REITs and Market Microstructure: A Comprehensive Analysis of Market Quality

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Abstract
In this study, we analyze the market quality differences, in terms of liquidity and volatility, between real estate investment trusts (REITs) and non-REIT common stocks. The recent financial crisis has significantly influenced the market quality for REITs. Our findings reveal intraday patterns indicating a lower liquidity, higher volatility, and greater price impact for REITs than non-REITs for the pre-crisis period. These relations reverse during the post-crisis period with REITs becoming more liquid, less volatile, and cheaper to trade than non-REITs. Further, we document that post-crisis trading interest in REITs has increased significantly as reflected by increased volume, number of trades, and number of quotes.

The ability of real estate investment trusts (REITs), as real estate investments, to be traded in the secondary market as common stocks has intrigued researchers since the early 1990s. The fact that REITs are traded on the secondary markets makes them more liquid than traditional real estate investments. However, REITs may not necessarily be perfect substitutes for conventional equity due to their unique institutional features. Specifically, the dividend distribution requirement and greater level of institutional ownership for REITs limits managerial discretion (Jensen, 1986) and improves corporate governance (Chung, Fung, and Hung, 2012). This implies a lower level of asymmetric information and, therefore, different risk characteristics as compared to non-REIT common stocks. These different characteristics make REITs more attractive to general investors due to their potential for adding diversification benefits to stock portfolios (Huang and Zhong, 2013; Chun, Sa-Aadu, and Shilling, 2004). However, any diversification benefits must be weighed against market microstructure differences, such as stock market liquidity and price volatility, which may translate into higher trading costs (Cannon and Cole, 2011; Bertin, Kofman, Michayluk, and Prather, 2005). In this paper, we investigate the impact of the 2008 financial crisis on REIT market quality. Hoffmann, Post, and Pennings (2013) argue that the 2008 financial crisis
was one of the worst stock market crashes during the past several decades. They document that individual investors were hit hard by the financial crisis, which almost halved their portfolio values within a few months. Malmendier and Nagel (2011) document that this dramatic shock to investor wealth permanently shifted investors’ return expectations and risk tolerance. Barberis, Shleifer, and Vishny (1998), Case and Shiller (2003), and Case, Quigley, and Shiller (2005) argue that if common stocks depreciate in value, some speculators, either irrationally or rationally, extrapolate that stocks no longer represent an attractive investment opportunity and shift to REITs. REITs tend to have low risk, serve as an inflation-hedging instrument, and have characteristics similar to defensive stocks. REITs are an attractive investment vehicle during highly volatile market conditions (Goetzmann and Ibbotson, 1990; Glascock, Michayluk, and Neuhauser, 2004; Jain, 2015; Cotter and Roll, 2015). Our hypothesis is that this flight to quality during the recent financial crisis results in higher trading volume and lower volatility due to price competition, and better REIT market quality as compared to non-REIT stocks.

Using high-frequency intraday data, our analyses confirm that REITs have lower pre-crisis period liquidity and substantially higher price volatility than non-REIT stocks as documented by earlier studies. However, we find that liquidity for REITs has improved significantly during the post-crisis period. Our results further show that, while the financial crisis dramatically increased price volatility for all common stocks, REITs were much less affected as compared to matching non-REIT stocks. We also document improved trading interest in REITs during the post-crisis period as reflected by increased volume, number of trades, and number of quotes. We find similar results for our intraday analyses. We show that our results are robust across different measures of market quality, REIT and non-REIT matching algorithms, and estimation methods. During the period of heightened volatility, investors fleeing risky securities found the long-term diversification benefits of REITs more attractive, improving the overall market quality of REITs.4

**Literature Review**

**REIT Liquidity: Historical Trend**

The explosive growth in the REIT market in the 1990s led many researchers to test whether the REIT microstructure environment changed accordingly. The ability of REITs to trade in the stock market makes them more attractive to investors as compared to other forms of real estate investments. Illiquidity carries a price (Amihud and Mendelson, 1991; Brennan and Subrahmanyam, 1996), which can result in a less efficient risk-return trade-off for REITs assuming that REITs are, ceteris paribus, less liquid than other common stocks. If the influence of REIT liquidity levels on returns is significant enough, the average investor may not consider REITs as appropriate substitutes for common stocks. Bhasin, Cole,

REITs’ dependence on external financing can curtail their ability to exploit profitable investment opportunities (Mooradian and Yang, 2001). This constraint is likely to be more severe during market crises (Ben-David, Franzoni, and Moussawi, 2011). At such times, capital providers may withdraw, forcing companies to liquidate their positions prematurely and leading to a deterioration of liquidity in the market. These liquidity dry-ups can occur simultaneously across asset types, which forces investors to undertake other trades with greater expected risk-adjusted returns.\footnote{On the other hand, Ooi, Wong, and Ong (2012) find that bank lines of credit insure REITs against credit rationing at the broad market level. Therefore, these possible liquidity dry-ups may not be as prominent in REITs.} We contribute to the REIT literature by analyzing the impact of the recent financial crisis on REITs’ stock market liquidity. Bhasin, Cole, and Kiely (1997), Clayton and MacKinnon (2002), and Ling and Naranjo (2003) argue that part of the increased investors’ interest in REITs in the last couple decades stemmed from desiring liquid access to the real estate asset class, especially during times of stock market downturns. Barberis, Shleifer, and Vishny (1998), Case and Shiller (2003), and Case, Quigley, and Shiller (2005) argue that if stock markets depreciate in value, some speculators, either irrationally or rationally, extrapolate that stocks no longer represent an attractive investment opportunity and shift to REITs. By examining REIT liquidity before and after the recent financial crisis, we empirically test the above theories.

REITs have low risk, serve as an inflation hedging instrument, and have characteristics similar to defensive stocks, which might make REITs an attractive investment vehicle in highly volatile market conditions (Goetzmann and Ibbotson, 1990; Glascock, Michayluk, and Neuhauser, 2004; Cotter and Roll, 2015; Jain, 2015). This flight to quality should result in higher trading volume for REITs, resulting in better liquidity. We analyze these arguments and test the following hypothesis:

**Hypothesis 1:** REIT liquidity improved during the post-financial crisis period.
Another interesting area of research is the substitutability of REITs for non-REIT common stocks. Researchers in this area offer conflicting predictions. Nelling, Mahoney, Hildebrand, and Goldstein (1995) document REIT liquidity to be similar to that of other common stocks. However, Ghosh, Miles, and Sirmans (1996) find that REITs may not be as liquid as comparably sized non-REIT stocks. Since these researchers consider a period before 1995, their findings are questionable in the current period. Hence, comparing REIT and non-REIT common stock liquidity during the pre- and post-financial crisis periods can provide some interesting insights about the substitutability of these investment vehicles. Since REIT income is derived from real property earnings, REITs’ long-term return characteristics must be identical to traditional real estate investments (Giliberto, 1990). Hence, we expect that during periods of extreme volatility and low interest rates, such as the recent financial crisis, investors would value the long-term diversification benefits of REITs. Additionally, Jain (2015) argues that the recent financial crisis increased the information asymmetry in the stock market. Danielsen, Harrison, Van Ness, and Warr (2014) argue that the regulatory distribution requirements force REITs to frequently raise capital in the public markets, which makes REITs more transparent (having lower information asymmetry) as compared to non-REIT stocks. This reduction in information asymmetry should increase the attractiveness of REITs as an investment opportunity. As investors flee from opaque common stocks to REITs, liquidity for REITs in comparison to non-REITs should improve. We test the following hypothesis:

**Hypothesis 2:** REITs have higher liquidity than non-REITs during the post-crisis period.

**REIT Volatility**

Understanding the evolution of volatility is very important as volatility is not only a major determinant of options prices (Foucault, 1999; Hasbrouck and Saar, 2002) but also plays an important role in execution strategies and investment decisions (Fleming, Kirby, and Ostdiek, 2003). Despite its importance, not until recently has REIT idiosyncratic risk attracted the attention of real estate researchers. Ooi, Wang, and Webb (2009) posit that the tendency of real estate markets to be localized and segmented has led to wide acceptance of the notion that real estate assets and property-related stocks, such as REITs, may be more exposed to idiosyncratic risk than typical common stocks. They find that idiosyncratic risk is priced and dominates the market beta in explaining REIT returns. Sun and Yung (2009) support these findings. However, Chiang, Jiang, and Lee (2009) find a negative relation between REIT returns and idiosyncratic volatility.

There is a paucity of published studies on the evolution of REIT volatility over time. We extend the literature by presenting a comprehensive analysis of REIT
volatility during the real estate market peak, bubble burst, and subsequent financial crisis. We analyze the evolution of REIT volatility during these periods and extend this analysis by presenting intraday volatility patterns and document the changes induced by the recent financial crisis. Investors fleeing risky securities during the crisis would find REITs, and their relatively low risk and inflation hedging abilities, more attractive. Hence, we expect a lower volatility for REITs as compared to non-REIT common stocks during the recent financial crisis. We test the following hypothesis:

**Hypothesis 3:** REITs have lower volatility than non-REITs during the post-crisis period.

**Intraday Patterns for REIT Liquidity and Volatility**

Finally, motivated by the literature on investment flows and optimal trading, we examine the intraday patterns for several market quality variables. The speed of trading has increased over the past decade and trades now happen within a few milliseconds (Hendershott, Jones, and Menkveld, 2011). Hence, an intraday analysis of liquidity and volatility can have significant implications for how investors choose to time their trades, to minimize trading costs or price impact.

While there is a rich literature on the intraday patterns for various microstructure parameters (e.g., McInish and Wood, 1992), only Bertin, Kofman, Michayluk, and Prather, (2005) analyze the intraday patterns for REITs. These authors also compare the intraday patterns for REITs with matching non-REIT stocks. While they show that REITs have a well-defined U-shape pattern for percentage spreads, they do not find a well-specified intraday pattern for volatility. They also show that REITs have lower liquidity than non-REIT common stocks. However, these results are derived using the data from the 1996 period. As shown by Jain (2005), technological advancements have dramatically changed trading; therefore, the relevance of results based on the data from 1996 is questionable. Current stock market microstructure research typically excludes REITs from analyses of market quality due to their unique characteristics discussed above. Hence, the liquidity and volatility differences between REITs and common stocks warrant a more in-depth analysis. In addition, we argue that the recent financial crisis might have a significant impact on investors’ trading behavior and thus, the intraday patterns that define stock market quality. The identification of post-financial crisis intraday liquidity and volatility patterns of REITs can also provide guidance on the optimal timing of trades to minimize trading costs or price impact.

**Data and Measures of Liquidity and Volatility**

We obtain the ticker symbols and the market capitalization for all stocks that were actively traded from the Center for Research in Security Prices (CRSP) database. We cross-reference the REITs with the January issue of each year (2005–2011) of the National Association of Real Estate Investment Trusts’ (NAREIT’s)
StockWatch. REITs not listed on StockWatch are deleted from the final sample. We also delete the stocks that are not traded in at least two consecutive years and stocks with no market capitalization available. Since mortgage REITs are different than both non-mortgage REITs and other common stocks, we remove these from our final sample. The remaining REITs and non-REIT common stocks are matched based on the previous year-end market capitalization. The resulting sample contains 214 REITs and 1,093 matching non-REIT stocks over the entire sample period.

We obtain the intraday data on stock prices, trading volume, trade prices, best bid and ask quotes, and the respective volume supplied for every five minutes of trading from the New York Stock Exchange (NYSE) Trades and Quotes (TAQ) database for all REITs and non-REIT matching stocks listed on the NYSE for the period from January 2005 to June 2011.

**Liquidity Measures**

Kyle (1985) states 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.” The author defines three components of bid-ask spread: tightness, depth, and resiliency. Tightness is the distance between the bid and ask quotes. Depth, defined as the volume supplied by each order, basically represents how many shares an investor can trade at a given price without causing a change in price. Resiliency represents how quickly the market can return to its original state after a large order. In simple terms, markets are liquid if a trader can trade quickly at a minimum cost of trading.

Trading volume, most recently studied by Bertin, Kofman, Michayluk, and Prather (2005), has been revealed as a significant activity-based measure of liquidity. However, in this paper, we base our analysis of volume on the number of trades, because Jones, Kaul, and Lipson (1994) find that this is a better measure of information asymmetry. In addition, we also analyze the average trade size and trading volume.

We estimate four different measures of time-lapse-weighted liquidity—quoted spread, relative spread, effective spread, and relative effective spread—for each stock at the end of every five minutes of trading as follows:

\[
\text{Quoted Spread} = \text{Sprd} = \frac{\sum_{i=1}^{t} \Delta t_i (Ask_i - Bid_i)}{\sum_{i=1}^{t} \Delta t_i} \tag{1}
\]

\[
\text{Relative Spread} = \text{Rsprd} = \frac{\sum_{i=1}^{t} \Delta t_i \left[ \frac{(Ask_i - Bid_i)}{\frac{Ask_i + Bid_i}{2}} \right]}{\sum_{i=1}^{t} \Delta t_i} \tag{2}
\]
where $\Delta t_i$ is defined as the time lapse between quotes.

While quoted spread, often called bid-ask spread, is the most widely used measure of liquidity, it is not without critics (Grossman and Miller, 1988; Lee, Mucklow and Ready, 1993). Relative spread, sometimes referred to as percentage spread, more accurately reflects the percentage cost of trading by scaling the size of the spread to the fundamental value of the stock, as reflected by the quote midpoint. Higher values for spreads indicate lower liquidity and vice versa.

$$ Effective\ Spread = \frac{\sum_{i=1}^{t} VOL_i \cdot 2 \cdot |Price_i - Midpoint_i|}{\sum_{i=1}^{t} VOL_i} \quad (3) $$

$$ Relative\ Effective\ Spread = \frac{\sum_{i=1}^{t} VOL_i \left[ \frac{Effective\ Spread_i}{Midpoint_i} \right]}{\sum_{i=1}^{t} VOL_i} \quad (4) $$

where $VOL_i$ is the trading volume, and $Midpoint_i$ is defined as:

$$ Midpoint_i = Bid_i - Ask_i = \frac{(Ask_i + Bid_i)}{2}. $$

Effective spread is the difference between the price at which a trader buys a stock and the fundamental value of the stock as reflected by the quote-midpoint (Smith and Whaley, 1994). This measure quantifies the cost of an order by taking two measures into account: price movement and the market impact due to widening of the spread resulting from the size of the order itself. Therefore, effective spread can be considered an estimate of the trader’s actual execution cost and the gross revenue earned by the liquidity provider. Relative effective spread scales the effective spread by the quote midpoint, and hence, presents a better characterization of a stock’s liquidity provisions. Higher values for spreads indicate lower liquidity and vice versa.

**Volatility Measures**

We calculate time-lapse-weighted price volatility for each stock at the end of every five minutes of trading as follows:
Price Volatility = Privol
= SQRT \left\{ \sum_{i=1}^{t} \Delta t_i \left[ \frac{Price_i^2 - \left( \frac{Price_i^2}{Number of Trades_i} \right)}{Number of Trades_i - 1} \right] \right\}. \tag{5}

Time-lapse-weighted price volatility presents a more accurate assessment of price volatility as it captures the movement in stock prices by taking into account the number of trades and the time lapse between subsequent price movements.

Results

Descriptive Statistics

Exhibit 1 reports the descriptive statistics for the various market quality parameters for REITs and comparable non-REIT firms matched on total market capitalization. We report the means for the full sample period, the pre-crisis period from January 2005 to July 2008, and the post-crisis period from August 2008 to June 2011. All values presented are calculated by taking the time-lapse-adjusted averages for each five-minute period of trading and then across stocks. Column (7) presents the difference in means for REITs between the pre-crisis and post-crisis periods.

The results in Exhibit 1, summarized in columns (1) and (2) (full sample period), show that shares of REITs have about 5% lower trading volume (VOLUME) than shares of comparable non-REIT stocks. We also find that the REITs are traded less than their non-REIT counterparts as reflected by the lower number of trades (NTRDS). The combined effect of VOLUME and NTRDS reflect that the average trade size for REITs is significantly lower than non-REIT stocks. As already established, REITs are widely held by institutional investors. To reduce price impact, it appears that these sophisticated investors are slicing their larger orders into several smaller trades to get better execution quality, resulting in a lower average trade size and a larger number of trades. We also find that REITs have lower number of quotes (NQUOTES) as compared to non-REIT matching stocks.

Columns (1) and (2) also report that REITs are more liquid than non-REIT stocks, as reflected by lower quoted spreads (QSPRD) and relative spreads (RSPRD). However, REITs also experience a higher price impact compared to matching non-REIT stocks as reflected by higher effective spreads (ESPRD) and relative effective spreads (RESPRD). Additionally, REITs are nearly 50% more volatile than matched non-REIT stocks over the full sample period.
### Exhibit 1 | Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Period</th>
<th>Pre-Crisis Period</th>
<th>Post-Crisis Period</th>
<th>Post-Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>REITS</td>
<td>STOCKS</td>
<td>REITS</td>
<td>STOCKS</td>
</tr>
<tr>
<td>VOL</td>
<td>11,480</td>
<td>12,017</td>
<td>5,986</td>
<td>10,253</td>
</tr>
<tr>
<td>NTRDS</td>
<td>62.21</td>
<td>66.55</td>
<td>25.98</td>
<td>36.54</td>
</tr>
<tr>
<td>NQUOTES</td>
<td>653.32</td>
<td>689.58</td>
<td>296.77</td>
<td>453.19</td>
</tr>
<tr>
<td>QSPRD</td>
<td>26.17</td>
<td>30.01</td>
<td>32.37</td>
<td>17.88</td>
</tr>
<tr>
<td>RSPRD (%)</td>
<td>1.73</td>
<td>1.55</td>
<td>2.53</td>
<td>1.24</td>
</tr>
<tr>
<td>ESPRD</td>
<td>0.22</td>
<td>0.14</td>
<td>0.36</td>
<td>0.17</td>
</tr>
<tr>
<td>RESPRD (%)</td>
<td>0.53</td>
<td>0.50</td>
<td>0.59</td>
<td>0.38</td>
</tr>
<tr>
<td>PRIVAR (%)</td>
<td>0.10</td>
<td>0.07</td>
<td>0.08</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Notes: We present summary statistics from January 1, 2005 through June 30, 2011 for all the non-mortgage REITs traded on the U.S. stock markets and the non-REIT firms matched based on the market capitalization. We sample the data for the first month in each quarter: January, April, July, and October, for six years: 2005 through 2011. Pre-crisis period consists of data from January 2005 to August 2008 and the remaining period is the post-crisis period. All the variables reported are the trading time-lapse-adjusted average for each five-minute period of trading. We then average the numbers across stocks and across years. VOL is the volume traded during five minutes of trading, NTRDS is the number of trades, NQUOTES is the number of quotes, PRIVAR is the price volatility, QSPRD is the time weighted quoted spreads, RSPRD is the time weighted relative spreads, ESPRD is the volume-weighted effective spreads, and RESPRD is the volume-weighted relative effective spreads for every five minutes of trading.

** Significant at 5% level.
*** Significant at 1% level.
These results contradict the findings of Bertin, Kofman, Michayluk, and Prather (2005) that REITs have lower liquidity and trading volume as compared to non-REIT stocks. We test whether these contradictory results are due to the recent financial crisis by dividing our sample into pre- and post-financial crisis periods. The results of this analysis are reported in Exhibit 1, columns (3) through (6). We find that during the pre-crisis period (columns (3) and (4)), REITs have 42% less VOLUME and nearly 29% less NTRDS as compared to non-REIT stocks. We also find that the NQUOTES for REITs are almost 35% less than those for non-REIT stocks. These results reflect the low level of trading interest in REITs during the pre-financial crisis period as compared to their non-REIT counterparts.

Our pre-crisis liquidity measures, QSPRD and RSPRD, are significantly higher for REITs reflecting that the REITs have lower liquidity than the non-REIT stocks. Hence, our contradictory results [as compared to Bertin, Kofman, Michayluk, and Prather (2005)] are due to the financial crisis. We also find that pre-crisis period price impact for REITs is higher than the non-REIT stocks as reflected by higher ESPRD and RESP RD. REITs are also nearly 2.5 times more volatile than non-REIT stocks for every five minutes of trading.

Columns (5) and (6) in Exhibit 1 also show that the financial crisis significantly impacted both the trading activity and market quality of REITs and non-REIT stocks. We find that trading volume for REITs during the post-crisis period is nearly three times the trading volume during the pre-crisis period. We also find that the NTRDS for REITs increased by almost four times while NQUOTES increased by more than three and a half times during the post-crisis period as compared to their pre-crisis level. Comparing the trading activity for REITs with non-REIT stocks during the post-crisis period, we find that VOLUME and NTRDS for REITs are much higher than those for non-REIT stocks. While the liquidity (QSPRD and RSPRD) has substantially declined for non-REIT stocks and slightly improved for REITs during the post-crisis period, REITs are almost 50% more liquid than non-REIT stocks during the post-crisis period. These findings support Hypothesis 1 (REITs have higher liquidity during the post-crisis period) and Hypothesis 2 (REITs have higher liquidity than non-REITs during the post-crisis period). We also document that non-REIT stocks experienced a much higher increase in volatility as compared to REITs during the post-crisis period, making non-REIT stocks about 23% more volatile as compared to REITs, which is consistent with Hypothesis 3 (REITs have lower volatility than non-REITs during the post-crisis period). In column (7), we report the statistical significance of the positive impact of the financial crisis on REIT trading activity as measured by trading volume, number of trades, number of quotes, and market quality as measured by liquidity, price impact, and volatility. The most striking finding is that, while the trading interest and market quality during the pre-crisis period is higher for non-REIT matching stocks, REITs have higher trading activity and better market quality during the post-crisis period.
Intraday Analysis of Market Quality

In this section, we analyze the evolution of various liquidity and volatility measures across a trading day by dividing the trading day into 77 five-minute intervals. In Exhibits 2–9, we summarize the intraday patterns for each of the market quality parameters across the 77 intraday trading intervals. For most of our liquidity and volatility measures, we observe well-established U-shape patterns (see McInish and Wood, 1992).

In Exhibits 2–4, we present the intraday trading pattern for trading volume, number of trades, and number of quotes, respectively, for the pre- and post-crisis periods. We observe that trading volume for REITs is lower than non-REIT stocks throughout the trading day during the pre-crisis period; however, REIT trading volume is significantly higher than that of non-REIT stocks during the post-crisis period. Additionally, REITs are quoted and traded less frequently than non-REIT stocks during the pre-crisis period. This relation is reversed during the post-crisis period, with REITs having twice as many quotes and trades as their non-REIT counterparts. These results suggest that, while intraday trading in both REITs and non-REITs increased following the financial crisis, the level of trading in REITs is significantly higher than that of non-REITs during the post-crisis period.

Exhibits 2 and 3 report that REIT trading volume is highest at the end of each trading day and reaches the minimum at about 1:30 p.m. Non-REIT stocks show a similar pattern; however, they do have higher pre-crisis trading volume and greater number of trades than REITs throughout the trading day. In contrast to the pre-crisis period, the trading volume and number of trades for REITs are significantly higher than non-REITs throughout the post-crisis day.

Exhibit 4 illustrates the five-minute average for the number of quotes during the trading day. While the pre-crisis patterns for both REITs and non-REITs are similar and have the previously mentioned U-shaped pattern, the post-crisis trading day for both REITs and non-REITs begins with the highest number of quotes and then declines to a minimum at around 1:30 p.m., with a steady rebound to the end of day value. As with trading volume and number of trades, the pre-crisis number of quotes for REITs is lower as compared to non-REITs while the post-crisis period number of quotes is higher for the REITs than for non-REIT firms.

Exhibits 5 and 6 illustrate the intraday patterns for our key liquidity measures: time-lapse-weighted quoted spread and time-lapse-weighted relative spread. Exhibit 5 shows that during the pre-crisis period, REITs were less liquid as compared to non-REIT matching stocks throughout the day. This relation reverses during the post-crisis period with REITs having higher liquidity than non-REIT matching stocks. We also observe a more pronounced inverted U-shaped pattern for quoted spreads for both REITs and non-REITs during the pre-crisis period. In Exhibit 6, we find similar results for relative spreads with REITs having lower liquidity than non-REITs during the pre-crisis period. However, during the post-crisis period, REITs become nearly twice as liquid as non-REIT matching stocks as reflected by lower relative spreads throughout the trading day.
Exhibit 2 | Intraday Pattern for Trading Volume
Exhibit 3 | Intraday Pattern for Number of Trades

Pre-Crisis Period

Post-Crisis Period

Number of Trades
per 5 minutes of trading

Time of Day

Number of Trades
per 5 minutes of trading

Time of Day

REITs
Non-REIT Stocks

REITs
Non-REIT Stocks
Exhibit 4 | Intraday Pattern for Number of Quotes

Pre-Crisis Period

Post-Crisis Period

Number of Quotes per 5 minutes of trading

Time of Day

Number of Quotes per 5 minutes of trading

Time of Day

REITs
Non-REIT Stocks
REITs
Non-REIT Stocks
Exhibit 5 | Intraday Pattern for Time-weighted Quoted Spreads

Pre-Crisis Period

Post-Crisis Period
Exhibit 6 | Intraday Pattern for Time-weighted Relative Spreads
The intraday patterns for price impact as measured by time-lapse-weighted effective and relative effective spreads are shown in Exhibits 7 and 8. We observe that the effective spreads are larger at the start of the trading day and decline significantly during the first half of trading during the pre-crisis period. After this initial decline, the level of effective spread starts increasing for the rest of the trading day for both REITs and non-REITs. The U-shaped pattern for effective spreads is more pronounced for REITs during the pre-crisis period. The most striking observation is that REITs experience a larger price impact than non-REITs during the pre-crisis period. However, this relation reverses during the post-crisis period, with REITs experiencing lower price impact than non-REITs.

Exhibit 9 presents the intraday patterns for volatility. Both REITs and non-REITs demonstrate high price volatility during the start and end of the trading day, during both sub-periods, forming a U-shaped pattern for the entire trading day. The U-shaped patterns are more pronounced during the post-crisis period. The pre-crisis price volatility for REITs is much higher than non-REITs. However, during the post-crisis period, REITs display much lower price volatility than non-REITs throughout the trading day.

Regression Analysis

We follow Stoll’s (2000) model to formally test the liquidity differences between REITs and non-REIT matching common stocks. Market orders demand liquidity while limit orders supply liquidity. The liquidity demanders incur a cost for immediate trading due to market frictions. These frictions are measured by the price premium paid by the liquidity demander for an immediate transaction (Demsetz, 1968; Stoll, 2000). Market sell orders are usually executed at the bid price, while market buy orders are usually executed at the ask price. The bid-ask spread represents the instantaneous cost of a round-trip trade and is a measure of market frictions. Demsetz (1968) and Stoll (2000) model the cross-sectional relation of spreads to firms’ trading characteristics as follows:

\[
RSPRD = \alpha_0 + \beta_1 \log VOL + \beta_2 \log NTRD + \beta_3 \log MV \\
+ \beta_4 \log PRICE + \beta_5 PRIVAR + \varepsilon,
\]

where \(RSPRD\) is the time-weighted relative spread for each five-minute trading interval, \(VOL\) is the volume traded, and \(NTRD\) is the number of trades for each five-minute trading interval. \(MV\) is the stock’s market value, \(PRICE\) is the stock’s price at the end of each five-minute trading interval, \(PRIVAR\) is the price volatility during the five-minute trading period, and \(\varepsilon\) is the error term.\(^{21}\)

To formally test the differences in liquidity between REITs and non-REIT matching stocks, we add a dummy variable, \(REIT\), to the above model.
Exhibit 7 | Time-weighted Effective Spreads

Pre-Crisis Period

Post-Crisis Period

Time of Day

Time of Day

Time Weighted Effective Spreads per 5 minutes of trading

Time Weighted Effective Spreads per 5 minutes of trading

REITs
Non-REIT Stocks

REITs
Non-REIT Stocks
Exhibit 8 | Time-weighted Relative Effective Spreads

Pre-Crisis Period

Post-Crisis Period
Exhibit 9 | Time-weighted Price Volatility
specification and analyze it separately for pre- and post-crisis periods. Hence, our final regression model takes the following form:

$$RSPRD = \alpha_0 + \beta_1 REIT + \beta_2 \text{LogVOL} + \beta_3 \text{LogNTRD} + \beta_4 \text{LogMV} + \beta_5 \text{LogPRICE} + \beta_6 \text{PRIVAR} + \epsilon.$$  (7)

We estimate the above regression model for both the pre- and post-crisis periods. Results of the analyses are summarized in Exhibit 10. We find that relative spreads are negatively related to measures of trading activity, such as volume ($\text{LogVOL}$) and number of trades ($\text{LogNTRD}$). Relative spreads are positively related to a stock’s volatility ($\text{PRIVAR}$). Consequently, stocks with higher trading volume and number of trades and lower volatility have lower spreads (higher liquidity). We also find that relative spreads are lower for larger firms and firms with higher stock prices. These results are consistent with Stoll (2000) and Cannon and Cole (2011).

The coefficient for REIT shares is statistically significant and positive during the pre-crisis period and statistically significant and negative during the post crisis period. This suggests that REITs have higher pre-crisis $RSPRD$ and lower post-crisis $RSPRD$ liquidity than non-REIT matching firms. This result is robust to alternate model specifications and is consistent with the univariate results presented in the previous sections. Hence, REITs have lower pre-crisis liquidity but higher post-crisis liquidity as compared to non-REIT matching common stocks. This result is consistent with Hypothesis 2.

**GARCH Analysis**

Exhibit 1 shows that REITs have higher pre-crisis and lower post-crisis volatility as compared to non-REIT matching stocks. We formally test these volatility differences using several GARCH models. We control for various factors proposed in the literature that provide explanatory power for volatility: spreads (Hasbrouck, 1999), depth (Ahn, Bae, and Chan, 2001), trading volume (Gallant, Rossi, and Tauchen, 1992), number of trades (Jones, Kaul, and Lipson, 1994), and Monday, to control for the weekend effect (French, 1980; Foster and Viswanathan, 1990).

Following Jain and Jiang (2014), we use two different model specifications to analyze the effect of the recent financial crisis on volatility and compare REIT and matching non-REIT common stock volatility. First, we consider the following two-stage auto-regressive model proposed by Schwert (1989). In the first stage, the unexpected return is estimated using the following regression model:
### Exhibit 10 | Proportionate Spreads and Stock's Trading Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Crisis</th>
<th>Post-Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>INTERCEPT</td>
<td>0.12***</td>
<td>0.10***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>REIT</td>
<td>0.06***</td>
<td>0.05***</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>LOG VOL</td>
<td>-0.02***</td>
<td>-0.02**</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>LOG NTRDS</td>
<td>-0.02***</td>
<td>-0.04**</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>LOG MV</td>
<td>-0.05***</td>
<td>-0.05**</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>LOG PRICE</td>
<td>-0.06***</td>
<td>-0.03**</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>PRIV AR</td>
<td>0.01***</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.004</td>
<td>0.151</td>
</tr>
</tbody>
</table>

Notes: To formally test the liquidity differences for non-mortgage REITs and non-REIT matching stocks, we analyze the following regression (Stoll, 2000):

$$\text{RSPRD} = \alpha_1 + \beta_1 \text{REIT} + \beta_2 \text{LogVOL} + \beta_3 \text{LogNTRDS} + \beta_4 \text{LogMV} + \beta_5 \text{LogPRICE} + \beta_6 \text{PRIVAR} + \epsilon,$$

where RSPRD is the time-weighted relative spreads for every five minutes of trading, REIT is a dummy variable that takes value of 1 for REITs and zero, otherwise, VOL is the volume traded, and NTRDS is the number of trades for every five minutes of trading. MV is the stock's market value, PRICE is the stock's price at the end of every five-minute period, PRIVAR is the price volatility during the five-minute trading period, and $\epsilon$ is the error term. Pre-crisis period consists of data from January 2005 to August 2008 and the remaining period is post-crisis period. White's corrected standard errors are reported in parentheses.

** Significant at 5% level.
*** Significant at 1% level.

\[ R_t = \sum_{k=1}^{5} \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + \epsilon_t, \quad (8) \]

where $R_t$ is the return on a stock for time $t$, and $D_k$ is a day-of-the-week dummy for day $k$. To avoid measurement errors due to the bid-ask bounce, we calculate
returns from the average of bid-ask prices (mid-quote) at the end of each five minutes of trading. The 12 lagged returns are included to account for short-term movements in conditional expected returns. The absolute value of the residual, \( e_r \), constitutes the estimate of the volatility for a stock at time \( t \).

In the second stage, we run the following regression model to analyze the return volatility:

\[
|e_{t,i}| = \alpha_0 + \beta_1 \text{REIT}_i + \beta_2 \text{RSPRD}_i + \beta_3 \text{DEPTH}_i + \beta_4 \text{VOL}_i + \beta_5 \text{NTRD}_i + \beta_6 M_i + \sum_{j=1}^{12} \delta_{ij} |e_{t-j,i}| + \mu_{t,i+1},
\]  

(9)

where \( \text{REIT} \) is a dummy variable that takes the value of 1 for REITs and zero otherwise, \( \text{RSPRD} \) is the time-lapse-weighted average relative spread, \( \text{DEPTH} \) is the time-lapse-weighted average volume supplied at the best bid and best ask, \( \text{ATS} \) is the average trade size, \( \text{VOL} \) is the volume traded, \( \text{NTRD} \) is the number of trades for each five-minute trading interval, \( M \) is a dummy variable that is equal to 1 for Mondays and 0 otherwise, and \( e_{t,i} \) is the residual from the return equation. The parameter \( \delta \) captures the persistence in volatility.

Pagan and Ullah (1988) find that the above two-stage estimation, using equations (8) and (9), leads to inconsistent estimates as the true volatility is unobservable. Also, Bollerslev and Domowitz (1991) note that the two-stage OLS model does not account for the volatility clustering observed in the data. To address these econometric problems, we use the following GARCH(1,1) specification:

\[
R_i = \sum_{k=1}^{5} \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + e_t, \quad \sigma_t^2 = \alpha_0 + \beta_1 \text{REIT}_i + \beta_2 \text{RSPRD}_i + \beta_3 \text{DEPTH}_i + \beta_4 \text{VOL}_i + \beta_5 \text{NTRD}_i + \beta_6 M_i + \alpha_1 e_{t-1}^2 + \gamma \sigma_{t-1}^2. 
\]  

(10)

Both equations are estimated simultaneously as one system. The variables are as defined previously. The selection of a GARCH(1,1) model is based on the tradeoff between accuracy and efficiency in model constructions. GARCH(1,1) has the lowest AIC and SIC values. We conduct the analysis using both the above mentioned model specifications. Since the results from the two models are qualitatively similar, we present only the results from GARCH(1,1) analysis.

In Exhibit 11, we summarize the results from the estimation of the various GARCH(1,1) models summarized by equations (10) and (11), using the high-frequency data sampled at a five-minute sampling frequency for all sample stocks for the pre- and post-crisis periods. Models 1 and 2 provide results for the pre-crisis period, while Models 3 and 4 provide the results for the post-crisis period.
### Exhibit 11 | Volatility GARCH Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Crisis</th>
<th>Post-Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>REITS</td>
<td>0.91***</td>
<td>0.41***</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>RSPRD</td>
<td>0.21***</td>
<td>0.11**</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>DEPTH</td>
<td>0.05***</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>VOL</td>
<td>0.01**</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>NTRDS</td>
<td>0.06***</td>
<td>0.16***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>MONDAY</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.05</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Notes: We report the results from the estimation of the following GARCH model for non-mortgage REITs and non REIT matching stocks:

\[ R_t = \sum_{k=1}^{5} \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + \epsilon_t. \]

\[ \sigma_t^2 = \alpha_0 + \beta_1 \text{REIT}_t + \beta_2 \text{RSPRD}_t + \beta_3 \text{DEPTH}_t + \beta_4 \text{VOL}_t + \beta_5 \text{NTRDS}_t + \beta_6 M_t + \epsilon_t \epsilon_{t-1} + \omega \epsilon_{t-1}^2. \]

\( R_t \) is the return on a stock for the five-minute interval \( t \), \( D_k \) is a day-of-the-week dummy for day \( k \), \( \sigma_t^2 \) is the conditional variance of \( \epsilon_t \) from the return equation, \( \text{REIT} \) is a dummy variable that takes value of 1 for REITs and zero otherwise, \( \text{RSPRD} \) is the time-lapse-weighted average relative spread, \( \text{DEPTH} \) is the time-lapse-weighted average volume at the best bid and best ask, \( \text{ATS} \) is the average trade size, \( \text{VOL} \) is the volume traded, \( \text{NTRDS} \) is the number of trades for each five minutes of trading, \( M \) is a dummy variable that is equal to 1 for Mondays and 0 otherwise, and \( \epsilon_t \) is the residual from the return equation. We report the standardized parameter estimates in this table. Pre-crisis period consists of data from January 2005 to August 2008 and the remaining period is post-crisis period. White’s corrected standard errors are reported in parentheses.

** Significant at 5% level.

*** Significant at 1% level.

The positive coefficient on the \( \text{REIT} \) dummy in Models 1 and 2 documents that REITs have significantly higher volatility than non-REIT matching stocks during the pre-crisis period. This relation reverses during the post-crisis period as documented by a negative and significant coefficient for the REIT dummy in Models 3 and 4. These results support Hypothesis 3. Consistent with the findings from the microstructure literature (see Jain and Jiang, 2014), we find a positive and statistically significant coefficient for \( \text{RSPRD} \), suggesting a negative relation...
between liquidity and volatility. We also find a positive and statistically significant coefficient for $NTRD$, which suggests that informed traders camouflage their trading activity by splitting one large trade into several small trades (Kyle, 1985; Admati and Pfleiderer, 1988). Thus the number of trades conveys private information as reflected by increased volatility (Jones, Kaul, and Lipson, 1994).

Overall, our results from GARCH analysis indicate that REITs have significantly higher volatility than non-REIT matching stocks during the pre-crisis period. We also document that, while the recent financial crisis increased the volatility for all of the sample stocks, the volatility for REITs as compared to non-REITs declined significantly during the post-crisis period.  

Robustness Tests

To address potential rival alternative hypotheses, we conduct several robustness tests. Specifically, we test whether our results are driven by exclusion of mortgage REITs, increased stock offerings by REITs during the post-crisis period, our matching process, or our definition of the crisis period. Results of these tests indicate that our findings of the changing REIT microstructure characteristics, in terms of improved liquidity and reduced volatility as compared to non-REIT stocks, during the post-crisis period are robust to these alternate economic or statistical explanations.

Mortgage vs. Non-mortgage REITs

It can be argued that mortgage REITs are different than the non-mortgage REITs and other common stocks as their fundamental and microstructural characteristics are more similar to fixed income securities. In the results presented thus far, we excluded mortgage REITs from our analyses. We test the robustness of our results by including the mortgage REITs and find results consistent with our findings. We conclude that our results are not driven by excluding mortgage REITs.

Increased REIT Seasoned Stock Offerings Post-crisis

We find that REITs significantly increased their seasoned equity offerings during the post-crisis period to raise capital (Exhibit 12). To test whether our results could be explained by the increase in REIT stock offerings, we excluded all the REITs with abnormal stock offerings during the post-crisis period. While we still find support for our significant liquidity and volatility differences results, we fail to find any statistical difference in trading activity, in terms of volume, number of trades, and number of quotes, between REIT and non-REIT common stocks during the post-crisis period. Therefore, the increased trading activity in REITs post-crisis may in fact be due in part to their increased seasoned stock offerings.
It can be argued that REITs are similar to value stocks (Anderson, Clayton, Mackinnon, and Sharma, 2005) and hence, a more appropriate metric to use for matching REITs and non-REITs should be book-to-market ratio. To test the robustness of our findings, we match the REIT and non-REIT stocks based on book-to-market ratio. We find results qualitatively similar to the ones presented earlier. We find that REITs have lower liquidity and higher volatility as compared to non-REIT stocks during the pre-crisis period. As with prior results, these relations reverse due to the financial crisis with REITs having higher liquidity and lower volatility.

**Matching Based on Trading Volume**

We test the robustness of our findings by matching the REIT and non-REIT stocks based on trading volume instead of market capitalization. This additional analysis gives us qualitatively similar results as presented earlier. We find that REITs have a lower number of trades and number of quotes, lower liquidity, higher price impact, and higher volatility as compared to non-REIT stocks during the pre-crisis period. As a result of the financial crisis, most of these relations change with
REITs having a higher number of trades and quotes, higher liquidity, lower price impact, and lower volatility.

**Double Sort Based on Market Capitalization and Trading Volume**

When we test the robustness of our findings by matching the REIT and non-REIT stocks first on market cap and then on trading volume, we find results consistent with those previously presented.

**Triple Sort Based on Fama and French (1993) Risk Factors**

We test the robustness of our findings by matching the REIT and non-REIT stocks first on market beta, then on market capitalization, and finally on book-to-market ratio. We find results consistent with those presented earlier.

**Alternate Definition for Post-crisis Period**

In our analysis, we define the post-crisis period as the period following August 2008. Our choice of date is based on the fact that during August of 2008, the S&P 500 index reached its local peak of 1300.68 and following that high price event saw an unprecedented decline. This period is marked by significant decline in market confidence and a dramatic collapse in risk appetites. An extreme flight to quality led to massive sell-offs in major world stock markets during September and October of 2008.

We test the robustness of our results using an alternate definition for the financial crisis period. The major world markets started showing signs of a financial crisis in the third quarter of 2007. The increasing inability of market participants to price some risky assets during this period, highlighted by the French bank BNP Paribas’s announcement to this effect on August 9, 2007, signaled the start of the financial crisis. The S&P 500 index hit its global maximum during October 2007 and ran downhill from there. Hence, we define post-financial crisis period as the period following October 2007. This exercise gives us even stronger results in terms of larger coefficients for the REIT dummy, supporting our findings.

**Excluding the Crisis Period**

Finally, we test whether our results are driven by the extreme market movements during late 2007 to early 2009. We remove this period and re-analyze the data. We find that most of our results hold to this alternate data sampling. However, we do not find any statistically significant difference in volatility between the pre- and post-crisis periods if we exclude the crisis period. Hence, our result of a
significant increase in volatility in our sample stocks during the post-crisis period is driven by the extremely volatile crisis period. A further analysis reveals that REIT volatility declined significantly during the post-crisis period.

**Conclusion**

In this study, we document the market quality differences between REIT and non-REIT common stocks. We define market quality in terms of stock market liquidity, price volatility, and price impact. We also test the impact of the recent financial crisis on the market quality for REITs and other common stocks. Finally, we present the differences in the intraday patterns of liquidity, volatility, and trading activity between REITs and non-REIT common stocks.

Prior to the recent financial crisis, we find that REITs have significantly poorer stock market quality, as documented by lower liquidity, higher price volatility, higher price impact, and lower trading activity, than non-REIT common stocks. However, the financial crisis dramatically improved the market quality for REITs. We find that, during the post-crisis period, REITs have higher liquidity, lower volatility, lower price impact, and greater trading activity than non-REIT stocks. These significant differences in stock market liquidity and volatility between REIT and non-REIT stocks and pre- and post-crisis periods are confirmed through regression analysis using Stoll’s (2000) model for relative spreads and the GARCH model, respectively. We show that our results are robust to alternate economic and statistical explanations for our findings.

Overall, our results suggest that REITs became more liquid during the post-crisis period. Additionally, their volatility and cost of trading declined significantly making them an attractive vehicle for adding diversification to investor portfolios. This is reflected by the increased trading activity in REITs during the post-crisis period.

Further, our analysis of intraday patterns indicates that it is preferable to trade REIT stocks during the closing hour of the trading day when liquidity is higher, volatility is lower, and the price impact is smaller as compared to the opening session of a trading day. By appropriately timing the trades, a trader can minimize transaction costs and improve execution quality.

This study contributes to the literature by not only documenting the significant market microstructure differences between the REIT and non-REIT common stocks but also presenting the evolution of market quality during the post-crisis period. Our results show that REITs behave differently as compared to non-REIT common stocks during the period of large market decline. Investors, fleeing risky investments, find the long-term diversification benefits of REITs more attractive during periods of high volatility and low interest rates. The portfolio adjustment actions of investors during these periods make REITs more liquid and less volatile.
Endnotes

1. A real estate investment trust (REIT) is a corporate tax designation for an entity that invests in real estate and is designed to provide a real estate investment structure similar to the structure provided by mutual funds for investment in stocks. This designation reduces or eliminates corporate taxes as long as a REIT distributes 90% of its taxable income as dividends. For more details, see Feng, Price, and Sirman (2011).

2. According to the National Association of Real Estate Investment Trusts (NAREIT), approximately 76% of all REIT shares were held by institutional investors in 2008. In fact, Huang and Zhong (2013) find that approximately 50% of all REIT shares are owned by the 25 largest institutional investors.

3. Chou and Chen (2014) argue that the unique characteristics of REITs create a very close tie between the performance of the REIT and the underlying property portfolio which, in turn, should increase the transparency in REIT valuation resulting in a higher liquidity.

4. This flight to REITs was further fueled by the historically low interest rates, which made the fixed income securities market less attractive to investors.

5. However, Cole (1998) finds that this increase in liquidity can be attributed to the “new REITs” going public between 1991 and 1993. These larger, higher priced REITs were traded with more volume than the REITs that existed in 1990. When he excludes these new REITs, he finds that there was actually a decline in REIT liquidity during that period.


7. Hill, Kelly, and Hardin (2012) examine accounting liquidity in the form of cash versus lines of credit and find that the proverbial saying “cash is king” holds for REITs as the market values cash over available lines of credit during periods of financial crisis.

8. Butler, Grullon, and Weston (2005) and Glascock and Lu-Andrews (2014) find that accounting liquidity is positively related to financial market liquidity. Cost of raising new capital is much higher when the financial markets are illiquid.

9. Subrahmanyam (2007) finds that there is significant liquidity spillover from REITs to non-REIT stocks.

10. Wang, Erickson, Gau, and Chan (1995) find that REITs have lower institutional investor participation and are followed by fewer stock analysts as compared to non-REIT stocks.

11. Jain (2005) documents that the way the trading takes place has changed dramatically over the past decade.

12. Devos, Ong, Spieler and Tsang (2013) examine the impact of the financial crisis on REIT institutional holdings. They suggest that the surge in volatility during periods of crisis may drive institutional investors away from REITs. However, their analysis of the various REIT subsectors (e.g. retail, industrial, etc.) reveals a “flight to quality” since institutional investors decreased their positions in the smaller riskier REITs and increased investment in larger, less risky ones.

13. McInish and Wood (1992) finds that most of the stocks experience lower liquidity (or higher spreads) at the start and the end of the trading day, and higher liquidity (or lower spreads) during the rest of the trading day, generating a U-shape pattern for spreads.
See Easley, Hvidkjaer, and Ohara (2010), Karolyi, Lee, and Van Dijk (2012), and Jain, Jain, and McInish (2016).

The fundamental and microstructural characteristics of mortgage REITs are more similar to fixed income securities.

Previous studies on REITs have matched REITs and non-REITs based on volume or liquidity. That process essentially matches based on a liquidity measure and then compares liquidity. In microstructure studies, however, match stocks are matched based on market capitalization, which is not a liquidity measure (see Stoll, 2000). We test the robustness of our results by matching REITs and non-REITs using volume, double sorting based on market capitalization and volume, and triple sorting based on Fama and French (1993) risk factors.

Due to computational limitations, we limit our analysis to the first month of each quarter—January, April, June, and October—for each of the sample years.

Quoted spread may not capture true trading cost since it might reflect differences in price levels across time and stocks.

We test the robustness of our results by deleting the extreme volatile period, the last quarter of 2007 through the first quarter of 2009, and by using an alternate post-crisis period definition. Details are provided in the robustness section.

Volume can proxy information arrival. This makes volume a proxy for liquidity since adverse selection (resulting due to information asymmetry) is an important component of liquidity (Kyle, 1985). Additionally, the new information about the financial markets should impact REITs and non-REITs similarly and hence, might not affect our findings.

Danielsen and Harrison (2000) find that determinants of REIT liquidity vary depending on the exchange where the security is listed and hence, we only analyze the REITs listed on NYSE.

Zhou and Anderson (2012) report extreme returns are more prominent for REIT returns compared to equities. Hence, REIT returns can be successfully modeled with GARCH models.

We analyzed Model 4 separately for REIT and non-REIT matching stocks and include a dummy variable, CRISIS, to control for the crisis period. We find the coefficient on CRISIS to be positive and statistically significant for both the REITs and non-REIT stocks at the 5% level of significance, which suggests that the recent financial crisis significantly increased the volatility for all the sample stocks.

Normal level of stock offerings is defined as the average stock offerings during the pre-crisis period by any given REIT. If any REIT’s stock offerings during the post-crisis period were significantly higher than the normal level, we excluded that REIT from our analyses.

References


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