.09*
Peru	367	1.01	**5.35***	**5.78***	1.35	1.19	−0.32	**5.16***	**6.39***	−1.36
Philippines	3,779	**1.92†**	**14.46***	**16.08***	**9.85***	**8.93***	−8.96*	**3.49***	**5.74***	−9.91*
Poland	877	−7.65*	**2.87***	**5.29***	1.21	0.23	−9.54*	1.43	**4.18***	−1.49
Portugal	1,756	**5.40***	**11.45***	**9.34***	**6.66***	**6.62***	−1.99†	**10.57***	**6.86***	−6.89*
Russia	210	−3.36*	1.09	−0.36	0.87	−0.36†	−4.06*	−0.02	−1.73	−1.80†
Singapore	2,693	**2.20†**	**5.12***	**7.07***	**5.46***	**1.69†**	−2.09†	0.98	**4.48***	−6.31*
South Africa	5,919	**1.98†**	**10.63***	**11.62***	**7.19***	**6.01***	−5.58*	**6.62***	**10.59***	−7.26*
Taiwan	10,927	−2.51*	**2.34***	**2.09†**	−0.11	−0.85	−1.90†	**1.87†**	**1.69†**	−0.23
Thailand	2,295	**5.96***	**10.85***	**9.43***	**8.50***	**8.20***	−5.85*	**3.67***	**2.60***	−8.57*
Venezuela	189	**1.98†**	**4.61***	**4.51***	**3.08***	**2.87***	−2.26†	**2.26†**	**2.16†**	−3.13*

* denotes significance at the 1% level;
† denotes significance at the 5% level.

the 23 markets. However, including the LOT measure clearly shows reduced power in explaining the spread plus commission costs. This is exemplified by the last column in Table 4, which shows Amihud's measure is never significant against the comparison regression containing Roll's measure, turnover, and the LOT measure. This is also found using the Stoll (2000) liquidity determinants.

4.3. Factor analysis

An open issue in the microstructure literature of equity markets is the role of common cross-firm variations in liquidity. Chordia et al. (2000) and Hasbrouck and Seppi (2001) find suggestive evidence of weak commonality in quoted liquidity. To generalize the results across all 31 emerging markets, I factor analyze the various liquidity measures. The measures of liquidity presented in this study can be regarded as empirical proxies for different aspects of liquidity. I augment the four proxies with a fifth measure used in literature, the Amivest measure, which is an estimate of market depth.[9] Roll's measure can be regarded as a proxy for the effective spread; Amihud's measure, price impact; Amivest measure, market depth; and, turnover, relative trading frequency. The LOT measure, by including the informed trader's reservation price, can be regarded as a general liquidity cost estimate encompassing some portion of each liquidity component. But, as Amihud (2002) notes, it is doubtful that a single measure captures all these liquidity aspects. The factor analysis provides some indication whether a single liquidity factor is being captured by any, or all, of these liquidity estimators.

I factor analyze five liquidity measures across all 31 emerging markets using maximum likelihood factor analysis, as opposed to using principal components, because maximum likelihood factor estimates are independent of the scale of the measurement. (These issues notwithstanding, similar results for determining the number of factors are found using principal components.) Thus, the maximum likelihood estimates of factor loadings for a given variable are proportional to the standard deviation of that variable. This is particularly important for these liquidity estimators because of the scale differences that quickly arise for each estimator and the importance I place on the factor loadings.

The first three eigenvalues are presented to determine how many factors are required to explain the variation in the five liquidity estimators. The factor loadings for each liquidity estimator explain which liquidity estimator(s) is more correlated with the dominant factor(s). A rule of thumb is to retain factors until the sum of the eigenvalues is asymptotic. This is usually reached if the first eigenvalue is much greater than one and the second eigenvalue is much less than one. As a practical matter, this is determined if the ratio of the first, largest eigenvalue and the next largest eigenvalue is much greater than one. Finally, I present the percentage of the total variance explained by the dominant factor(s). The results are in Table 5.

As shown in Table 5, in 19 of the 31 emerging markets, a single factor is sufficient to explain the five liquidity measures. For instance, for the single factor countries such as Brazil, the first eigenvalue is 1.57 and the second eigenvalue is 0.18. This implies that 90% [1.57/(1.57 + 0.18)] of the common variance of all five liquidity measures is explained by the first factor. (The last eigenvalue could be negative

[9]The Amivest measure is defined as $\sum_{t=1}^{Q} volume_t / \sum_{t=1}^{Q} |R_t|$. Daily prices and volume are summed to obtain the quarterly estimate. If a zero return occurs on day t, then the Amivest measure is left undefined for that day. Only valid observations are used in the quarterly liquidity estimate. This limitation leaves the Amivest measure potentially inestimable for almost half of the days in a quarter for some countries.

Table 5
Maximum likelihood factor analysis
Five liquidity measures are factor analyzed from the years 1991 to 2000 with the first three eigenvalues presented. The LOT liquidity measure is defined by $\alpha_2 - \alpha_1$. Roll's measure is based on the serial autocorrelation of daily security returns. Amihud's measure is defined as $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$. Turnover is defined as $1/D_q \sum_{t=1}^{Q} volume_t/shares\ outstanding$. The Amivest ratio is defined as $\sum_{t=1}^{Q} volume_t / \sum_{t=1}^{Q} |R_t|$. Eigenvalues represent the amount of variance accounted for by that factor. If the ratio of the largest eigenvalue to the second eigenvalue is greater than one, then a single factor is sufficient to explain most of the variance in the five liquidity measures. If this ratio is less than one, then more than one factor is necessary to explain the variance in the five factors. The factor loadings provide the correlation between each liquidity measure and the dominant factor(s). If two factors are dominant, then the second line reports the loading for that factor. The dominant liquidity measure(s) for each significant factor exhibits the highest factor(s) loading and is indicated by bold type. Significance of the each liquidity measure is denoted if the loading is at least 55%. This ensures that the liquidity variable explains at least 30%, or the square of the loading, of the eigenvalue. The last column contains the percentage of the total variation explained by the dominant factor(s). N is the sample size in firm-quarters

Country	N	Eigenvalues			Factor loadings on dominant factor(s)					Percent
		First	Second	Third	Roll	LOT	Amihud	Amivest	Turnover	variance explained
Argentina	1,142	1.95	1.57	0.05	−0.01	0.01	−0.02	**0.99**	**0.97**	39.00
					0.29	**0.99**	**0.71**	−0.03	0.00	31.40
Brazil	807	1.57	0.18	0.01	0.47	**0.92**	0.48	−0.05	0.25	31.40
Chile	3,136	1.61	0.16	0.00	0.45	**0.99**	0.51	−0.16	0.01	32.30
China	12,198	1.20	0.02	0.00	0.43	**0.90**	0.49	0.01	−0.01	24.00
Colombia	450	1.43	1.08	−0.06	0.02	−0.04	0.02	**0.99**	**0.58**	28.60
					0.46	**0.89**	0.39	−0.10	0.08	21.60
Czech Republic	1,479	1.62	0.71	−0.08	−0.00	−0.09	−0.06	**1.00**	**0.78**	32.40
Cyprus	388	1.11	0.47	0.06	0.41	**1.00**	0.34	−0.01	−0.05	22.20
Egypt	683	1.57	0.15	0.02	0.25	**1.00**	**0.55**	−0.25	−0.05	31.40
Greece	5,968	2.00	0.75	0.10	−0.08	**0.72**	**0.87**	−0.26	−0.23	40.00
Hungary	619	1.66	1.48	−0.05	−0.05	−0.06	−0.03	**1.00**	**0.78**	33.20
					0.56	**0.92**	0.54	0.01	0.02	29.60
India	10,218	1.68	0.16	−0.09	**0.58**	**0.80**	**0.84**	−0.09	−0.04	33.60
Indonesia	4,043	1.79	1.22	0.08	**0.71**	**0.99**	**0.55**	−0.08	0.07	35.80
					0.08	−0.05	−0.08	0.53	**0.97**	24.40
Israel	2,058	1.77	0.09	0.00	0.52	**0.96**	0.52	0.09	−0.08	35.40
Korea	26,721	1.00	0.46	−0.03	0.35	**0.95**	0.42	−0.05	0.00	20.00
					0.13	−0.01	−0.01	0.49	**0.61**	9.20
Malaysia	13,269	1.28	0.51	−0.07	0.37	**0.87**	**0.56**	−0.05	−0.03	25.60
Mexico	2,184	1.46	0.83	−0.52	0.01	0.05	0.00	0.44	**1.00**	29.20
					0.40	**0.89**	**0.58**	−0.12	0.00	16.60
Morocco	383	1.42	1.05	−0.16	**0.65**	**0.76**	**0.57**	−0.28	0.11	28.40
					−0.04	0.02	−0.10	0.51	**0.89**	21.00
Pakistan	2,041	1.67	0.11	−0.04	0.50	**0.92**	**0.75**	−0.12	−0.03	33.40
Peru	1,114	1.31	1.02	0.01	0.34	**0.99**	0.42	−0.13	0.02	26.20
					−0.04	0.04	−0.02	**0.99**	0.58	20.40
Philippines	3,694	1.58	0.14	−0.01	0.53	**0.99**	0.53	0.07	0.02	31.60
Poland	1,529	0.92	0.38	−0.06	0.28	0.51	**0.69**	−0.23	0.22	18.40
Portugal	1,172	1.60	0.09	0.07	0.47	**0.90**	**0.74**	−0.16	−0.05	32.00
Russia	338	1.64	0.80	−0.07	0.46	0.31	0.53	−0.40	**0.78**	32.80
					0.40	**0.67**	0.33	0.33	0.32	16.00

Table 5 (*continued*)

Country	*N*	Eigenvalues			Factor loadings on dominant factor(s)					Percent
		First	Second	Third	Roll	LOT	Amihud	Amivest	Turnover	variance explained
Singapore	7,225	1.72	1.24	0.01	**0.61**	**0.96**	**0.62**	−0.06	0.04	34.40
					0.13	−0.02	−0.14	**0.59**	**0.92**	24.80
South Africa	6,441	1.64	0.27	−0.03	0.51	**0.94**	**0.67**	−0.03	−0.01	32.80
Sri Lanka	2,572	1.42	0.17	−0.02	0.46	**1.00**	0.43	−0.08	0.01	28.40
Taiwan	11,909	1.10	0.09	−0.00	0.34	**0.95**	0.27	−0.08	0.02	22.00
Thailand	10,380	2.12	1.20	−0.08	**0.59**	**0.89**	**0.65**	−0.07	0.02	42.40
					0.04	−0.12	−0.06	**0.57**	**0.95**	24.00
Turkey	5,230	1.35	0.11	0.03	0.23	**0.97**	**0.56**	−0.11	0.11	27.00
Venezuela	512	1.02	0.88	−0.03	0.24	**0.92**	0.31	−0.10	0.06	20.40
					0.09	−0.13	−0.18	**0.57**	**0.71**	17.60
Zimbabwe	1,246	1.60	0.10	−0.02	**0.73**	**0.77**	**0.65**	−0.18	−0.01	32.00
All countries	140,800	1.19	0.01	−0.01	0.46	**0.97**	0.38	−0.01	0.01	23.80
NYSE/Amex	84,834	1.98	0.26	0.01	**0.82**	**0.97**	**0.59**	−0.16	0.01	39.60

because the reduced correlation matrix of the maximum likelihood technique perhaps is not positive semidefinite.) In addition, for Brazil, 31.40% [1.57/5] of the total variation in the five liquidity measures is explained by a single factor and that single factor is 92% correlated with the LOT measure.

The factor loadings, detailing which liquidity measure(s) is more correlated with the dominant factor(s), are presented in bold type. Significance of the liquidity measure is indicated if the loading is greater than 55%. This requires that the liquidity variable explain at least 30%, or the square of the loading, of the eigenvalue.

The consistent result for each of the emerging markets is that the LOT measure and Amihud's measure are more highly correlated with the dominant factor(s) than the other remaining liquidity measures and that turnover is distinctly different from Roll's measure, the LOT measure, or Amihud's measure. Within single factor countries, with the exception of the Czech market, turnover never dominates Roll's measure, the LOT measure, or Amihud's measure. Among dual factor countries, the grouping of Roll's measure, the LOT measure, and Amihud's measure load together while the Amivest measure and turnover load on the second factor. The results suggest that turnover measures a liquidity component distinctly different from that measured by either Roll's measure, the LOT measure, or Amihud's measure.

Combining all emerging markets together shows that a single factor explains much of the common variance of all five liquidity estimates and that the LOT liquidity estimate is more highly correlated with that factor than are the competing liquidity measures. For comparative purposes, the NYSE and Amex market is presented in the final row of Table 5. As shown, even in the U.S. market, a single factor dominates but with significant loadings on Roll's measure, the LOT measure, and Amihud's measure.

The majority of the emerging markets that require two factors to represent the five liquidity variables are civil law countries. The exceptions to this general civil law classification are Singapore and Thailand, as well as those countries not classified as either code law or civil law by La Porta et al. (1998), i.e., Hungary, Morocco, and Russia. Additionally, the dominant factors identified for each country appear dependent on legal origin. For instance, the code law countries of India, Pakistan, Singapore, South Africa, Thailand, the United States, and Zimbabwe all load on the Roll measure, the LOT measure, and Amihud's measure, whereas the civil law countries typically load on a single factor, usually the LOT estimate or Amihud's measure. Thus, the factors could proxy for either legal origin or related variables such as political risk, insider trading enforcement, or judicial system.

5. Determinants of emerging market liquidity

La Porta et al. (1998) assert that differences in investor protection may be attributed to the legal origin of a country. They argue that legal rules protecting investors from expropriation by insiders shape the small investors' willingness to participate in equity markets. Countries with weak investor protections limit investor participation narrowing the capital markets and concentrating ownership (reducing the float). They divide the world into two basic legal origin categories: code law and civil law. Code law countries are of English origin; civil law countries are of French or German origin. La Porta et al. (1997) find French/civil law countries have the weakest investor protections (rule of law) and the least developed capital markets compared with English/code law countries. Bhattacharya and Daouk (2002) link the existence and enforcement of insider trading laws to liquidity, reasoning that liquidity providers increase the spread to protect themselves from insiders. The tradition for the rule of law is fostered by the presence of stable political institutions that protect investors from government expropriation.

The enforcement of legal rules also affects information risk through the regulation of insider trading. The prospect of more insider trading increases the spread because of greater adverse selection. The lack of insider trading laws or the lack of specific enforcement of insider trading rules increases the information risk that is borne by the market maker resulting in larger spreads. Political risk also plays a potentially substantial role in the liquidity of emerging markets. Political institutions that do not control corruption, do not provide stable government through popular support, or do not protect against expropriation (of investment) reduce the capital available to the market and to market makers and increase the costs of trading by reducing the depth of the market. The conjecture is that cross-sectional differences and time-series changes in legal rule enforcement and political risk would result in cross-sectional liquidity effects.

Each country is grouped into French/civil law and English/code countries using dummy variables, zero for French/civil law countries and one for English/code law countries, based on the La Porta et al. (1998) classifications to examine the influence of legal origin on liquidity. However, focusing on code law and civil law

classifications limits the analysis to only 22 countries. In addition, I examine the effect of insider trading using the results of Bhattacharya and Daouk (2002), the rule of law using the results of La Porta et al. (1997), and political risk on liquidity levels. Political risk measures are obtained from the International Country Risk Guide (ICRG).[10] Table 6 presents the results using a country random effects model. This specification adjusts the variance for country-level cross-correlation due to common omitted factors within each country. The use of a random effects specification, as opposed to a fixed effects regression, is required because of the lack of variation for the institutional variables within each country. As with the prior regressions, both the LOT model and Amihud's model estimates are presented for robustness with significant coefficients shown in bold type. The results are presented with specific controls for firm-level liquidity characteristics of price, volume, volatility, and market capitalization for each regression. The first panel reports the liquidity levels based on the LOT estimate, while the last panel reports the liquidity levels based on Amihud's measure. These two measures have been shown to reflect the majority of the variation among the various liquidity measures used in emerging markets.

As shown in Table 6, the code law dummy variable, indicating increased trading costs for French/civil law countries compared with English/code law countries, as well as the insider trading variable is negative but insignificant. These results are consistent in sign with those of Bhattacharya and Daouk (2002) who use turnover as a liquidity proxy, but who do not control for country effects. (An OLS specification results in negative and significant insider trading coefficients for both the LOT and Amihud's measure.) The rule of law variable (judicial), is negative and significant in the LOT liquidity regressions but falls from significance in the Amihud liquidity measure regressions. Similar results are obtained excluding the code dummy variable in each regression.[11] I would predict that trading costs, based on the LOT measure, are 80 basis points lower for countries with a better tradition for the rule of law.

Extending the results to political risk shows that trading costs, based on the LOT measure, decrease by 10 basis points, and price impact costs decrease by 1.7% for countries and times of increased political stability. Lower tradition for the rule of law and decreased political stability increase trading costs. But, regardless of the liquidity

[10]Quarterly time-series estimates are provided by the PRS Group Inc. for all countries from 1991 to 2000. The political risk measure is an amalgamation of 12 country elements and ranges from zero to 100. A smaller political risk measure indicates increased political risk. However, a portion of the political risk index contains a judicial component and is therefore highly correlated with the La Porta et al. (1998) rule of law index. For this study, the correlation is 69% and is likely to cause multicollinearity in regression results. For this reason, separate law and order index regressions as well as separate political risk index regressions are run.

[11]Using an OLS-based regression shows that for either the LOT measure or Amihud's measure trading in French/civil law countries is more expensive than is trading in English/code law countries consistent with La Porta et al. (1998). The LOT-based liquidity measure predicts an increase of 50 basis point in trading costs in French/civil law countries relative to English/code law countries, while Amihud's measure predicts an increased price impact effect trading in French/civil law countries relative to English/code law countries. The liquidity cost advantage of code law countries persists even after including the political institution variables of insider trader enforcement, rule of law (judicial) and political risk. This is found for both the LOT measure and Amihud's measure.

Table 6
Legal origin and political institution random effects tests

Country random effects regression coefficients are reported for quarterly liquidity measures on each of the institutional risk measures and firm liquidity characteristics for 22 emerging markets that are classified as either code law or civil law by La Porta et al. (1998). Code is a variable set to zero for French/civil law countries and is set to one for English/code law countries. Inside refers to the enforcement of inside trading laws and is assigned a zero for the years prior to and including the enforcement date and a one thereafter, consistent with Bhattacharya and Daouk (2002). Judicial refers to the efficiency of the judicial system as reported by La Porta et al. (1997). A zero to ten scale is used in which lower numbers indicate less tradition for law and order. Political risk refers to the political risk rankings provided by International Country Risk Guide (ICRG). Lower political risk rankings indicate reduced political stability. The liquidity measures are the LOT measure, derived from Lesmond et al. (1999), and Amihud's measure. Amihud's measure is defined by $1/D_q \sum_{t=1}^{Q} |R_t|/(price_t * volume_t)$. The firm liquidity characteristics are price, volume, daily return volatility, and market capitalization. Price, volume, and market capitalization are natural log scaled. There are 842 observations per regression

Variable	LOT liquidity estimate							Amihud liquidity measure						
	Code	Insider	Judicial	Political	Without political	Without judicial	All	Code	Insider	Judicial	Political	Without political	Without judicial	All
Intercept	0.126*	0.118*	0.159*	0.123*	0.158*	0.123*	0.152*	13.898*	13.409*	13.034*	13.877*	12.930*	13.897*	12.834*
	(5.89)	(5.52)	(6.59)	(6.28)	(6.01)	(5.64)	(5.87)	(9.00)	(8.63)	(7.56)	(9.26)	(6.89)	(8.51)	(6.81)
Code law	−0.004				−0.006	−0.003	−0.004	−0.370				−0.314	−0.322	−0.268
	(0.36)				(0.54)	(0.25)	(0.40)	(0.59)				(0.49)	(0.50)	(0.42)
Insider		−0.002			−0.001	−0.001	−0.001		−0.104			−0.107	−0.059	−0.072
		(0.71)			(0.61)	(0.33)	(0.25)		(0.60)			(0.31)	(0.34)	(0.41)
Judicial			**−0.008***		**−0.008***		**−0.005†**			0.116		0.119		0.189
			(2.84)		(2.79)		(2.07)			(0.73)		(0.73)		(1.13)
Political risk				**−0.001***		**−0.001***	**−0.001***				**−0.017†**		**−0.017†**	**−0.019†**
				(5.43)		(5.36)	(5.05)				(2.09)		(2.04)	(2.22)
Price	−0.002	−0.002	−0.002	−0.003†	−0.002	−0.003†	−0.003*	−0.154	−0.156	−0.147	0.187†	−0.158	−0.193†	0.191†
	(1.44)	(1.49)	(1.55)	(2.48)	(1.64)	(2.50)	(2.56)	(1.86)	(1.88)	(1.77)	(2.21)	(1.87)	(2.26)	(2.25)
Volume	−0.003*	−0.003*	−0.002*	−0.002*	−0.002*	−0.002*	−0.002*	−0.593*	−0.592*	−0.594*	−0.585*	−0.595*	−0.585*	−0.587*
	(3.35)	(3.33)	(3.24)	(2.99)	(3.24)	(2.99)	(2.98)	(10.27)	(10.26)	(10.29)	(10.13)	(10.28)	(10.12)	(10.16)
Volatility	19.932*	20.031*	19.889*	19.555*	19.974*	19.599*	19.575*	523.526*	529.090*	524.620*	510.161*	531.196*	514.164*	516.395*
	(29.27)	(28.85)	(29.22)	(28.97)	(28.77)	(28.44)	(28.40)	(9.59)	(9.53)	(9.61)	(9.32)	(9.55)	(9.21)	(9.24)
Market capitalization	0.001	0.001	0.002	0.000*	0.001	0.001	0.000	−0.191†	−0.175†	−0.186†	−0.144	−0.172†	−0.138	−0.127
	(1.63)	(1.26)	(1.59)	(0.24)	(1.33)	(0.20)	(0.05)	(2.52)	(2.21)	(2.45)	(1.83)	(2.16)	(1.68)	(1.53)

* denotes significance at the 1% level;
† denotes significance at the 5% level.

measure used or how the institutional variables are incorporated into the regression, only political risk appears consistently associated with the level of liquidity costs. Firms originating from countries with improved political stability have lower liquidity costs. These political costs appear to dominate the code law/civil law classifications and the institutional variables of insider trading and rule of law.

6. Conclusions

Using five common liquidity measures, this study analyzes the efficacy of these estimators in measuring firm-level liquidity, both within and across countries, using 31 emerging markets. The liquidity estimators considered are Roll's measure (Roll, 1984), the Amivest measure (Amihud et al., 1997), Amihud's measure (Amihud, 2002), turnover, and the LOT measure (Lesmond et al., 1999). I test these measures against the quoted bid–ask and find that liquidity costs vary appreciably across emerging markets. Using the bid–ask spread as a basis, liquidity costs range from 1% for the Taiwanese market to over 47% for the Russian market. The magnitude and cross-country dispersion of liquidity costs highlights the importance that liquidity plays on market efficiency tests, home bias influences, asset pricing concerns, and cross-listing effects.

Overall, the results indicate that each measure has strengths and weakness when used to assess cross-country or within-country liquidity. Cross-country differences in liquidity are best reported using the price based models of Lesmond et al. (1999) and Roll (1984). The LOT measure is over 80% correlated with the underlying cross-country bid–ask spread, while Roll's measure is over 49% correlated with the underlying cross-country bid–ask spread. The volume-based models of Amihud and turnover are downward biased for low liquidity markets. This downward bias is practically manifested by reduced trading volume that specifically affects turnover and by zero returns that specifically affects Amihud's measure. However, within-country correlations show the LOT measure and Amihud's measure are, on average, 50% correlated with each country's bid–ask spread. Turnover is insignificantly correlated with the underlying bid–ask spread in 60% of the markets tested.

Tests of each measure's efficacy in representing the within-country bid–ask spread is further tested using a variety of methods encompassing regression analysis, factor analysis, and a likelihood ratio test. The findings indicate that the LOT measure and Amihud's measure dominate Roll's measure and turnover. Factor analysis indicates that in almost half of the 31 markets, a single factor represents the common variation in all of the liquidity measures examined. This single factor appears most correlated with the Lesmond et al. (1999) estimate and, to a lesser extent, Amihud's measure. However, the ubiquitous turnover measure does not appear to be related to any of the common variation in any of the other measures. These results cast significant doubt on the use of turnover as a viable liquidity measure in emerging markets, either in assessing cross-country or within-country liquidity.

Examining the impact of legal and political institutions on emerging market liquidity reveals that macro-level institutions strictly dominate the civil law/code law

classifications of La Porta et al. (1998), the legal enforcement issues of Bhattacharya and Daouk (2002), and, to a lesser extent, the traditions for the rule of law as prescribed by La Porta et al. (1997). The economic significance of political risk in promoting market liquidity is underscored by results that show trading costs, based on the LOT measure, decrease by 10 basis points, and price impact costs decrease by 1.7% for countries and times of increased political stability. In addition, liquidity costs, based on the LOT measure, are 80 basis points lower for countries with a better tradition for the rule of law. The impact of weak political institutions can potentially affect equity valuation and the cost of capital. Because a market's liquidity is a manifestation not of its history, but of its extant political institutions, to improve the liquidity of a market requires improving the country's political institutions as well.

Appendix A. Commissions and fees

The commissions and fees are given in Table A.1.

Table A.1
Commissions and fees
Capital gains tax, other taxes and fees, and commissions are gathered from the *Bloomberg Terminals* and various exchanges. Capital gains tax refers to taxes accruing to foreigners holding stocks. Other taxes and fees refer to ancillary costs with VAT referring to value added tax and GST referring to government services tax. Commissions are stated as ranges representative of the costs that can accrue to traders based on the volume of trade (on volume), on the price of the stock (on value), or on the broker's discretion (negotiable). Variable commissions are costs dependent on the type of stock traded on that exchange. Exchange dependent commission costs refer to costs that vary depending on the exchange on which security is traded. N/A refers to exchange data that are unavailable. Local currency abbreviations are the Cyprus pound (CYP), Czech Republic koruna (CZK), Indian rupee (INR), Indonesian rupiah (IDR), Malaysian ringgit (RM), National Taiwan dollar (NTD), Portuguese Escudo (PTE), Sri Lanka rupee (LKR), Zimbabwe dollar (ZWD)

Country	Capital gains tax	Other taxes and fees	Commissions
Latin America			
Argentina	Exempt	0.18% exchange and market	Fully negotiated
Brazil	Exempt	0.05% transaction and clearing	0.5–2.0% (on volume), negotiable
Chile	15%	0.5% (on volume) 18% VAT of commissions	0.35–1.0% (on value)
Colombia	Exempt	None	0.25–1.0%, fully negotiable
Mexico (foreign)	Exempt	None	Retail: 1–1.7% (on value) Institutions: Flat 0.8%, negotiable
Peru	Exempt	None	0.01–0.15% (on value)
Venezuela	30%	1% exchange fee, seller only	Variable, determined by brokers

Table A.1 (*continued*)

Country	Capital gains tax	Other taxes and fees	Commissions
East Asia			
China (foreign)	Exempt	0.18% exchange and market	0.81–1.05% (exchange dependent)
Korea	10–25%	0.45% securities transaction	0.4–0.5% (exchange dependent)
Philippines (foreign)	Exempt	10% VAT of transfer fee 0.5% transaction tax 0.5% transaction fee	1.5% (maximum)
Taiwan	Exempt	0.3%, seller only	NTD 20 minimum, 0.1425%
South Asia			
India	10% long term 30% short term	0.5% stamp duty	INR 25 per trade minimum 0.25–2.5% (whichever is higher)
Indonesia	Exempt	0.1% stock exchange IDR 2000 stamp duty 10% VAT of commissions	1.0%, negotiable
Malaysia	Exempt	0.05% clearing fee RM 200.00 stamp duty 0.46 RM exchange	RM 0.005, trades < RM 0.5 RM 0.01, trades > RM 0.5 < RM 1 1.0%, trades on first RM 500,000 0.75%, next RM 500,000 to RM 2,000,000 0.5%, amount > RM 2,000,000
Pakistan	N/A	N/A	N/A
Singapore	Exempt	0.05% clearing 0.3% stamp duty 30% GST of commissions	0.5–1.0%, (on volume) negotiable
Sri Lanka	15%	0.10 LKR per contract	1.51% < 1 million LKR 1.26% > 1 million LKR
Thailand	Exempt	0.1% stamp duty	50 bhat minimum, 0.5%, negotiable
Europe			
Cyprus	Exempt	None	1.25–1.5%, trades < 1000 CYP 1–1.25%, trades 1001 CYP to 100,000 CYP 0.3–1.0%, trades > 100,001 CYP
Czech Republic	25% short term	0.25% exchange (unquoted stock)	0.9–4%, trades < 10,000 CZK 1–2%, > 10,000 to < 1,000,000 CZK

Table A.1 (*continued*)

Country	Capital gains tax	Other taxes and fees	Commissions
	20–47% long term	0.125% exchange fee (quoted stock)	0.4–0.5%, > 1,000,000 CZK
Greece	Exempt	0.1% clearing and transfer	0.5–1% (on value) 100 drachma minimum
Hungary	Domicile rate		0.5–1.0%, variable
Poland	Exempt	0.2%, seller only	0.9% per US$5,000 transaction 0.8% per US$10,000 transaction 0.6% per US$50,000 transaction
Portugal	10%, short term	0.04% stock market	0.5%, trades < 5 million PTE
	Exempt, long term	6% of commission	0.4%, > 5 Million to < 20 million PTE 0.25%, > 20 million PTE Negotiable, > 50 million PTE
Turkey	Exempt	None	1% maximum, negotiable
Russia	Exempt	0.3% stamp duty 1.5% registration	3.0–5.0% (on value)
Middle-East/Africa			
Egypt	Exempt	None	2 Egyptian pounds minimum 0.5 maximum
Israel	Exempt	None	$5.00 (U.S.) minimum 1.0% maximum, negotiable
Morocco	Exempt	None	Negotiable
South Africa	Exempt	VAT at commission rate	1.4%, trades < 1,500,000 rand
		0.5% marketable security	0.21%, > 1,5000,000 rand
		1.0% stamp duty	15 rand basic charge
Zimbabwe	10%	None	2.0%, trades < 50,000 ZWD 1.5%, > 50,001 ZWD, < 100,000 ZWD 1.0%, < 100,001 ZWD

Appendix B. Vuong likelihood ratio test

Vuong (1989) provides a likelihood ratio test for non-nested model selection to test whether a reference model and comparison model do equally well at explaining the underlying data. The reference model is the LOT measure (Lesmond et al.,1999) or Amihud's measure (Amihud, 2002) and the comparison models are the remaining liquidity measures and the liquidity determinants of Stoll (2000). Each of the comparison models are tested independently against the reference LOT measure or

Amihud's measure with each regression stated as

$$\text{Reference Model}: S + C_j = \theta_0 + \theta_1\ (\text{reference liquidity measure}_j) + \varepsilon_j,$$
$$\text{Comparison Model 1}: S + C_j = \gamma_0 + \gamma_1\ \text{other liquidity measure(s)}_j + \varepsilon_j, \quad \text{and}$$
$$\text{Comparison Model 2}: S + C_j = \gamma_0 + \gamma_1\ \text{price}_j + \gamma_2 \text{volume}_j + \gamma_3 \sigma_j^2 + \gamma_4 \text{size}_j + \varepsilon_j,$$

where $S + C_j$ refers to the average, proportional bid-ask spread plus commission cost for each firm-quarter j within each country. The comparison liquidity measures are Roll's estimate (Roll, 1984), the Amivest measure (Amihud et al., 1997), and turnover. Alternatively, I add either the LOT measure or Amihud's measure depending on the reference model. Price is the average annual daily stock price in local currency, and volume is the average annual daily trading volume. σ^2 is the daily average volatility. Size is the quarterly market capitalization and is defined as the share price times the number of shares outstanding. Share price is measured at the beginning of each quarter, while the number of shares outstanding is measured at the beginning of each year.

The basis of the test is a likelihood ratio of the log likelihood function for the reference model to the log likelihood function for the comparison model. Using R to represent the reference model and C to represent the comparison model:

$$LR_n(\hat{\theta}, \hat{\gamma}) \equiv L_n^R(\hat{\theta}) - L_n^C(\hat{\gamma}) = \sum\nolimits_{i=1}^{n} \log \frac{f(\mathrm{S} + \mathrm{C}|Z_i; \hat{\theta}_n)}{g(\mathrm{S} + \mathrm{C}|Z_i; \hat{\gamma}_n)}, \tag{8}$$

where LR_n is the likelihood ratio function for n firm-quarter observations in each country. Z_i is a vector of m independent standard normal variables, $\hat{\theta}_n$ is the maximum likelihood parameter estimates for the reference model, and $\hat{\gamma}_n$ is the maximum likelihood parameter estimates for the comparison model. The variance of the likelihood ratio is given by Vuong as

$$\hat{\omega}_n^2 = \frac{1}{n} \sum\nolimits_{j}^{n} \left(\frac{1}{2} [\log(\hat{\sigma}_C^2) - \log(\hat{\sigma}_R^2)] + \frac{1}{2} \left[\frac{\varepsilon_{C,j}^2}{\hat{\sigma}_C^2} - \frac{\varepsilon_{R,j}^2}{\hat{\sigma}_R^2} \right] \right) - \left[\frac{1}{n} LR_n \right]^2, \tag{9}$$

where ε is the residual using the fitted parameters for either the LOT regression case or the comparison model case. Vuong shows that the likelihood ratio statistic converges to a normal distribution:

$$\text{Under } H_0 : n^{-1/2} \frac{LR_n(\hat{\theta}_n, \hat{\gamma}_n)}{\hat{\omega}_n^2} \xrightarrow{\mathrm{D}} \mathrm{N}(0, 1). \tag{10}$$

The resultant test statistic is stated as

$$Z = \frac{1}{\sqrt{n}} \frac{LR_n(\hat{\theta}_n, \hat{\gamma}_n)}{\hat{\omega}_n}. \tag{11}$$

A one-sided Z-statistic tests whether either of the reference models, the LOT measure or Amihud's measure, is more highly associated with the underlying $S + C$ cost than the comparison model(s). The test is directional, given by a positive or negative Z-statistic, indicating which model is more highly associated with the

underlying $S+C$ cost. A positive and significant Z-statistic indicates that the reference measure is more highly associated with the underlying $S+C$ cost than the comparison measure(s). A negative and significant Z-statistic indicates the comparison measure is more highly associated with the underlying $S+C$ cost.

Alternatively, the Z-statistic can be obtained from a linear regression if the log ratio is defined at every quarter j as

$$m_j = \frac{1}{2}\log\left[\frac{\hat{\sigma}_C^2}{\hat{\sigma}_R^2}\right] + \frac{1}{2}\left[\frac{\varepsilon_{C,j}^2}{\hat{\sigma}_C^2} - \frac{\varepsilon_{R,j}^2}{\hat{\sigma}_R^2}\right]. \tag{12}$$

Vuong states that a useful abstraction of the test statistic in Eq. (12) " $\frac{1}{\sqrt{n}}\frac{LR_n(\hat{\theta}_n,\hat{\gamma}_n)}{\hat{\omega}_n}$ is numerically equal to $[(n-1)/n]^{1/2}$ times either the usual t-statistic on the constant term in a linear regression of m_j on only the constant term, or the usual t-statistic on the coefficient of m_j in a linear regression of one on m_j (p. 318)." Stated another way, the Z-statistic can be obtained by regressing m_j on unity and multiplying the t-statistic from this regression by $[(n-1)/n]^{1/2}$. This is the procedure employed in the paper.

References

Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. Journal of Financial Markets 5, 31–56.

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid–ask spread. Journal of Financial Economics 17, 223–249.

Amihud, Y., Mendelson, H., Lauterbach, B., 1997. Market microstructure and securities values: evidence from the Tel Aviv Stock Exchange. Journal of Financial Economics 45, 365–390.

Bailey, W., Jagtiani, J., 1994. Foreign ownership restrictions and stock prices in the Thai capital market. Journal of Financial Economics 36, 57–88.

Bekaert, G., Harvey, C., 1995. Time-varying world market integration. Journal of Finance 50, 403–444.

Bekaert, G., Harvey, C., 1997. Emerging equity market volatility. Journal of Financial Economics 43, 29–78.

Bekaert, G., Urias, M., 1996. Diversification, integration, and emerging market closed end funds. Journal of Finance 51, 835–869.

Bekaert, G., Harvey, C., Lundblad, C., 2003. Liquidity of emerging markets: lessons from emerging markets. Unpublished working paper. Duke University, Durham, North Carolina.

Benston, G., Hagerman, R., 1974. Determinants of the bid–asked spread in the over-the-counter market. Journal of Financial Economics 1, 353–364.

Berkman, H., Eleswarapu, V., 1998. Short-term traders and liquidity: a test using Bombay Stock Exchange data. Journal of Financial Economics 47, 339–355.

Bhattacharya, U., Daouk, H., 2002. The world price of insider trading. Journal of Finance 57, 75–108.

Brennan, M., Subrahmanyam, M., 1995. Investment analysis and price formation in securities markets. Journal of Financial Economics 38, 361–381.

Chordia, T., Roll, R., Subrahmanyam, A., 2000. Commonality in liquidity. Journal of Financial Economics 56, 3–28.

Cohen, K., Ness, W., Okuda, H., Schwartz, R., Whitcomb, D., 1976. The determinants of stock returns volatility: an international comparison. Journal of Finance 31, 733–740.

Coval, J., Moskowitz, T., 1999. Home bias at home: local equity preference in domestic portfolios. Journal of Finance 54, 2045–2073.

Dahlquist, M., Robertsson, G., 2001. Direct foreign investment institutional investors, and firm characteristics. Journal of Financial Economics 59, 413–440.

De Roon, F., Nijman, T., Werker, B., 2001. Testing for mean-variance spanning with short sale constraints and transaction costs: the case of emerging markets. Journal of Finance 56, 721–742.

Domowitz, I., Glen, J., Madhavan, A., 1998. International cross-listing and order flow migration: evidence from an emerging market. Journal of Finance 53, 2001–2028.

Domowitz, I., Glen, J., Madhavan, A., 2000. Liquidity, volatility, and equity trading costs across countries over time. Unpublished working paper. Penn State University, College Station, Pennsylvania.

Eleswarapu, V., Venkataraman, K., 2003. The impact of legal and political institutions on equity trading costs: a cross-country analysis. Unpublished working paper. Southern Methodist University, Dallas, Texas.

Fama, E., 1991. Efficient capital markets: II. Journal of Finance 46, 1575–1617.

Foerster, S., Karolyi, A., 1999. The effects of market segmentation and investor recognition on asset prices: evidence from foreign stocks listing in the United States. Journal of Finance 54, 981–1013.

Froot, K., O'Connell, P., Seasholes, M., 2001. The portfolio flows of international investors. Journal of Financial Economics 59, 151–194.

Harris, L., 1989. A day-end transaction price anomaly. Journal of Financial and Quantitative Analysis 24, 29–45.

Harris, L., 1990. Statistical properties of the Roll serial covariance bid–ask spread estimator. Journal of Finance 45, 568–579.

Harris, L., 1994. Minimum price variation, discrete bid–ask spreads, and quotation sizes. Review of Financial Studies 7, 149–178.

Harvey, C., 1995. The cross-section of volatility and autocorrelation in emerging equity markets. Finanzmarkt und Portfolio Management 9, 134–147.

Hasbrouck, J., Seppi, D., 2001. Common factors in prices, order flows and liquidity. Journal of Financial Economics 59, 383–411.

Jain, P., 2002. Institutional design and liquidity on stock exchanges. Unpublished working paper. Indiana University, Bloomington, Indiana.

Kang, J., Stulz, R., 1997. Why is there a home bias? An analysis of foreign equity portfolios in Japan. Journal of Financial Economics 46, 3–28.

Keim, D., Madhavan, A., 1997. Transaction costs and investment style: an inter-exchange analysis of institutional equity trades. Journal of Financial Economics 46, 265–292.

Kyle, A., 1985. Continuous auctions and insider trading. Econometrica 53, 1315–1336.

La Porta, P., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1997. Legal determinants of external finance. Journal of Finance 52, 1131–1150.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1998. Law and finance. Journal of Political Economy 106, 1113–1155.

Lesmond, D., 1995. Transaction costs and security return behavior: the effect on systematic risk estimation and firm size. Unpublished Dissertation. State University of New York at Buffalo, Buffalo, New York.

Lesmond, D., Ogden, J., Trzcinka, C., 1999. A new estimate of transaction costs. Review of Financial Studies 12, 1113–1141.

Lesmond, D., Schill, M., Zhou, C., 2004. The illusory nature of momentum profits. Journal of Financial Economics 43, 1121–1142.

Levine, R., Schmukler S., 2003. Migration, Spillovers, and Trade Diversion: the Impact of Internationalization on Stock Market Liquidity. No. 9614. National Bureau of Economic Research, Cambridge, MA.

Maddala, G., 1983. Limited Dependent and Quantitative Variables in Econometrics. Cambridge University Press, Cambridge, MA.

Miller, D., 1999. The market reaction to international cross-listing: evidence from Depository Receipts. Journal of Financial Economics 51, 103–124.

Obstfeld, M., Rogoff, K., 2000. The six major puzzles in international macroeconomics: is there a common cause? Unpublished working paper. National Bureau of Economic Research, Cambridge, MA.

Pagano, M., 1989. Trading volume and asset liquidity. Quarterly Journal of Economics 104, 255–274.
Roll, R., 1984. A simple implicit measure of the effective bid–ask spread in an efficient market. Journal of Finance 39, 1127–1139.
Rouwenhorst, G., 1999. Local factors and turnover in emerging markets. Journal of Finance 54, 1439–1464.
Stoll, H., 2000. Friction. Journal of Finance 56, 1–31.
Stoll, H., Whaley, R., 1983. Transaction costs and the small firm effect. Journal of Financial Economics 12, 57–79.
Summers, L., 2000. International financial crises: causes, prevention, and cures. American Economic Review, Papers and Proceedings 90, 1–16.
Vuong, Q., 1989. Likelihood ratio tests for model selection and non-nested hypotheses. Econometrica, 307–333.
White, H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48, 817–838.
White, H., 1982. Maximum likelihood estimation of misspecified models. Econometrica 50, 1–25.
World Bank, 2001. Global Development Finance: Country Tables, The World Bank Group, International Bank for Reconstruction and Development (www.worldbank.org).