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Back from Beyond the Bid-Ask Spread: Estimating Liquidity in International Markets

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Back from Beyond the Bid-Ask Spread: Estimating Liquidity in International Markets [3]

Abstract

Research on the topic of liquidity has greatly benefited from the improved availability of data. Researchers have addressed questions regarding the factors that influence bid-ask spreads and the relationship between spreads and risk, return and liquidity. Intra-day data have been used to measure the effective spread and researchers have been able to refine the concepts of liquidity to include the price impact of transactions on a trade-by-trade analysis.

The growth in the creation of tax-transparent securities has greatly enhanced the visibility of securitized real estate, and has naturally led to the question of whether the increased visibility of real estate has caused market liquidity to change. Although the growth in the public market for securitized real estate has occurred in international markets, it has not been accompanied by universal publication of transaction data. Therefore this paper develops an aggregate daily data-based test for liquidity and applies the test to US data in order to check for consistency with the results of prior intra-day analysis. If the two approaches produce similar results, we can apply the same technique to markets in which less detailed data are available and offer conclusions on the liquidity of a wider set of markets.

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1. Introduction

The development of international stock markets has produced an increasing number of innovations in investment vehicles. In particular, tax-transparent securities for real estate investment have been introduced in a number of stock markets. The arguments for their introduction include enhancing allocative efficiency. However, experience in the US suggests that the development of such vehicles (in particular Real Estate Investment Trusts, i.e. REITs) has also increased liquidity and has therefore contributed to an improved operational efficiency in real estate markets. The availability of trade-by-trade data in the US has facilitated research into the liquidity of trading in REITs but such data are not universally available and it may therefore not be possible to replicate the US research in international markets.

This paper seeks to establish the extent to which the primary results of Clayton and MacKinnon (2000) obtained using intra-day data can be replicated with daily returns. By employing less-finely defined data some information is lost. However, the loss is compensated by the ability to investigate longer periods of time and to address other relevant factors including the separation of size and market influences on liquidity.

We use daily US data over the period 1993 to 2005; a sample period which includes the two years covered by Clayton and MacKinnon (1993 and 1996). An estimating equation based on daily data is derived and then applied to each year within the sample period. Because of the extended period used in this study, we are able to quantify changes in market liquidity over time and also to distinguish between the effect of company size and market. Having shown that our results are consistent with the findings of Clayton and MacKinnon we also examine the UK and Australian markets during the same sample period. The UK was chosen because it had a well developed securities market in property companies prior to the introduction of a REIT vehicle in 2007. Australia was chosen because it was the first international market (following the US) to introduce tax-transparent real estate vehicles (Listed Property Trusts) in 1971.

2. Previous Research

Liquidity has been extensively studied in equity markets. It can be argued that liquidity influences expected returns, either because investors might be prepared to pay a premium for liquid stocks when the market is down (Chordia et al., 2000, 2001) or because, investors might perceive liquidity as a source of additional returns in different phases of markets (Acharya and Pedersen 2005 and Amihud, 2002).

The connection between liquidity and the magnitude of the bid-ask spread is similarly well established; the larger the spread, the more expensive is trading in the stock. This, in turn, implies that investors would be inhibited in exploiting perceived mis-pricing or in making minor adjustments to their portfolio position, resulting in less trading and less liquidity. The connection between liquidity and the bid-ask spread in other stock markets has been demonstrated by Boothe (1988) and Gwilym, Clare and Thomas (1998)[4].

However, the size of the bid-ask spread is but one component of liquidity; Brennan and Subrahmanyam (1996) argue that the spread only accounts for inventory costs, which are thought to be relatively minor compared with other costs of market making. For example, a market lacking depth would result in prices moving away from investors seeking to trade in larger quantities as market makers adjusted their bid-ask prices, even though the spread might remain unchanged (Kyle, 1985). Investors would therefore become aware that trading would be difficult in any large quantities in markets that lacked depth and might require a risk premium to

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[4] See also Capozza et al. (2004), Kluger and Miller (1990) and Chalmers and Kadlec (1998) for research into real estate and other markets.

compensate for this source of risk. In this framework, the bid-ask spread reflects the "tightness" aspect, i.e. the spread is only giving some indication of the costs in a short-term round trip transaction. Studies of the bid-ask spread have therefore assumed away the substantial minority of transactions that have taken place either within the spread or, perhaps for large trades, outside the quoted spread.

3. Derivation of Research Model

In assessing the behavior of stock-liquidity, Clayton and MacKinnon (2000) (hereafter C&M) concentrate their analysis on the change in stock price associated with the size of trade. This was a powerful approach to the problem, enabled by the researchers' access to trade-by-trade data. We start by applying the C&M model to aggregate daily price changes rather than to intra-day price changes.

The C&M model assumes a linear relationship between the change of price between two successive trades and (a) the volume of shares traded and (b) the difference between the direction of successive trades (Brennan and Subrahmanyam, 1996). This latter variable reflects the effective spread – if successive trades are in the same direction (e.g. retail buyer initiated), the computed difference would be zero. However, if the directions were different the variable would be either +2 or -2. The price change would therefore reflect (half) the effective price change between the market maker's bid and offer prices. On the question of volume, their model implies that a large buy order would shift market makers' prices upwards while small orders would have less effect.

Algebraically the price change relationship on a trade-by-trade basis is represented by

$$P_t - P_{t-1} = \lambda I_t Q_t + \phi(I_t - I_{t-1}) + \varepsilon_t \qquad (1)$$

Where: λ = market depth or inverse liquidity parameter

ϕ = the effective cost of the transaction

Q_t = the volume of stock traded, and

I_t = Direction Indicator where:

I_t = 1 for retail investor's initiated buy and

I_t = -1 for retail investor's initiated sell transaction.

In this formulation, the lower the impact of large trades, the more liquid is the market. Thus over time, if the market were to become more liquid and deeper, it would be reflected in a smaller estimatedλ. C&M found that, for their REIT samples in 1993 and 1996, the market was more liquid in 1996 than in 1993. However as shown in equation (1), they were also testing for the effective bid-ask spread by the ϕ parameter. On the whole, they were unable to find evidence that the ϕ parameter changed significantly between 1993 and 1996. C&M also found that changes in liquidity were most obvious in REITs that were, or became, self advised and self managed.

C&M concluded that their study had demonstrated the value of intra-day data and their results advanced the study of liquidity assessment significantly. However, what remains unknown is whether their results derive entirely from the use of the intra-day data or whether the changes in liquidity they document would have been revealed with the aggregated daily data that might be more widely available in other international markets).

In our sample we are using daily returns and daily transaction volume, therefore a natural question is to ask what would happen if we were to take the aggregate of daily trades using the above formulation. Summing equation (1) over the number of trades per day we derive equation (2):

$$\sum_{t=1}^{n}(P_t - P_{t-1}) = \lambda\sum_{t=1}^{n} I_t Q_t + \phi\sum_{t=1}^{n}(I_t - I_{t-1}) + \sum_{t=1}^{n}\varepsilon_t \qquad (2)$$

The LHS of equation (2) equals the price change (or return) over the day. The first variable on the RHS sums to the total net transactions in the day and the second term represents the sum of transactions indicators. Since every transaction apart from the first and last appears twice with the opposite sign, all intermediate transaction indicators cancel except for the first and last. In the absence of new information, the expected daily price change would arise from trade changing direction; that is, the opening trade taking place at the bid (ask) price and the closing trade taking place at the ask (bid) price .

We therefore can rewrite equation (2) as

$$P_{close} - P_{open} = \lambda \sum_{t=1}^{n} I_t Q_t + \phi(I_{close} - I_{open}) + u_t \qquad (3)$$

which reflects the argument that ϕ is the estimated parameter for the difference between the trades that occur between open and close. The λ term indicates the effect of trading volumes on price movements during the course of the day.

To distinguish between market liquidity in response to net sales and purchases we create dummy variables to capture positive and negative price movements which will allow asymmetrical responses to changes in market direction. In addition, since we are using price indices, the absolute changes in prices are replaced by relative price changes in the form of log returns[5]. Our estimated regression therefore takes the form of

$$r_t = \alpha_0 + \alpha_1 Dup + \alpha_2 Ddown + \lambda_0 \sum_{t=1}^{n} Q_t + \lambda_1 Dup \sum_{t=1}^{n} Q_t + \lambda_2 Ddown \sum_{t=1}^{n} Q_t + \varepsilon_t \qquad (4)$$

[5] We also obtained results using price changes and they were not materially different from the ones obtained using log returns and presented here.

where *Dup* and *Ddown* are dummy variables that reflect whether the market price has risen or fallen during the day. In this model, market-wide information that is not accompanied by systematic trading is captured in the constant α_0 and the residual error terms ε_t. The sum of the estimated α coefficients therefore reflects the effective spread for small transactions and corresponds to the $\phi(I_{close} - I_{open})$ term in equation (3). The estimated λ terms reflect the sensitivity of the market to increases in volume. Note that the estimated λ coefficients indicate market depth because a "deep" market (lowλ) would be characterized by the ability to absorb large volumes of trading without excessive price movements. Note also that the first intercept term is not redundant because it reflects the returns on days in which no trade takes place.

In terms of simple market economics, we can envisage a highly elastic demand curve for stock at the current price, some of which is provided by the market maker but the bulk of which is provided by other investors. If the market lacks depth, investors wishing to trade may find that the price has to move more to encourage buyers or sellers to enter the market. Thus, they will face a downward sloping demand curve if they wish to sell and an upward sloping supply curve if they wish to buy. This suggests that additional depth in the market may allow investors to trade without the market price changing. In contrast, information flows may result in price changes without significant trading. We distinguish between upward and downward price movements because of evidence in many markets that liquidity is asymmetrical (see Madhaven and Sofianos, 1998 and Chung et al., 1999). In particular, Escribano and Pascual (2005) show that for the NYSE, the adjustment to trading is not symmetrical but that increased volatility in stock price returns tends to lead to greater symmetry in the bid-ask spread.

The upward and downward price changes are given respectively by equations (5) and (6)

$$r_t = \alpha_0 + \alpha_1 Dup + (\lambda_0 + \lambda_1 Dup)\sum Q_t + \varepsilon_t \tag{5}$$

$$r_t = \alpha_0 + \alpha_2 Ddown + (\lambda_0 + \lambda_2 Ddown) \sum Q_t + \varepsilon_t \qquad (6)$$

The estimated slopes (λ_i) represent the market depth; the smaller the absolute slope, the more liquid is the market and the more stock the market can absorb or supply at a price that does not differ much from the current price. The intercept terms (α_i) provide some insight into the transaction costs in the market since the sum of the absolute values of the α shows the minimum difference between buy and sell orders (see Figure 1). It thus corresponds to the estimate by C&M of the effective spreads cost and we hereafter use the symbol α to refer to the sum of the absolute values of the intercepts.

[INSERT FIGURE 1]

4. US Data

Daily price changes, trading volumes and the market membership of 184 US REITs were obtained from SNL Financials. Bid and ask prices were obtained from Reuters for a smaller sample of US REITs which we use only for comparative purposes.

The bid-ask spread for REIT *i* at time *t* is calculated as follows:

$$SPREAD_{i,t} = \frac{PA_{i,t} - PB_{i,t}}{(PA_{i,t} + PB_{i,t})/2}$$

where $PB_{i,t}$ and $PA_{i,t}$ respectively represent the bid and ask price for company *i* at time *t*.

Table 1 contains descriptive statistics for price changes and trading volumes and shows a fairly consistent growth in numbers of REITs and the trading volume.

[INSERT TABLE 1 HERE]

Throughout the period of study (1993-2005) new REITs were being introduced into the market. Since we were running regressions for each calendar year, we added new companies to the data set only when there were at least 60 data points for the year of entry in order to provide reasonably robust parameter estimates. We report annual average estimates of coefficients, along with the R^2 of the regression and the number of REITs available in that particular year. If all REITs have a full time series for all variables, the maximum number of regressions would be 2,392 for the overall sample (184 REITs * 13 years). Since all 184 REITs are not part of the sample for the entire period, we are able to run only 1,618 regressions. For each year the available number of estimated equations is reported in the last column of Table 2. This column can be compared with the last column of Table 1, which contains the total number of REITs existing in our sample for each year.

5. Observations and Hypotheses

US real estate sector returns are illustrated in Figure 2, which shows the performance of our sample of REITS, relative to the overall equity market. As can be seen, REITs underperformed the S&P 500 from 1995 until early 2000, when REITs were resilient in the face of a fall in the equity market which lasted through 2002. Thereafter, REITs performed similarly to the rest of the equity market until the end of 2005.

[INSERT FIGURE 2 HERE]

In Figure 3 we show reported spreads for REITs from 1991 onwards. Note that spreads peaked in 1993. This result is consistent with the finding of C&M that liquidity increased between 1993 and 1996. In fact, the change appears to have taken place early in that interval because reported spreads fell sharply in 1994.

[INSERT FIGURE 3 HERE]

Previous research has concluded that, after a rise at the end of the 1980s, spreads fell in the 1990s (Nelling et al., 1995). However, it has also been shown that average REITs spreads fell from 1993 to 1996, not because there was a general reduction in REIT spreads, but because new REITs appeared that were more liquid than the existing REITs (see Cole, 1998).

From the previous work and from the above discussion we therefore would expect to observe the following:

Market Depth (λ) from 1993 onward: The estimated slopes on the positive return days should be positive; the slopes on negative return days should be negative. The slopes should become flatter (reflecting increasing market depth and improved liquidity) from 1993 to 1996 and later as the REIT market continued to develop and expand.

Estimated Spreads (α) from 1993 onward: The estimated intercepts on positive (negative) return days should be positive (negative). The estimated (half) spreads should also decrease over time, signaling an improvement in liquidity.

New vs. Old REITs: There should be more liquidity for the new REITs introduced in the post-1993 market.

NYSE vs. other markets: The NYSE should be more liquid than the other markets (ASE and NASDAQ[6]). In exploring this question, we have to deal with the complication that large cap REITs would be expected to be more liquid than small cap REITs and that the market effect might therefore be confused with a size effect. We therefore include in our analysis some further exploration of the size vs. market effects. Ideally, we would like to test whether the NASDAQ effects were different from the other markets but the sample of NASDAQ stocks was insufficiently large to make meaningful comparisons[7].

Effective spreads (α) and reported spreads: The estimates of effective spreads, represented by the sum of the absolute values of the intercepts, from equation (4), would be related to the bid-ask spreads reported by Reuters[8].

6. Regression Results

Before reporting the regression results, we first consider alternative interpretations of the regressions. For example, although we are regressing returns on volume, it might be thought that the direction of influence runs from returns to volume. In support of our interpretation, Clark (1973), Karpoff (1987), Tauchen and Pitts (1983) argue that trading volume proxies for the flow of new information and the level of disagreement between traders (which we identify with market depth). For an interesting extension of their work, see Rodgers et al. (2001).

Notwithstanding the thrust of previous research, as a precautionary step we first conduct Granger causality tests on individual stock returns and trading volume.

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[6] For evidence see Bessembinder and Kaufman (1997); Chan and Lakonishok (1997); Huang and Stoll (1996).

[7] There is another complication with NASDAQ trades in that they may be reported as being two trades if the dealer buys and sells to retail investors. In analysing the effect of volume, this would imply that NASDAQ might seem more liquid than the other markets, but the results would be even more pronounced if the NASDAQ volumes were deflated. So our conclusions would not be affected, NYSE does provide more liquidity.

[8] Glosten and Harris (1998); Lin et al. (1995), Holthausen, Leftwich and Mayers (1987)

The results showed little of significance. Of the 2,762 Granger regression tests, 12.9 percent suggested that daily volume Granger-caused daily returns, while 9.7 percent suggested that daily returns Granger-caused daily volume (at the 95 percent confidence level). Only in 1995, did we find more instances of returns Granger-causing volume (14.8 percent) than volume causing returns (11.5 percent). The Granger-causality results suggest that this was not a dominant issue that affected stock prices in the sample used in this study.

Market Spreads and Market Depth 1993 onward

Table 2 summarizes the results of estimating the regression shown in equation (4) for each year from 1993 to 2005 for our sample of US REITs. Note that over time the intercepts (α) move closer to each other, implying declining spreads in the market over the period. For both positive and negative intercepts the sharpest reduction is from 1993 to 1994, which is consistent with the findings of C&M. For the market depth coefficients (λ) both of the slopes become flatter over the sample period signifying improving market depth. There is some asymmetry in the slopes; the positive slope is generally greater in absolute terms than the negative slope. This implies that retail investors' buying pressure causes more price movement than retail investors' selling pressure. The only two exceptions occur in 2002 and 2004 and by then both upward and downward price sensitivity has declined by more than 50% compared with their values in the 1990s. The slope asymmetry therefore tends to disappear when the market depth improves.

[INSERT TABLE 2 HERE]

Although there is substantial variation among the regression results for each company, the strength of the regressions is clearly indicated by the average adjusted R^2 for the regressions, which are all larger than 55 percent. The daily data are noisy and we would not expect the regressions to explain variation in returns very strongly. We calculated the proportion of significant estimates for this regression and show the results in Table 3. It is interesting to note that in the early part of the sample period, the results were strongly significant in the majority of cases. As time progressed, however, the slopes of the regressions decreased and thus it is not surprising that the proportion of significant parameters also declined.

[INSERT TABLE 3 HERE]

New vs. Old REITs

The next issue we examine is the relative liquidity of the new and old REITs. We first divided our sample into the REITs that existed before 1993 and those that have appeared since that year. We then estimated equation (4) for both samples. The results are reported in the form of differences in intercepts and slopes for new and old REITs. In Table 4, the positive intercepts for new REITs are almost always lower than for older REITs (except in two years when they are equal). In contrast, the negative intercepts are always lower in absolute terms for new REITs, implying smaller effective spreads for new REITs. The slopes of new REITS are also consistently smaller in absolute terms than for old REITs suggesting that the market is deeper for newer REITs.

[INSERT TABLE 4 HERE]

Furthermore, consistent with prior research, we noted that older REITs have shown more variation in liquidity over the sample period. In contrast, new REITs are more liquid and less affected by year-to-year changes in market conditions.

NYSE vs. other markets

The final question we examine for US REITs is the relative liquidity of different markets. As mentioned above, we would have liked to distinguish between the

NASDAQ and other markets. However, we had only 8 stocks quoted on the NASDAQ so instead we divided our sample into NYSE and all other markets and estimated equation (4) for both sub-samples. The estimates conform closely to our expectations (see Table 5). NYSE REITs appear to have lower effective spreads and greater liquidity throughout the period.

[INSERT TABLE 5 HERE]

As mentioned above, we note that large cap REITs would be expected to be more liquid than small cap REITs – see Brounen et al. (2007) for research on the effects of firm size and different markets – and that this effect might confound the market effect. In order to investigate this issue, for the years 2001 to 2005[9], we regress (1) the estimated market depth parameter (λ, the sum of the absolute slopes) and (2) the estimated effective spread (α, the sum of the absolute intercepts), against a market dummy (NYSE=1), firm size (represented by the log of total assets), and the interaction between market and size as follows:

$$\lambda = \beta_o + \beta_1 DNYSE + \beta_2 size + \beta_3 [DNYSE * size] + \eta \quad (7a)$$

$$\alpha = \beta_o + \beta_1 DNYSE + \beta_2 size + \beta_3 [DNYSE * size] + \eta \quad (7b)$$

The results from this estimation are presented in Table 6. Turning first to the regression of market depth (equation 7a), we note that in every year (apart from 2003) NYSE stocks were more liquid than non-NYSE stocks and large stocks were more liquid than small stocks. However the effect of size was not relevant for NYSE stocks because there was no significant difference between the coefficient β_3 and the absolute value of the coefficient β_2[10]**.** In other words, we find that once a REIT is listed on the NYSE, the size of the firm does not matter because the market will guarantee the existence of analysts looking at that company and hence

[9] There were insufficient observations of the non-NYSE REITs before 2001 to include earlier years.

[10] We performed the Wald test and in none of the reported regressions was the difference significant at the 10% level.

its liquidity. This result has also a wider implication for other international markets. If we consider the European example, we may find that (especially small) real estate vehicles in countries with small stock exchanges may decide to list in markets with a better market coverage by analysts (e.g. London, Frankfurt, and Paris). Consequently, in the medium to long term we might speculate on whether a concentration of stocks would trade in the main markets, with less trading in smaller local markets.

[INSERT TABLE 6 HERE]

The effective spread regressions (equation 7b) provide a similar picture. Trading costs are lower for NYSE stocks and for large companies. However, as for market depth, we find that once a REIT is listed on the NYSE, the size of the firm does not matter. More specifically, according to the Wald test, there is no significant difference between the coefficient β_3 and the absolute value of the coefficient β_2 (i.e. REITs traded on the NYSE do not benefit from being large).

To summarize the results of our US analysis, we have shown that the use of aggregate daily data produces results for the 1993 to 2005 period that are consistent with earlier results based on trade-by-trade data. Furthermore, we have distinguished between the effects of market and size factors on liquidity, as well as the declining degree of asymmetry in market depth.

Having demonstrated the robustness of the use of aggregate daily data, we now apply it to two other markets; the UK and Australia. The UK was chosen because it has had a significant sector of quoted real estate securities for a long time period. The Australian market was selected because it was the second country (after the US) to introduce tax-transparent real estate vehicles. We first present the UK results.

7. Application of Model to UK Property Companies

To show the robustness of our liquidity estimation technique, we collected aggregate daily data from the UK market for the 37 major property companies composing the FTSE 350 real estate sector index. From Thomson DataStream we were able to obtain stock prices, daily trading volumes (i.e. sum of the value of transactions taking place on any day) and bid and ask prices at the end of each day. Note that the values are designated in British Sterling so are not directly comparable with the US figures. Our sample starts in the early 1990s just after a period in which real estate had suffered significant losses. The market had recovered by 1993 and subsequently reflected the general cyclical changes in the equity market until the late 1990s. The later period witnessed some shrinkage of the real estate sector as several companies were subject to private equity or management buy-outs. A significant difference in price changes could be observed from 2003 onwards as property companies started to become more attractive than other equities (the index increased from a value of 150 at the end of 2002 to a value of 350 at the end of 2005).

[INSERT FIGURE 4 HERE]

Figure 5 displays average annual spreads for the UK market. Note that there is movement in reported spreads common to both the UK and the US in the early 1990s; spreads fell in the UK market from a high in 1992 to 1994 where they remained with only minor changes for the rest of the period.

[INSERT FIGURE 5 HERE]

Table 7 presents the results from estimating equation (4) on the property companies in the sector for each year in the sample. We observe slightly decreasing intercept dummies, reflecting decreasing effective spreads from 1993 through 2005. The steepness of the slopes (market depth) shows a substantial change between 1993 and 1994 but no clear trend through the rest of the period, although there is a much greater variability than observed for US REITs.

[INSERT TABLE 7 HERE]

8. Application of Model to Australian LPTs

Australian Listed Property Trusts were established in 1971 and now account for more than 10% of the capitalization of the Australian stock market. In recent years, they have experienced both expansion and a wave of mergers and takeovers but their aggregate performance has been better than that recorded by the overall market. In the five year period ending 2005, the sector achieved more than twice the total return of the rest of the market. Figure 6 presents the performance of LPTs over the 1992 – 2005 sample period.

[INSERT FIGURE 6 HERE]

Table 8 presents the results of the estimation of equation (4) for the Australian market. The companies are chosen from the constituents of the Dow-Jones Australian LPT index. Because of mergers and expansions, the number of companies used in the regression fluctuates over the period from a low of 14 in 1993 to a high of 45 in 2000. Data were collected from Thomson Datastream and trading values are designated in Australian $.

The results of the regressions are consistent with those of the UK. There is less evidence of a sharp increase in liquidity at the start of the period and there is no obvious asymmetry in the market effective spreads. The effective spreads showed a tendency to decline only after 1999. There is a persistent asymmetry in the market depth for upward and downward price movements, except in 2002 and

2004 (echoing the results of the US) when liquidity was high and the asymmetry seemed less pronounced.

[INSERT TABLE 8 HERE]

9. Comparison of Reported Spreads and Estimated Effective Spreads.

The results of the analysis using aggregate daily data in the US were shown to be consistent with previous research using trade-by-trade data. Although the regression results reveal changes in the UK and Australian markets, there might appear to be little evidence that the results reflect what had been observed or reported in the two markets. Mindful of this issue, we wanted to compare the estimates from the regressions with publicly available data and the obvious source was reported bid-ask spreads. As mentioned in the data sourcing, we had collected closing bid-ask spreads for a sample of US REITs and we also collected closing bid-ask spreads for the UK and Australian markets.

There is some difficulty with collecting bid-ask spreads because where recorded, they are often taken at the close of trading and may be very noisy equivalents of typical spreads throughout the day. Accordingly we averaged the reported bid-ask spreads for each company-year in order to compare them with the effective spreads estimated in equation (4). We then regressed the effective spread against the reported spread and the results are shown in Table 9.

[INSERT TABLE 9 HERE]

As can be seen, the results are significant – effective spreads estimated from aggregate daily returns are positively related to reported spreads. The weakest relationship is between the US reported spreads and our estimates. This results from two different factors. First, the US market is more liquid than other markets and therefore the effective spread might be less than the reported spread with more transactions taking place within the spread during the day. Second, the sample of REITs for which we were able to collect spreads was smaller than the sample used in the main regression analysis.

The Australian market had the strongest relationship between the two spreads (with an adjusted R-squared of over 90%) but the effective spread actually was greater than the reported spread. This may suggest that the market depth for Australian LPTs is thinner than the market depth for US REITs and UK property companies. Nevertheless, it would appear that the daily return model is capturing information that is to some extent reflected in transaction-level data as well as official spread-based information.

10. Conclusions

Data availability inhibits research on international market microstructure. However, in this paper we develop a simple technique of estimating liquidity using aggregate daily stock price returns that appears to be consistent with the results of previous research obtained using intra-day data. Although we do not argue that our technique is superior to the use of intra-day data, our results are consistent with those of previous research. Moreover, our findings shed light upon the behavior of market liquidity or market depth over the relatively long period since 1993.

More specifically we show that liquidity improved dramatically from 1993 to 1994 in the US REIT sector. As previous researchers have suggested, the improvements resulted largely from the introduction of new REITs. The degree of liquidity is related to both the size of REITs and the market in which their stocks are traded. The NYSE appeared to offer more liquidity than might have been expected; even after controlling for the size of companies traded on the NYSE.

As stock markets around the world introduce REIT-like vehicles, it is important to track the liquidity of the new vehicles. The results presented in this paper suggest that daily returns can be utilized to replicate the results of more detailed studies of trade-by-trade data. We do not claim to offer superior insights into the liquidity of developing markets. However, we conclude that daily data (which is more accessible and manageable than trade-by-trade data) can be used to reveal dynamic changes in market microstructure over a wider range of markets than have so far been studied.

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Appendix 1: Figures

Figure 1: Hypothetical Relationship between Trading Volume and Returns

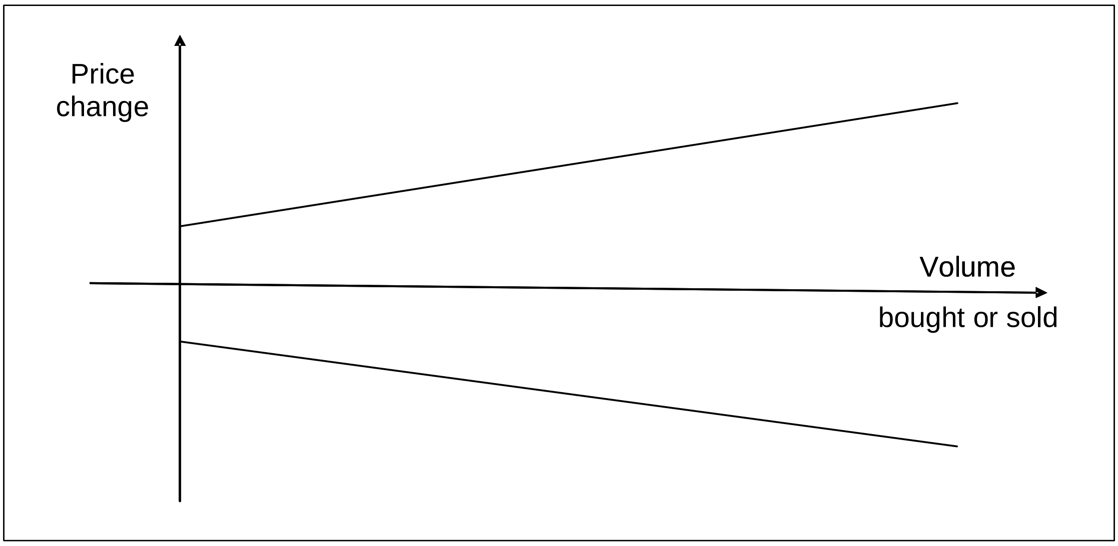
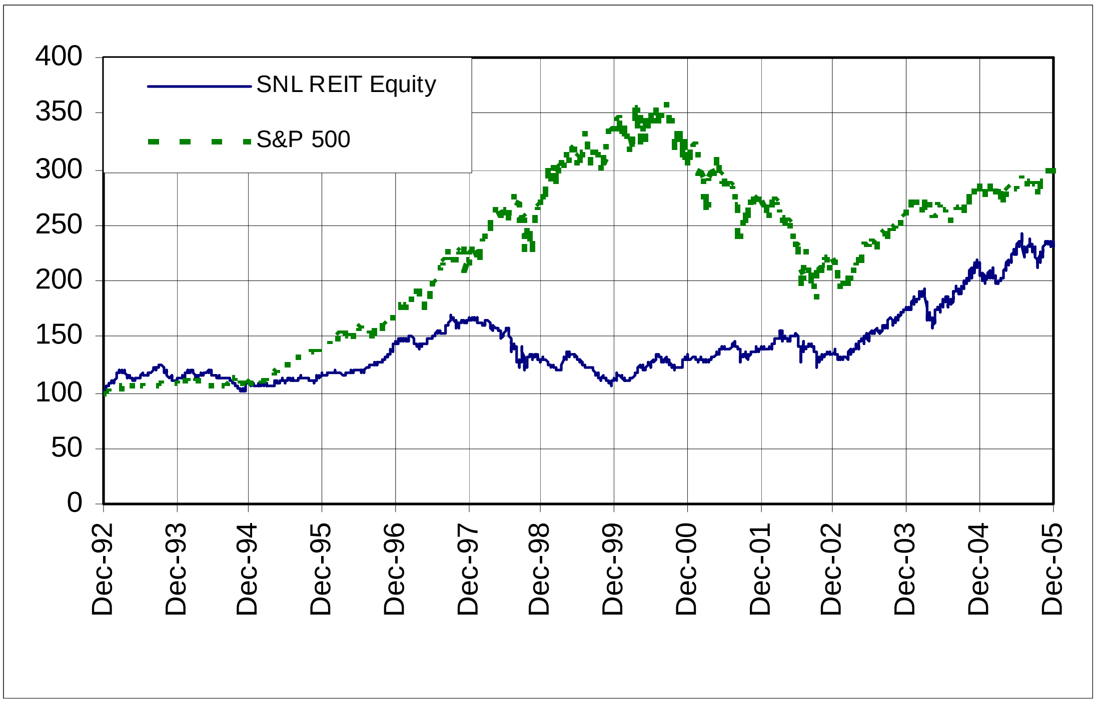
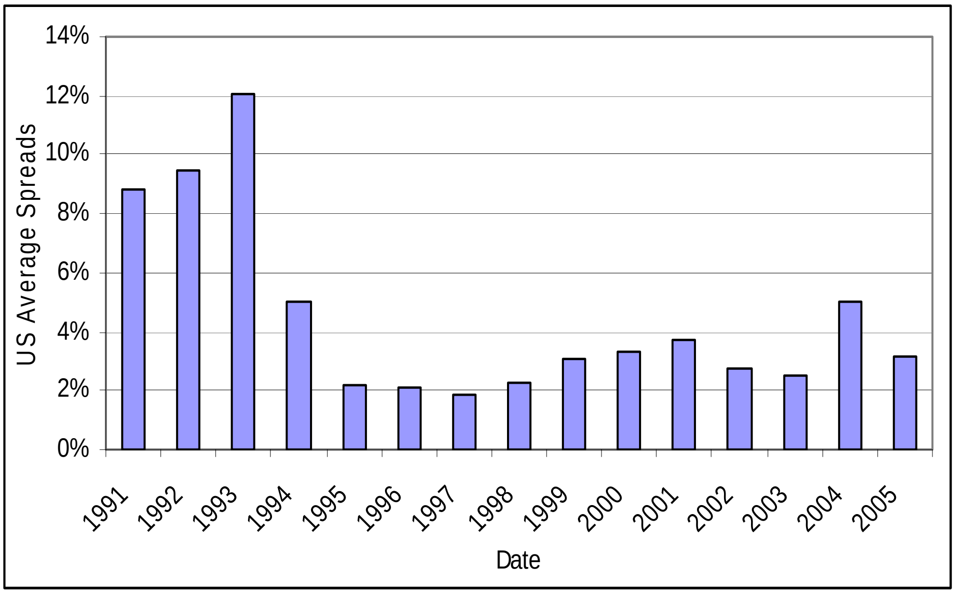


Figure 2: Performance of S&P 500 and US Equity REITs (1993-2005).



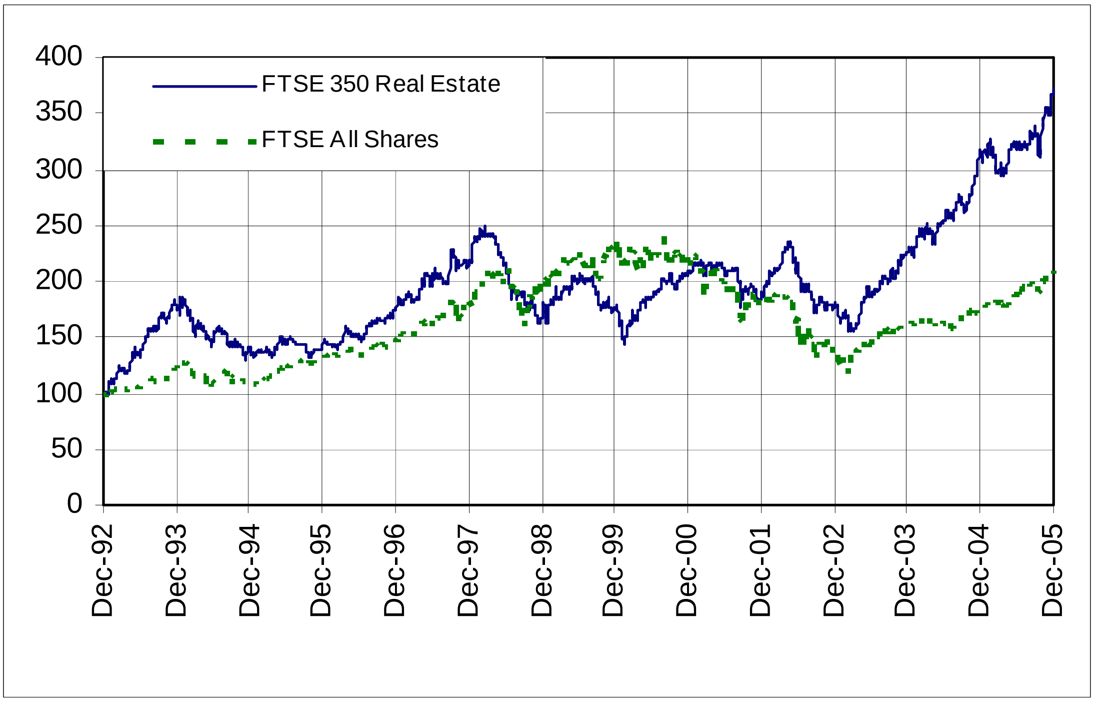
Source: SNL Financials. Total return indices for US S&P 500 and SNL Equity REITs, rebased to 100 in December 1992

Figure 3: Reported Spreads: US REITs (1991-2005)



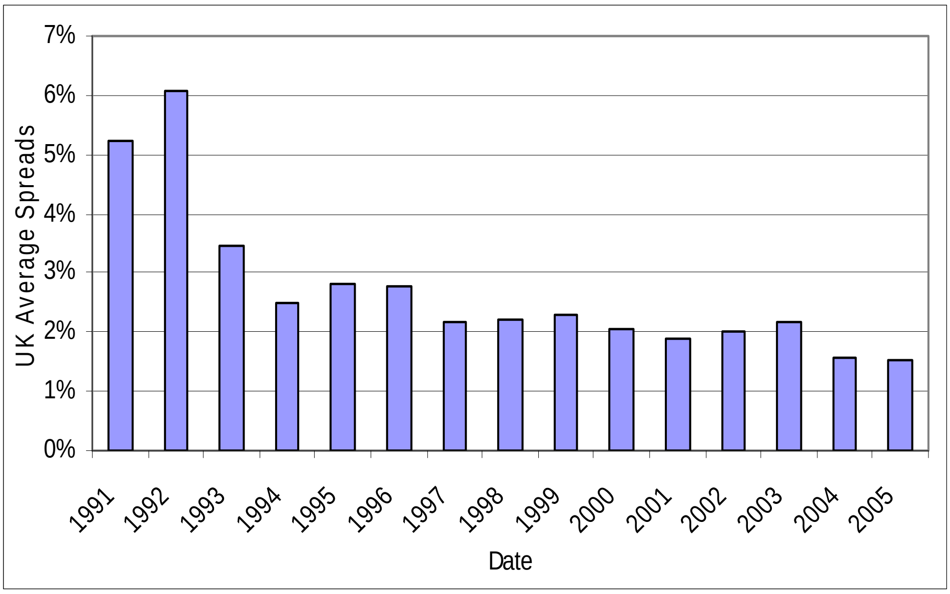
Source: Thomson Datastream. Yearly average of closing reported bid-ask spreads for a sample of 25 US REITs. Spreads are computed for each company as follows: $SPREAD_{i,t} = \frac{PA_{i,t} - PB_{i,t}}{\left(PA_{i,t} + PB_{i,t}\right)/2}$, where $PA_{i,t}$ and $PB_{i,t}$ respectively represent the bid and ask prices of company *i* at time *t*.

Figure 4: Performance of FTSE All Share and FTSE 350 Real Estate Sector (1993-2005).



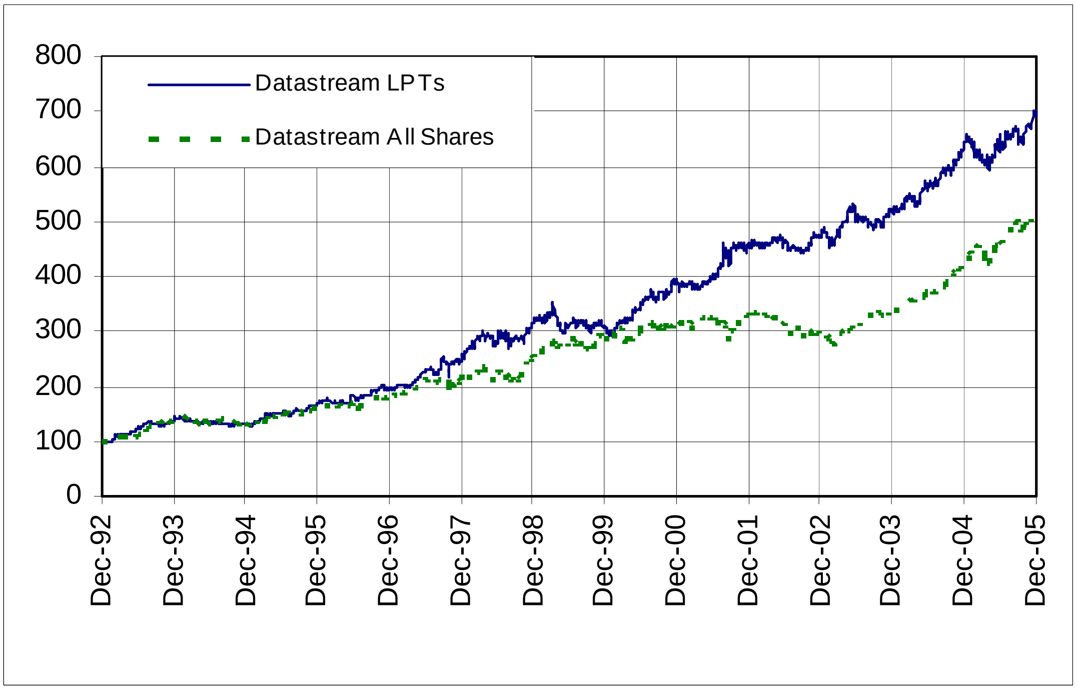
Source: Thomson Datastream. Total return indices for UK FTSE All Share and FTSE 350 Real Estate Sector, rebased to 100 for December 1992.

Figure 5: Reported Spreads: UK Property Companies (1991-2005)



Source: Thomson Datastream. Yearly average of closing reported bid-ask spreads for a sample of 25 UK property companies. Spreads are computed for each company as follows: $SPREAD_{i,t} = \frac{PA_{i,t} - PB_{i,t}}{(PA_{i,t} + PB_{i,t})/2}$, where $PA_{i,t}$ and $PB_{i,t}$ respectively represent the bid and ask prices of company i at time t.

Figure 6: Performance of Thomson Datastream Australian All Share and Thomson Datastream LPTs (1993-2005)



Source: Thomson Datastream. Total return indices for Australian Datastream All Share and Listed Property Trusts, rebased to 100 for December 1992.

Appendix 2: Tables

Table 1: Descriptive statistics of daily returns and volumes for US REITs (1993-2005)

	Returns		Volumes ($)		No. REITs
	Average	Cross-sectional Standard Deviation	Average	Cross-sectional Standard Deviation	
1993	0.04%	0.14%	48,679	59,985	67
1994	-0.03%	0.11%	41,562	44,968	95
1995	0.03%	0.18%	46,070	82,480	100
1996	0.06%	0.13%	58,820	68,465	106
1997	0.04%	0.20%	80,617	90,085	122
1998	-0.07%	0.18%	89,723	110,565	130
1999	-0.07%	0.09%	96,745	123,243	134
2000	0.03%	0.10%	101,340	128,090	134
2001	0.04%	0.11%	137,099	204,805	135
2002	0.00%	0.12%	164,381	233,229	143
2003	0.11%	0.09%	185,007	254,117	154
2004	0.10%	0.33%	225,361	266,995	174
2005	0.00%	0.22%	230,464	281,158	183

Source: SNL Financials. Yearly average of daily returns and aggregate daily volumes of each trust in the US REIT sample. The cross-sectional standard deviation is calculated as the standard deviation of average daily returns of each REIT for each year.

Table 2: Means of parameter estimates for regressions in US (1993-2005)

$$r_t = \alpha_0 + \alpha_1 Dup + \alpha_2 Ddown + \lambda_0 \sum_{t=1}^{n} Q_t + \lambda_1 Dup \sum_{t=1}^{n} Q_t + \lambda_2 Ddown \sum_{t=1}^{n} Q_t + \varepsilon_t$$

	Constant	Dummy		Lambda	Lambda dummy		R^2	No. REITs
	α_0	Positive α_1	Negative α_2	λ_0	Positive λ_1	Negative λ_2		
1993	0.000	0.029	-0.028	0.000	0.100	-0.013	0.70	61
1994	0.000	0.027	-0.026	0.000	0.027	-0.019	0.72	92
1995	0.000	0.022	-0.022	0.000	0.052	-0.034	0.74	98
1996	0.000	0.017	-0.017	0.000	0.015	-0.005	0.72	101
1997	0.000	0.017	-0.017	0.000	0.027	-0.006	0.67	114
1998	0.000	0.016	-0.016	0.000	0.025	-0.008	0.59	125
1999	0.000	0.014	-0.014	0.000	0.040	-0.019	0.65	130
2000	0.000	0.015	-0.015	0.000	0.034	-0.031	0.65	131
2001	0.000	0.014	-0.015	0.000	0.019	-0.016	0.59	132
2002	0.000	0.015	-0.014	0.000	0.006	-0.024	0.59	139
2003	0.000	0.012	-0.011	0.000	0.018	-0.014	0.61	150
2004	0.000	0.013	-0.012	0.000	0.007	-0.039	0.62	166
2005	0.000	0.010	-0.009	0.000	0.007	-0.007	0.61	179

The table reports the yearly average estimates of the regressions of equation (4) represented above. In each year 1993-2005 the daily price change of each US REIT is regressed against a constant (α_0), two dummy variables representing days with respectively positive (α_1) and negative (α_2) price change (we assume the former to refer to days where the aggregate daily trading volumes initiated by buyer exceed the ones initiated by sellers), aggregate daily trading volumes (λ_0) and an interaction between each of the two dummy variables and trading volumes (respectively (λ_1, λ_2). The α and λ parameters respectively represent the average of the estimated effective bid-ask spreads and the average of the estimated market depth coefficients. The averages reported were for the number of regressions reported each year. Source of data: SNL Financials.

Table 3: Proportion of parameter estimates significant at the 5% level in the regression reported in Table 2.

	Dummy		Lambda	
	Positive α_1	Negative α_2	Positive λ_1	Negative λ_2
1993	32.8%	23.0%	96.7%	98.4%
1994	24.4%	21.1%	100.0%	100.0%
1995	33.7%	20.4%	99.0%	99.0%
1996	28.3%	14.1%	100.0%	100.0%
1997	18.6%	15.9%	93.8%	94.7%
1998	15.2%	7.2%	68.8%	78.4%
1999	27.1%	13.2%	77.5%	83.7%
2000	16.0%	17.6%	79.4%	77.9%
2001	6.9%	10.8%	49.2%	42.3%
2002	2.2%	5.8%	35.0%	28.5%
2003	8.7%	8.0%	34.7%	34.0%
2004	3.6%	6.6%	28.3%	27.7%
2005	1.7%	3.9%	30.7%	30.7%

The table summarizes the proportion of significant α and λ parameter estimates for the regressions of daily returns against trading volumes for each US REIT reported in Table 2. Source of data: SNL Financials.

Table 4: Differences in the means of the parameter estimates for new US REITs against old REITs (1993-2005)

	Dummy		Lambda dummy		New REITs
	Positive α_1	Negative α_2	Positive λ_1	Negative λ_2	
1993	-0.012	0.008	-0.097	0.012	11
1994	-0.002	0.002	-0.053	0.039	41
1995	-0.006	0.006	-0.081	0.063	48
1996	-0.005	0.005	-0.011	0.017	51
1997	-0.002	0.003	-0.011	0.007	64
1998	0.000	0.003	-0.031	0.004	76
1999	0.000	0.001	-0.011	0.009	81
2000	-0.006	0.006	-0.051	0.050	82
2001	-0.007	0.007	-0.033	0.012	82
2002	-0.003	0.001	-0.002	0.016	90
2003	-0.002	0.002	-0.011	0.016	100
2004	-0.002	0.001	-0.011	0.010	116
2005	-0.003	0.004	-0.009	0.014	129

Note: There were 50 old REITs used in the sample for comparative purposes.

The table is constructed by running the regressions of equation (4) for (a) old REITs and (b) new REITs and reporting the average difference between the estimated coefficients for the α and λ terms. There are 13 sets of results; 11 of the positive estimated α intercepts (average of the estimated effective bid-ask spreads) are of the correct sign, whilst all of the negative estimated α intercepts are of the correct sign. All the λ coefficients (average of the estimated market depth coefficients) are also of the correct sign. If there were no systematic difference between the new and the old REITs, the probability of observing 2 or less contrary observations from a sample size of 13 would be 1.1% so the results reported in the table would seem very robust. Regressions were run on daily returns against trading volumes for each US REIT in each year 1993-2005. The averages reported were for the number of regressions reported each year. Source of data: SNL Financials.

Table 5: Differences in the means of the parameter estimates for NYSE REITs against REITs traded on other markets (1993-2005)

	Dummy		Lambda dummy		NYSE REITs	Other REITs
	Positive α_1	Negative α_2	Positive λ_1	Negative λ_2		
1993	-0.020	0.019	-0.103	0.024	48	13
1994	-0.016	0.014	-0.017	0.112	74	18
1995	-0.020	0.017	-0.097	0.055	78	20
1996	-0.017	0.019	-0.015	0.045	81	20
1997	-0.016	0.018	-0.009	0.009	88	26
1998	-0.020	0.018	-0.062	0.034	94	31
1999	-0.011	0.008	-0.021	0.021	95	35
2000	-0.015	0.017	-0.051	0.034	96	35
2001	-0.016	0.017	-0.047	0.007	96	36
2002	-0.014	0.014	-0.034	0.035	99	40
2003	-0.008	0.009	-0.039	0.031	103	47
2004	-0.006	0.008	-0.030	0.032	116	50
2005	-0.008	0.009	-0.015	0.016	127	52

Note: (Parameter estimates for NYSE – parameter estimates for other markets)

The table is constructed by running the regressions of equation (4) for (a) NYSE REITs and (b) non-NYSE REITs and reporting the average difference between the estimated coefficients for the α and λ terms. As in the preceding table, the differences between the parameter estimates for the NYSE and non-NYSE markets are all in the expected direction. The results would seem to be robust to the conclusion that NYSE offers more liquidity than the other markets.

Table 6: Regression of Market Depth (Panel A) and Effective Spreads (Panel B) against Market Dummy, (Log-)Size and the interaction between Size and Market.

$$\lambda = \beta_o + \beta_1 DNYSE + \beta_2 size + \beta_3 [DNYSE * size] + \eta$$
$$\alpha = \beta_o + \beta_1 DNYSE + \beta_2 size + \beta_3 [DNYSE * size] + \eta$$

	Panel A: Market Depth (λ)					Panel B: Effective Spreads (α)				
	Coefficients				**F-stat**	**Coefficients**				**F-stat**
	β_0	β_1	β_2	β_3		β_0	β_1	β_2	β_3	
2001	1.24***	-0.995***	-0.09***	0.074***	10.15	0.347***	-0.304***	-0.024***	0.022***	17.30
t-stat	*4.91*	*-2.78*	*-4.40*	*2.72*		*6.47*	*-4.01*	*-5.57*	*3.85*	
2002	0.66***	-0.518***	-0.047***	0.038***	14.69	0.348***	-0.312***	-0.024***	0.022***	14.95
t-stat	*5.95*	*-3.23*	*-5.29*	*3.15*		*5.99*	*-3.72*	*-5.13*	*3.55*	
2003	0.41*	-0.35	-0.031*	0.03	1.28	0.226***	-0.171***	-0.016***	0.013***	22.37
t-stat	*1.91*	*-1.09*	*-1.77*	*1.12*		*7.93*	*-3.93*	*-6.82*	*3.93*	
2004	1.057***	-0.982***	-0.074***	0.069***	11.27	0.171***	-0.13***	-0.011***	0.009***	24.18
t-stat	*5.04*	*-3.10*	*-4.45*	*2.95*		*8.37*	*-4.22*	*-7.03*	*4.15*	
2005	0.911***	-0.865***	-0.064***	0.061***	11.91	0.214***	-0.157***	-0.015***	0.012***	28.79
t-stat	*5.47*	*-3.33*	*-4.94*	*3.24*		*9.48*	*-4.46*	*-8.29*	*4.53*	

* Significant at 90% confidence level
** Significant at 95% confidence level
*** Significant at 99% confidence level

For each year, the averages of the estimated λ (Panel A) and α (Panel B) coefficients across the REITs are regressed against a dummy variable to distinguish between stock exchange (*DNYSE* being equal to 1 if the market is NYSE, 0 otherwise), market capitalization (*size*) and an interaction term (*DNYSE * size*).

Table 7: Means of parameter estimates for regressions in UK (1993-2005)

$$r_t = \alpha_0 + \alpha_1 Dup + \alpha_2 Ddown + \lambda_0 \sum_{t=1}^{n} Q_t + \lambda_1 Dup \sum_{t=1}^{n} Q_t + \lambda_2 Ddown \sum_{t=1}^{n} Q_t + \varepsilon_t$$

	Constant	Dummy		Lambda	Lambda dummy		R^2	No. Prop. Cos.
	α_0	Positive α_1	Negative α_2	λ_0	Positive λ_1	Negative λ_2		
1993	0.000	0.012	-0.012	0.000	0.121	-0.007	0.61	14
1994	0.000	0.012	-0.011	0.000	0.048	-0.021	0.67	19
1995	0.000	0.012	-0.011	0.000	0.050	-0.048	0.72	20
1996	0.000	0.010	-0.009	0.000	0.044	-0.015	0.70	18
1997	0.000	0.013	-0.011	0.000	0.075	-0.041	0.56	20
1998	0.000	0.009	-0.009	0.000	0.016	-0.041	0.57	25
1999	0.000	0.011	-0.009	0.000	0.095	-0.047	0.56	25
2000	0.000	0.009	-0.008	0.000	0.015	-0.023	0.53	26
2001	0.000	0.008	-0.010	0.000	0.052	-0.030	0.53	32
2002	0.000	0.011	-0.011	0.000	0.032	-0.013	0.54	32
2003	0.000	0.011	-0.010	0.000	0.055	-0.029	0.55	32
2004	0.000	0.009	-0.008	0.000	0.034	-0.036	0.57	35
2005	0.000	0.009	-0.008	0.000	0.037	-0.011	0.57	39

Data source: Thomson Datastream. The table reports the yearly average estimates of the regressions of equation (4) represented above. In each year 1993-2005 the price change of each UK property company is regressed against a constant (α_0), two dummy variables representing days with respectively positive (α_1) and negative (α_2) price change (we assume the former to refer to days where the aggregate daily trading volumes initiated by buyer exceed the ones initiated by sellers), aggregate daily trading volumes (λ_0) and an interaction between each of the two dummy variables and trading volumes (respectively (λ_1, λ_2). The α and λ parameters respectively represent the average of the estimated effective bid-ask spreads and the average of the estimated market depth coefficients. The averages reported were for the number of regressions reported each year. Source of data: Thomson Datastream.

Table 8: Means of parameter estimates for regressions in Australia (1993-2005)

$$r_t = \alpha_0 + \alpha_1 Dup + \alpha_2 Ddown + \lambda_0 \sum_{t=1}^{n} Q_t + \lambda_1 Dup \sum_{t=1}^{n} Q_t + \lambda_2 Ddown \sum_{t=1}^{n} Q_t + \varepsilon_t$$

	Constant α_0	Dummy		Lambda λ_0	Lambda dummy		R^2	No. LPTs
		Positive α_1	Negative α_2		Positive λ_1	Negative λ_2		
1993	0.000	0.008	-0.008	0.000	0.000	0.000	0.71	14
1994	0.000	0.013	-0.014	0.000	0.027	-0.004	0.72	21
1995	0.000	0.008	-0.008	0.000	0.036	0.000	0.76	22
1996	0.000	0.010	-0.011	0.000	0.025	-0.001	0.73	27
1997	0.000	0.012	-0.012	0.000	0.021	-0.007	0.67	33
1998	0.000	0.013	-0.013	0.000	0.020	-0.004	0.69	37
1999	0.000	0.015	-0.014	0.000	0.022	-0.014	0.71	42
2000	0.000	0.014	-0.014	0.000	0.023	-0.011	0.71	45
2001	0.000	0.012	-0.012	0.000	0.017	-0.012	0.69	42
2002	0.000	0.010	-0.010	0.000	0.007	-0.013	0.74	35
2003	0.000	0.010	-0.010	0.000	0.016	-0.012	0.71	34
2004	0.000	0.009	-0.010	0.000	0.010	-0.013	0.73	28
2005	0.000	0.009	-0.009	0.000	0.013	-0.010	0.63	21

Data source: Thomson Datastream. The table reports the yearly average estimates of the regressions of equation (4) represented above. In each year 1993-2005 the daily price change of each Australian LPT is regressed against a constant (α_0), two dummy variables representing days with respectively positive (α_1) and negative (α_2) price change (we assume the former to refer to days where the aggregate daily trading volumes initiated by buyer exceed the ones initiated by sellers), aggregate daily trading volumes (λ_0) and an interaction between each of the two dummy variables and trading volumes (respectively (λ_1, λ_2). The α and λ parameters respectively represent the average of the estimated effective bid-ask spreads and the average of the estimated market depth coefficients. The averages reported were for the number of regressions reported each year. Source of data: Thomson Datastream.

Table 9: Regression of reported spreads on effective spreads

$$Effective\,Spread_t = \mu + \gamma\ Reported\ Spread_t + \eta_t$$

Market	Coefficients		Regression tests	
	μ	γ	F-statistic	Adjusted R^2
US REITs	0.02	0.60	7.12	0.44
t-stat	2.81	2.67		
UK Property Companies	0.01	0.68	651.99	0.68
t-stat	15.14	25.53		
Australian LPTs	0.01	1.46	1860.06	0.93
t-stat	18.68	43.13		

The table reports the estimates of the regression of the absolute sum of effective bid-ask spreads – sum of α_1 *and* α_2 coefficients in equation (4) – for each company/trust in each year 1993-2005, against the average spreads reported by Thomson Datastream / Reuters. If effective spreads represent a good estimate of reported spreads, we expect the intercept (μ) to be equal to 0 and the slope of the linear relationship (γ) to be equal to 1.