

# **REITs and Market Microstructure: A Comprehensive Analysis of Market Quality**

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# **REITs and Market Microstructure: A Comprehensive Analysis of Market Quality**

## **Abstract**

*This study analyzes the market quality differences, in terms of liquidity and volatility, between Real Estate Investment Trusts (REITs) and non-REIT common stocks. The 2008 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 pre-crisis period. These relationships reverse during 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.*

*JEL classification: G12; G14; R33*

*Keywords: REITs, Liquidity, Volatility, Intra-day, GARCH, Financial Crisis*

## Introduction

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 higher level of institutional ownership for REITs limits managerial discretion (Jensen 1986) and improves corporate governance (Chung, Fung, and Hung 2012) implying a lower level of asymmetric information and, therefore, different risk characteristics as compared to non-REIT common stocks.<sup>1,2</sup> Although these different characteristics make REITs more attractive to general investors due to their potential for adding diversification benefits to stock portfolios (Huang and Zhong 2011; Chun, Sa-Aadu, and Shilling 2004), any diversification benefits must be weighed against market microstructure differences, such as stock market liquidity and price volatility, which translate into higher trading costs (Cannon and Cole 2011; Bertin, Kofman, Michayluk, and Prather 2005).<sup>3</sup>

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<sup>1</sup> 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 Sirmans (2011).

<sup>2</sup> 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 (2011) find that approximately 50% of all REIT shares are owned by the 25 largest institutional investors alone.

<sup>3</sup> Liquidity encompasses transactional properties of markets including tightness (distance between buy and sell quotes), depth (stock volume supplied at the best quotes), and resiliency (speed of stock price recovery after a shock). In simple terms, a stock is liquid if a trader can trade quickly without paying much premium. Volatility is a measure of riskiness of a stock and captures the movements in the stock prices.

Current microstructure research excludes REITs from the analysis of market quality due to their unique characteristics discussed above.<sup>4</sup> Hence, the liquidity and volatility differences between REITs and common stocks warrant a more in-depth analysis. Asset-pricing literature posits that illiquidity is priced (Amihud and Mendelson, 1991; Brennan and Subrahmanyam, 1996) which can result in a less efficient risk-return trade-off for REITs than desired if REITs are less liquid than other common stocks.<sup>5</sup> Additionally, volatility is a major determinant of option prices (Hasbrouck and Saar 2002; Foucault 1999), and plays an important role in execution strategies and investment decisions (Fleming, Kirby, and Ostdiek 2003). Therefore, the identification of intraday liquidity and volatility patterns of REITs can reveal optimal timing of trades to minimize trading costs or price impact. Further, a comparative analysis of these intraday patterns for REITs and non-REIT common stocks can verify REITs' substitutability for a common stock investor.

REITs' dependence on external financing can curtail their ability to exploit profitable investment opportunities (Mooradian and Yang 2001).<sup>6</sup> This constraint is likely to be more severe during market crises (Ben-David, Franzoni, and Moussawi 2011). At such times, capital providers may withdraw their funds and force companies to liquidate their positions prematurely which can deteriorate 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.<sup>7</sup> Hill, Kelly, and Hardin (2012) support this prediction for REITs and find that

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<sup>4</sup> See Easley, Hvidkjaer, and Ohara (2010); Karolyi, Lee, and Van Dijk (2012), Jain, Jain, and McInish (2013) among others.

<sup>5</sup> If the influence of REIT liquidity levels on returns is significant enough, the average investor may not consider REITs as comparable substitutes for common stocks.

<sup>6</sup> Also see Gromb and Vayanos (2010) for a survey of literature.

<sup>7</sup> See Chordia, Sarkar, and Subrahmanyam (2005), Goyenko and Ukhov (2009) and Baele, Bekaert, and Inghelbrecht (2010).

the market value of REITs holding more cash was higher during the recent financial crisis. 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.<sup>8</sup> Glascock, Michayluk, and Neuhauser (2004) support this prediction and document that REITs were much less affected than non-REIT stocks by the October 27, 1997 market decline which originated in foreign exchange markets. However, the 2008 financial crisis originated in the real estate market with the bubble burst in 2007. Hence, analyzing the effect of the 2008 financial crisis on REIT market quality and comparing that to the effect on non-REIT market quality could provide some interesting insights.<sup>9,10</sup>

Using high frequency intraday data, our analysis confirms that REITs have lower pre-crisis period liquidity than non-REIT stocks as documented by earlier studies. However, the liquidity for REITs has significantly improved during the post-2008 financial crisis period. Additionally, we find that REITs have substantially higher price volatility than non-REIT stocks during the pre-crisis period. Our results further show that, while the 2008 financial crisis has dramatically increased the price volatility for all common stocks, REITs have become less volatile as compared to matching non-REIT stocks during the post-crisis period. We also document improved trading interest in REITs during the post-financial crisis period as reflected by increased volume, number of trades and number of quotes.

Next, our analysis of intraday patterns indicates that REITs have lower liquidity and trading interest than non-REIT common stocks throughout the trading day during the pre-

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<sup>8</sup> Butler, Grullon, and Weston (2005) finds that the accounting liquidity is positively related to financial market liquidity. Cost of raising new capital is much higher when the financial markets are illiquid.

<sup>9</sup> We extend Cannon and Cole (2011) by presenting intraday patterns to identify optimal trading strategies for investors and analyzing the effect of the 2008 financial crisis on REIT stock market quality.

<sup>10</sup> Subrahmanyam (2007) finds that there is significant liquidity spillover from REITs to non-REIT stocks.

financial crisis period. Additionally, we find that the price impact, as measured by effective spreads and relative effective spreads, and price volatility is higher for REITs throughout the trading day when compared to non-REIT stocks during the pre-crisis period. However, this relationship is reversed following the financial crisis with REITs becoming more liquid, less volatile, and cheaper to trade as compared to non-REIT common stocks.

Regression analysis using the Stoll (2000) model for relative spread confirms the significant stock market liquidity differences between REIT and non-REIT stocks. Finally, we confirm robustness of our findings of price volatility differences between REITs and non-REIT stocks using several GARCH models.

We test several potential explanations for our findings. We find that the increase in REIT's trading activity can be explained by the increase in the seasoned equity offerings post-financial crisis. However, we cannot find any economic or statistical explanation for the changing REIT microstructure characteristics, in terms of improved liquidity and reduced volatility as compared to non-REIT stocks, during the post-crisis period. The underlying cause or the process of this evolution requires a more in-depth analysis and can lead to a fertile area for future research.

## 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. Brennan and Subrahmanyam (1996) indicate that illiquidity is priced and REIT returns may, therefore, be more related to stock market liquidity than the return on direct real estate investment. Bhasin, Cole and Kiely (1997) find a decline in REIT percentage bid–ask spreads during the 1990–1994 period. Improved REIT liquidity was confirmed by Below, Kiely and MacIntosh (1996) between 1992 and 1994 and Cole (1998) between 1991 and 1993.<sup>11</sup>

Clayton and MacKinnon (2000) extends the literature by analyzing the REIT liquidity for the period from 1993–1996. They find that self-advised, self-managed REITs exhibited liquidity declines during that period. More recently, Cannon and Cole (2011) analyze daily, non-microstructure data for the period of 1988-2007 and find that REIT liquidity “improved during the early and mid-1990s, deteriorated during the late 1990s, and then improved dramatically during 2000–2006.”

However, the above studies analyze the REIT liquidity during the pre-2008 financial crisis period.<sup>12</sup> Unavailability of external financing during the financial crisis could curtail REITs’ ability to exploit profitable investment opportunities (Mooradian and Yang 2001; Ben-David, Franzoni, and Moussawi 2011), which should be reflected by reduction in REIT’s stock

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<sup>11</sup> 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.

<sup>12</sup> 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.

market liquidity. We fill this gap in the REIT literature by analyzing the impact of the financial crisis on REIT liquidity.

*Are REITs less liquid than non-REIT common stocks?*

Another interesting area of research is the substitutability of REITs for non-REIT common stocks. The literature in this area, thus far, has ambiguous predictions. Nelling, Mahoney, Hildebrand and Goldstein (1995) document REIT liquidity to be similar to other common stocks' liquidity. However, Ghosh, Miles and Sirmans (1996) find that REIT liquidity may not be as liquid as comparably sized non-REIT stocks.<sup>13</sup> Since these studies consider a period before 1995, their findings are questionable in the current period.<sup>14</sup> Hence, comparing the 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.

*Intraday patterns for REIT liquidity and volatility*

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 changes in liquidity and volatility can have strong implications for timing of trades for investors in order to minimize trading costs or price impact. While there exists a rich literature analyzing the intraday patterns for various microstructure parameters (see McNish and Wood 1992), we could only find one study analyzing the intraday patterns for REITs (Bertin, Kofman, Michayluk and Prather 2005). These authors also compare these intraday patterns for REITs with matching non-REIT stocks. They show that REITs have the well-defined U-shape pattern for percentage

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<sup>13</sup> Wang, Erickson, and Chan. (1995) find that REITs have lower institutional investor participation and are followed by fewer stock analysts as compared to non-REIT stocks.

<sup>14</sup> Jain (2005) documents that the way the trading takes place has changed dramatically over the past decade.

spreads while they do not find any well specified intraday pattern for volatility. The authors further 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 the way trading takes place over the past decade and hence, the validity of the results based on the data from 1996 is questionable. In addition, based on previous discussion, we argue that the 2008 financial crisis might have a significant impact on investors' trading behavior and thus, the intraday patterns that define the stock market quality.

### *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 it also plays an important role in execution strategies and investment decisions (Fleming Kirby, and Ostdiek 2003). Despite its importance, only 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. Devos, Ong, Spieler and Tsang (2012) 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.

We extend this literature by presenting a comprehensive analysis of REIT volatility during the real estate market peak, bubble burst, and the financial crisis that followed by analyzing intraday data for the first month of each quarter (e.g. January, April, July, and October) for each year from January 2005 to June 2011. We not only analyze the evolution of REIT volatility during these periods but also present the intraday patterns and document the changes induced by the financial crisis.

### **Data and measures of liquidity and volatility**

Our sample includes the intraday price and the number of shares for every trade for all the REITs listed on the NYSE for the period from January 2005 to June 2011. We obtain our data from various sources and 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. 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 NAREIT StockWatch and the 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. The remaining REITs and non-REIT common stocks are matched based on the previous year-end market capitalization. Previous studies on REITs have matched REITs and non-REITs based on volume or liquidity.<sup>15,16</sup> This resulted in 214 REITs and 1,093 matching non-REIT stocks over the period of 42 months.

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<sup>15</sup> That process essentially matches based on a liquidity measure and then compares liquidity. Most microstructure studies, however, match stocks based on market capitalization, which is not a liquidity measure.

<sup>16</sup> See Stoll (2000).

We obtain the intraday data on stock prices, trading volume, best bid and ask quotes and the respective volume supplied for every five-minutes of trading from the Trades and Quotes (TAQ) database.

### *Liquidity Measures*

In words of Kyle (1985) “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,” Kyle (1985) 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 back to its original state after a large order. In simple terms, markets are liquid if a trader can trade quickly without paying much of a premium.

Trading volume, most recently studied by Bertin, Kofman, Michayluck and Prather (2005), has also been revealed as significant activity-based measures of liquidity. 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:

$$Quoted\ Spread = Sprd = \frac{\sum_{i=1}^t \Delta t_i (Ask_i - Bid_i)}{\sum_{i=1}^t \Delta t_i} \quad (1)$$

$$Relative\ Spread = Rsprd = \frac{\sum_{i=1}^t \Delta t_i \left[ \frac{(Ask_i - Bid_i)}{\left( \frac{Ask_i + Bid_i}{2} \right)} \right]}{\sum_{i=1}^t \Delta t_i} \quad (2)$$

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 and Lee, Mucklow and Ready 1993). However, 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.

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

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

where  $\Delta t_i$  is defined as the time lapse between quotes,  $VOL_i$  is the trading volume, and  $Midpoint_i$  is defined as

$$Midpoint_i = Bid - Ask\ Midpoint = \frac{(Ask_i + Bid_i)}{2}$$

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 captures the cost of an order by including both price movement and 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 execution cost actually paid by the trader 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*

Volatility is a major determinant of options prices (Foucault 1999; Hasbrouck and Saar 2002), and plays an important role in execution strategies and investment decisions (Fleming, Kirby, Ostdiek 2003). We present the time series variations in REIT volatility and test if the REITs are more volatile than comparable non-REIT stocks. We calculate time lapse weighted price volatility for each stock at the end of every five minutes of trading. This measure is defined as follows:

*Price Volatility = Privol*

$$= \text{SQRT} \left\{ \frac{\sum_{i=1}^t \Delta t_i \left[ \text{Price}_i^2 - \left( \frac{\text{Price}_i^2}{\text{Number of Trades}_i} \right) \right]}{\sum_{i=1}^t \Delta t_i} \right\} \quad (5)$$

The above volatility estimation approach presents a more accurate assessment of price volatility. 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*

Table 1 reports the descriptive statistics for the various market quality parameters for REITs and comparable non-REIT firms matched based on the total market capitalization at the end of the previous year. We report the means for the full sample period and for the pre-crisis period from January 2005 to July 2008 and the post-crisis period from August 2008 to June 2011, separately.<sup>17</sup> All the numbers reported in the table are calculated by taking the time-lapse-adjusted averages for each five-minute period of trading and then across stocks.

////////// *Insert Table 1 about Here* //////////

The results summarized in Columns (1) and (2) (full sample period) show that the REITs have about 10% lower trading volume (*VOLUME*) than comparable non-REIT stocks. We also find that the REITs are traded less than their non-REIT counterparts as reflected by lower number of trades (*NTRDS*). The combined effect of *VOLUME* and *NTRDS* reflect that the average trade sizes for REITs are significantly lower than non-REIT stocks. As already established, REITs are widely held by institutional investors. To reduce price impact, 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.

Table 1 further 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 the matching non-REIT stocks as reflected by higher effective

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<sup>17</sup> We test the robustness of our results by deleting the extreme volatile period from the last quarter of 2007 to the first quarter of 2009 and by using an alternate post-crisis period. Details are provided in the robustness section.

spreads (*ESPRD*) and relative effective spreads (*RESPRD*). Additionally, REITs are nearly 5 times more volatile than the matched non-REIT stocks over the full sample period.

These results contradict the findings of Bertin, Kofman, Michayluk and Prather (2005) who show that the REITs have lower liquidity and trading volume as compared to non-REIT stocks. In a further analysis, we test whether these contradictory results are due to the financial crisis of 2008 by dividing our sample into pre- and post-financial crisis periods. The results of this analysis are reported in Table 1, Columns (3) through (6). We find that during the pre-crisis period (Columns (3) and (4)), REITs have 36% less *VOLUME* and nearly 31% less *NTRDS* as compared to non-REIT stocks. We also find that the *NQUOTES* for REITs are almost 5% 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 *RESPRD*, and REITs are nearly 14 times more volatile than non-REIT stocks for every five minutes of trading.

Columns (5) and (6) show that the financial crisis has significantly impacted the trading activity and the market quality for both REITs and non-REIT stocks. We find that trading volume for REITs during the post-crisis period is nearly 3 times the trading volume during the pre-crisis period. We also find that the *NTRDS* for REITs has increased by almost 4 times while *NQUOTES* has increased by more than 3 times during the post-crisis period. Comparing the trading activity for REITs with non-REIT stocks during the post-crisis period, we find that the

VOLUME and NTRDS for REITs are much higher 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 the non-REIT stocks during the post-crisis period. We also document that the financial crisis has increased the volatility for non-REIT stocks, making them about 50% more volatile as compared to REITs.

Figures 1 through 8 graphically summarize the above results. Figures 1, 2 and 3 show that the financial crisis has substantially increased the volume, number of trades, and number of quotes for both REITs and non-REIT stocks. However, the most striking finding is that, while the trading interest during the pre-crisis period is higher for non-REIT matching stocks, REITs have higher trading activity during the post-crisis period.

*////////// Insert Figures 1 through 8 about Here //////////*

Figures 4 and 5 show that REITs have lower liquidity than non-REITs during the pre-crisis period as reflected by higher quoted and relative spreads. However, during the post-crisis period this relationship is reversed and REITs have lower quoted and relative spreads indicating higher liquidity when compared to their non-REIT counterparts. We also observe that the liquidity for both REITs and non-REIT matching firms deteriorated during the crisis period.

In figures 6 and 7, REITs have higher price impact when compared to non-REITs though 2008 as indicated by high effective and relative effective spreads. The financial crisis significantly increased the price impact for both REIT and non-REIT stocks reflecting the increased cost of immediate trading by impatient traders. We also observe that post-crisis REITs have significantly lower price impact than non-REIT matching stocks.

Figure 8 shows that the price volatility has been lower for both REITs and non-REIT stocks for the period from 2005 to mid-2007. Although the impact of the financial crisis is evident for both REIT and non-REIT stocks, REIT volatility increased dramatically during the crisis period. Volatility started declining during 2009 and reached its pre-crisis level by the end of that year. However, the volatility for REITs continued to decline during the post-crisis period, making them less risky than the comparable non-REIT stocks.

#### *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. Figures 9 through 16 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 the well-established U-shape patterns (see McNish and Wood 1992).

In Figures 9 through 11, 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 relationship 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 the intraday trading in both REITs and non-REITs has increased following the financial crisis, the level of trading in REITs has been significantly higher than that of non-REITs during the post-crisis period.

Figure 9 demonstrates that REITs end each pre-crisis period trading day with approximately the highest trading volume for the day and reaches its minimum at about 1:30 p.m. Non-REIT stocks show a similar pattern, however, they do have higher pre-crisis trading volume than REITs throughout the trading day. Post-crisis period trading volume for both REITs and non-REIT stocks begins the day at their highest point and follow a U-shaped pattern for the rest of the trading day. In contrast to the pre-crisis period, the trading volume for REITs is significantly higher than non-REIT trading volume throughout the post-crisis day.

In Figure 10, pre-crisis number of trades for both REITs and non-REITs has a steady decline from approximately 10:00 a.m. until about 1:30, after which the number of trades increases steadily to end the day at their highest level. The patterns for post-crisis number of trades for both REITs and non-REIT stocks appears to remain unchanged, however, post-crisis REIT number of trades increases to nearly twice the pre-crisis averages at the beginning of each day with the minimum at about 1:30 p.m.

Figure 11 illustrates the five-minute average number of quotes during a 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.

*////////// Insert Figures 9 through 11 about Here //////////*

Figures 12 and 13 illustrate the intraday patterns for our key liquidity measures – time-lapse weighted quoted spread and time-lapse weighted relative spread. Figure 12 shows that

during the pre-crisis period REITs were less liquid as compared to non-REIT matching stocks throughout the day. This relation is reversed during the post-crisis period with REITs having higher liquidity than non-REIT matching stocks throughout the day. We also observe a more pronounced inverted U-shaped pattern for quoted spreads for both REITs and non-REITs during the post-crisis period. In Figure 13, 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.

The intraday patterns for price impact as measured by time-lapse weighted effective and relative effective spreads are shown in Figures 14 and 15. We observe that the effective and relative effective spreads are larger at the start of the trading day and decline significantly during the first 30 minutes of trading during the pre-crisis period. After this initial decline, the level of effective spread remains stable for the rest of the trading day for both, REITs and non-REITs. Additionally, REITs experience a larger price impact than non-REITs during the pre-crisis period. However, this relationship reverses during the post-crisis period, with REITs experiencing lower price impact than non-REITs. The U-shape pattern for both effective and relative effective spreads is more pronounced during post-crisis period.

Figure 16 presents the intraday patterns for volatility. Non-REITs demonstrate high price volatility during the pre-crisis period during the start of the trading day followed by a steady decline during the rest of the day. The pre-crisis price volatility for REITs is much higher than non-REITs and displays a U-shape pattern throughout the trading day. However, during the post-crisis period REITs display much lower price volatility than non-REITs throughout the trading day.

////////// Insert Figures 12 through 16 about Here //////////

### *Regression analysis*

Further, we follow the Stoll (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 have to incur a cost for immediate trading due to the market frictions. These frictions can be measured by the price premium paid by a 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 spread between the bid and ask can measure the instantaneous cost of a round trip trade and hence, can be a measure of market frictions. Demsetz (1968) and Stoll (2000) model the cross-sectional relation of spreads to firms' trading characteristics in the following form:

$$RSPRD = \alpha_0 + \beta_1 \text{LogVOL} + \beta_2 \text{LogNTRD} + \beta_3 \text{LogMV} + \beta_4 \text{LogPRICE} + \beta_5 \text{PRIVAR} + \varepsilon \quad (6)$$

where *RSPRD* is the time weighted relative spreads for every five minutes of trading, *VOL* is the volume traded, and *NTRD* 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  $\varepsilon$  is the error term.<sup>18</sup>

To formally test the differences in liquidity between REITs and non-REIT matching stocks we add a dummy variable, *REIT*, to the above model specifications. We also add a dummy variable, *CRISIS*, to capture the impact of the recent financial crisis on liquidity. *CRISIS*

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<sup>18</sup> 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.

takes a value of 1 for the post-crisis period of August 2008-2011, zero, otherwise. Hence, our final regression model takes following form:

$$RSPRD = \alpha_0 + \beta_1 REIT + \beta_2 \text{Log VOL} + \beta_3 \text{Log NTRD} + \beta_4 \text{Log MV} + \beta_5 \text{Log PRICE} + \beta_6 PRIVAR + \varepsilon \quad (7)$$

Results from this analysis are summarized in Table 2. We find that relative spreads are negatively related to measures of trading activity, such as volume (*LOG VOL*) and number of trades (*LOG NTRDS*), and are positively related to stock's volatility (*PRIVAR*). Hence, 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 prices. These results are consistent with Stoll (2000) and Cannon and Cole (2011).

The coefficient for REIT is statistically significant 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* 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.

////////// *Insert Table 2 about Here* //////////

### *GARCH analysis*

Table 1 shows that REITs have higher volatility than non-REIT matching stocks. We formally test this volatility difference using several GARCH models. We also test the impact of the recent financial crisis on volatility of all the sample stocks. We control for various factors proposed in the literature that can explain 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 (2012), we use two different model specifications to analyze the effect of recent the financial crisis on volatility and comparing the REIT and the 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:

$$R_t = \sum_{k=1}^5 \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + \varepsilon_t \quad (8)$$

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,  $\varepsilon_t$ , 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:

$$|\varepsilon_{i,t}| = \alpha_0 + \beta_1 REIT_t + \beta_2 RSPRD_t + \beta_3 EP_t + \beta_4 VOL_t + \beta_5 NTRD_t + \beta_6 M_t + \sum_{j=1}^{12} \delta_{i,j} |\varepsilon_{i,t-j}| + \mu_{i,t+1} \quad (9)$$

where  $REIT$  is a dummy variable that takes value of 1 for REITs zero, otherwise,  $RSPRD$  is the time lapse weighted average relative spread,  $DEPTH$  is the time lapse weighted average volume at the best bid and best ask,  $ATS$  is the average trade size,  $VOL$  is the volume traded,  $NTRD$  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  $\varepsilon_t$  is the residual from the return equation. The parameter  $\delta$  captures the persistence in volatility.

However, Pagan and Ullah (1988) find that the above two stage estimation, using equations (5) and (6), 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 volatility clustering observed in the data. So, to take care of these econometric problem, we use the following GARCH(1,1) specification:

$$R_t = \sum_{k=1}^5 \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + \varepsilon_t \quad (10)$$

$$\sigma_t^2 = \alpha_0 + \beta_1 REIT_t + \beta_2 RSPRD_t + \beta_3 DEPTH_t + \beta_4 VOL_t + \beta_5 NTRD_t + \beta_6 M_t + \alpha_1 \varepsilon_{t-1}^2 + \gamma \sigma_{t-1}^2 \quad (11)$$

Both equations are estimated simultaneously as one system. The variables are as defined previously. The selection of 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.

Table 3 summarizes the results from the estimation of the various GARCH(1,1) models summarized by equations (11) and (12), using the high frequency five-minute data for all sample stocks for pre- and post-crisis periods. Models 1 and 2 show that REITs have significantly higher volatility than non-REITs matching stocks during the pre-crisis period. This relationship reverses during the post-crisis period. Models 3 and 4 show that the 2008 crisis has significantly

reduced the volatility for REITs.<sup>19</sup> We also find a positive and statistically significant coefficient for NTRD, which suggests that the informed trader camouflages his trading activity by splitting one large trade into several small trades (Kyle 1985; Admati and Pfleiderer 1988). Hence, 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 CRISIS has increased the volatility for the sample non-REIT stocks, the volatility for REITs has declined significantly during the post-crisis period.

////////// *Insert Table 3 about Here* //////////

## **Potential explanations for our results**

### *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. We test the robustness of our results by excluding the mortgage REITs and find even stronger support for our findings. Hence our results are not driven by inclusion of mortgage REITs.

### *Increased REIT's seasoned stock offerings post-crisis*

In pursuit of explaining our interesting findings, we explored the seasoned equity offerings by our sample REITs. We found that REITs significantly increased their seasoned

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<sup>19</sup> We analyzed the Model 4 separately for REIT and non-REIT matching stocks and find the coefficient on CRISIS to be positive and statistically significant for non-REIT stocks at 5% level of significance and negative and statistically significant for REITs at 1% level of significance.

equity offerings during the post-crisis period to raise capital (Figure 17). To test if our results could be explained by the excessive stock offerings, we excluded all the REITs with abnormal stock offerings during the post-crisis period.<sup>20</sup> 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. Hence, the increased trading activity in REITs post-crisis is due to their increased seasoned stock offerings.

////////// *Insert Figure 17 about Here* //////////

#### *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 lower number of trades and number of quotes, lower liquidity, higher price impact and volatility as compared to non-REIT stocks during the pre-crisis period. But, the financial crisis changes most of these relationships with REITs having higher number of trades and quotes, higher liquidity, lower price impact and volatility.

#### *Double sort based on market capitalization trading volume*

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 to the ones presented earlier.

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<sup>20</sup>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.

*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 to the ones presented earlier.

*Alternate definition for post-crisis period*

To derive our results, we define post-crisis period as the period following August 2008. Our choice is based on the fact that during August of 2008, S&P 500 index reached its local peak of 1300.68 and since then it saw an unprecedented decline. Together with the rest of the world, prospects for Asia and the Pacific abruptly changed in mid-September 2008 with the bankruptcy of Lehman Brothers. 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 world major markets during September and October of 2008.

We test the robustness of our results using an alternate definition for financial crisis. 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 9 August, 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 REIT and CRISIS 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 significant increase in volatility of our sample stocks during the post-crisis period is driven by the extremely volatile crisis period. A further analysis reveals that the REIT volatility has rather declined significantly during the post-crisis period.

## **Conclusion**

In this study, we document the market quality differences between the REIT and non-REIT stocks, matched based on market capitalization. We define market quality in terms of stock market liquidity, price volatility, and price impact. We also test the impact of the 2008 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 2008 financial crisis, we find that REITs have significantly poor stock market quality, as documented by lower liquidity, higher price volatility, higher price impact, and lower trading activity, than the non-REIT common stocks. However, the 2008 financial crisis has dramatically changed the market quality for REITs. We find that, during the post-crisis period, REITs have higher liquid, 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 the Stoll (2000) model for relative spread and GARCH model, respectively.

Overall, our results suggest that REITs have become more liquid during the post-crisis period. Additionally, their volatility and cost of trading has declined significantly making them

an attractive vehicle for adding diversification to any stock portfolio. This is reflected by increased trading activity in REITs during the post-crisis period.

Further, our analysis of intraday patterns indicates that REITs prior to the financial crisis have lower liquidity, higher volatility, greater price impact, and lower trading activity than non-REIT common stocks throughout the trading day. However, this relationship is reversed following the financial crisis. The intraday patterns suggest that it is preferable to trade REIT stocks during the closing hour of the trading day when the liquidity is higher, volatility is lower, and the price impact is smaller as compared to the opening session of a trading day. Hence, by appropriately timing the trades, a trader can minimize the transaction costs and improve the 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.

We explored several economic and statistical reasons for our findings but none of these can explain the changing REIT microstructure characteristics, in terms of improved liquidity and reduced volatility as compared to non-REIT stocks, during the post-crisis period. The underlying cause or the process of this evolution requires a more in-depth analysis and can lead to a fertile area for future research.

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**Table 1****Descriptive statistics**

We present summary statistics from January 1, 2005 through June 30, 2011 for all the REITs traded on the US 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 6 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. Then we 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

Variable	Full Period		Pre-Crisis Period		Post-Crisis Period	
	REITS	STOCKS	REITS	STOCKS	REITS	STOCKS
VOL	10,158	11,249	6,158	9,643	16,530	13,852
NTRDS	46.62	47.20	23.91	34.62	82.78	67.58
NQUOTES	659.57	739.75	331.35	347.33	1,182.33	933.50
QSPRD	26.69	33.92	31.84	15.51	23.69	41.55
RSPRD (%)	1.36	1.37	1.49	0.97	1.26	2.01
ESPRD	0.12	0.10	0.14	0.09	0.08	0.12
RESPRD (%)	0.49	0.48	0.51	0.36	0.42	0.68
PRIVAR (%)	0.08	0.03	0.10	0.01	0.04	0.06

**Table 2.****Proportionate spreads and stock's trading characteristics**

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

$$RSPRD = \alpha_0 + \beta_1 REIT + \beta_2 LogVOL + \beta_3 LogNTRD + \beta_4 LogMV + \beta_5 LogPRICE + \beta_6 PRIVAR + \varepsilon$$

where *RSPRD* is the time weighted relative spreads for every 5 minutes of trading, *REIT* is a dummy variable that takes value of 1 for REITs 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  $\varepsilon$  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.

Variable	Pre-Crisis		Post-Crisis	
	Model 1	Model 2	Model 3	Model 4
INTERCEPT	0.02*** (0.00)	0.02*** (0.00)	0.03*** (0.00)	0.05*** (0.01)
REIT	0.03*** (0.01)	0.03*** (0.00)	-0.07*** (0.01)	-0.06*** (0.01)
LOG VOL		-0.01** (0.00)		-0.03** (0.01)
LOG NTRDS		-0.01** (0.00)		-0.02** (0.00)
LOG MV		-0.02** (0.00)		-0.02** (0.00)
LOG PRICE		-0.02* (0.01)		-0.04* (0.02)
PRIVAR		0.03*** (0.00)		0.05*** (0.01)
ADJ R <sup>2</sup>	0.009	0.145	0.011	0.183

\*\*\* Significant at 1% level

\*\* Significant at 5% level

\* Significant at 10% level

**Table 3.****Volatility GARCH regression**

We report the results from the estimation of the following GARCH model:

$$R_t = \sum_{k=1}^5 \alpha_k D_k + \sum_{j=1}^{12} \beta_j R_{t-j} + \varepsilon_t$$

$$\sigma_t^2 = \alpha_0 + \beta_1 REIT_t + \beta_2 RSPRD_t + \beta_3 DEPTH_t + \beta_4 VOL_t + \beta_5 NTRD_t + \beta_6 M_t + \alpha_1 \varepsilon_{t-1}^2 + \gamma \sigma_{t-1}^2$$

$R_t$  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  $\varepsilon_t$  from the return equation,  $REIT$  is a dummy variable that takes value of 1 for REITs zero, otherwise,  $RSPRD$  is the time lapse weighted average relative spread,  $DEPTH$  is the time lapse weighted average volume at the best bid and best ask,  $ATS$  is the average trade size,  $VOL$  is the volume traded,  $NTRDS$  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  $\varepsilon_t$  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.

Variable	Pre-Crisis		Post-Crisis	
	Model 1	Model 2	Model 3	Model 4
REIT	1.21*** (0.20)	0.48*** (0.08)	-0.57*** (0.12)	-0.43*** (0.07)
RSPRD		0.04* (0.03)		0.03 (0.05)
DEPTH		0.01 (0.02)		0.01 (0.03)
VOL		0.04** (0.02)		0.01 (0.02)
NTRDS		0.28*** (0.04)		0.34*** (0.06)
MONDAY		0.03 (0.05)		0.05 (0.04)
ADJ. R <sup>2</sup>	0.07	0.18	0.06	0.15

\*\*\* Significant at 1% level

\*\* Significant at 5% level

\* Significant at 10% level

Figure 1. Trading Volume

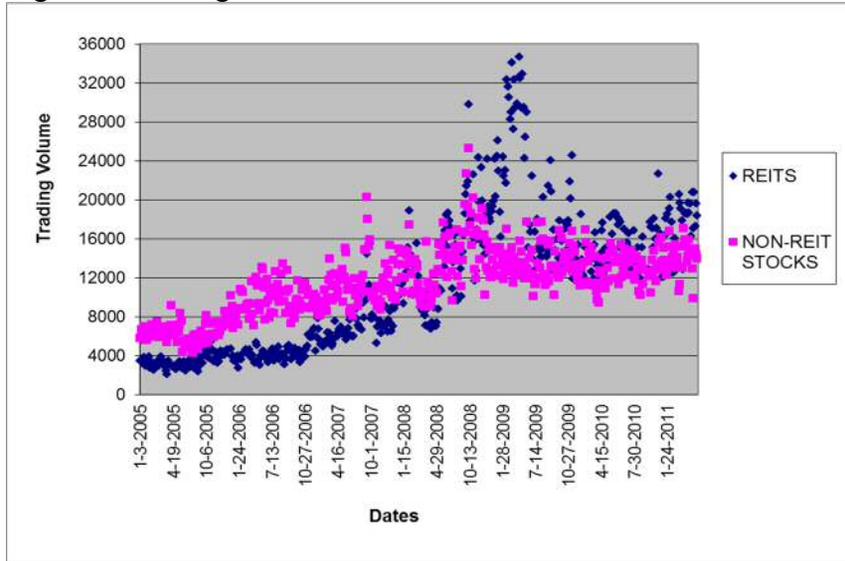


Figure 2. Number of Trades

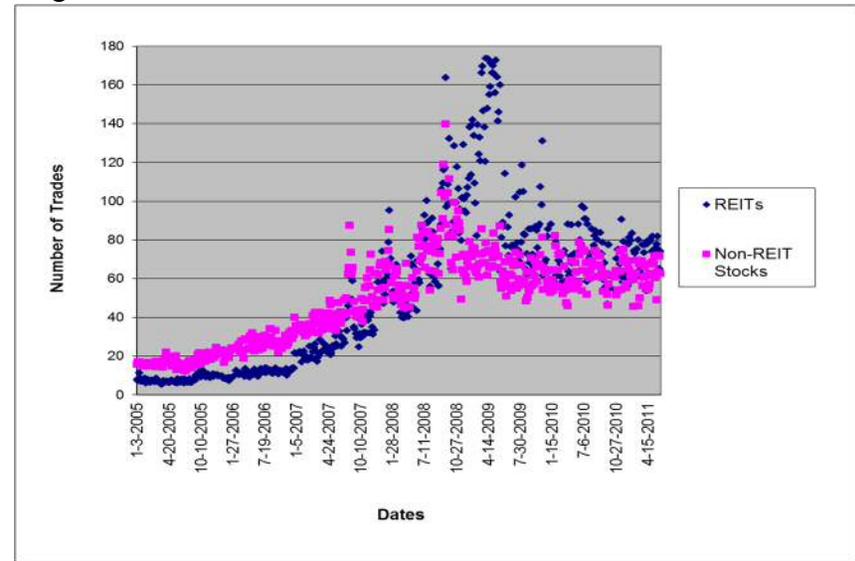


Figure 3. Number of Quotes

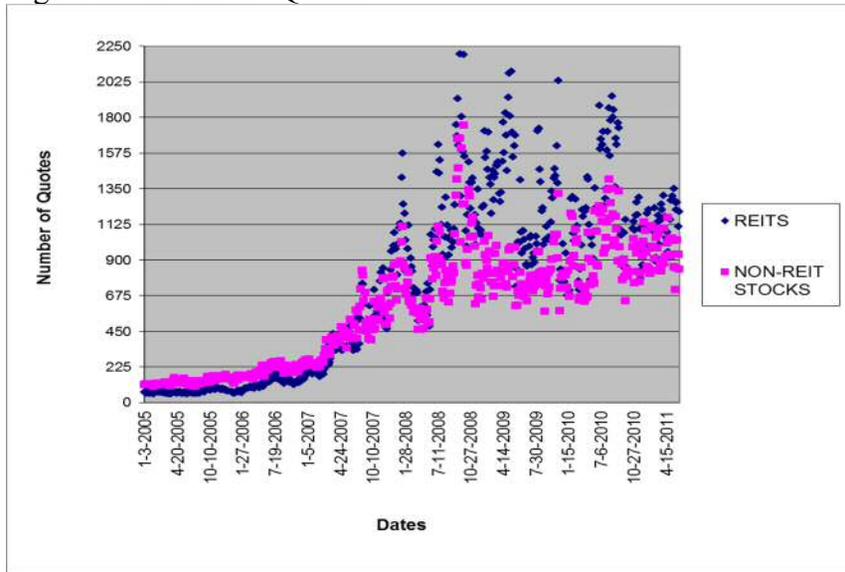


Figure 4. Time-weighted Quoted Spreads

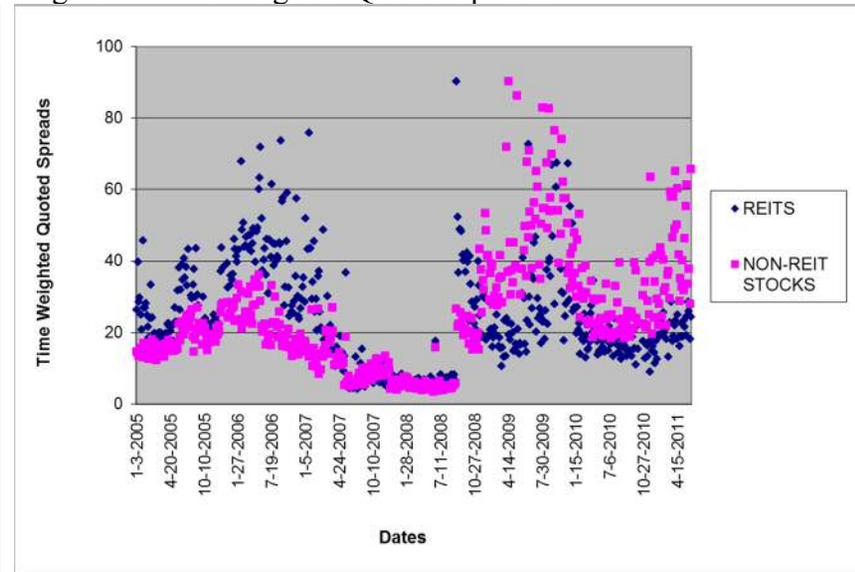


Figure 5. Time-weighted Relative Spreads

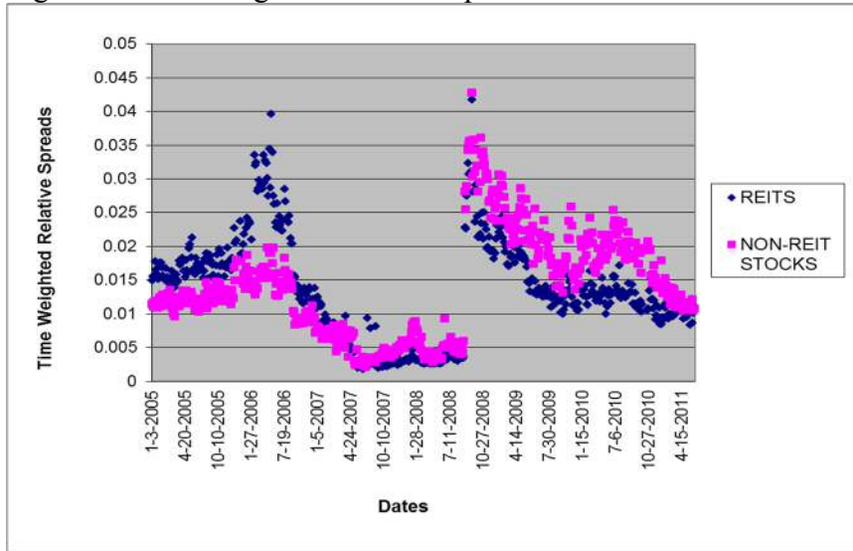


Figure 6. Time-weighted Effective Spreads

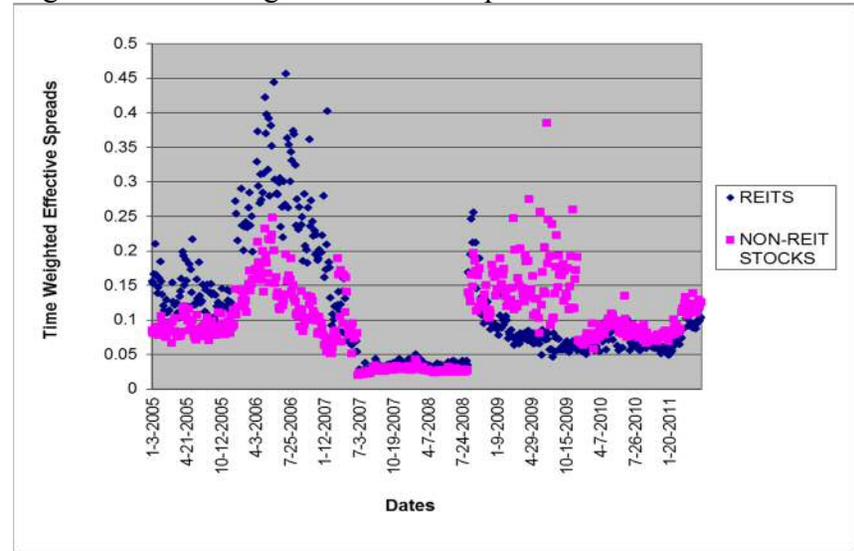


Figure 7. Time-weighted Relative Effective Spreads

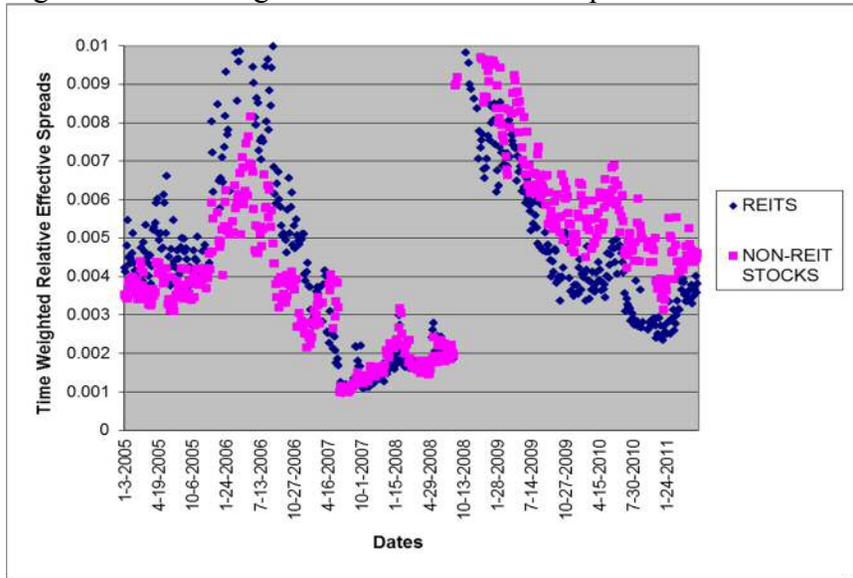


Figure 8. Time-weighted Price Volatility

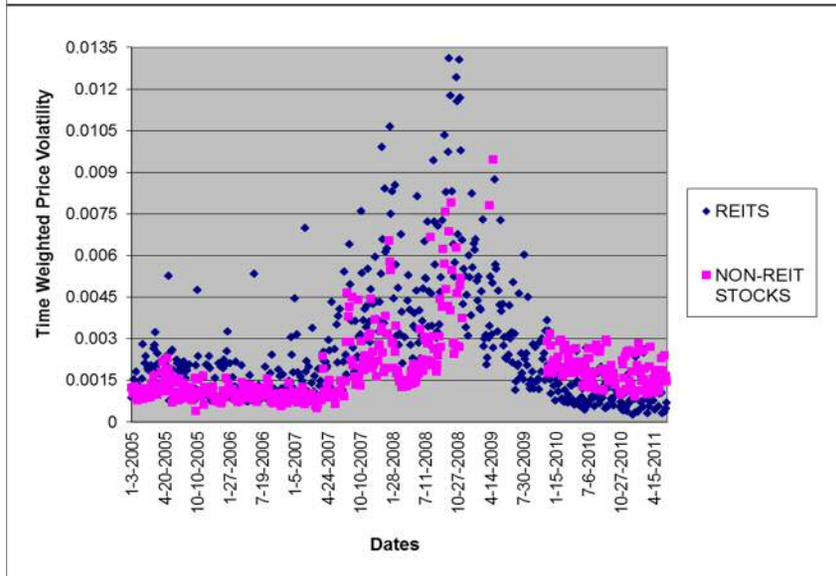
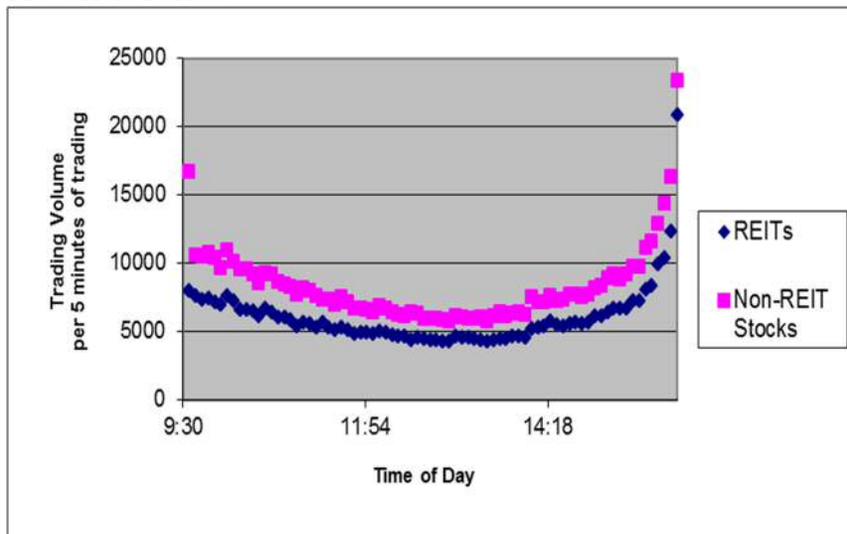


Figure 9. Intraday pattern for trading volume  
Pre-Crisis Period



Post-Crisis Period

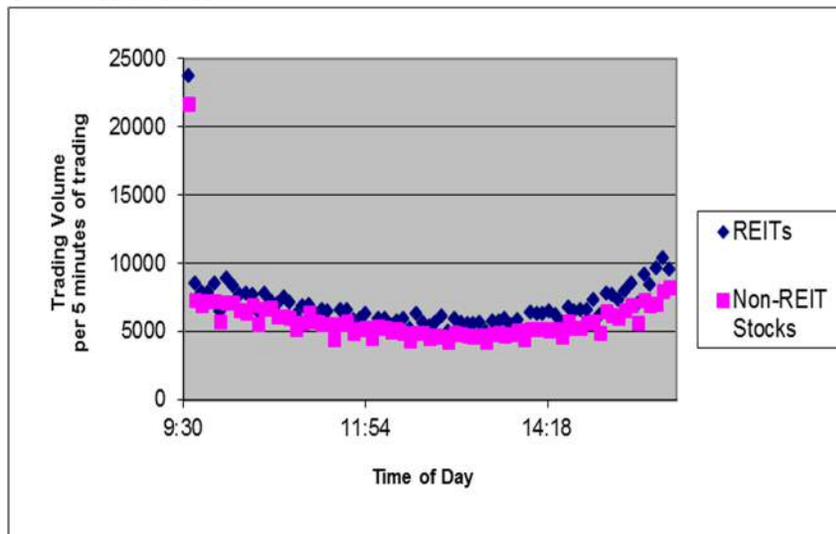
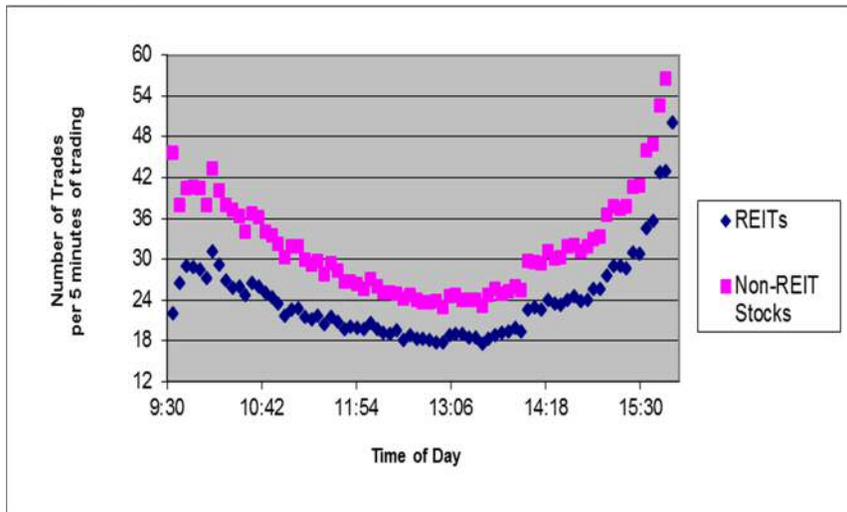


Figure 10. Intraday pattern for number of trades  
Pre-Crisis



Post-Crisis

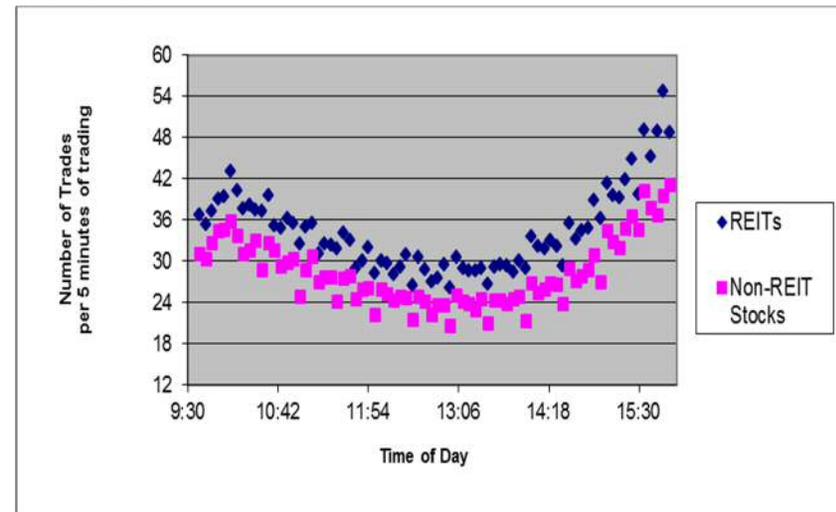
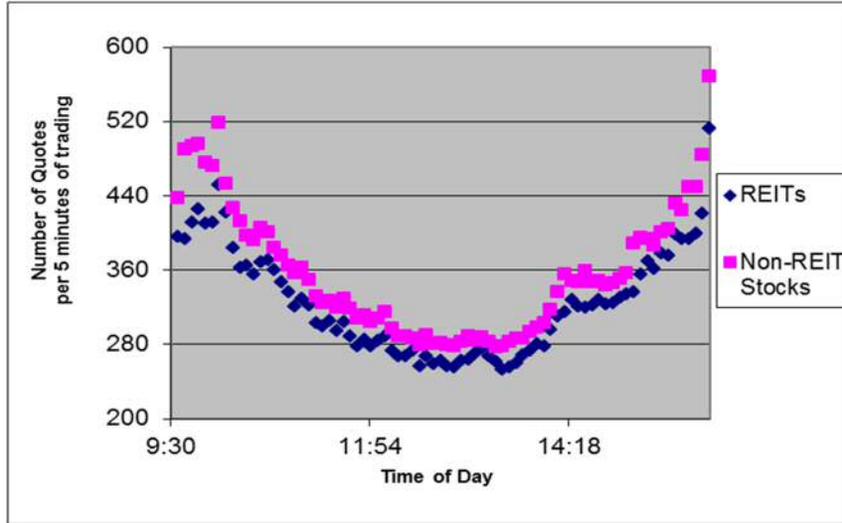


Figure 11. Intraday pattern for number of quotes  
Pre-Crisis



Post-Crisis

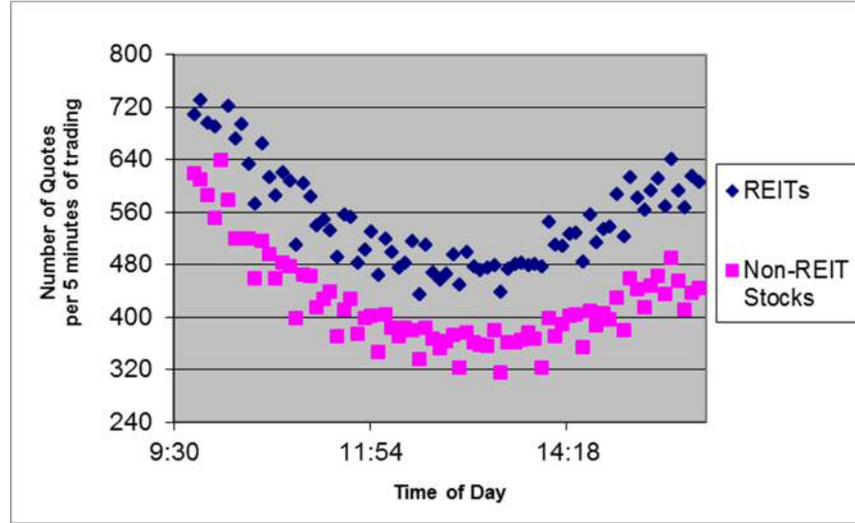
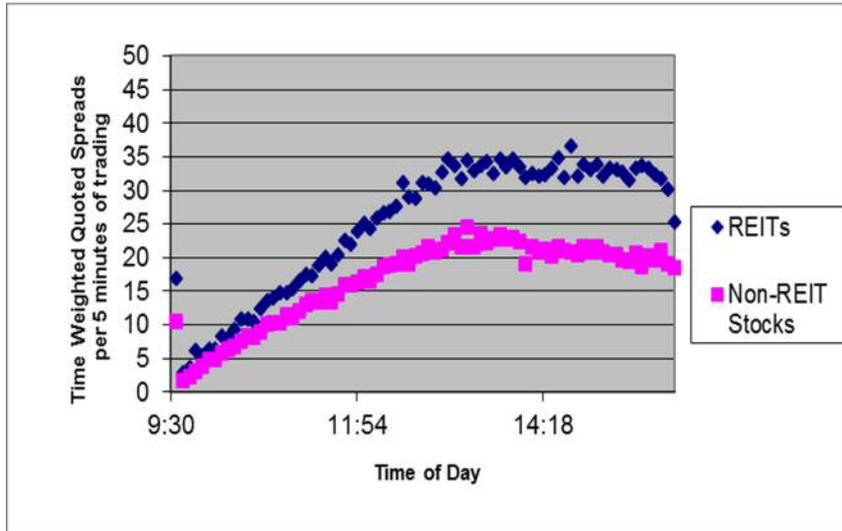


Figure 12. Intraday pattern for time weighted quoted spreads  
Pre Crisis



Post-Crisis

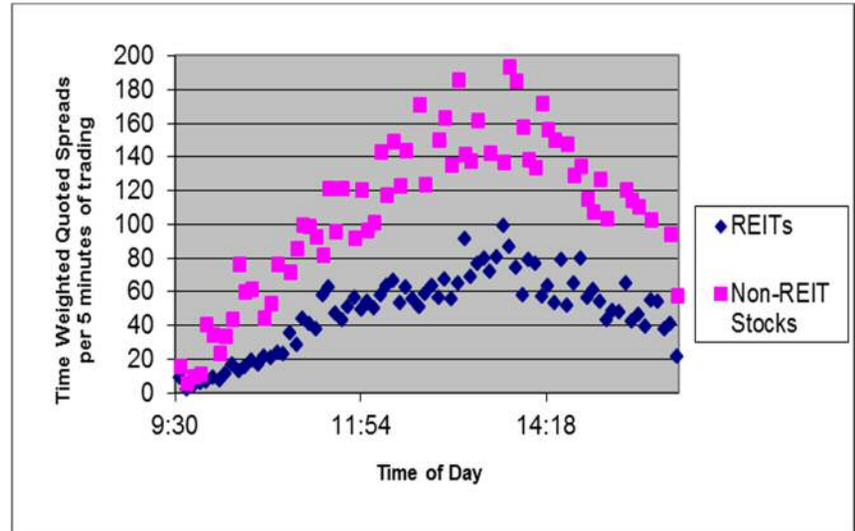
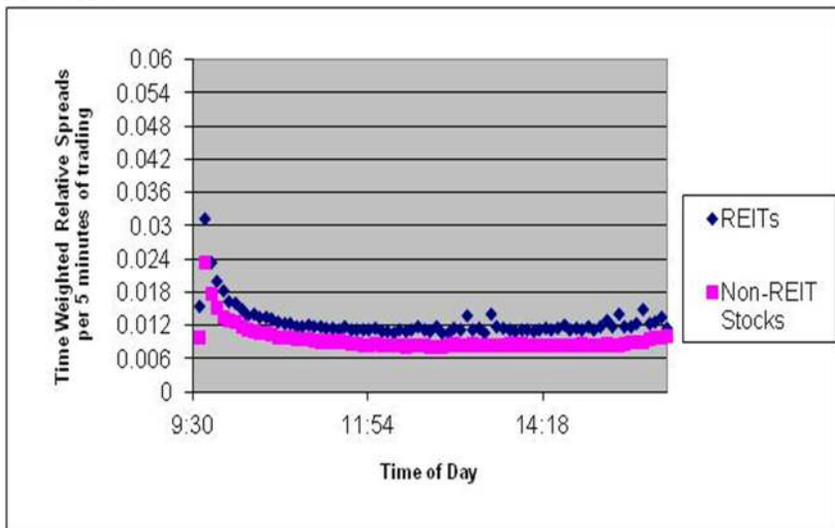


Figure 13. Intraday pattern for time-weighted relative spreads  
Pre-Crisis



Post-Crisis

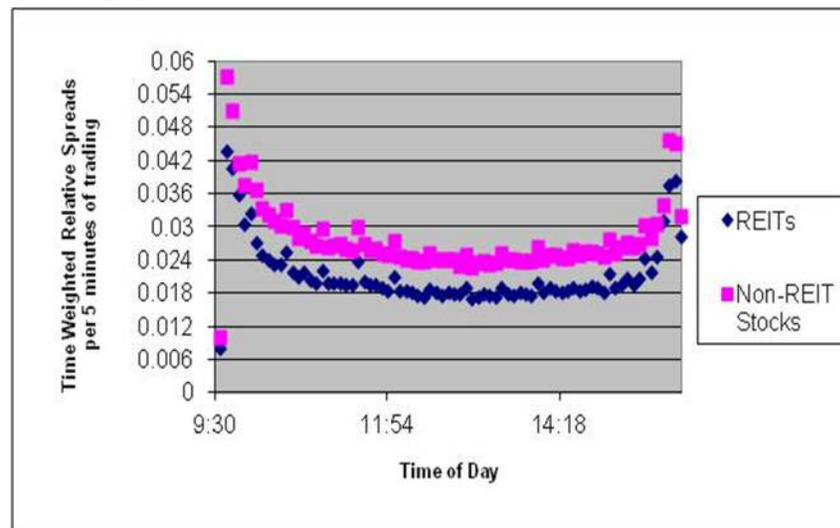
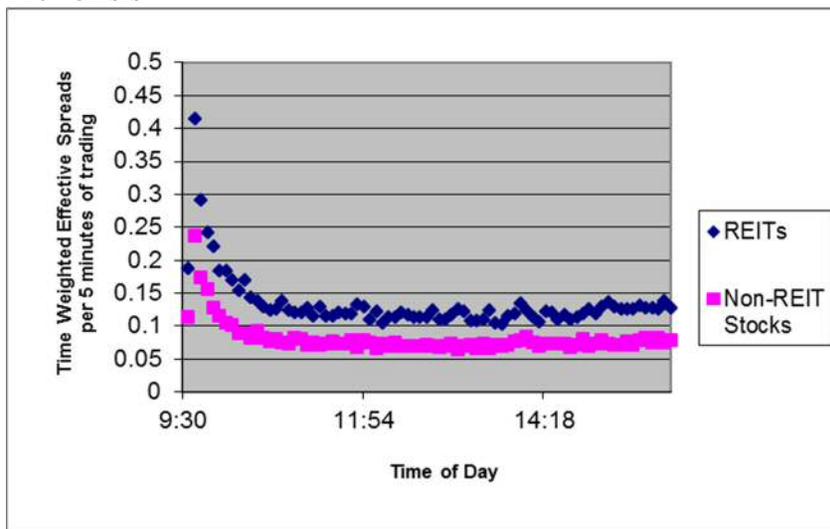


Figure 14. Time-weighted effective spreads  
Pre-Crisis



Post-Crisis

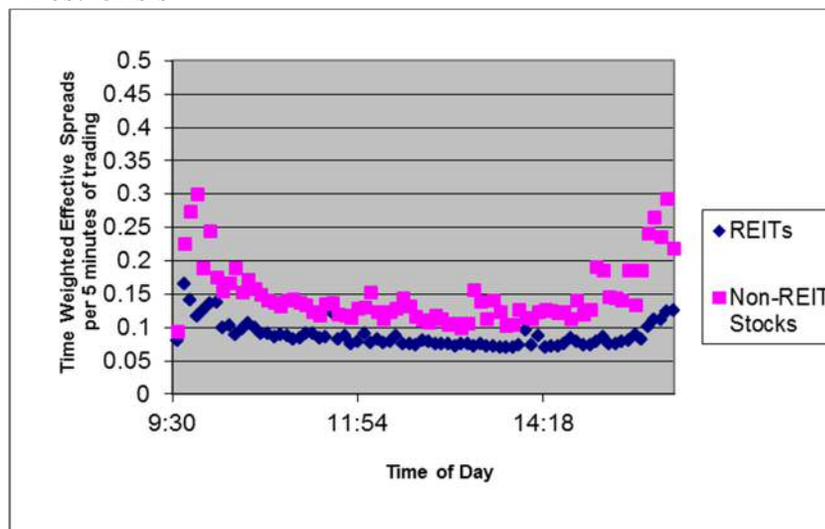
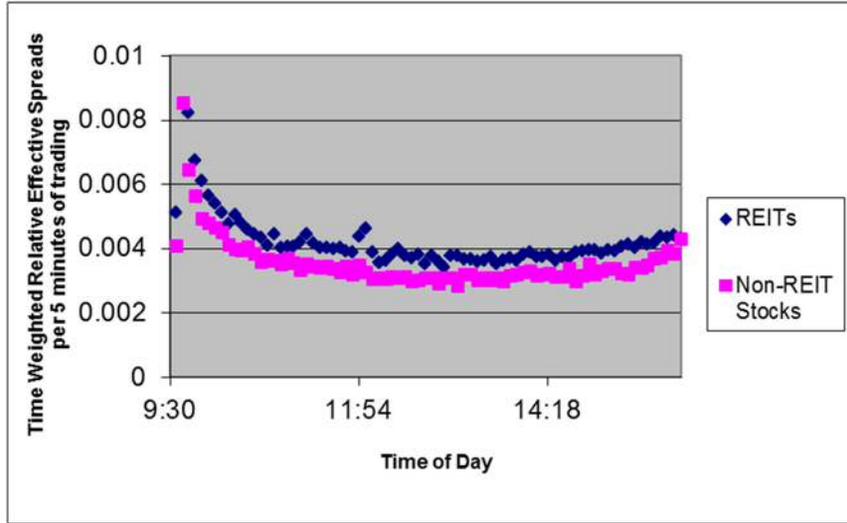


Figure 15. Time-weighted relative effective spreads  
Pre-Crisis



Post-Crisis

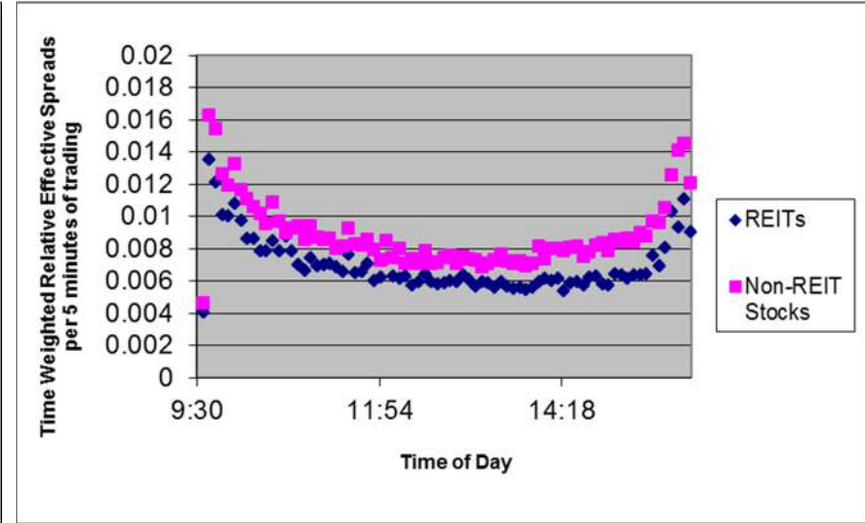
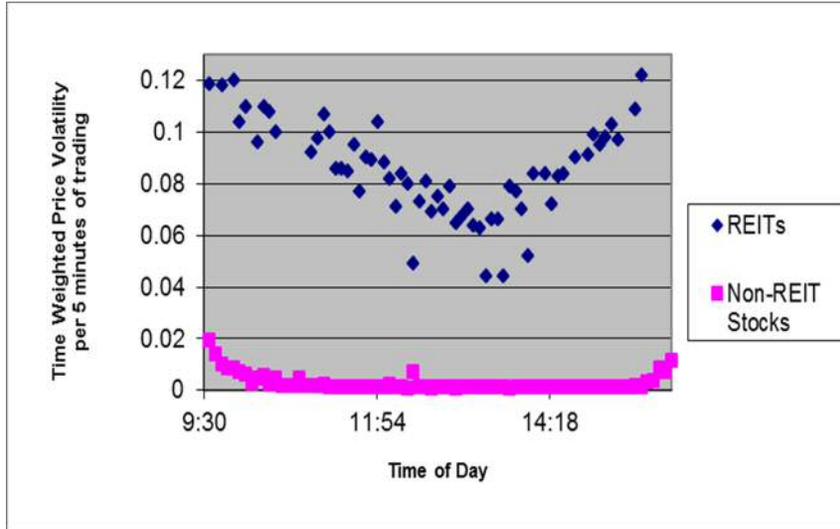


Figure 16. Time-weighted price volatility  
Pre-Crisis



Post-Crisis

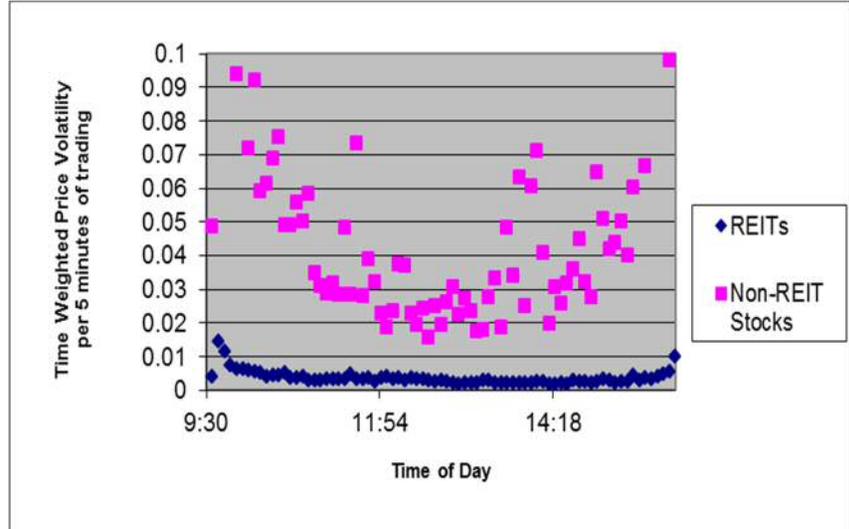


Figure 17. REIT's seasoned stock offerings

