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**Liquidity, Return, and Order Flow Linkages Between REITs  
and the Stock Market**

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## Abstract

### **Liquidity, Return, and Order Flow Dynamics Linkages Between REITs and the Stock Market**

This paper explores liquidity and order flow spillovers across NYSE stocks and real estate investment trusts (REITs). Impulse response functions and Granger causality tests indicate the existence of persistent liquidity spillovers running from REITs to non-REITs. Specifically, REIT liquidity indicators are forecastable from non-REIT ones, at both daily and monthly horizons. While REIT prices appear to be set efficiently in that neither REIT nor non-REIT order flows forecast REIT returns, we find that order flows and returns in the stock market negatively forecast REIT order flows. This result is consistent with the notion that real estate markets are viewed as substitute investments for the stock market, which causes down-moves in the stock market to increase money flows to the REIT market.

# 1 Introduction

Market microstructure research has exploded in recent years, mainly due to the recognition that while much theoretical literature in finance assumes frictionless markets, illiquidity and order flows do impact price formation. The role of illiquidity has recently attracted attention from traders, regulators, exchange officials as well as academics. Further, ever since the seminal work of Amihud and Mendelson (1986), many studies such as Brennan and Subrahmanyam (1996), Brennan, Chordia and Subrahmanyam (1998), Jacoby, Fowler, and Gottesman (2000), Jones (2001), and Amihud (2002) have documented the role of liquidity as a determinant of expected returns. In addition, Pástor and Stambaugh (2003) and Acharya and Pedersen (2005) relate liquidity risk to expected stock returns.

Since the literature suggests that stock returns and hence, firms' cost of capital, are influenced by levels of as well as fluctuations in liquidity, understanding time-series variation in this quantity is of fundamental relevance, and much research has focused on this issue. While early studies on the determinants of liquidity focused principally on the cross-section (e.g., Benston and Hagerman, 1974, and Stoll, 1978), recent work has shifted its focus towards studying the time-series properties of liquidity. Chordia, Roll and Subrahmanyam (2000, 2001), Hasbrouck and Seppi (2001) and Huberman and Halka (2001) consider co-movements in trading activity and liquidity in the equity markets.

Recently, there also has been an increase in interest in another microstructural quantity, namely, order imbalances. Researchers have explored the relation between order flows and both contemporaneous as well as lagged returns (see, for example, Chan and Fong, 2000, and Chordia, Roll, and Subrahmanyam, 2002, 2005). Part of the interest has likely been driven by the theoretical link between returns and order imbalances, manifested in well-known models of market microstructure. For example, the well-known Kyle (1985) model relates price changes to net (pooled) order flow. As Chordia, Roll, and Subrahmanyam (2002) point out, the Kyle setting is more readily applicable in the context of signed order imbalances over a time interval, as opposed to trade-by-trade data, since the theory involves pooled and not sequential trades. Similarly, the dynamic inventory models of Ho and Stoll (1983) and Spiegel and Subrahmanyam (1995) also study how market makers accommodate net order flows from outside investors.

An important step towards understanding the dynamics of liquidity and order flows (and their effect on asset returns) is to explore whether there are spillovers across different markets for investments. In this vein, some recent papers (Goyenko, 2005, Chordia, Sarkar, and Subrahmanyam, 2005) have gone beyond equity markets and considered liquidity and order flow spillovers across stock and fixed income markets. So far, however, the literature has restricted itself to investigating such spillovers within financial securities. As pointed out by Case, Quigley, and Shiller (2005), however, real estate forms a substantial portion of the portfolio of many agents, and consequently is likely to attract

both long-term investors as well as speculators. The empirical question naturally arises as to whether one can expect linkages in the returns, order flows, and liquidities across equities and real estate markets. The answer to such a question can potentially shed light on the economic issue of whether these alternative investments are complements or substitutes and whether there are concomitant pressures on trading costs as agents re-allocate assets in their portfolio after observing price moves in either asset.

While the above question is clearly intriguing, reliable data on direct investment in real estate is not readily available. One can indirectly trade real estate, however, through real estate investment trusts (REITs). These securities are actively traded on stock exchanges, and form a convenient avenue by which one can explore linkages between stock and real estate investments. Indeed, the market for REITs has boomed in recent years and by attracting considerable institutional and individual investor interest (Parsons, 1997, Clayton and MacKinnon, 2002). Part of this interest has stemmed from desiring liquid access to the real estate class of investments in times of stock market downturns, for example, during the mild recession of the 1990s and the technology stock decline of the early 2000s (see, e.g., Bhasin, Cole, and Kiely, 1997, and Ling and Naranjo, 2003).<sup>1</sup>

In this paper, we conduct an initial investigation into the nature of the joint dynamics across returns, order flows, and liquidity indicators for REITs and the stock market.

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<sup>1</sup>Articles in the popular press have also highlighted the tremendous growth in REIT markets, see, for example, “Thinking of investment in real estate? Get real,” J. Waggoner, *USA Today*, June 16, 2005, or “REITs Rally Again, Defying Predictions,” *Wall Street Journal*, J. Forsyth, March 22, 2006, p. D1.

Note that earlier liquidity studies such as Chordia Roll, and Subrahmanyam (2001) or Hasbrouck and Seppi (2001) have simply excluded REITs from their analysis. Our study, however, allows us to shed light on the economic question of whether real estate investments are substitutes or complements in relation to the stock market.<sup>2</sup> For example, when the stock market goes up, how does this affect order flows in REITs? Does stock market liquidity help forecast the liquidity of REITs? Is there contemporaneous comonality between the liquidity and order flos of REITs and stock market liquidity/order flows? To the best of our knowledge, the preceding questions have yet to be answered in the literature.

We use liquidity indicators that are obtained by averaging stock liquidity measures within a day, and then calculating daily value-weighted averages across stocks. Following a first-stage adjustment of the time-series to remove deterministic effects such as calendar regularities, vector autoregressions are employed to explore dynamic movements and co-movements in liquidity, returns, and order flows. To obtain reliable results, we use a long time-series of more than 3000 days of data, specifically, the period from 1988 to 2002.

In brief, our results can be summarized as follows. Our Granger-causality results indicate that stock market liquidity leads liquidity in REITs. In addition, order imbalances in the stock market also forecast order imbalances in REITs. We estimate impulse re-

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<sup>2</sup>Indeed, many arguments in the popular press suggest investing in the real estate market during periods of stock market downturns. See, for example, "Simple ways to diversify beyond stocks, bonds," by Mary Rowland, at <http://moneycentral.msn.com/content/Investing/StartInvesting/p8386.asp>.

response functions to examine the dynamics of the cross-sectional relationships in liquidity, volatility and returns between small and large cap stocks. The impulse responses show that REIT spreads respond to stock spreads, with the response peaking after one day. Dollar imbalances in the stock market inversely forecast number imbalances in REITs. Assuming number imbalances better capture the activities of retail investors than those of large institutions while dollar imbalances do the opposite, this suggests that small investors are induced to be net buyers of REITs following periods of heavy selling in the stock market. This result is consistent with the notion that real estate markets are viewed as substitutes to the stock market, at least by retail investors.

Our first-stage adjustment procedure also documents some interesting calendar regularities for non-REIT stocks that are not as pronounced for REITs. For example, we show that there is a statistically significant increase in spreads within the month of January, especially in the value-weighted portfolio of non-REIT stocks. This is consistent with the notion that portfolio managers' withdrawal from large stocks after end-of-the-year window-dressing affects liquidity at the beginning of the year. Such a phenomenon, is not expected for REIT stocks; this is consistent with what we find.

The rest of the paper is organized as follows. Section 2 provides a brief literature review. Section 3 describes how the liquidity data is generated, while Section 4 presents basic time-series properties of the data, and describes the adjustment process to stationarize the series. Section 5 provides an economic rationale for our vector autoregressions

(VARs) and presents our VAR results. Section 6 concludes.

## 2 Literature Review and Broad Hypotheses

The market for REITs, as well as the linkages between real estate markets and stocks have been analyzed extensively. The specific issues that we consider, however, have not yet been addressed. Thus, Ling and Naranjo (2003) analyze the linkage between REIT capital flows and REIT returns at a quarterly horizon. They do not, however, address the dynamic linkage between REITs and the stock market. Quan and Titman (1999) consider the linkages between real estate markets and stock markets in an international context, while Gyourko and Keim (1992) analyze the forecasting ability of stock returns for real estate returns. These papers, however, do not consider order flows and liquidity. Liu, Hartzell, Grissom, and Greig (1990) and Goetzmann and Ibbotson (1990) analyze the return performance of REITs, while Chan, Hendershott, and Sanders (1990) consider the factor structure of REIT returns, but again, do not analyze the microstructural aspects that we consider. In a paper closely related to ours Wang, Erickson, Gau, and Chen (1995) analyze institutional holdings and analyst following in REITs but do not explicitly consider the joint dynamic structure of the liquidity of REIT and non-REIT stocks.

In sum, the joint dynamic structure of liquidity, returns, and order flows across REITs and the stock market has yet to be analyzed. Such an analysis fills a lacuna in

the literature which is potentially valuable. Thus, do investors view real estate and the stock market as substitutes or complements? Arguments can be made for either scenario. For example if stock market participants invest more in real estate markets when they become more wealthy (i.e., when returns go up), as suggested by Cocco (2005) and Kullman and Siegel (2003), then we would expect real estate markets to positively respond to stock returns and order flows. We would also expect a co-movement in liquidity because order imbalances are intimately related to illiquidity indicators (Chordia, Roll, and Subrahmanyam, 2002).

Stock markets and real estate may also be viewed as substitutes by investors. If stock markets depreciate in value, it may be that some speculators, either irrationally or rationally, extrapolate that stocks no longer represent an attractive investment opportunity and shift to the alternative real estate market (viz., Case and Shiller, 2003, Case, Quigley, and Shiller, 2005, or Barberis, Shleifer, and Vishny, 1998). This would cause a negative relation between real estate and stock market returns and order flows. Liquidity spillovers also are predicted in this scenario, because order flows generally exert a contemporaneous influence on liquidity owing to inventory pressures (Ho and Stoll, 1983).

### **3 Liquidity and Trading Activity Data for REITs and non-REIT stocks**

Stock liquidity data were obtained for the period January 1, 1988 to December 31, 2002 (the data extends the time-period considered of Chordia, Roll, and Subrahmanyam, 2001, by four additional years). The data sources are the Institute for the Study of Securities Markets (ISSM) and the New York Stock Exchange TAQ (trades and automated quotations). The ISSM data cover 1988-1992, inclusive, while the TAQ data are for 1993-2002.

This paper analyzes liquidity measures that the previous literature has focused upon, viz., quoted and effective spreads. Based on earlier literature (e.g., Amihud and Mendelson, 1986, Benston and Hagerman, 1974, and Hasbrouck 1991), we also analyze returns and trading activity. We use order imbalances as measures of trading activity, rather than volume, because imbalances bear a stronger relation to returns representing aggregate pressure on the inventories of market makers. These imbalances are calculated using the Lee and Ready (1991) algorithm, and, as such, are estimates of the true imbalances. Since imbalances are intimately related to returns (see Chordia, Roll, and Subrahmanyam, 2002), the use of returns (in addition to imbalances) allows us to pick up any imbalance-related effects that may be attenuated by the use of an imperfect proxy for the imbalance variable.

We follow the filter rules and selection criteria in Chordia, Roll and Subrahmanyam (2001) to extract transaction based measures of liquidity and order imbalances from transactions data. The measures we extract are: (i) quoted spread (QSPR) measured as the difference between the inside bid and ask quote (ii) effective spreads (ESPR), defined as the twice the absolute difference between the transaction price and the mid-point of the prevailing quote. The transactions based liquidity measures are averaged over the day to obtain daily liquidity measures for each stock. The daily order imbalance is calculated in two ways: OIBNUM is defined as the number of buys less the number of sells sold divided by the total number of buys plus sells, and OIBDOL is defined as the dollar value of shares bought less the dollar value of shares sold divided by the total dollar value of shares traded.

To mitigate bid-ask bounce effects within our sample, we do *not* use CRSP for calculating returns. Instead, we use the mid-points of closing bid-ask quotes from the transactions databases for this purpose. Specifically, the daily return for each stock is obtained as the relative change in the last bid-ask quotation of each day, relative to that of the previous day.

Once the individual stock data is assembled, in each calendar year, the stocks are divided into two groups. The first group is real estate investment trusts (REITs) that were listed throughout the period on the NYSE.<sup>3</sup> The second group consists of all non-

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<sup>3</sup>We focus our attention on equity REITs and not mortgage REITs, because the latter are not

REIT NYSE stocks that were listed continuously during our sample period.<sup>4</sup> Each year, value-weighted daily averages of liquidity are then obtained for each portfolio, and daily time-series of liquidity are constructed for the entire sample period, based on market capitalization as of the end of the previous calendar year.

In our analysis, returns are adjusted for calendar regularities and autocorrelations. First, value-weighted returns are calculated for each portfolio. Then, we obtain the modified returns as the residuals from the following regression (see Schwert, 1990, Jones, Kaul, and Lipson, 1994, and Chan and Fong, 2000):

$$R_{it} = a_1 + \sum_{j=1}^4 a_{2j} D_j + \sum_{j=1}^{12} a_{3j} R_{it-j} + e_{it}, \quad (1)$$

where  $D_j$  is a dummy variable for the day of the week and  $R_{it}$  represents the daily return on the stock.

Finally, OIBNUM and OIBDOL are obtained as daily value-weighted averages of the individual stock values of these quantities. At the end of these exercises, we have complete time-series of returns, order flow measures, and quoted as well as effective spreads for the two portfolios. In our tables, we attach an “N” prefix to our variables to denote the quantities for the non-REIT portfolio.

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completely representative of hard asset investment in real estate.

<sup>4</sup>In a manner consistent with economic intuition, on days where no trade was recorded in a security, the order imbalance, the return, and the change in liquidity were imputed to be zero relative to the previous day.

## 4 Basic Properties of the Data

### 4.1 Summary Statistics

In Table 1, we present summary statistics associated with liquidity, returns, and order imbalance measures. Since previous studies such as Chordia, Roll, and Subrahmanyam (2001) suggest that the reduction in tick sizes likely had a major impact on bid-ask spreads, we provide separate statistics for the periods before and after the two changes to sixteenths and decimalization.

We note that quoted spreads are below effective spreads in every case, which is consistent with intuition, because effective spreads capture the effects of orders executing within the posted bid-ask quotes. The difference between the spreads for REIT and non-REIT stocks, however, has narrowed in recent years. For example the difference is about six cents in the eighths regime but dropped to about one cent in the decimal regime. Figure 1 plots the time-series for quoted spreads for REITs and non-REIT stocks. The figure documents the spread declines caused by the two changes in the tick size and also demonstrates how spreads of the two categories of securities have converged in recent years. In particular, REIT spreads have dropped to levels very close to that of non-REIT stocks following decimalization.

Also note that the standard deviation of the liquidity variables is greater for REITs than for non-REITs but this may be due to the smaller quantity of firms that comprise the

REIT portfolio. The order imbalance and return numbers do not show any consistent patterns across the two categories of securities. For example, the mean OIBNUM is greater for REITs in the eighth regime, but the inequality reverses direction in the sixteenth period and then reverses direction again in the decimal period. The average value of OIBDOL is bigger for non-REIT stocks relative to REITs for the eighth and sixteenth regime but the reverse is true in the decimal regime. The return performance of REITs was markedly better than non-REITs in the decimal period, which is consistent with the higher values of imbalances for REITs relative to non-REITs in this period.

In Table 2, we present the correlation matrix for returns and order flows (Panel A) and liquidity variables (Panel B). It is interesting to note that REIT returns are negatively correlated with order imbalances in non-REIT stocks, though the magnitude is modest. This suggests that when REIT returns are low, imbalances are greater in non-REIT stocks. We will shed more light on this type of cross-effect in Section 5. Note that the correlations between non-REIT returns and order imbalances are trivial, suggesting that the contemporaneous influence of REIT order flows on the stock market is modest. This result is consistent with intuition, given that REITs are a specialized market segment.

Order imbalance measures for both REIT and non-REIT portfolios are positively cross-correlated, though, as is expected, the own correlations are larger than the cross-portfolio ones. We also observe that the liquidity measures are all positively correlated with each other, suggesting joint determination of spreads in REITs and non-REITs.

## 4.2 Adjustment of Time-Series Data on Liquidity

Our goal is to explore the dynamic relationships between liquidity, price formation, and trading activity, across REITs and non-REITs, at the daily and monthly horizons. Liquidity across stocks may be subject to deterministic movements such as time trends and calendar regularities. Since we do not wish to pick up such predictable effects in our time-series analysis, we adjust the raw data for deterministic time-series variations in a manner similar to Gallant, Rossi, and Tauchen (1992) and Chordia, Roll, and Subrahmanyam (2005).

All the series, returns, order imbalance, spreads, depths, and volatility are transformed by linear regressions on a set of adjustment variables, which are as follows. First, to account for calendar regularities in liquidity, returns, and volatility, we use (i) four dummies for Monday through Thursday; (ii) 11 month of the year dummies for February through December, and (iii) a dummy for non-weekend holidays set such that if a holiday falls on a Friday then the preceding Thursday is set to 1, if the holiday is on a Monday then the following Tuesday is set to 1, if the holiday is on any other weekday then the day preceding and following the holiday is set to 1; this captures the fact that trading activity declines substantially around holidays. We also include (iv) a time trend and the square of the time trend to remove deterministic trends that we are not seeking to explain.

Table 2 presents the regression coefficients for liquidity measures. Panels A and B document results for REITs and non-REITs, respectively. We find that the post-16th dummy is not significant for REIT quoted spread, suggesting that the 1/8 tick size was not binding for these companies. However, this dummy is indeed significant for effective spreads, suggesting that many REIT transactions executed at lower costs within the quotes in the eighth regime. The decimalization dummy is significant for both indicators and both samples of stocks, suggesting that the move to pennies reduced spreads uniformly for both samples.

We find that day of the week regularities are not present to any material or significant extent in REIT liquidity indicators, though spreads appear to be lower at the beginning of the week for non-REIT stocks (the latter evidence is consistent with Chordia, Roll, and Subrahmanyam, 2001). However, the beginning of the year results in high quoted spreads for both categories of securities. This is consistent with the notion that portfolio managers' withdrawal from large stocks after end-of-the-year window-dressing affects liquidity at the beginning of the year. Regularities are less noticeable for effective spreads. This may either be due to noise in measuring effective spreads (since they are calculated by matching earlier quotes to later transactions), or because the costs of executing large institutional trades captured in effective spreads (since quoted spreads are only valid for small orders) are less susceptible to liquidity-affecting trading patterns induced by individual investors. With the exception of quoted REIT spreads, periods surrounding

holidays appear to have higher liquidity, suggesting smaller order imbalances during these periods which may lead to decreased spreads. Also, a lack of small investor activity around holidays may lead to higher quoted spreads for REITs.

In the remainder of the paper, we analyze joint dynamics in the adjusted series (comprising of residuals obtained from the Table 2 regressions) of illiquidity indicators. For convenience, however, we retain the same variable names (QSPR and ESPR), with the appropriate prefixes for REIT and non-REIT securities.

## 5 Vector Autoregressions

As discussed in Section 2 Our goal is to explore intertemporal associations between market liquidity, returns, and order imbalances across the two categories of stocks. We therefore use vector autoregression (VAR) methodology. We estimate two separate types of VARs. In the first VAR, we look for joint dynamics in the liquidity measures for REIT and non-REIT securities. In the second, we analyze returns and order flows across the two different categories of securities.<sup>5</sup>

In each case, we choose the number of lags on the basis of the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). Where these two criteria indicate different lag lengths, we choose the lesser lag length for the sake of parsimony.

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<sup>5</sup>The logic for this separation of VARs is that signed returns and order flows do not directly affect liquidity in microstructure models. Instead it is unsigned absolute return or volatility that is the driver of liquidity in such theoretical frameworks (viz., Kyle, 1985 or Glosten and Milgrom, 1985).

Typically, the slope of the information criterion (as a function of lags) is quite flat for larger lag lengths, so the choice of smaller lag lengths is justified.

We also perform VARs at both the daily and monthly horizons to examine short- and long-horizon dynamics across the markets for REITs and non-REIT stocks. In the daily VARs, our criteria imply a lag length of six for the liquidity VARs, and a lag length of three for the return/order flow ones. For the monthly VARs, the lag length implied is two for each of the VARs.

## 5.1 VAR Estimation Results

### 5.2 Daily VARs

We now present the results of VARs performed at horizons of one day. In Table 3, we present Chi-square statistics for the null hypothesis that variable  $i$  does not Granger-cause variable  $j$ . Specifically, we test whether the lag coefficients of  $i$  are jointly zero when  $j$  is the dependent variable in the VAR. The cell associated with the  $i^{th}$  row variable and the  $j^{th}$  column variable shows the statistic associated with this test.

Panels A and B of Table 3 presents the daily Granger causality results for REITs and non-REIT stocks, respectively. For simplicity and parsimony, in Panel B we present results only for causality running from endogenous variables to the REIT stocks, since we expect the stock market should lead the REIT sector. Since we found the lead from REITs to non-REITs to be largely insignificant, omission of the causation running from

REITs to non-REITs does not lead to a substantive loss of economic or empirical insight. Also, since results for quoted spreads are similar to those for effective spreads, these also are omitted for the time being (though we report robustness checks for quoted spreads later in the paper).

We find that there is Granger causation running from non-REIT effective spreads to REIT ones, but not vice versa. This suggests that non-REIT effective spreads are material in forecasting REIT liquidity over the next day. The result is consistent with the notion that informed trading about factors that systematically affect stock returns would be occur first in the larger non-REIT stocks, and then spill over to the relatively smaller REITs (Lo and MacKinlay, 1990).

We also find in Panel B that in most cases REIT order flows are Granger-caused by non-REIT flows and returns. This is consistent with the preceding argument that informational spillovers occur with a lag in REIT stocks. They also are consistent with the notion that asset allocational decisions after past stock market moves affect future order flows in REITs. Note, however, that while these findings suggest joint dynamics of the relevant time-series, they do not indicate any information about the direction of the effect. Also, the Granger causality results are based on analyses of coefficients from a single equation. A clearer picture can potentially be provided by impulse response functions (IRFs), which account for the full dynamics of the VAR system.

An IRF traces the impact of a one standard deviation innovation to a specific variable on the current and future values of the chosen endogenous variable. We use the inverse of the Cholesky decomposition of the residual covariance matrix to orthogonalize the impulses. Results from the IRFs are generally sensitive to the specific ordering of the endogenous variables. While somewhat subjectively, we chose the ordering to be ESPR, NESPR for the spread regressions and OIBNUM, OIBDOL, RET, NOIBNUM, NOIBDOL, NRET, for the return/order flow ones, we also found the ordering to not affect the results materially.

Figure 2 illustrates the response of a variable to a unit standard deviation orthogonalized shock to another variable for a period of 6 days. Monte Carlo two-standard-error bands (based on 1000 replications) are provided to gauge the statistical significance of the responses. Period 1 in the impulse response functions represents the contemporaneous response, and the units on the vertical axis are in actual units of the response variable (e.g., dollars in the case of spreads).

In Panel A, we consider the response of the effective bid-ask spread of REITs to non-REITs. We find that non-REIT spreads are useful in forecasting future REIT effective spreads for up to five days. The reverse response lasts only for a day, however. For completeness, we also present the impulse responses for the quoted spreads in Panel B, and find results similar to those for the effective spreads. Specifically, the impulse response of REIT quoted spreads to non-REIT ones is more persistently significant than

the reverse response. This clearly indicates that the liquidity of REIT markets can be forecasted from non-REIT spreads. The evidence is consistent with the notion that liquidity-shifting events originate first in the large stocks (which dominate the value-weighted non-REIT index). The results also support the notion that REIT spreads may respond to shifting asset allocational demands in REITs after events in the stock market that affect both returns and liquidity.

The return and order flow impulse responses are presented in Panel C of Figure 2. REIT imbalance in number of transactions responds positively to non-REIT number imbalances but negatively to non-REIT dollar imbalances. However, the latter response is far more persistent. The response of REIT returns to non-REIT imbalances in numbers is positive but barely significant at the second period. Prices in REIT markets appear to be set quite efficiently, however, since there is no evidence that one can forecast REIT returns by conditioning on past order flows in either REIT or non-REIT markets. Overall, the major finding is that of joint dynamics between order flows REIT and non-REIT stocks, with the strongest relation being that between REIT number imbalances and past non-REIT dollar imbalances.

Since we expect OIBNUM to capture the actions of small traders and OIBDOL to be more representative of large traders, the results are generally consistent with the notion that following trades in a certain direction by large traders in the stock market, small traders place trades in the opposite direction in REITs. This suggests that the price

pressure created by, say, a negative OIBDOL in the stock market causes small traders to find REITs more attractive and submit buy orders on net in these markets. Thus, it appears that these two markets are viewed as substitutes by small traders. This type of substitution can be expected to have a concomitant effect on liquidity, as we find. Since daily returns may be excessively noisy, however, we will shed more light on this issue when we analyze monthly returns.

### 5.3 Monthly VARs

We now turn to longer horizon vector autoregressions. In this section, returns are computed by compounding the residuals from equation (1) over the relevant period. Liquidity and imbalance measures are computed by simply averaging the adjusted daily time-series over the relevant time span. As before, we present results for effective spreads in Panel A of Table 4. For parsimony, we do not report results for quoted spreads. Results for returns and order flow appear in Panel B.

We find that REIT effective spreads continue to be Granger-caused by non-REIT spreads, though the reverse is not true. This implies that even at the monthly horizon, shocks to stock market liquidity forecast future liquidity levels in REITs. This evidence is consistent with the notion that investment decisions in response to new information are not made instantaneously by smaller investors owing to cognitive or monitoring costs. Therefore, informational shocks that affect liquidity in large cap stocks (reflected in the

value-weighted large cap index) spill over with a lag because they affect the trading decisions of individual investors in the smaller REIT stocks with a delay of as much as a month.

The Granger causality results in Panel B indicate that while REIT returns are not Granger-caused by any of the non-REIT variables, REIT order imbalance in numbers is Granger-caused by non-REIT returns. This confirms the daily results that order imbalances in REITs respond to order flows and/or returns in non-REIT stocks. Again, however, a clearer picture potentially can emerge from examining impulse response functions, since they are based on the full system, as opposed to the Granger causality results, which are based on a single equation.

We present impulse responses for the monthly VARs in Figure 3. These generally confirm and accentuate the Granger-causality results. Specifically, we see from Panel A that the response of REIT effective spreads to non-REIT ones is significant at the second period, but the reverse response is not significant beyond the contemporaneous relation. Further, Panel B indicates that REIT order imbalance in numbers responds inversely to innovations in not just non-REIT returns but also dollar imbalances in non-REIT stocks. Again, this is evidence of joint order flow dynamics in REIT and non-REIT stocks. At the same time, REIT prices appear to be set in a manner consistent with market efficiency because none of the impulse responses for returns (in the last row of Table 4, Panel B) appear to be significant.

Overall, the results are consistent with the notion that a negative shock to returns in the stock market causes small traders shift to REITs, which is again consistent with the notion that these two markets are viewed as substitutes by small traders. However, OIBNUM only has a weak effect on REIT returns (the relevant Granger causality statistic in Table 4 is only marginally significant), and unreported results confirm that the impulse response of REIT returns to OIBNUM are not significant. Thus, it appears that this type of substitution is not likely to lead to superior return performance. The liquidity effects we document are consistent with the notion that the cross-dynamics of order flow affect the inventory imbalances of market markets, which, in turn, cause cross-dynamics in liquidity across REITs and the stock market.

From the perspective of economic significance, in the daily VARs, a one standard deviation shock to OIBDOL in non-REIT stocks causes extra OIBNUM of 7.8% in the opposite direction for REITs over the following ten day period. Similarly, in the monthly VARs, a one standard deviation shock to OIBDOL causes an effect of 5% on average daily OIBNUM over the following five-month period. Finally, a one standard deviation shock to effective spreads in the stock market leads to an cumulative ten-day impact of one cent on REIT effective spreads; assuming 250 trading days in an year, this is equivalent to an annualized extra trading cost of \$2.5 million on a \$10 million transaction. Thus, the economic significance of all our effects are material.

## 6 Concluding Remarks

This paper represents the first attempt to obtain an empirical understanding of the joint dynamics of liquidity, returns, and order flows across equity and real estate markets. Since real estate is an important alternative to equity investment, there are sound economic rationales for cross-asset dependence in the time-series we consider. Given that direct data on real estate investments are hard to obtain, however, we take first things first and consider the relation between real estate investment trusts (REITs) and a value-weighted index on non-REIT equities. To facilitate the drawing of reliable conclusions, we use a long time series consisting of over 3000 trading days (1988-2002).

The analysis clearly demonstrates the existence of joint dynamics across the REIT and non-REIT sectors. Non-REIT liquidity indicators Granger-cause those in the REIT market. Specifically, non-REIT effective spreads forecast shifts in REIT spreads at both daily and monthly horizons, and this effect is economically significant. This suggests that asset allocational decisions following liquidity- and return-shifting events in the stock market spill over to REITs with a lag. This allows REIT liquidity to be forecastable from liquidity movements in the non-REIT sector, at both daily and monthly horizons.

We also find that at the daily horizon, the impulse responses of REIT returns to non-REIT order flow are marginally significant. A more robust result is that REIT order flows in number of transactions respond negatively to non-REIT order flows and returns

at the monthly horizon. It appears that, for example, price pressures past negative order flows of large investors in the stock market attract small investors to the alternative investment represented by REITs. In this sense, REIT investments appear to be viewed as substitutes for non-REIT ones by small investors. At the same time, REIT prices appear to be set efficiently, since REIT returns are unpredictable from past order flows and returns in both REIT and non-REIT sectors.

Overall, the analysis presents a picture which not only indicates that liquidity across different sectors is jointly determined in a contemporaneous sense, but also is consistent with the notion that cross-effects of returns on order flows are persistent. However, many issues remain to be explored. First, it would be useful to consider real estate transactions other than those in the market for REITs, though those data are harder to obtain and require a more sophisticated treatment. Second, it may be useful to more closely analyze cross-effects in the dynamics of institutional (and complementarily, individual) holdings of REITs and non-REIT stocks. Finally, whether the link between REITs and the stock market is related to more fundamental variables such as interest rates remains to be explored. These issues are left for future research.

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**Table 1: Levels of stock market liquidity for REITs and non-REIT stocks**

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. The return numbers have been multiplied by 1000. RET denotes the daily return, OIBNUM and OIBDOL, the order imbalance in dollars and transactions, respectively, and QSPR (ESPR) the quoted (effective) spread. The suffix “N” stands for non-REIT stocks. The sample spans the period January 4, 1988 to December 31, 2002.

	1/4/1988-6/23/1997			6/24/1997-1/28/2001			1/29/2001-12/31/2002		
	Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.
REITs									
RET	-0.402	0.092	0.024	-0.045	0.165	0.010	0.279	0.379	0.009
OIBNUM	0.096	0.092	0.254	0.055	0.050	0.133	0.205	0.208	0.123
OIBDOL	0.070	0.077	0.303	0.079	0.086	0.213	0.176	0.182	0.167
QSPR	0.250	0.250	0.052	0.141	0.137	0.028	0.053	0.051	0.015
ESPR	0.163	0.157	0.052	0.099	0.094	0.048	0.042	0.039	0.011
Non-REITs									
NRET	-0.272	0.361	0.020	-0.016	-0.466	0.012	-0.537	-1.041	0.014
NOIBNUM	0.052	0.055	0.092	0.084	0.083	0.038	0.082	0.082	0.040
NOIBDOL	0.103	0.102	0.105	0.127	0.125	0.058	0.129	0.130	0.052
NQSPR	0.190	0.189	0.020	0.126	0.125	0.011	0.045	0.043	0.010
NESPR	0.130	0.121	0.035	0.085	0.084	0.010	0.036	0.035	0.007

**Table 2 Correlation Matrix**

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. RET denotes the daily return, OIBNUM and OIBDOL, the order imbalance in dollars and transactions, respectively, and ESPR the effective spread. The suffix “N” stands for non-REIT stocks. The sample spans the period January 4, 1988 to December 31, 2002.

## Panel A: Returns and Order Flows

	RET	OIBNUM	OIBDOL	NRET	NOIBNUM	NOIBDOL
RET	1.00	0.020	0.077	0.717	-0.094	-0.049
OIBNUM	0.020	1.00	0.697	0.004	0.148	0.063
OIBDOL	0.077	0.697	1.00	0.017	0.095	0.095
NRET	0.717	0.004	0.017	1.00	0.116	0.191
NOIBNUM	-0.094	0.148	0.095	0.116	1.00	0.725
NOIBDOL	-0.049	0.064	0.095	0.191	0.725	1.00

## Panel B: Liquidity

	QSPR	ESPR	NQSPR	NESPR
QSPR	1.00	0.737	0.909	0.751
ESPR	0.737	1.00	0.702	0.653
NQSPR	0.909	0.702	1.00	0.802
NESPR	0.751	0.653	0.802	1.00

**Table 2: Adjustment regressions for liquidity**

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. QSPR (ESPR) stands for quoted (effective) spread, and DEP for depth measured as the average of the posted bid and ask dollar amounts offered for trade. The sample spans the period January 4, 1988 to December 31, 2002. Holiday: a dummy variable that equals one if a trading day satisfies the following conditions, (1) if Independence day, Veterans' Day, Christmas or New Year's Day falls on a Friday, then the preceding Thursday, (2) if any holiday falls on a weekend or on a Monday then the following Tuesday, (3) if any holiday falls on a weekday then the preceding and the following days, and zero otherwise. Monday-Thursday: equals one if the trading day is Monday, Tuesday, Wednesday, or Thursday, and zero otherwise. February-December: equals one if the trading day is in one of these months, and zero otherwise. The tick size change dummy equals 1 for the period June 24, 1997 to January 28, 2001. The decimalization dummy equals 1 for the period January 29, 2001 till December 31, 2002.

Table 2, continued

Panel A: REITs

Variable	Quoted spread		Effective spread	
	Coefficient	T	Coefficient	T
Monday	0.2063	106.46	-0.0013	-0.56
Tuesday	0.0025	1.53	0.0019	0.83
Wednesday	0.0021	1.32	-0.0014	-0.60
Thursday	-0.0009	-0.54	-0.0022	-0.94
February	0.0003	0.20	-0.0017	-0.53
March	-0.0094	-4.29	-0.0028	-0.90
April	-0.0098	-4.67	-0.0001	-0.03
May	-0.0030	-1.41	-0.0042	-1.34
June	-0.0116	-5.46	0.0000	-0.01
July	-0.0079	-3.74	0.0032	1.00
August	-0.0023	-1.08	0.0005	0.16
September	-0.0050	-2.39	0.0057	1.77
October	-0.0045	-2.06	0.0045	1.45
November	-0.0058	-2.77	0.0051	1.59
December	-0.0071	-3.30	0.0063	0.88
Holiday-1	0.0121	2.48	-0.0097	-2.58
Post16th	0.0000	-0.01	-0.0307	-4.41
postdeci	-0.0210	-4.44	-0.0626	-16.59
time	-0.1259	-49.10	-0.0176	-5.81
(time**2)	-0.0267	-12.96	0.1382	48.47
Intercept	0.2063	106.46	-0.0013	-0.56
Adjusted R <sup>2</sup>	0.867		0.508	

Table 2, contd.

Panel B: Non-REITs

Variable	Quoted spread		Effective spread	
	Coefficient	T	Coefficient	T
Monday	-0.0024	-4.35	-0.0026	-1.79
Tuesday	-0.0017	-3.15	-0.0016	-1.13
Wednesday	-0.0012	-2.28	-0.0020	-1.41
Thursday	-0.0007	-1.38	-0.0024	-1.71
February	0.0033	4.43	0.0020	1.04
March	0.0011	1.57	0.0000	-0.02
April	0.0017	2.37	0.0018	0.91
May	-0.0029	-4.12	-0.0001	-0.08
June	-0.0050	-7.01	-0.0038	-2.03
July	-0.0044	-6.07	-0.0036	-1.91
August	-0.0046	-6.49	-0.0029	-1.53
September	-0.0067	-9.24	-0.0027	-1.37
October	-0.0015	-2.16	0.0010	0.55
November	-0.0044	-6.10	-0.0002	-0.11
December	0.0002	0.10	-0.0001	-0.02
Holiday-1	-0.0284	-33.10	-0.0175	-7.68
Post16th	-0.0975	-61.33	-0.0491	-11.64
postdeci	-0.0409	-47.38	-0.0314	-13.73
time	0.0044	6.26	-0.0086	-4.66
(time**2)	0.1788	274.48	0.1204	69.63
Intercept	-0.0024	-4.35	-0.0026	-1.79
Adjusted R <sup>2</sup>	0.962		0.605	

**Table 3: Granger causality results (daily horizon).**

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. The sample spans the period January 4, 1988 to December 31, 2002. RET denotes the daily return, OIBNUM and OIBDOL, the order imbalance in dollars and transactions, respectively, and ESPR the effective spread. The suffix “N” stands for non-REIT stocks. In Panel A, the Granger causality results are for a VAR involving effective spreads for REIT and non-REIT stocks. In Panel B, the results are for a VAR involving order flows and returns. Chi-square statistics are presented for the hypothesis that the row variable does not Granger-cause the column variable, with p-values in parentheses.

**Panel A: Liquidity**

	ESPR	NESPR
ESPR		10.04 (0.12)
NESPR	40.06 (0.00)	

**Panel B: Returns and order flows**

	OIBNUM	OIBDOL	RET
OIBNUM		117.64 (0.00)	11.14 (0.01)
OIBDOL	64.09 (0.00)		5.75 (0.13)
RET	10.96 (0.01)	4.33 (0.023)	
NOIBNUM	32.24 (0.00)	13.13 (0.00)	2.99 (0.39)
NOIBDOL	12.50 (0.01)	2.12 (0.55)	3.58 (0.31)
NRET	4.25 (0.24)	1.59 (0.66)	0.14 (0.99)

**Table 4: Granger causality results (monthly horizon).**

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. The sample spans the period January 4, 1988 to December 31, 2002. RET denotes the monthly return, OIBNUM and OIBDOL, the order imbalance in dollars and transactions, respectively, and ESPR the effective spread. The suffix “N” stands for non-REIT stocks. In Panel A, the Granger causality results are for a VAR involving effective spreads for REIT and non-REIT stocks. In Panel B, the results are for a VAR involving order flows and returns. Chi-square statistics are presented for the hypothesis that the row variable does not Granger-cause the column variable, with p-values in parentheses.

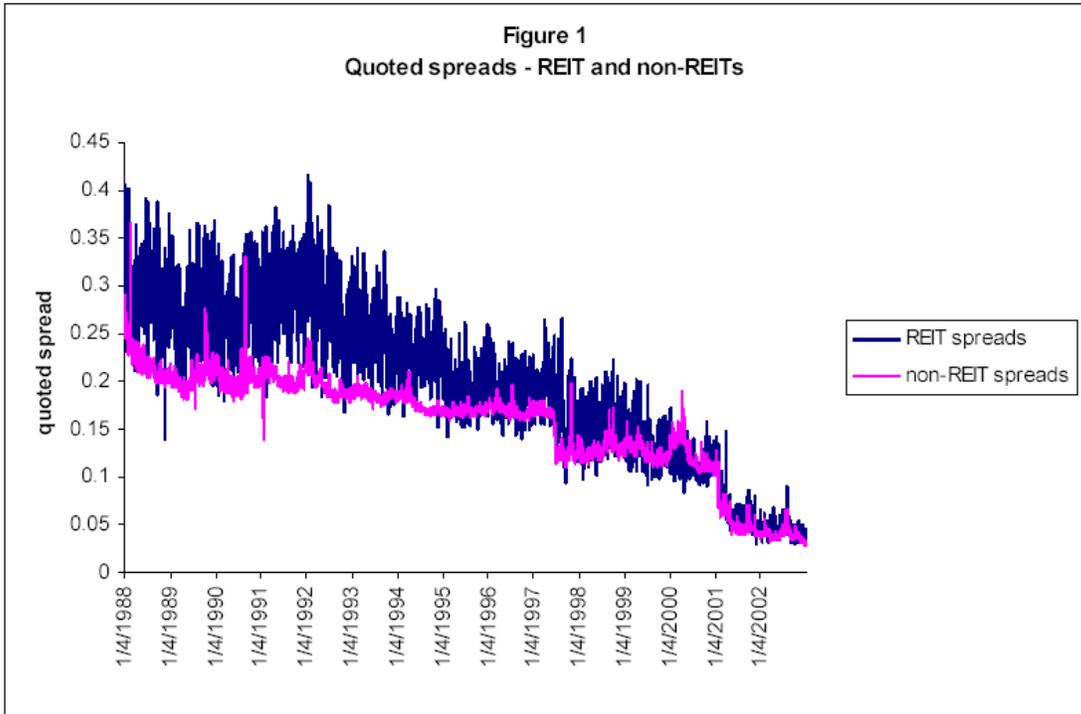
**Panel A: Liquidity**

	ESPR	NESPR
ESPR		0.255 (0.88)
NESPR	7.48 (0.02)	

**Panel B: Returns and order flows**

	OIBNUM	OIBDOL	RET
OIBNUM		23.81 (0.00)	5.82 (0.05)
OIBDOL	5.81 (0.06)		
RET	4.56 (0.10)	1.03 (0.60)	0.57 (0.75)
NOIBNUM	3.05 (0.22)	1.47 (0.48)	2.46 (0.29)
NOIBDOL	2.98 (0.23)	3.19 (0.20)	1.52 (0.47)
NRET	10.47 (0.01)	4.34 (0.11)	3.21 (0.20)

Figure 1  
Quoted spreads - REIT and non-REITs

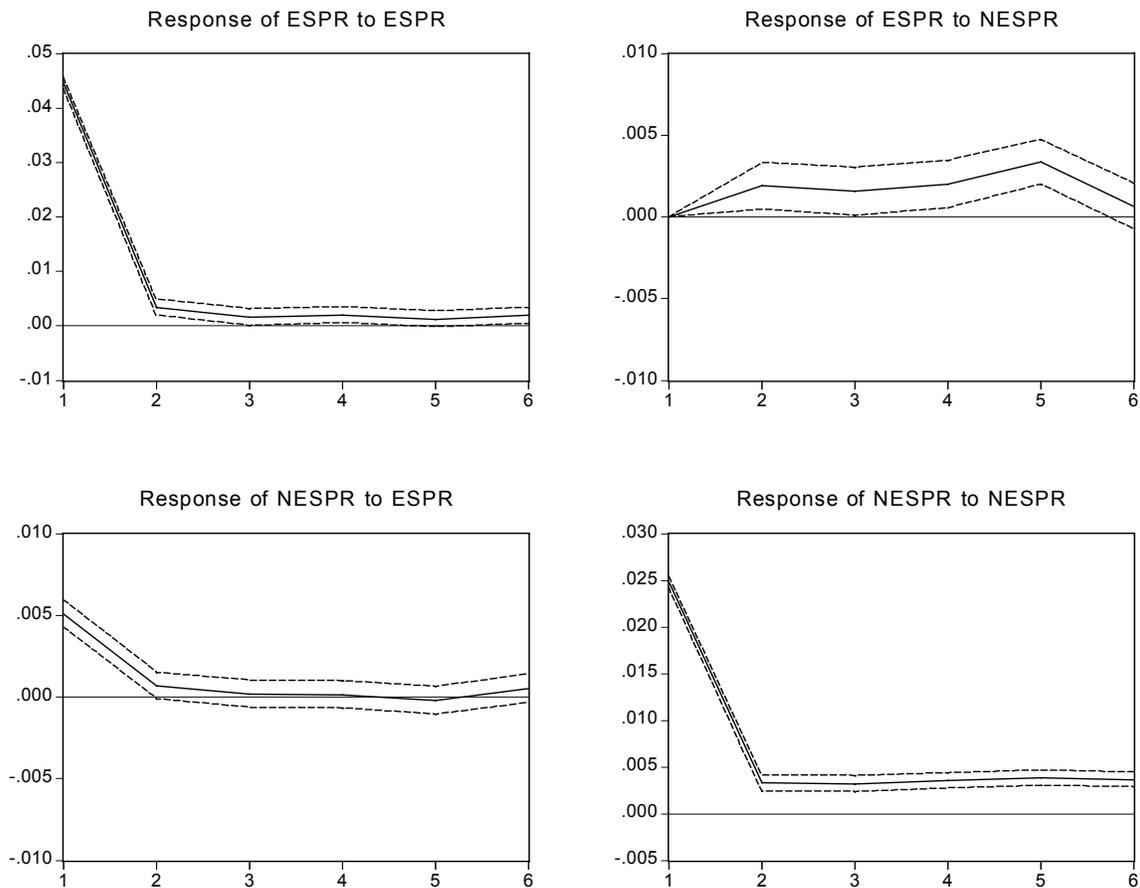


## Figure 2. Impulse Response Functions (daily horizon)

The stock liquidity series are constructed by first averaging all transactions for each individual stock on a given trading day and then constructing value-weighted averages for all individual stock daily means that satisfy the data filters described in the text. The sample spans the period January 4, 1988 to December 31, 2002. RET denotes the daily return, OIBNUM and OIBDOL, the order imbalance in dollars and transactions, respectively, and ESPR the effective spread. The suffix "N" stands for non-REIT stocks. In Panel A, the Granger causality results are for a VAR involving effective spreads for REIT and non-REIT stocks. In Panel B, the results are for a VAR involving order flows and returns.

### Panel A. Response of REIT and non-REIT effective spreads to each other

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



# Panel B. Response of REIT and non-REIT quoted spreads to each other

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

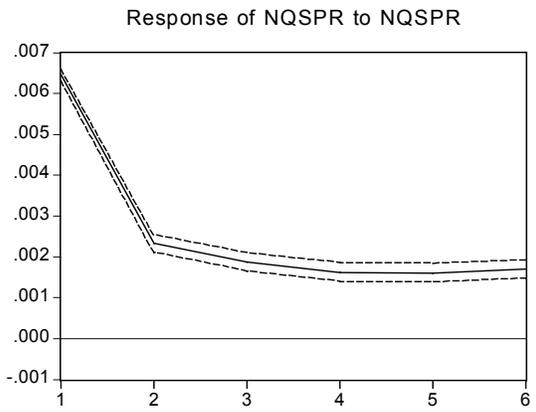
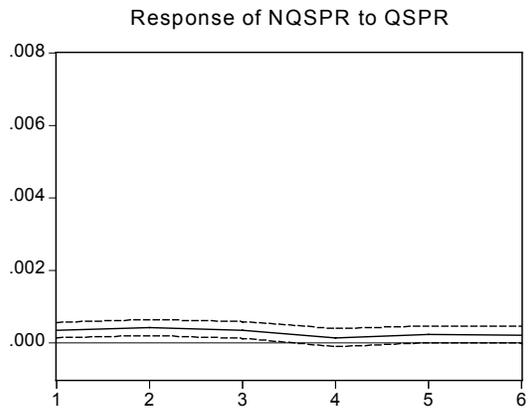
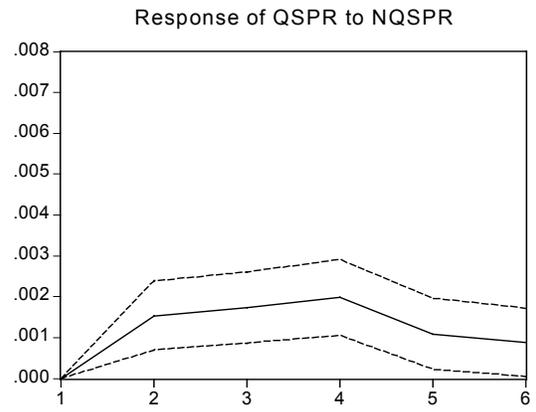
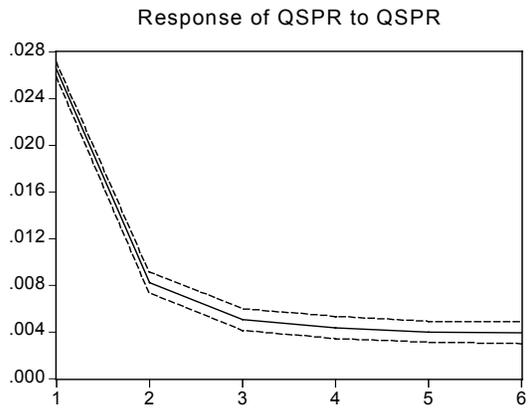
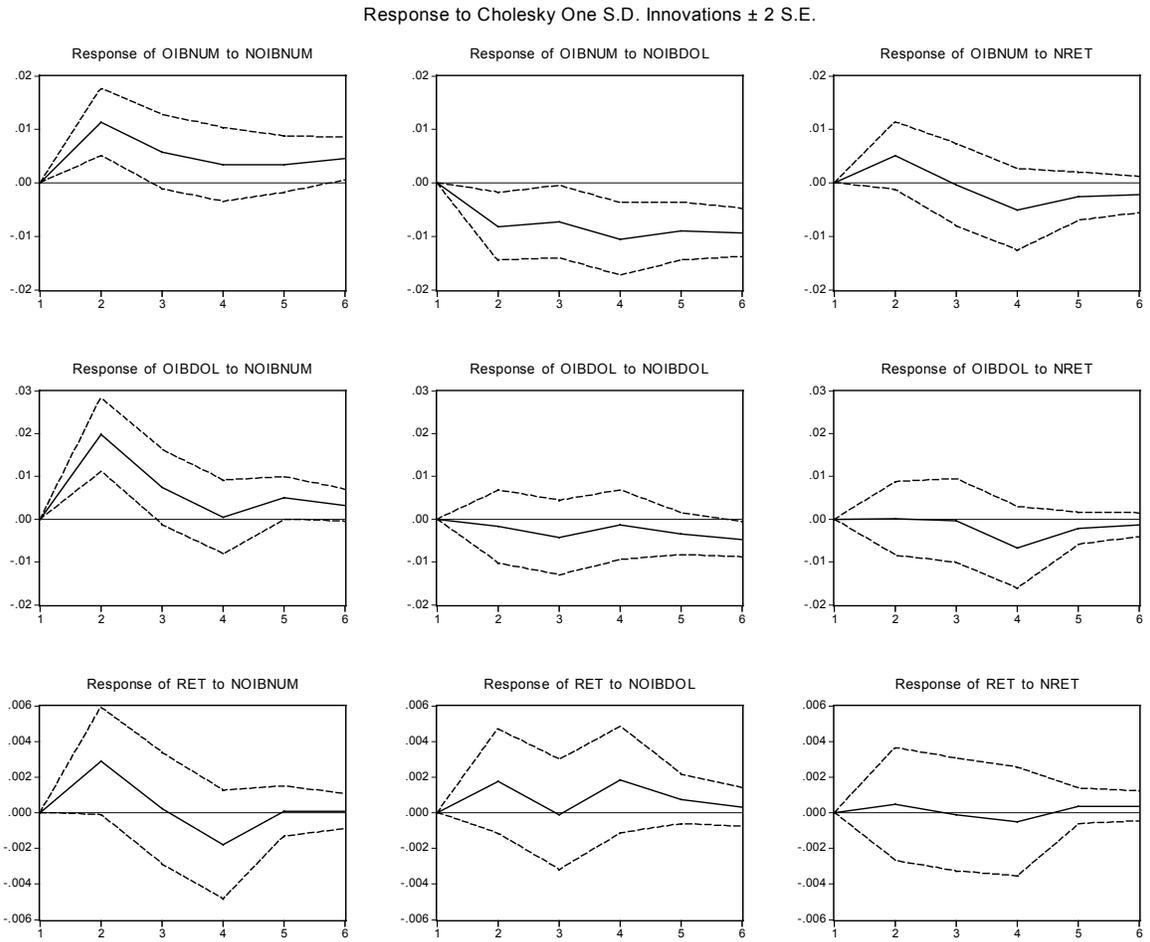


Figure 2, continued

Panel C. Response of REIT order flows and returns to non-REIT order flows and returns

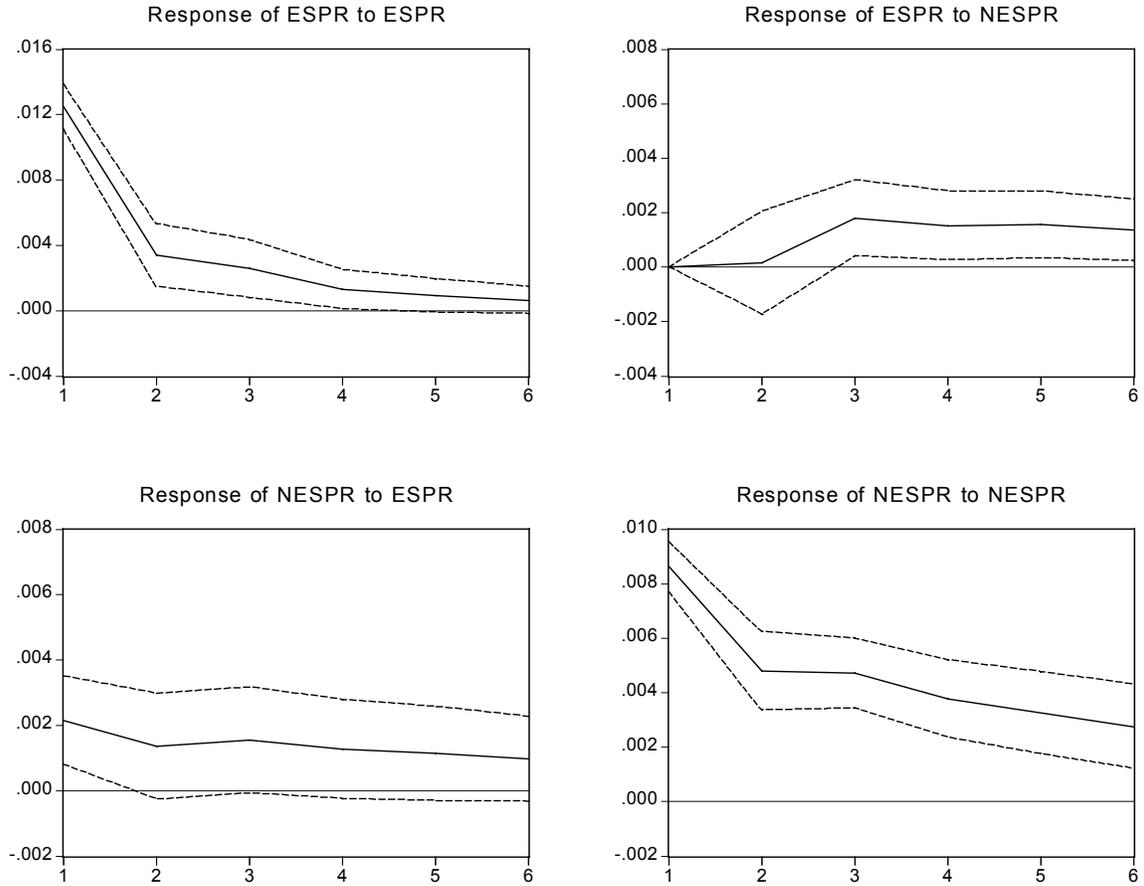


### Figure 3. Impulse Response Functions (monthly horizon)

The figure presents impulse response functions from the VARs with endogenous variables.

#### Panel A. Response of REIT and non-REIT spreads to each other

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.



# Panel B. Response of REIT order flows and returns to non-REIT order flows and returns

Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

