Property Market Liquidity and REIT Liquidity

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Abstract

This paper examines a channel for the cross-market transmission of liquidity: investable asset liquidity can affect investment uncertainty and, thereby, influence stock liquidity. Our empirical results support the model's prediction that the liquidity of the underlying market of a REIT's properties can affect stock liquidity. This impact is especially evident during the global financial crisis period. Furthermore, the influence is stronger with increased information asymmetry, investment growth, and financial constraints of the firm. Overall, our results reveal that corporate investment decisions, including the selection of asset location, can affect stock liquidity and firm value. The liquidity of a REIT's fixed assets, which are traditionally viewed as illiquid, can affect stock liquidity.

Keywords: Geographic asset location, real estate returns, liquidity.

JEL Classification: G12, R3

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1 Introduction

Motivated by the fallout from the global financial crisis, researchers have devoted increased attention to the spillover in liquidity shocks across asset classes. One channel for investigation relates to investor portfolio allocation. A change in the illiquidity of one asset class will affect its relative attractiveness. As a result, an illiquidity shock in one market can influence the demand for this asset and other assets (Pasquariello, 2007). Chan et al. (2011) investigate the linkages across financial, commodity and real estate assets and find a flight-to-quality phenomenon (from stocks to treasury bonds) over the ”crisis” regime and flight from quality (from treasury bonds to stocks) in the ‘tranquil’ regime. In addition, the influence from common factors, including common information (Pasquariello, 2007, Fleming et al., 1998), funding liquidity (Kyle and Xiong, 2001, Brunnermeier and Pedersen, 2009) and monetary policy (Goyenko and Ukhov, 2009), can lead to co-movement in liquidity across assets. For example, Bond and Chang (2012) find significant directional Granger causality for liquidity proxies from the public to private real estate markets. Hoesli et al. (2017) find a positive correlation between REIT liquidity commonality and real estate market liquidity commonality. Agents’ correlated trading activity and investor sentiment play a major role in explaining the cross-asset commonality in liquidity.

By studying the transmission of illiquidity between direct real estate markets and Real Estate Investment Trusts (REITs), we propose another channel for the cross-market transmission of liquidity – the underlying asset channel. The liquidity of investable-asset markets can reflect investment uncertainty and trading costs, thereby influencing stock illiquidity. REITs primarily invest in private real estate markets, which are segmented. If the investment channel really matters, REITs with assets located in different markets should be subjected to different levels of illiquidity based on the markets where their properties are located. In other words, variations in the liquidity across property markets should be able to explain the variations in

REIT stock liquidity. Furthermore, by focusing on a firm-level analysis our paper differs from the previous REIT literature on the transmission of liquidity between the private and public market, which primarily uses national real estate market liquidity as a proxy. We argue that using the national liquidity index may not capture the heterogeneity in local real estate markets.

One challenge in the analysis is the potential endogeneity between these two markets, as REITs are also active investors in commercial real estate. Some REITs may have a bias for liquid markets and their transactions, in turn, can affect private real estate market liquidity. Ghent (2019) documents the nexus between the liquidity preference of investors and underlying market liquidity: Delegated investors are concentrated in cities with higher turnover. By calibrating a search model, she demonstrates that heterogeneity in liquidity preferences renders some markets more liquid, even when assets have identical cash flows.

In this paper, we address this issue using two approaches. We first use the distance of underlying assets to a REIT's headquarters as an instrument for the selection of geographic markets (self-selection). We also use house price growth, which is unlikely to be determined by REIT transactions, as an instrument for private real estate market liquidity to address the concern that commercial property market liquidity can be affected by REIT transactions (reversal causality). Based on these instruments, our empirical results confirm a significant impact of local real estate market illiquidity on REIT equity illiquidity. The impact increases significantly during the crisis period, which implies the transmission of a liquidity shock (i.e., drying up) from direct to indirect markets.

Our results highlight how managerial investment decisions can affect stock liquidity. It is well known that two fundamental drivers of stock liquidity are uncertainty and information asymmetry. However, very little evidence has been found regarding whether and how corporate investment decisions affect stock liquidity. Gopalan et al. (2012) show the relationship between asset liquidity, as measured by balance-sheet asset composition, and stock liquidity depends on the tendency of the firm to invest. The interdependence is stronger for firms that are less likely to reinvest their liquid assets (i.e., firms with fewer growth opportunities and financially constrained firms). Becker-Blease and Paul (2006) investigate the relationship between stock liquidity and investment opportunities. They document a positive relationship between changes in capital expenditures and an exogenous change in stock liquidity, indicating that stock liquidity influences corporate investment decisions.

In this paper, we provide new evidence of the impact on stock liquidity due to the uncertainty associated with the investment decision. The underlying asset market liquidity captures the uncertainty. Moreover, we show that the influence depends on information asymmetry, investment growth, and financial constraints. REITs with geographically dispersed assets, higher investment growth, and tighter financial constraints are more sensitive to the liquidity in their underlying asset or property markets. This result sheds light on the value of holding properties in more liquid markets.

Our paper also contributes to the literature on asset liquidity and stock liquidity. Asset liquidity is commonly based on balance-sheet-level asset liquidity with a focus on cash holdings (Gopalan et al., 2012, Ze-to, 2016, Morellec, 2001, Foley et al., 2007). Here, we show that the liquidity of fixed asset markets can affect stock liquidity. REITs provide an appealing laboratory for our study, as REITs hold significantly less cash and more fixed assets than other public firms. To be qualified as a REIT, a firm must pay a minimum of 90% of its taxable income in the form of shareholder dividends and hold at least 75% of its assets as real estate. These requirements limit a REIT's ability to retain capital internally. As a result, REITs on average carry cash and equivalents equal to 3% of total assets, which is remarkably less than the 18.48% average reported for the full sample of public firms (Hardin et al., 2009). Using cash holdings alone as a measure of asset liquidity may miss the relationship between the asset and stock liquidity for REITs.

As shown in our empirical results, different from the finding by Gopalan et al. (2012), REIT stock liquidity is not significantly affected by the level of cash holdings. In addition, we find that firm-specific exposure to real estate or property market liquidity significantly influences REIT liquidity. This finding confirms that the liquidity of fixed assets, which are traditionally viewed as illiquid, can affect stock liquidity.

Incorporating the liquidity of underlying properties adds additional information to the relationship between asset liquidity and stock liquidity.

Last, our results provide further evidence on how stock liquidity is influenced by a firm's geographic location. Prior studies find that firm location, as measured by the location of its headquarters, matters for a firm's stock liquidity. For instance, Loughran and Schultz (2005) find that the shares of rural firms have a lower turnover rate than that of urban firms (i.e., firms located in the 10 largest metropolitan statistical areas (MSAs) in terms of total population). Bernile et al. (2015a) find a positive relationship between the liquidity of local stocks and the performance of the state- and MSA-level economy. Our paper supplements the previous literature by showing that stock liquidity can also be affected by the location of underlying assets. In the finance literature, location is mostly identified by the location of the firm's headquarters (Bernile et al., 2015b, Becker et al., 2011, Hong et al., 2008, Pirinsky and Wang, 2006, Tuzel and Zhang, 2017). Some recent literature starts to identify the location of firms' assets by counting the citation frequency of the names of the states in the firm's 10-K files (10-K state-citation-based measure) (Garcia and Norli, 2012, Bernile et al., 2015b). REITs, again, provide a rich environment to precisely identify the location of assets, as firms report the exact location of each property it owns. With this information, we are able to capitalize on the importance of asset location for firm value (as opposed to headquarters location for firm value).

The remainder of the paper proceeds as follows. Section 2 discusses the related literature, and Section 3 presents the theoretical framework. Section 4 describes our data and methodology. Section 5 presents our findings, and Section 6 concludes.

2 Liquidity, Commercial Real Estate and REITs: Related Literature

Stock liquidity has received great attention from researchers and practitioners, as theoretical and empirical research has shown that liquidity risk is a priced factor for assets (Acharya and Pedersen, 2005, Pastor and Stambaugh, 2003, Lee, 2011, Amihud, 2002, Brennan and Subrahmanyam, 1996). In general, the literature documents a positive relationship between liquidity and expected returns. Two explanations for this relationship are that (1) liquidity can reduce the cost of capital (Amihud and Mendelson, 1986) or (2) liquidity may facilitate better incentive contracts (Holmstrom and Tirole, 1993). For instance, Acharya and Pedersen (2005) incorporate liquidity risk into the asset pricing model; the liquidity risk has three dimensions: commonality in liquidity, the covariance of asset returns with market liquidity, and the covariance of asset liquidity with market returns. Pastor and Stambaugh (2003) investigate whether market-wide liquidity is a state variable important for asset pricing. They show that expected stock returns are related to the sensitivity of returns to fluctuations in aggregate liquidity.

Essentially, liquidity is a symptom of a market reaction to a variety of factors. Some factors are more fundamental, such as firm size, capitalization, and P/E Ratio. Other factors may be more complex, such as asset composition (Gopalan et al., 2012), information flow (Attig et al., 2006), ownership structure (Kothare, 1997), business cycle (Naes et al., 2011), investor sentiment (Clayton et al., 2008, Freybote and Seagraves, 2018), and uncertainty (Rehse et al., 2019), among others. Using Hurricane Sandy as a natural experiment, Rehse et al. (2019) test the effects of uncertainty on market liquidity by comparing the market reactions of REITs with and without properties in the widely published evacuation zone of New York City prior to landfall. Clayton and MacKinnon (2000) find strong evidence of an increase in U.S. REIT liquidity during the period from 1993 to 1996. In an international setting, Marcato and Ward (2007) show that liquidity is related to REIT visibility. Large REITs and REITs listed on the NYSE are more liquid. In another international context, Brounen et al. (2009) document two factors for REIT stock liquidity: firm size and shareholder base. REIT liquidity is positively related to a firm's market capitalization and negatively related to the percentage of shares held by institutional investors. Recent literature shows that the geographic location of the underlying assets can also affect stock liquidity. For instance, Wang et al. (2019) empirically test the magnitude of this illiquidity multiplier across U.S. REITs and find significant liquidity spillovers among REITs with geographically overlapping real estate holdings. Liu et al. (2019) show that location quality, as measured by the degree of industry diversification of local MSAs, can affect the liquidation value of REITs. Ling et al. (2019b) show that institutional investors exploit location-based information asymmetries by overweighting firms with greater economic interests in the investor's home MSA.

Given the hybrid nature of REITs, another strand of literature attempts to understand the dynamics of REIT liquidity by linking it to the liquidity in the underlying real estate market. Benveniste et al. (2001) examine the relationship between the liquidity of equity and its market value. The authors document a premium of a 12-22% increase in firm value by creating liquid equity claims on relatively illiquid property assets. Bond and Chang (2012) investigate cross-market liquidity between public and private real estate markets using several proxies for liquidity. The authors find that both markets share a generally similar trend in their liquidity. They also find that liquidity in the public market can predict liquidity in the private market, but not vice versa. This result implies a directional Granger causality from public markets to private markets. Also using a VAR model and Granger causality test, Agarwal and Hu (2014) show that property market liquidity leads that of the REIT market. They also find that returns in the property market have a causal effect on the liquidity and returns of the REIT market. Hoesli et al. (2017) also confirm a positive correlation between REIT liquidity commonality and real estate market liquidity commonality. The correlation, which varies over time, exploded during and after the global financial crisis.

At the same time, an issue the previous literature does not address was in play: the well-known fact that real estate markets are heterogeneous and have various level of liquidity. Fisher et al. (2004) report that the transaction frequency of properties varies dramatically from period to period and market to market. Based on property-level data from the National Council of Real Estate Investment Fiduciaries (NCREIF), they show that the probability of a property's being sold is positively related to market cycle (property returns) and macroeconomic conditions (employment). In addition, owner characteristics and property characteristics affect transaction frequency. Focusing on the office market, Devaney et al. (2017) show that in addition to macroeconomic conditions, the transaction volume of U.S. cities is also significantly affected by credit availability, the degree of institutional investment in a market, and the percentage of foreign investors in the market.

The types of traders have also received attention from researchers. Wiley (2017) studies the interlinkages between commercial real estate prices, property market fundamentals, credit policy, transactions volume, and the participation of highly active investors. He does not find a significant impact of transaction volume on property price; instead, markets with a higher share of active buyers tend to exhibit higher property returns. Highly active investors may have information advantages and therefore be able to better predict the market (i.e., “informed traders”); for instance, they may increase their participation before higher appreciation. Through their activities, they may contemporaneously influence higher prices when they outbid other investor types (i.e., a “clientele effects”) or, due to the herding effect, other groups may expand market share following periods of higher observed price appreciation. Ghent (2019) also documents differences in liquidity across U.S. cities and finds that the liquidity of commercial real estate markets is linked to investor composition. She finds that delegated investors have shorter holding periods, and they are concentrated in cities with higher turnover. The heterogeneity in liquidity preferences of different type of investors renders some markets more liquid even when assets have identical cash flows. Thus, given the heterogeneity in property market liquidity, using an aggregate or national liquidity indicator to study property market and REIT liquidity may miss some important dynamics. Our paper seeks to address this shortcoming in the literature.

3 Theoretical Framework

We follow the theoretical framework of Gopalan et al. (2012) and derive the relationship based on the assumption that stock liquidity today depends on both the structure of the firm’s assets today and the expectation regarding future investment.

We assume that there are 3 dates: 0, 1, and 2. At date 0, a firm has total assets with the value normalized to \$1. The assets are composed of cash of value \$$a$ and property of value \$[1-a], and a is between 0 and 1. Each dollar of property will return $\tilde{x}$ units of cash on date 2, and $\tilde{x} = \mu_x + \tilde{\varepsilon}_x$, and $\tilde{\varepsilon}_x \sim N(0, \sigma_x^2)$.

Bond et al. (2004) derives property market liquidity based on the cost of trading, which includes both direct costs (e.g., search frictions and commissions), and indirect costs (e.g., the price impact due to the act of trading and risk due to the uncertainty of the timing of the sale). Due to the cost of trading, the return of the in-place assets equals to the return without the cost of trading ($\tilde{x}$) less the trading cost per dollar volume ($\tilde{L}_x$). $\tilde{L}_x$ reflects the illiquidity discount to the asset-in-place and we assume that $\tilde{L}_x = \mu_{xL} + \tilde{\varepsilon}_{xL}$, with $\tilde{\varepsilon}_{xL} \sim N(0, \sigma_{xL}^2)$. As a result, the total variability of the return from assets-in-place ($var\left(\tilde{x} - \tilde{L}_x\right)$) on date 2 equals to $\sigma_x^2 + \ \sigma_{xL}^2$, which can be decomposed into two parts: the component without trading costs (σ_x^2) and the component due to the illiquidity discount (σ_{xL}^2). We define shocks to the trading cost, $\tilde{\varepsilon}_{Lx}$, as being independent from the shock to optimal returns, $\tilde{\varepsilon}_x$.

At date 1, cash a will be allocated between an interim dividend and a new project, so that $a\gamma$ dollars of the money will be invested in another project located in market y. γ is the proportion of cash allocated to the new project and $1 - \gamma$ the fraction of cash paid out as a dividend. If the firm uses external finance, γ can be larger than 1; this indicates investment in excess of the cash available with the firm at date 0. The output of the new investment is given by the stochastic production function: $\tilde{y} = kah(\gamma)(1 + \tilde{\varepsilon}_y)$, where $\tilde{\varepsilon}_y \sim N\left(0, \sigma_y^2\right)$. The expected output from the new project is $kah(\gamma)$. We follow Gopalan et al. (2012) and assume a concave production function $h(\gamma)$, which means $h(\cdot) > 0$, $h'(\cdot) > 0$ and $h''^{(\cdot)} < 0$. Parameter k captures growth opportunities, and a higher k indicates higher marginal productivity at the asset level. We define the correlation between $\tilde{\varepsilon}_y$ and $\tilde{\varepsilon}_x$ as ρ.

At date 2, a liquidating dividend is paid to equity holders. We define the trading cost per dollar volume in market y as $\tilde{L}_y$, with $\tilde{L}_y = \mu_{yL} + \tilde{\varepsilon}_{yL}$, and $\tilde{\varepsilon}_{yL} \sim N\left(0, \sigma_{yL}^2\right)$. The output of the new investment is reduced to $kah(\gamma)(1 + \tilde{\varepsilon}_y - \mu_{yL} - \tilde{\varepsilon}_{yL})$. We define the correlation between the transaction costs of asset-in-place and new project ($\tilde{\varepsilon}_{yL}$ and $\tilde{\varepsilon}_{xL}$) as ρ_L.

Assuming that all agents are risk neutral and the risk-free interest rate is zero (Gopalan et al., 2012), at date 1, Firm value $V(\gamma)$ depends on expected cash flow from the existing project $(1 - a)(\mu_x - \mu_{xL})$, expected cash flow from the new project ($kah(\gamma)(1 - \mu_{yL})$), and interim dividend $a(1 - \gamma)$:

$$V(\gamma) \equiv (1 - a)(\mu_x - \mu_{xL}) + kah(\gamma)(1 - \mu_{yL}) + a(1 - \gamma). \qquad (1)$$

The manager optimally decides on the allocation of cash between the interim dividend and investment to maximize firm value:

$$\max_{\gamma > 0} V(\gamma).$$

$V(\gamma)$ is maximized when the 1st-order derivative on γ equals zero, which gives

$$\gamma^* = {h'}^{-1} \left(\frac{1}{k}\right). \qquad (2)$$

At date 0, the firm's stock is traded in a market with three types of traders: an insider, noise traders, and a market maker (Kyle, 1985, Gopalan et al., 2012). We assume perfect knowledge of insider traders, which means that the insider knows the actual realizations of both $\tilde{\varepsilon}_y$ and $\tilde{\varepsilon}_x$. The market maker observes the total order flow and sets a price equal to the expectation of firm value based on the observed flow. Noise traders are uninformed and trade an exogenous amount $\tilde{u} \sim N(0, \sigma_u^2)$. σ_u^2 is uncorrelated with $\tilde{\varepsilon}_y$, $\tilde{\varepsilon}_x$, $\tilde{\varepsilon}_{yL}$ and $\tilde{\varepsilon}_{xL}$. At date 0, both the market maker and the insider anticipate the optimal investment decision of the manager at date 1. As a result, the expected firm value is $V(\gamma^*)$ and the variance of the firm value can be derived as

$$\sigma_0^2 \equiv (1 - a)^2(\sigma_x^2 + \sigma_{xL}^2) + a^2k^2h(\gamma^*)^2(\sigma_y^2 + \sigma_{yL}^2) + 2a(1 - a)kh(\gamma^*)\sigma_x\sigma_y\rho + 2a(1 - a)kh(\gamma^*)\sigma_{xL}\sigma_{yL}\rho_L. \qquad (3)$$

Equation (8) implies that the volatility of the total assets of the firm comes from the variability of the value of the assets in place $(1 - a)^2\sigma_x^2$, the variability due to the transaction costs in market *x*, $(1 - a)^2\sigma_{xL}^2$, the variability of the value of the new project $a^2k^2h(\gamma^*)^2\sigma_y^2$, the variability due to the transaction costs in market *y*, $a^2k^2h(\gamma^*)^2\sigma_{yL}^2$, and the contribution of the correlation between markets *x* and *y*. Following Kyle (1985) and Clayton and MacKinnon (2000), in equilibrium the market maker uses a linear pricing function with a slope of Kyle's lambda (λ):

$$\lambda = \frac{1\sigma_0}{2\sigma_u}, \tag{4}$$

where σ_0 is endogenous and given by equation (8). λ measures market illiquidity, which is defined as a ratio of the amount of private information the informed trader is expected to have to the amount of noise trading. λ is inversely related to market depth. It quantifies the price impact per $1 of cash flow, assuming no financial distress, and is frequently used as a measure of stock illiquidity. Given σ_u, λ increases as σ_0 increases.

Proposition 1. *In the absence of financial distress, a REIT's stock illiquidity and the REIT's fixed assets illiquidity are positively correlated.*

Because

$$\frac{\partial\lambda}{\partial\sigma_{xL}} = 2(1-a)akh(\gamma^*)\sigma_{yL}\rho_L + 2(1-a)^2\sigma_{xL} > 0, \tag{5}$$

and

$$\frac{\partial\lambda}{\partial\sigma_{yL}} = 2a^2k^2h^2(\gamma^*)\sigma_{yL} + 2(1-a)akh(\gamma^*)\sigma_{xL}\rho_L > 0, \tag{6}$$

Proposition 1 can easily be proved. A higher illiquidity discount (σ_{xL}^2 and σ_{yL}^2) implies higher asset volatility of REIT (σ_0), and therefore a higher λ. The illiquidity of the local market where the firm invests can increase the investment uncertainty of the firm and, therefore, increases the firm's stock liquidity. Gopalan et al. (2012) define asset liquidity as the share of cash holdings (*a*). We focus on the liquidity of the underlying property assets (σ_{xL}^2 and σ_{yL}^2), which is traditionally viewed as an "illiquid" asset. Proposition 1 suggests that the liquidity of fixed assets affects stock liquidity via the investment asset channel.

Proposition 2. *In the absence of financial distress, a REIT's stock illiquidity and its underlying fixed assets illiquidity are more positively correlated for REITs with a higher investment-growth rate.*

When a REIT has a higher investment growth rate, which implies a higher γ^*, it is easy to prove that the sensitivity of share illiquidity to real estate market illiquidity ($\frac{\partial\lambda}{\partial\sigma_{xL}}$ and $\frac{\partial\lambda}{\partial\sigma_{yL}}$) increases, as

$$\frac{\partial\lambda}{\partial\sigma_{xL}\partial\gamma^*} = 2(1-a)ak\rho_L\sigma_{yL}h'(\gamma^*)>0 \quad (7)$$

$$\frac{\partial\lambda}{\partial\sigma_{yL}\partial\gamma^*} = 2(1-a)akh'(\gamma^*)\sigma_{xL}\rho_L + 4a^2k^2\sigma_{yL}h(\gamma^*)h'(\gamma^*) > 0. \quad (8)$$

Proposition 2 implies that if a firm has a higher tendency to investment, the illiquidity of the market where its investment is located is more likely to affect the firm's stock liquidity.

Because REITs have to pay out at least 90% of taxable income as dividends, and due to the lumpiness of real estate assets, REITs must raise external funding quite frequently and therefore have a relatively high loan to value (LTV) ratio compared with many non-property firms. In this section, we will discuss the impact of financial distress on REIT stock illiquidity. We incorporate the Merton model into our theoretical framework:

$$E(\gamma^*) = \max(V(\gamma^*) - D, 0). \quad (9)$$

We assume the liability of D, which is raised at date 1 and will mature at date 2. Therefore, the expected value of this firm to shareholders equals the difference $V(\gamma^*) - D$ when the value of the assets $V(\gamma^*) - D$ is greater than the liability D. However, if the debt D exceeds the asset value $V(\gamma^*)$, shareholders get nothing. The value of equity $E(\gamma^*)$ is related to the value of assets and liabilities. It can also be noted that with the financial constraint, there exists a $\bar{\gamma}$ such that $\gamma \leq \bar{\gamma}$. γ^* will also be changed accordingly, as

$$\gamma^* = \min\left(\bar{\gamma}, {h'}^{-1}\left(\frac{1}{k}\right)\right). \quad (10)$$

We then apply the Black-Scholes-Merton model to relate the market value of equity E to asset value $V(\gamma^*)$:

$$E = V(\gamma^*)N(d_1) - De^{-r}N(d_2), \quad (11)$$

where *r* is the risk-free interest rate, N is the cumulative standard normal distribution, and d_1 and d_2 are given by

$$d_1 = \frac{\ln\left(\frac{V}{D}\right)+(r+\frac{1}{2}\sigma_0^2)}{\sigma_0}, \text{ and } d_2 = d_1 - \sigma_0. \quad (12)$$

This implies that the equity return volatility relates to the asset volatility:

$$\sigma_{0E} = \frac{V(\gamma^*)}{V(\gamma^*)-D}\sigma_0 N(d_1) = \frac{1}{1-L^*}N\left(\frac{-\ln(\mathrm{L}^*)+(r+\frac{1}{2}\sigma_0^2)}{\sigma_0}\right)\sigma_0, \quad (13)$$

where L^* stands for the LTV ratio given γ^*. To simplify the derivation, we assume that the REIT makes "same-store" investments, which means that $\sigma_x^2 = \sigma_y^2$, $\sigma_{xL}^2 = \sigma_{yL}^2$ and $\rho = 1$, $\rho_L = 1$. Equation (8) can be simplified as

$$\sigma_0^2 \equiv (1 - a + akh(\gamma^*))^2(\sigma_{xL}^2 + \sigma_x^2). \quad (14)$$

Therefore

$$\lambda = \frac{1\sigma_{0E}}{2\sigma_u} = \frac{1}{2(1-L^*)\sigma_u}N\left(\frac{-\ln(L^*)+(r+\frac{1}{2}(1-a+akh(\gamma^*))^2(\sigma_{xL}^2+\sigma_x^2))}{(1-a+akh(\gamma^*))\sqrt{(\sigma_{xL}^2+\sigma_x^2)}}\right)(1 - a + akh(\gamma^*))^2(\sigma_{xL}^2 + \sigma_x^2) \quad (15)$$

Proposition 3. *The stock illiquidity of a financially distressed REIT is more sensitive than a non-distressed REIT to the underlying property market in which the REIT allocates its assets.*

Proposition 4 is proved using a numerical solution, as the relationship can be nonlinear and therefore analytical partial derivations are not very informative. We simulate how σ_{0E}varies with debt ratio and illiquidity discount (σ_{xL}). We set a as 10%, because the required payout ratio for REITs is 90%. $h(\gamma^*)$ is set as 1.076, as the average property investment total return from 1978 to 2015 is 7.6%, according to the

NCREIF database. σ_x is set as 8.3% based on NCREIF database. k is set as 1.2, since the average market to book ratio for U.S. REITs from 1996 to 2015 is around 1.2. LTV is set as varying between 0 and 1, and the illiquidity component of asset return volatility (σ_{xL}) is set as between 0 and 1.

Figure 1 illustrates the change in expected equity volatility (σ_{0E}) with the change in LTV and real estate return volatility triggered by market illiquidity (σ_{xL}). The highest equity volatility occurs when both LTV and σ_{xL} reach their highest levels. The relationship between σ_{0E} and σ_{xL} remains positive at the different levels of debt ratio. But when σ_{xL} exceeds a certain threshold, we see an exponential relationship between LTV and σ_{0E}.

<< Figure 1 about here >>

Figure 2 provides more detailed information on the relationship between REIT share illiquidity and the underlying real estate market illiquidity given different levels of debt ratio. When the debt ratio is 30%, a change in σ_{xL} between 0 and 0.5 is associated with a change in σ_{0E} from 0.10 to 0.60. When the debt ratio rises to 90%, the slope goes up with a corresponding change in σ_{0E} from 0.25 to 1.34.

<< Figure 2 about here >>

4 Data and Methodology

4.1 Exposure to Property Market Illiquidity

The liquidity of the underlying properties for each REIT is based on the property portfolio of each firm and the illiquidity of the MSA in which the firms' properties are located:

$$\mathrm{T}_{i,t} = \sum_{m=1}^{M} w_{m.i,t} \tau_{m,t}, \quad (16)$$

where $\tau_{m,t}$ is the illiquidity measure in MSA m at period t, and $w_{m.i,t}$ represents the share of properties of firm i in each market at period t. $w_{m.i,t}$ is calculated as the number of properties located in MSA m to total properties,[1] and location data for REIT property portfolios are extracted from the S&P Global Market Intelligence, formerly SNL Financial, database. For instance, if REIT A has 80% of its properties located in the New York MSA and 20% in Miami, $\mathrm{T}_{i,t}$ for REIT A will be calculated as $\mathrm{T}_{i,t} = \sum_{m=1}^{2} w_{m.i,t}\tau_{m,t_{m,t}} = 80\% * \tau_{NY,t} + 20\% * \tau_{Miami,t}$. $\tau_{m,t}$ is based on property market turnover ($Turnover_{m,t}$):

$$\tau_{m,t} = \frac{\max(Turnover_{m,t}) - Turnover_{m,t}}{\max(Turnover_{m,t}) - \min(Turnover_{m,t})}, \quad (17)$$

For MSAs with a high turnover, $\tau_{m,t}$ will be lower, which indicates less illiquidity. Property turnover in each MSA is defined as the number of sold properties this year divided by the total number of properties. We collect the number of properties and sold properties in 144 core-based statistical areas (CBSAs) and MSAs since 1978 from the NCREIF database.[2] Figure 3 plots the average turnover rate across the 144 MSAs from 1996 to 2015, which have an average turnover rate of 2.14%. The turnover rate drops to 1.2% during the 2000 recession and rises to 6% in 2005 during the real estate boom. In 2008, the market froze and the turnover rate declined to less than 0.5%. The market steadily recovered in 2012, and the average turnover rate grew to between 2% and 3%.

<< Figure 3 about here >>

Table 1 lists the MSAs with the highest average turnovers from 1996 to 2015. Atlanta-Sandy Springs-Marietta, GA and Phoenix-Mesa-Scottsdale, AZ are the two most liquid property markets, with an NCREIF

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[1] Alternatively, the weight can be size or adjusted cost. The latter is the maximum of (1) the reported book value, (2) the initial cost of the property, or (3) the historic cost of the property, including capital expenditures and tax depreciation (Ling et al., 2019b). As shown in Appendix 1, size-weighted or adjusted-cost weighted real estate market illiquidity exposure generates very robust results.

[2] In the NCREIF data, property markets are divided into Metropolitan Divisions (MD). For instance, for the NCREIF the Detroit-Warren-Dearborn, MI MSA is divided into two MDs: Detroit-Dearborn-Livonia, and Warren-Troy-Farmington Hills. However, S&P Global Market Intelligence uses an MSA code for property location that is only at the level of the MSA (Detroit-Warren-Dearborn). Therefore we convert MD property market to MSA turnover. The MSA turnover is calculated as the average MD turnovers weighted by the number of properties in each MD of that MSA.

turnover rate of more than 10% from 1996 to 2015. Washington-Arlington-Alexandria, DC-VA-MD-WV; Los Angeles-Long Beach-Anaheim, CA; and Chicago-Naperville-Joliet, IL-IN-WI are ranked third to fifth, with an average turnover rate of more than 9%. MSAs with a more liquid property market tend to have a larger economic size (as measured by GDP) and a higher house price growth rate. The correlation coefficient between MSA NCREIF turnover rate and average GDP from 2000 to 2015 is 54%,[3] and the correlation coefficient with the average house price change from 1996 to 2015 is 57%. We do not see a significant correlation with MSA-level unemployment rates.

<< Table 1 about here >>

We acknowledge that using the NCREIF turnover rate to measure commercial property market illiquidity is not without limitations. First, the NCREIF database provides property information only from its members, who may have different investment horizons and holding periods. In addition, NCREIF data may have limited coverage. Furthermore, liquidity is much more complex than a simple sales or turnover rate (Bond et al., 2004). Other elements, such as cost, pricing, and risk components, should be considered. For instance, Fisher et al. (2007) and Buckles (2008) define liquidity for commercial property markets by using both TBI transaction price index and TBI supply index. Crosby and McAllister (2004), Bond et al. (2007), and Lin and Vandell (2007) focus on the risk exposure that occurs during the extended marketing period of a commercial real estate asset. Lin and Vandell (2007) propose a measure called "market timing liquidity risk." Crosby and McAllister (2004) and Bond et al. (2007) collect data on transaction time for individual transactions.

As a robustness test, we also use property market liquidity indices developed by van Dijk and Francke (2019).[4] Using property transaction data provided by Real Capital Analytics (RCA) from 2005 to 2018, van Dijk and Francke (2019) estimate liquidity indices based on the demand and supply reservation price for

[3] MSA-level GDP in Bureau of Economic Analysis data only dates back to 2001.
[4] We are very grateful to van Dijk and Francke for sharing their estimated liquidity indices.

31 U.S. regions.[5] The RCA liquidity indices provide an alternative metric for NCREIF turnover. Two benefits of van Dijk and Francke (2019)'s indices are (1) RCA collects transaction data for a wider set of properties than those in the NCREIF data, and (2) van Dijk and Francke property market liquidity indices are intended to capture price impact rather than transaction volume. As shown in Figure 3, the national average of van Dijk and Francke's RCA liquidity index shares a quite similar trend to our NCREIF turnover metric. The correlation coefficient between the two series is 72%. It seems that liquidity measured by price impact is lagged to the change in transaction volume, which can be caused by the stickiness of the real estate market.

The estimated property market illiquidity based on NCREIF turnover and RCA liquidity for each REIT ($T_{i,t}$) is summarized in Table 2. The average $\tau_{m,t}$ is 0.893 and the standard deviation is quite small at only 0.07. The maximum illiquidity is 1, which means that no NCREIF properties in this MSA have been sold in the year. The minimum is 0.45. Based on van Dijk and Francke's RCA liquidity indices, REITs have an average property market illiquidity of 0.4069 and a standard deviation of 0.1755.

<< Table 2 about here>>

4.2 REIT Share Illiquidity

Data on individual company characteristics are collected from S&P Global Market Intelligence, and daily bid and ask prices come from the CRSP database. We collect data for all available U.S. listed real estate companies with asset location information between 1998 and 2015, and obtain a total of 202 real estate firms. Overall, 76% of the REIT properties are located in the 144 NCREIF-derived MSAs. Among these firms, 145 have more than 70% of their properties located in the 144 MSAs, and therefore we restrict the sample to those 145 firms. Due to missing values in other explanatory variables, the final sample consists

[5] The 31 regions include Atlanta, Austin, Baltimore, Boston, Charlotte, Chicago, Dallas, Washington DC, Denver, Detroit, Other Mid-West, Other North East, Other South West, Other West, Houston, Los Angeles, Las Vegas, Miami, Minneapolis, New York City, Orlando, Philadelphia, Phoenix, Portland, Sacramento, San Diego, Seattle, San Francisco, and Tampa.

of 119 distinct REITs.

Figure 4 shows the number of firms with complete observations in our sample over the study period, as well as the market capitalization in each year. Up until 2015, the number of listed real estate companies steadily increased from 23 to 100 and the average firm size increased nearly 10-fold. Total market capitalization grew from $10 billion to over $538 billion. During the global financial crisis, real estate companies experienced a large drop in size and shrank to $110 billion as of 2009. Starting in 2010, real estate stocks recovered to their pre-crisis values. Between 2010 and 2015, real estate companies showed the highest increase in market capitalization across the entire sample period.

<< Figure 4 about here>>

We construct three measures of stock illiquidity.[6] The first is the illiquidity measure proposed by Amihud (2002), which is based on the absolute percentage price change per dollar of the daily trading volume. This measure follows Kyle's concept of illiquidity: the response of price to order flow. Amihud calculates the illiquidity of stock *i* as the average ratio of the daily absolute return to the (dollar) trading volume on that day, which can be denoted as $\frac{|R_{itd}|}{VOLD_{itd}}$. R_{itd} is the return on stock *i* on day *d* of month *t*, and $VOLD_{itd}$ is the respective daily volume in dollars, which is calculated as the product of daily trading volume in shares and the closing price of the previous day ($VOL_{itd}P_{itd-1}$).

For each stock, the monthly illiquidity ratio is defined as

$$ILLIQ_{it} = 1/D_{it} \sum_{d=1}^{D_{it}} |R_{itd}|/VOLD_{itd} \qquad (18)$$

where D_{it} is the number of days for which data are available for stock i in month t. Stock illiquidity is

[6] We also generated results based on general stock market turnover as the fourth REIT liquidity measure. We thank Jean-Christophe Delfim, Martin Hoesli and other discussants for the suggestion. As shown in Appendix 1, the results are somewhat weaker than using the other three liquidity measures. However, they are qualitatively robust, especially in the baseline model.

compounded in a given month only if more than 15 days' worth of data are available for that month ($D_{it} > 15$).

The second measure is the implicit bid-ask spread, which was first proposed by Roll (1984). It measures the illiquidity of stock *i* as the square root of the negative daily autocorrelation of its returns:

$$s_{it} = \sqrt{-cov(R_{itd}, R_{itd-1})}, \tag{19}$$

where s_{it} is the illiquidity of stock *i* in month m. Roll motivates s_{it} as one-half the posted bid-ask spread. It also measures the effective cost of the transaction: If the autocorrelation of stock returns is positive, it is set to be 0.

The third measure is the observed bid-ask spread, which is calculated as the quoted percentage spread. It is measured for each trade as the ratio of the quoted bid-ask spread and the bid-ask midpoint ($(Ask_{itd} + Bid_{itd})/2$). Monthly estimates are a simple average through month t:

$$Qspread_{it} = \frac{1}{D_{t,i}} \sum_{d=1}^{D_t} \frac{Ask_{itd} - Bid_{itd}}{(Ask_{itd} + Bid_{itd})/2} \tag{20}$$

Ask_{itd} and Bid_{itd} are the ask and bid quotes prevailing at the time of the d^{th} trade of asset *i* in month *t*.

4.3. Firm Characteristics

We also use three classical measures of asset liquidity defined in the corporate finance literature and as specified by Gopalan et al. (2012):

$$WAL1_{i,t} = \frac{Cash\ \&\ Equivalents_{i,t}}{Total\ Assets_{i,t-1}} \times 1 + \frac{Other\ Assets_{i,t}}{Total\ Assets_{i,t-1}} \times 0, \tag{21}$$

$$WAL2_{i,t} = \frac{Cash\ \&\ Equivalents_{i,t}}{Total\ Assets_{i,t-1}} \times 1 + \frac{Other\ Current\ Assets_{i,t}}{Total\ Assets_{i,t-1}} \times 0.5, \tag{22}$$

$$WAL3_{i,t} = \frac{Cash\ \&\ Equivalents_{i,t}}{Total\ Assets_{i,t-1}} \times 1 + \frac{Other\ Current\ Assets_{i,t}}{Total\ Assets_{i,t-1}} \times 0.75 + \frac{Tangible\ Fixed\ Assets_{i,t}}{Total\ Assets_{i,t-1}} \times 0.5. \quad (23)$$

As reported in Table 2, on average, the proportion of cash and equivalents to previous year total assets is only 3%. Not surprisingly, non-REITs have a much higher proportion of cash and equivalents as compared to REITs. When fixed tangible assets are included, WAL3 increases to around 60%.

Table 2 summarizes all other firm-level characteristics, averaged across time, from 1996 to 2015 and across the 119 REITs. The average monthly return across all REITs is 0.8%, and the monthly return volatility is 38.2%. We also see a large variation across the size of the companies in terms of market capitalization, with the highest being $57 billion and the lowest $0.35 million. On average, a company has a market capitalization of $2,927 million. The average book to market ratio is 0.82, which is similar to the average ratio of 0.8 across all types of industries. The average debt to equity ratio is 1.56. The average real estate investment growth rate is 0.18%, with a maximum of 3.66% and a minimum of -0.98%. We also account for market power or market concentration, which is measured by the Herfindahl-Hirschman Index (HHI) at the MSA level. The HHI measures the geographic concentration of the properties of one firm across different MSAs. It is calculated by squaring the market share of properties located in each MSA with respect to the total number of properties for the given firm *i* in a given MSA *l* in a given year *t*, and then summing the resulting shares across MSAs. The HHI ranges from close to 0 to 1. When the HHI equals 1, it means that all properties of the firm are located in the same MSA and the concentration is highest. The lower the HHI value, the less concentrated are the REIT's properties across MSAs. As shown in Table 2, the average HHI for our sample is 0.20, and the standard deviation is 0.24.

<< Table 2 about here >>

4.4 Methodology

To assess the impact of property market illiquidity on REIT share illiquidity, we run an unbalanced panel regression with fixed effects[7]:

$$y_{i,t} = \alpha \mathrm{T}_{i,t-1} + \beta X_{i,t-1} + \varphi_i + \delta_t + e_{i,t}, \tag{24}$$

where $y_{i,t}$ stands for REIT share illiquidity, which is measured by Amihud illiquidity ($ILLIQ_{it}$), Roll illiquidity (s_{it}), or bid-ask spread ($Qspread_{it}$). $\mathrm{T}_{i,t-1}$ measures the illiquidity of the underlying property market, as described previously. The significance of α would imply the relationship between property market illiquidity and REIT share illiquidity. $X_{i,t}$ is a matrix of firm characteristics, including debt to equity ratio; one of the three asset liquidity measures; previous return volatility, which is measured as the standard deviation of returns in the last month; momentum effect, which is measured by returns over the past 6 months; log of market value; book to market ratio; real estate investment growth rate; and MSA focus of properties measured by Herfindahl index based on the number of MSAs in which the firm's properties are located. β is a vector of corresponding coefficients. φ_i and δ_t stand for fixed effects.

5 Empirical Results

5.1 Property market illiquidity and REIT illiquidity

Table 3 reports results for our estimation of Equation (24) with Amihud illiquidity as the dependent variable. We see a significantly positive relationship between property market illiquidity and REIT share illiquidity, confirming proposition 1. A 1-unit increase in property market illiquidity is associated with an approximately 0.12-unit increase in the Amihud illiquidity of REIT shares. If we consider the economic significance, the coefficient can also be interpreted whereby a one standard deviation increase in property market illiquidity is associated with a 0.032 standard deviation increase in the Amihud illiquidity of a

[7] Appendix 2 reports results using Fama MacBeth cross-sectional regressions and annual data. As shown in Appendix 2, results based on this estimation approach remain robust.

REIT.[8] Although the impact is statistically significant, it is economically moderate. This finding is consistent with previous literature. For instance, Hoesli et al. (2017) document a moderate relationship between the commonality in property market liquidity and REIT liquidity; they find a 6% correlation coefficient for the across-asset commonality in liquidity.

Regarding asset liquidity, Model 1 is based on cash and equivalent holdings (WML1), Model 2 adds other current assets into the asset liquidity measurement (WML2), and Model 3 further includes fixed tangible assets (WML3). In all cases, property market illiquidity is significant and positively related to REIT illiquidity. In contrast to Gopalan et al. (2017), REIT cash holdings do not significantly increase stock liquidity. The reason could be that REITs, in general, are constrained in cash due to their dividend payout policies. When tangible fixed assets are considered (WAL3), the coefficient for asset liquidity becomes significant (Model 6). However, the relationship is negative. This finding is consistent with Gopalan et al.'s theoretical derivation, which shows that the impact of asset liquidity (as measured by the proportion of liquid assets) can be positive, zero, or negative, depending on the share of liquid assets. Other control variables have the expected sign. Illiquidity increases with previous return volatility. Winners with higher previous returns tend to have more liquid shares. In addition, smaller REITs, REITs with a higher book to market ratio and REITs with a lower investment growth rate tend to have lower share liquidity.

<< Table 3 about here>>

Using the RCA liquidity index, we also find a significant positive relationship between property market illiquidity and REIT stock illiquidity (Table 3, Models 4, 5, and 6). A one standard deviation decrease in property market liquidity is associated with a 0.1567 standard deviation decrease in REIT share liquidity. The economic impact is larger with the RCA data compared with the NCREIF turnover measure. However, it should be noted that the RCA measure only covers the period from 2005 to 2015, and the local real estate market is defined differently relative to the NCREIF definition. As a result, the two samples are not the

[8] The economic impact is calculated as the coefficient multiplied by the standard deviation of the property market illiquidity measure, then divided by the standard deviation of the REIT share illiquidity measure.

same. Since the RCA liquidity measure covers a much shorter time span and has more limited regional divisions than the NCREIF version, the following analysis is based on the NCREIF turnover measure.

The first concern regarding identification of the relationship between property market illiquidity and REIT share illiquidity is that $w_{m.i,t}$ may be affected by self-selection; some REITs have a bias for less risky and more liquid real estate markets. As Ghent (2019) demonstrates, delegated investors are concentrated in cities with higher turnover. To address this issue, we use the relative distance between a REIT's property market holdings and the REIT's headquarters as an instrument for $w_{m.i,t}$. Based on the home bias theory, the distance of assets to the headquarters can be a good predictor for the firm's asset allocation. Market participants often choose local investments to reduce information asymmetry in opaque information environments (Garmaise and Moskowitz, 2004, Ling et al., 2018). On the other hand, Ling et al. (2019) also show that institutional investors tend to overweight REITs with local investments. In other words, the distance to the headquarters may affect investor preference for the stock and, thereby, affect stock liquidity.[9] Since we have already controlled for institutional ownership in the main model, we argue that relative distance is an exogenous instrument for $w_{m.i,t}$.[10]

For each firm, we regress the proportion of properties in MSA *m* on the distance to the headquarters:

$$w_{m.i,t} = p_i + q_i \ln D_{m,i,t} + e_t, \tag{25}$$

[9] However, the relationship between institutional ownership and REIT stock liquidity is still mixed. For instance, Below et al. (1995) and Bhasin et al. (1997) find a positive link between institutional ownership and liquidity. Chiang and Venkatesh (1988) do not find a significant relationship between levels of institutional ownership and REIT bid-ask spreads, and find a negative relationship.

[10] A potential criticism for using distance to the headquarters as an exogenous instrument is that the liquidity of a firm's shares can also be affected by the investment diversification strategy. For instance, Garcia and Norli (2012) find that local firms have lower investor recognition, which implies lower stock liquidity for local firms. We note and emphasize that we are using the relative distance of each property to the headquarter as the instrument – we are not using the absolute distance. Therefore, this instrument is not affected by whether the firm is a local firm or dispersed firm. It is independent with of the average distance of the assets to the headquarters. For example, if firm A has all assets in one distant MSA, and if firm B has all assets in its headquarters MSA, the weights for both firms are 1, although firm A is a dispersed firm and firm B is a local firm.

where $D_{m,i,t}$ is the average distance of properties located in MSA m to the headquarters of REIT i. For instance, if two properties are located in MSA m, $D_{m,i,t}$ is the average distance of these two properties to the REIT's headquarters. For the estimation of Equation 30, the REIT must have investments in at least three MSAs. For firms with properties located in only one or two MSAs, we use the observed weights. The estimated q_i is illustrated in Figure 5. Most of the coefficients are negative. So the instrumented weight is calculated as $\hat{w}_{m.i,t} = \hat{p}_i + \hat{q}_i \ln D_{m,i,t}$ and the local beta is calculated as $\hat{\Upsilon}_{i,t}^{dist} = \sum_{m=1}^{M} \hat{w}_{m.i,t} \tau_{m,t}$. One issue with the two-stage least squares regression is that the standard error of the instrumented variable can be biased. Therefore, we use bootstrapping to generate the standard error of $\hat{\Upsilon}_{i,t}^{dist}$. We first bootstrap Equation (25) and then bootstrap Equation (24) using the bootstrapped $\hat{w}_{m.i,t}$ to generate the standard error of α. In other words, the standard error of α is generated using bootstrapped error terms for both Equations (24) and (25).[11] The estimated results, which are reported in Table 4, Model 7, are very robust.

Although the distance is conditionally exogenous to MSA illiquidity, the relevance of the instrument needs to be tested. We use an F test for each firm-month observation. The p-values of these F statistics are plotted out in Figure 6. The x-axis is the p-value of the test, and the y-axis is the frequency of each p-value. Of the 20,431 firm-month observations, 8,332 (40.73%) have a p-value lower than 10%. We exclude those firm-month observations with insignificant F-test and construct $\hat{\Upsilon}_{i,t}^{dist\_sig}$ using only observations with significant F-tests. Results are reported in Table 4, Model 8. Due to the reduction in firm-month observations in the first-stage regression, the number of $\hat{\Upsilon}_{i,t}^{dist\_sig}$ decreases. Consequently, the total number of observations in the second stage (Model 8) is reduced by nearly half. However, the coefficient for real estate market illiquidity is robust.

[11] In this paper, when an instrumented variable is used, the standard error of its coefficient is generated using bootstrapping. For instance, the standard errors of coefficient α in Table 4, Models 4, 5, and 6 are generated by bootstrapping Equation (25) and Equation (24). The standard errors of coefficient α in Table 4, Models 7 to Model 12 are generated by bootstrapping Equation (28), and Equation (24). The standard errors of coefficient α in Table 4, Models 13 and 14 are generated by bootstrapping Equation (25), Equation (28), and Equation (24).

Since the preceding analysis reduces the observations, we use a Heckman correction to determine whether the remaining sample is still representative of the full sample. We first investigate the probability of surviving (Equation 26), and then include the estimated probability as an additional regressor to correct for potential selection bias (Equation 27):

$$\mathrm{Pb}_{\mathrm{i,t}} = c + dX_{i,t} + \varphi_i + \delta_t + u_{i,t}, \tag{26}$$

$$y_{i,t} = \alpha \widehat{\Upsilon}_{i,t-1}^{dist\_sig} + \beta X_{i,t} + \theta \widehat{IM_{\iota,t}} + \gamma_i + \delta_t + e_{i,t}, \tag{27}$$

where $\mathrm{Pb}_{\mathrm{i,t}}$ is an indicator variable with the value of one when the F test is significant at the 10% level and zero when the F test is insignificant. In other words, a significant F test means that the distance to the headquarters is a valid instrument for this firm at this period. $\widehat{IM_{\iota,t}}$ is the inverse Mill's ratio based on the estimated probability in Equation (26). Results for Equation (27) are reported in Table 4, Model 9. The coefficient for the real estate market illiquidity remains significant.

The second concern is that REIT transactions affect property market liquidity, resulting in a reversal relationship: i.e., REIT liquidity influences property market liquidity. For instance, focusing on the aggregated commonality of liquidity in both public and private real estate markets from 1993 to 2010, Bond and Chang (2012) find a directional Granger causality from public to private real estate markets. Based on a theoretical framework and calibration, Ghent (2019) also shows that heterogeneity in the liquidity preferences of investors renders some markets more liquid, even when assets have identical cash flows. As a result, property market liquidity might be affected by REIT transactions. To address potential reversal causality, we use the change in a residential house price index provided by Federal Housing Finance Agency (FHFA) as an instrument to predict MSA turnover rate. We argue that REIT transactions are not likely to directly influence residential house prices.

$$Turnover_{m.t} = l + g\Delta \ln HP_{m,t} + e_{m,t}, \tag{28}$$

Considering that the turnover rate is always between 0 and 1, we use a probit panel regression. The estimated g is 9.85 with a T statistic of 2.88. The increase in house prices is positively related to the increase in commercial property turnover. The R squared of Equation (28) is 24%. The F statistic is 8.29, which is significant at the 1% level; this confirms the relevance of the instrument.[12] With this approach, the illiquidity of the underlying property markets for each REIT is calculated using the estimated turnover ($\widehat{Turnover}_{m,t}$) rather than the observed one.

$$\hat{\tau}_{m,t} = \frac{\max(\widehat{Turnover}_{m,t}) - \widehat{Turnover}_{m,t}}{\max(\widehat{Turnover}_{m,t}) - \min(\widehat{Turnover}_{m,t})}, \tag{29}$$

$$\hat{\mathrm{T}}_{i,t}^{HP} = \sum_{m=1}^{M} w_{m.i,t} \hat{\tau}_{m,t} \tag{30}$$

Results based on the instrumented turnover rate are reported in Table 4, Model 10. Again, the results are quite robust.

Luo et al. (2017) find that changes in house prices have an impact on local stock liquidity. For our analysis, house price change is calculated for the MSAs in which the REIT's properties are located and not necessarily for the REIT's headquarters MSA. Most REITs have assets outside their home MSA. However, Lou et al.'s finding does not necessarily imply that REIT stock liquidity is affected by house price in the underlying property MSAs. Consequently, and as a robustness test, we exclude those REITs with all investments in their home MSA. The results, reported in Table 4, Model 11, remain robust.

As apartment REITs mainly invest in residential markets, their performance can be directly affected by house prices. Therefore, house price change may not be a suitable instrument for apartment REITs. However, in our sample, less than 10% of the observations are from apartment REITs, so the results may

[12] One might also test the exogeneity of the instrument. However, because MSA-level turnover has a different dimension than the REIT illiquidity measure (in other words, a different number of observations in stage one and two regressions), a J-test is not applicable here.

not be seriously affected. If we exclude apartment REITs from the sample, the results are quite robust, as reported in Table 4, Model 12.[13]

We next use the instrumented weights (based on Model 7) and instrumented turnover rate (based on Model 10) to construct the illiquidity of underlying property markets to address both the self-selection issue and reversal causality issue:

$$\widehat{\Upsilon}_{i,t}^{HP\ dist} = \sum_{m=1}^{M} \widehat{w}_{m.i,t} \hat{\tau}_{m,t} \tag{31}$$

As shown in Table 4, Model 13, the results are robust. A one standard deviation decrease in the liquidity in the property market is associated with a 0.113 standard deviation decrease in REIT share liquidity.

Next, we address whether the relationship between REIT and real estate market liquidity is driven by the commonality in the liquidity of the two markets. This relationship may be due to nationwide factors such as changes in investor sentiment (Freybote and Seagraves, 2018) or credit supply (Davis and Zhu, 2011), etc. Time fixed effect should be able to capture this comovement. Nevertheless, we include the average real estate market illiquidity across all MSAs and the average Amihud illiquidity across all REITs as additional control variables and exclude time fixed effects. As shown in Table 4, Model 14, the illiquidity of local property markets coefficient remains significant, which implies that the transmission of illiquidity is indeed based on the geographic allocation of assets to segmented real estate markets. Average property market illiquidity and average REIT stock illiquidity coefficients are each highly significant.

A concern may also arise due to variations in economic situations across MSAs in which REITs allocate their properties. For instance, Bernile et al. (2015a) show that the liquidity of local equity markets can be affected by local business cycles. To address this potential issue, we include the average unemployment rate of the MSAs in which REITs invest. As shown in Model 14, Table 4, REIT stock illiquidity is

[13] If we only include apartment REITs in the baseline regression and use FHFA house price change as the instrument, the coefficient for property market illiquidity exposure rises to 0.5541, with a standard error of 0.0913. The significantly higher coefficient confirms the argument that apartment REITs are more sensitive to housing market liquidity. This can further support our robustness test in which we exclude apartment REITs. We thank several conference participants, most particularly Roland Füss, for motivating this analysis.

significant and positively related to the local unemployment rate, which confirms the local business cycle and stock liquidity theory proposed by Bernile et al. (2015a). We do not attempt to isolate the illiquidity transmission from local business cycles, as the illiquidity of a real estate market may reflect local economic conditions. Therefore, this analysis is still based on the specification of Model 13.

Liquidity is also strongly related to market density. In most downtown areas, for instance, the property market is more liquid. Therefore, concerns may arise that liquidity only captures the impact of investing in downtown or suburban areas—that is, the density of the location rather than the liquidity. Therefore, we control for the density of local property markets. We add another control variable: the average number of properties located with a 5 km radius of each property. As shown in Model 14, the coefficient for density is significant and negative, which confirms that stock liquidity improves by investing in more dense locations; these also tend to be more liquid markets. The real estate market illiquidity exposure remains significant, which implies that our liquidity measurement can capture liquidity information in addition to property density.

<< Table 4 about here>>

Table 5 reports robust results for two alternative stock illiquidity measures, Roll and price spread. In each case, Table 5 reports statistical evidence that property market illiquidity can cause REIT shares illiquidity. Economically, a one standard deviation change in property market illiquidity ($\widehat{\Gamma}_{i,t}^{Dist\_HP}$) is related to a 0.08 standard deviation change in Roll illiquidity and a 0.121 standard deviation change in price spread.

<< Table 5 about here>>

5.2 Time variation in the transmission of illiquidity

Prior studies find time-varying liquidity in public and private real estate markets (Hoesli et al., 2017, Bond and Chang, 2012). In Table 6, we further divide our sample into three time periods: before the global financial crisis (1996–2006), the crisis period (2007–2009), and the post-crisis period (2010–2015). We show the results for all three stock illiquidity measures: Panel A is the Amihud illiquidity measure, Panel B the Roll illiquidity measure, and Panel C the price spread. Again, and as shown in Table 6, the results are relatively robust across the three illiquidity measures. The strongest transmission of liquidity appears during the crisis period, when market liquidity is severely depressed. During the crisis period, a one standard deviation increase in property market illiquidity is associated with an increase in Amihud illiquidity, Roll illiquidity, and price spread by 0.301, 0.356, and 0.356 standard deviations, respectively. This relationship is economically remarkable: The impact is more than 10 times stronger relative to the whole period. After the crisis, the transmission becomes weaker but remains statistically significant. This finding is consistent with the previous literature.

<< Table 6 about here >>

The dramatic increase in the transmission of liquidity between public and private markets during the crisis period can be supported by our theoretical model. As $\frac{\partial \lambda}{\partial \rho} = 2a(1-a)kh(\gamma^*)\sigma_{xL}\sigma_{yL} > 0$, it is easy to show that an increased correlation between property markets results in a greater impact of property market liquidity on REIT stock liquidity. During the crisis period, the comovement among U.S. regional property markets rose (Zhu et al., 2013, Kallberg et al., 2014, Miao et al., 2011); consequently, we expect property market liquidity to have a great impact on REIT liquidity.

5.3 Cross firm variation in the transmission of illiquidity

In this section, we provide additional analysis of our three propositions by dividing the sample according to firm characteristics, including the location of assets, investment growth, and financial constraints. As shown in our previous analysis, the illiquidity of real estate markets can affect the illiquidity of REIT shares. However, firms may be subject to different levels of illiquidity discount (σ_{xL}). For instance, firms with an information advantage in a certain market should have lower transaction costs (L) in those markets. As a result, these firms may be less vulnerable to real estate market illiquidity. For firms investing in less familiar markets, the searching costs (L) could be higher and the illiquidity discount would also be higher. In the previous sections, we assume that the transaction costs are the same across firms given a certain market. We further test Proposition 1 by considering the different levels of information advantage across firms. If transaction cost (L) and the associated illiquidity discount (σ_{xL}) really matter, we would expect firms with an information advantage (disadvantage) to be less (more) sensitive to the illiquidity of underlying real estate markets.

We use two measures for information advantage for REITs: size and share of assets in the home market. Larger firms tend to be more experienced, and therefore we assume that larger firms have an information advantage. We compare the half of our sample comprised of larger REITs and the half with smaller REITs. Table 7, Panel A reports the results. The coefficient of the real estate market illiquidity is larger for smaller REITs based on the Amihud illiquidity measure. Similarly, Hoesli et al. (2017) observe that larger REITs tend to comove less with the private market. However, the difference in the coefficient is insignificant based on the Roll illiquidity measurement and price spread.

If we categorize REITs according to the share of local investments, the empirical evidence is much stronger. The information advantage of local investment is well documented in the literature; this is especially the case in real estate markets, where the information environment is more obscure due to the low transaction volume (Garmaise and Moskowitz, 2004, Ling et al., 2018). We compare the half of REITs with a higher concentration of properties in their headquarters MSA and the half with a lower proportion. Table 7, Panel B reports the results. The coefficient for REITs having less than 5.8% of properties in their home MSA is significantly larger than REITs that invest mainly in their local market. In other words, diversification may increase information asymmetry, and therefore result in the firm’s being more vulnerable to liquidity shocks in the underlying market. For the 50% of REITs with the most properties located outside their home MSA, a one standard deviation increase in real estate market illiquidity results in a 0.241, 0.223, and 0.276 standard deviation increase in share illiquidity measured by Amihud, Roll, and price spread, respectively.

<< Table 7 about here>>

Table 8 presents the relationship between illiquidity and investment growth. According to Proposition 2, REIT stock illiquidity will be more sensitive to real estate market illiquidity for REITs with higher investment growth. We again compare the 50th percentile of REITs with higher growth (i.e., lower funds from operations (FFO) payout ratio[14] or higher real estate investment growth rate, in the grey columns of Table 8) with the other 50th percentile with the lowest real estate investment growth (i.e., higher FFO payout ratio or lower real estate investment growth rate, in the white columns of Table 8). As shown in Table 8, for REITs with a lower payout ratio or higher investment growth, the coefficient for real estate market illiquidity is larger. Based on the investment growth rate, the difference is significant based on all three measure. This result supports Proposition 2. For the 50th percentile of REITs with the higher real estate investment growth rate, a one standard deviation increase in property market illiquidity is accompanied by a 0.115, 0.123, and 0.165 standard deviation increase in Amihud illiquidity, Roll illiquidity, and price spread, respectively.

<< Table 8 about here>>

A REIT's financial constraints can also increase the sensitivity to real estate market illiquidity. Debt to asset ratio and cash interest coverage rate serve as our measures of financial constraint. We see a significant difference in the coefficient for real estate market illiquidity between REITs with the highest and lowest debt to asset ratios (Table 9, Panel A) and cash interest coverage ratios (Table 9, Panel B) based on the Amihud measurement. For the half of REITs with the highest cash interest coverage ratio, a one standard deviation increase in property market illiquidity is accompanied by a 0.113, 0.099, and 0.120 standard deviation increase in Amihud illiquidity, Roll illiquidity, and price spread, respectively.

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[14] REITs normally use FFO as a measurement of earnings, which is defined as GAAP net income plus depreciation. The rationale for using FFO rather than a cost-based accounting measurement is the increased value of property investments over time, which renders the depreciation deduction inaccurate in valuing a REIT. REITs are required to distribute 90% of net income, which is roughly equivalent to about 50% to 60% of the FFO payout ratio.

<< Table 9 about here>>

5.4 The Value of Property Market Liquidity

As a facet of our analysis, we examine the value implications of the relationship between asset liquidity and stock liquidity for REITs. If the improvements in REIT share liquidity caused by the increase in underlying property market liquidity leads to higher firm value, then the strategy of allocating assets to more liquid real estate markets will likely be more valuable, all else being equal.

To test this prediction, we regress a REIT's value proxy on the average property market illiquidity weighted by its asset portfolio:

$$Q_{i,t} = \alpha \hat{\Upsilon}_{i,t-1}^{HP\ dist} + \beta X_{i,t} + \varphi_i + \delta_t + e_{i,t}, \tag{32}$$

where $Q_{i,t}$ stands for the REIT's annual Tobin's Q, which has been widely used as a measure of firm valuation (Capozza and Seguin, 1999, Riddiough and Steiner, 2018, Ling et al., 2019a, Capozza and Seguin, 2003). $Q_{i,t}$ is defined as the ratio of market equity (stock price times the number of shares) to replacement costs. We follow Ling et al. (2019a) and calculate replacement costs as the book value of property adding back depreciation minus book liabilities. Control variables are the same as in previous sections. The results of this regression are reported in Table 10. Model 25 is for all periods, and Models 26 to 28 divide the sample into pre-crisis (1996–2006), crisis (2007–2009), and post-crisis (2010–2015) periods. We find a significant relationship between property market illiquidity and REIT relative valuation, and the impact increases dramatically during the crisis periods. From 2007 to 2009, a one standard deviation decrease in property market liquidity is associated with a 31.8% decrease in value, as measured by Tobin's Q. The relationship remains significant after the crisis period. Overall, a REIT's value is related to the individual property market liquidities where the REIT's assets are located.

<< Table 10 about here>>

6 Conclusion

This paper proposes the investment channel that leads to the transmission of liquidity shocks across markets – the liquidity of the market where the firm invests can reflect the uncertainty in the investment and, thereby, affects the stock liquidity. To accomplish this, we construct a sample of 119 distinct REITs over the period from 1996 to 2015. The data allow us to measure a REIT's real estate asset liquidity by linking the proportion of its properties located in a specific property market and a proxy for that market's liquidity. We find a significant impact on individual REIT liquidity due to the liquidity of the local, underlying property market where the assets are located. This finding supports the investment channel transmission proposition. Our analysis controls for self-selection bias and reversal causality. A one standard deviation increase in property market illiquidity is associated with a more than 0.1 standard deviation increase in REIT stock illiquidity. During the global financial crisis, the impact rises to more than 0.3 standard deviation in REIT share illiquidity. Furthermore, we show that the sensitivity of REIT share liquidity to the underlying property market also depends on the firm's information environment, investment growth, and financial constraints. We further show that stock illiquidity caused by the illiquidity of the markets where the underlying assets are located can explain stock valuation in a statistically significant way: A one standard deviation increase in property market illiquidity results in a 31.8% decrease in Tobin's Q during the crisis period. The positive relationship between the liquidity of underlying local real estate markets and REIT share liquidity, as well as the valuation, implies that corporate investment decisions, including the selection of geographic markets, can affect stock liquidity and firm value.

References

ACHARYA, V. V. & PEDERSEN, L. H. 2005. Asset pricing with liquidity risk. *Journal of Financial Economics,* 77**,** 375-410.

AGARWAL, S. & HU, M. R. 2014. Liquidity Dynamics between REIT and Property Markets. *Working Paper*.

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

AMIHUD, Y. & MENDELSON, H. 1986. Asset Pricing and the Bid Ask Spread. *Journal of Financial Economics,* 17**,** 223-249.

ATTIG, N., FONG, W. M., GADHOUM, Y. & LANG, L. H. P. 2006. Effects of large shareholding on information asymmetry and stock liquidity. *Journal of Banking & Finance,* 30**,** 2875-2892.

BECKER-BLEASE, J. R. & PAUL, D. L. 2006. Stock liquidity and, investment opportunities: Evidence from index additons. *Financial Management,* 35**,** 35-51.

BECKER, B., CRONQVIST, H. & FAHLENBRACH, R. 2011. Estimating the Effects of Large Shareholders Using a Geographic Instrument. *Journal of Financial and Quantitative Analysis,* 46**,** 907-942.

BELOW, S., KIELY, J. & MCINTOSH, W. 1995. An Examination of Informed Traders and the Market Microstructure of Real Estate Investment Trusts. *Journal of Real Estate Research,* 10**,** 335-361.

BENVENISTE, L., CAPOZZA, D. R. & SEGUIN, P. J. 2001. The value of liquidity. *Real Estate Economics,* 29**,** 633-660.

BERNILE, G., KORNIOTIS, G., KUMAR, A. & WANG, Q. 2015a. Local Business Cycles and Local Liquidity. *Journal of Financial and Quantitative Analysis,* 50**,** 987-1010.

BERNILE, G., KUMAR, A. & SULAEMAN, J. 2015b. Home away from Home: Geography of Information and Local Investors. *Review of Financial Studies,* 28**,** 2009-2049.

BHASIN, V., COLE, R. A. & KIELY, J. K. 1997. Changes in REIT liquidity 1990-1994: Evidence from intra-day transactions. *Real Estate Economics,* 25**,** 615-630.

BOND, S., CROSBY, N., HWANG, S., KEY, T., LIZIERI, C., MATYSIAK, G., MCALLISTER, P. & WARD, C. 2004. The liquidity in Commerical Property Market *IPF Project*

BOND, S. A. & CHANG, Q. Q. 2012. Liquidity dynamics across public and private markets. *Journal of International Money and Finance,* 31**,** 1890-1910.

BOND, S. A., HWANG, S., LIN, Z. G. & VANDELL, K. D. 2007. Marketing period risk in a portfolio context: Theory and empirical estimates from the UK commercial real estate market. *Journal of Real Estate Finance and Economics,* 34**,** 447-461.

BRENNAN, M. J. & SUBRAHMANYAM, A. 1996. Market microstructure and asset pricing: On the compensation for illiquidity in stock returns. *Journal of Financial Economics,* 41**,** 441-464.

BROUNEN, D., EICHHOLTZ, P. & LING, D. 2009. The Liquidity of Property Shares: An International Comparison. *Real Estate Economics,* 37**,** 413-445.

BRUNNERMEIER, M. K. & PEDERSEN, L. H. 2009. Market Liquidity and Funding Liquidity. *Review of Financial Studies,* 22**,** 2201-2238.

BUCKLES, B. W. 2008. Liquidity Dynamics in Commerical Real Estate. *Journal of Real Estate Portfolio Management,* 43**,** 258-280.

CAPOZZA, D. R. & SEGUIN, P. J. 1999. Focus, transparency and value: The REIT evidence. *Real Estate Economics,* 27**,** 587-619.

CAPOZZA, D. R. & SEGUIN, P. J. 2003. Inside ownership, risk sharing and Tobin's q-ratios: Evidence from REITs. *Real Estate Economics,* 31**,** 367-404.

CHAN, K. F., TREEPONGKARUNA, S., BROOKS, R. & GRAY, S. 2011. Asset market linkages: Evidence from financial, commodity and real estate assets. *Journal of Banking & Finance,* 35**,** 1415-1426.

CHIANG, R. & VENKATESH, P. C. 1988. Insider Holdings and Perceptions of Information Asymmetry - a Note. *Journal of Finance,* 43**,** 1041-1048.

CLAYTON, J. & MACKINNON, G. 2000. Measuring and explaining changes in REIT liquidity: Moving beyond the bid-ask spread. *Real Estate Economics,* 28**,** 89-115.

CLAYTON, J., MACKINNON, G. & PENG, L. 2008. Time variation of liquidity in the private real estate market: An empirical investigation. *Journal of Real Estate Research,* 30**,** 125-160.

CROSBY, N. & MCALLISTER, A. 2004. Disconstructing the transaction process. *Investment Property Forum Working Paper 2 in the series on Liquidity in Commercial Property Markets*.

DAVIS, E. P. & ZHU, H. B. 2011. Bank lending and commercial property cycles: Some cross-country evidence. *Journal of International Money and Finance,* 30**,** 1-21.

DEVANEY, S., MCALLISTER, P. & NANDA, A. 2017. Which Factors Determine Transaction Activity across US Metropolitan Office Markets? *Journal of Portfolio Management,* 43**,** 90-104.

FISHER, J., GATZLAFF, D., GELTNER, D. & HAURIN, D. 2004. An analysis of the determinants of transaction frequency of institutional commercial real estate investment property. *Real Estate Economics,* 32**,** 239-264.

FISHER, J., GELTNER, D. & POLLAKOWSKI, H. 2007. A quarterly transactions-based index of institutional real estate investment performance and movements in supply and demand. *Journal of Real Estate Finance and Economics,* 34**,** 5-33.

FLEMING, J., KIRBY, C. & OSTDIEK, B. 1998. Information and volatility linkages in the stock, bond, and money markets. *Journal of Financial Economics,* 49**,** 111-137.

FOLEY, C. F., HARTZELL, J. C., TITMAN, S. & TWITE, G. 2007. Why do firms hold so much cash? A tax-based explanation. *Journal of Financial Economics,* 86**,** 579-607.

FREYBOTE, J. & SEAGRAVES, P. 2018. The Impact of Investor Sentiment on Commercial Real Estate Market Liquidity. *Journal of Real Estate Research,* 40**,** 597-627.

GARCIA, D. & NORLI, O. 2012. Geographic dispersion and stock returns. *Journal of Financial Economics,* 106**,** 547-565.

GARMAISE, M. J. & MOSKOWITZ, T. J. 2004. Confronting information asymmetries: Evidence from real estate markets. *Review of Financial Studies,* 17**,** 405-437.

GHENT, A. C. 2019. What's Wrong with Pittsburgh? Investor Composition and Trade Frequency in US Cities *Working Paper*.

GOPALAN, R., KADAN, O. & PEVZNER, M. 2012. Asset Liquidity and Stock Liquidity. *Journal of Financial and Quantitative Analysis,* 47**,** 333-364.

GOYENKO, R. Y. & UKHOV, A. D. 2009. Stock and Bond Market Liquidity: A Long-Run Empirical Analysis. *Journal of Financial and Quantitative Analysis,* 44**,** 189-212.

HARDIN, W. G., HIGHFIELD, M. J., HILL, M. D. & KELLY, G. W. 2009. The Determinants of REIT Cash Holdings. *Journal of Real Estate Finance and Economics,* 39**,** 39-57.

HOESLI, M., KADILLI, A. & REKA, K. 2017. Commonality in Liquidity and Real Estate Securities. *Journal of Real Estate Finance and Economics,* 55**,** 65-105.

HOLMSTROM, B. & TIROLE, J. 1993. Market Liquidity and Performance Monitoring. *Journal of Political Economy,* 101**,** 678-709.

HONG, H., KUBIK, J. D. & STEIN, J. C. 2008. The only game in town: Stock-price consequences of local bias. *Journal of Financial Economics,* 90**,** 20-37.

KALLBERG, J. G., LIU, C. H. & PASQUARIELLO, P. 2014. On the Price Comovement of U.S. Residential Real Estate Markets. *Real Estate Economics,* 42**,** 71-108.

KOTHARE, M. 1997. The effects of equity issues on ownership structure and stock liquidity: A comparison of rights and public offerings. *Journal of Financial Economics,* 43**,** 131-148.

KYLE, A. S. 1985. Continuous Auctions and Insider Trading. *Econometrica,* 53**,** 1315-1335.

KYLE, A. S. & XIONG, W. 2001. Contagion as a wealth effect. *Journal of Finance,* 56**,** 1401-1440.

LEE, K. H. 2011. The world price of liquidity risk. *Journal of Financial Economics,* 99**,** 136-161.

LIN, Z. G. & VANDELL, K. D. 2007. Illiquidity and pricing biases in the real estate market. *Real Estate Economics,* 35**,** 291-330.

LING, C. H., WANG, C. & ZHOU, T. 2019a. Institutional Cross-Ownership, Motivated Investors, and Firm Value: Evidence from Real Estate Investment Trusts. *Working Paper*.

LING, D. C., NARANJO, A. & SCHEICK, B. 2018. There's No Place Like Home: Information Asymmetries, Local Asset Concentration, and Portfolio Returns. *Working Paper*.

LING, D. C., WANG, C. & ZHOU, T. 2019b. The Geography of Real Property Information and Investment: Firm Location, Asset Location, and Institutional Ownership. *Working Paper*.

LIU, C. H., LIU, P. & ZHANG, Z. P. 2019. Real Assets, Liquidation Value and Choice of Financing. *Real Estate Economics,* 47**,** 478-508.

LOUGHRAN, T. & SCHULTZ, P. 2005. Liquidity: Urban versus rural firms. *Journal of Financial Economics,* 78**,** 341-374.

LUO, J., XU, L. M. & ZURBRUEGG, R. 2017. The Impact of Housing Wealth on Stock Liquidity. *Review of Finance,* 21**,** 2315-2352.

MARCATO, G. & WARD, C. 2007. Back from beyond the bid-ask spread: Estimating liquidity in international markets. *Real Estate Economics,* 35**,** 599-622.

MIAO, H., RAMCHANDER, S. & SIMPSON, M. W. 2011. Return and Volatility Transmission in US Housing Markets. *Real Estate Economics,* 39**,** 701-741.

MORELLEC, E. 2001. Asset liquidity, capital structure, and secured debt. *Journal of Financial Economics,* 61**,** 173-206.

NAES, R., SKJELTORP, J. A. & ODEGAARD, B. A. 2011. Stock Market Liquidity and the Business Cycle. *Journal of Finance,* 66**,** 139-176.

PASQUARIELLO, P. 2007. Imperfect competition, information heterogeneity, and financial contagion. *Review of Financial Studies,* 20**,** 391-426.

PASTOR, L. & STAMBAUGH, R. F. 2003. Liquidity risk and expected stock returns. *Journal of Political Economy,* 111**,** 642-685.

PIRINSKY, C. & WANG, Q. H. 2006. Does corporate headquarters location matter for stock returns ? *Journal of Finance,* 61**,** 1991-2015.

REHSE, D., RIORDAN, R., ROTTKE, N. B. & ZIETZ, J. 2019. The effects of uncertainty on market liquidity: Evidence from Hurricane Sandy. *Journal of Financial Economics,* In Press.

RIDDIOUGH, T. & STEINER, E. 2018. Financial Flexibility and Manager–Shareholder Conflict: Evidence from REITs. *Real Estate Economics***,** 1-40.

TUZEL, S. & ZHANG, M. B. 2017. Local Risk, Local Factors, and Asset Prices. *Journal of Finance,* 72**,** 325-370.

VAN DIJK, D. W. & FRANCKE, M. K. 2019. INtegration of Funding and Market Liquidity in Real Estate: International Evidence. *Working Paper*.

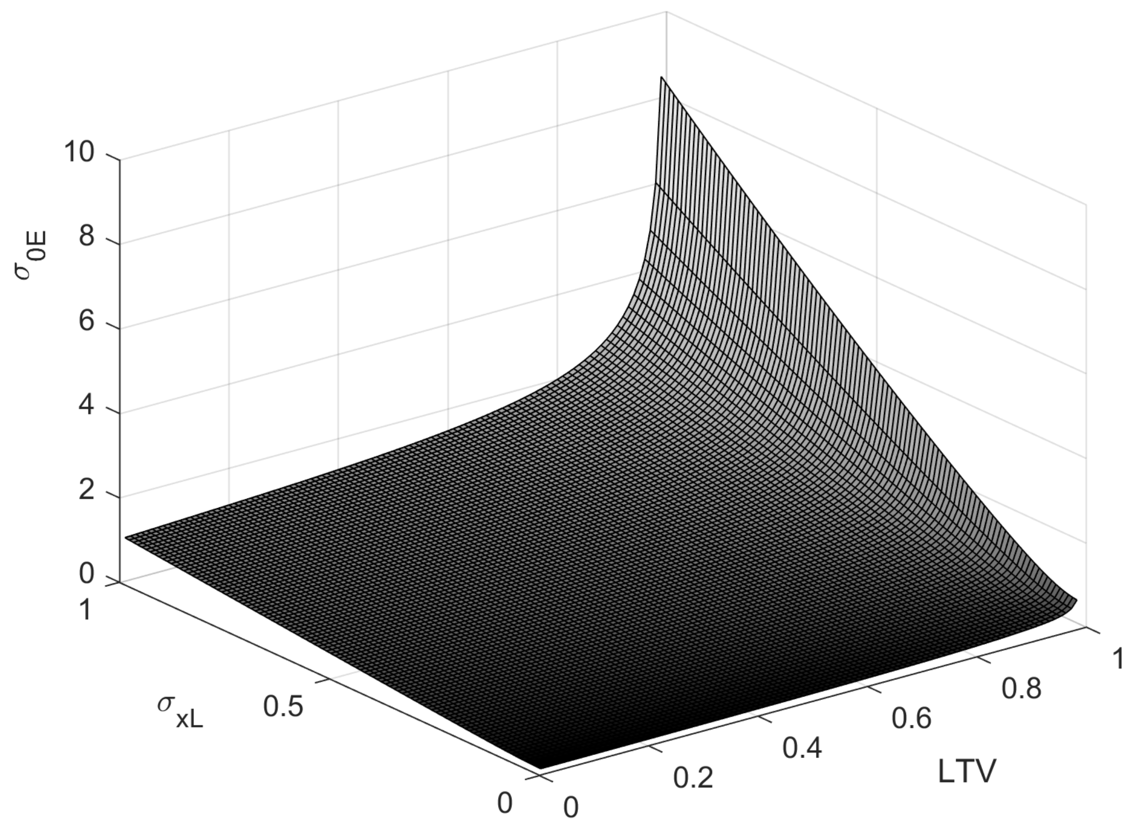
WANG, C., COHEN, J. P. & GLASCOCK, J. L. 2019. Geographically Overlapping Real Estate Assets, Liquidity Spillovers, and Liquidity Multiplier Effects. *Working Paper*.

WILEY, J. A. 2017. Leverage, liquidity and information in commercial property prices. *Journal of Property Research,* 34**,** 77-107.

ZE-TO, S. Y. M. 2016. Asset liquidity and stock returns. *Advances in Accounting,* 35**,** 177-196.

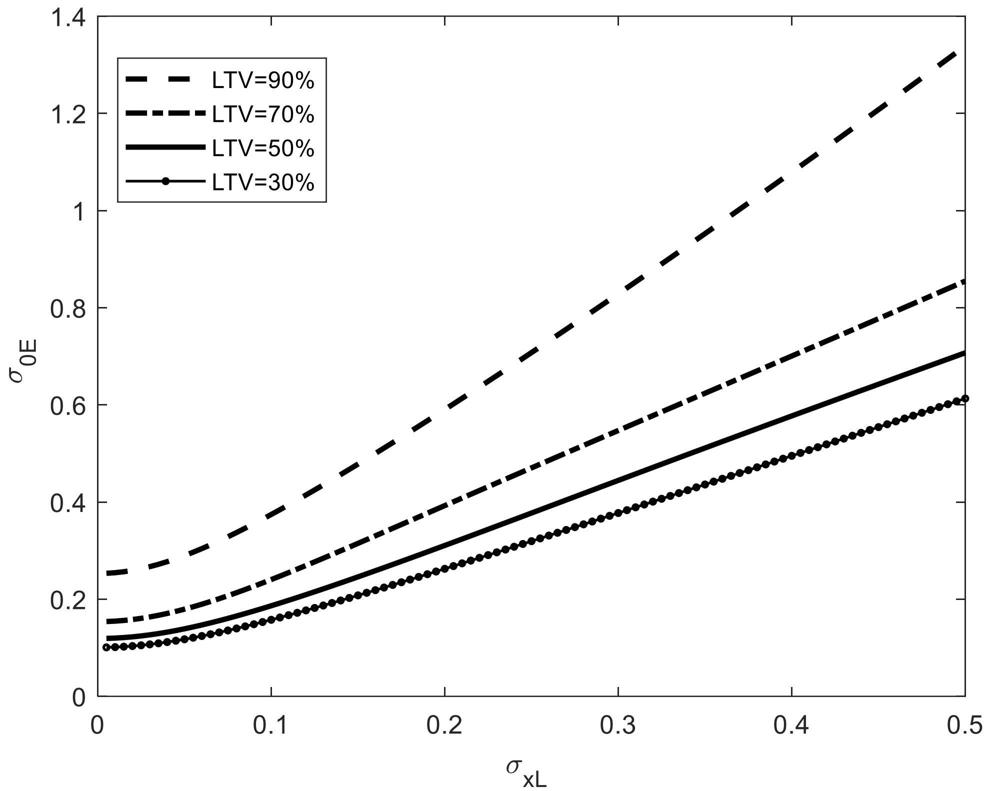
ZHU, B., FUSS, R. & ROTTKE, N. B. 2013. Spatial Linkages in Returns and Volatilities among U.S. Regional Housing Markets. *Real Estate Economics,* 41**,** 29-64.

Figure 1: Illiquidity component of asset return volatility, loan to value ratio, and expected REIT stock volatility



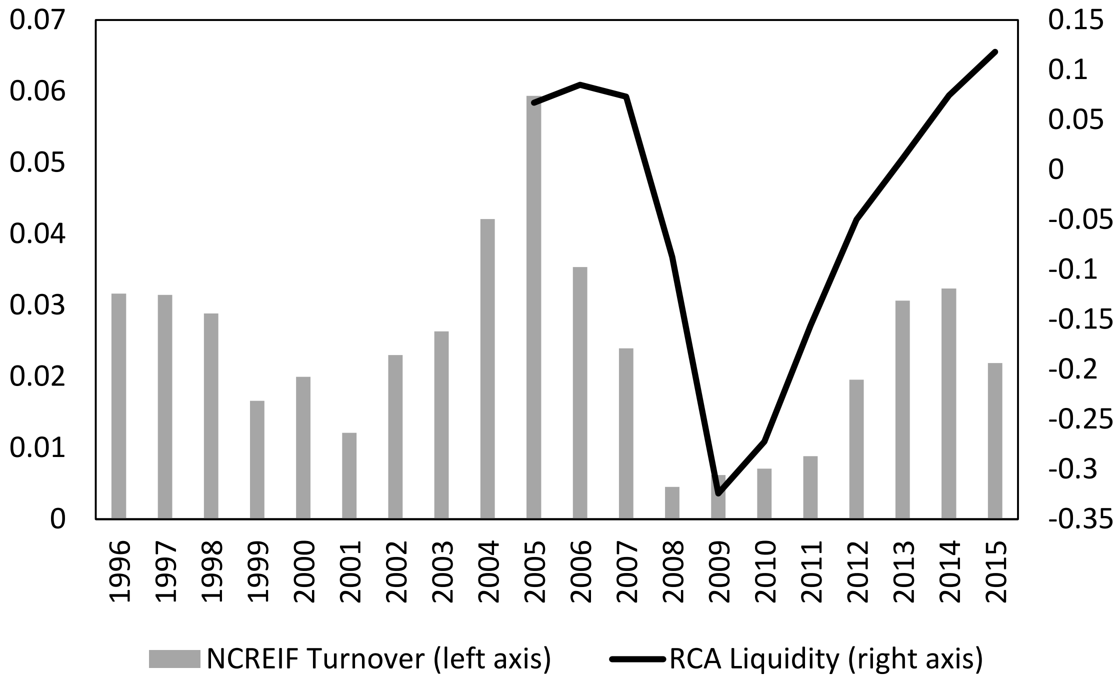
Note: This graph shows the relationship between loan to value ratio (LTV), asset return volatility due to market illiquidity (σ_{xL}), and REIT equity volatility (σ_{0E}).

Figure 2: Illiquidity component of asset return volatility and expected REIT stock volatility



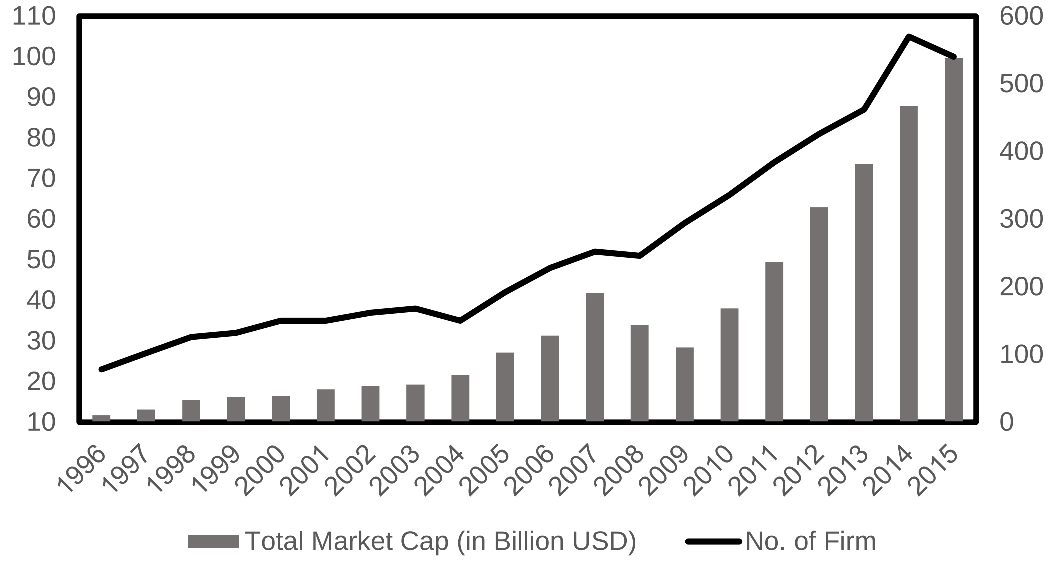
Note: This graph shows the relationship between loan to value ratio (LTV), Illiquidity component of asset return volatility due to market illiquidity (σ_{xL}), and expected REIT equity volatility (σ_{0E}).

Figure 3: Average Liquidity Measures across Property Markets



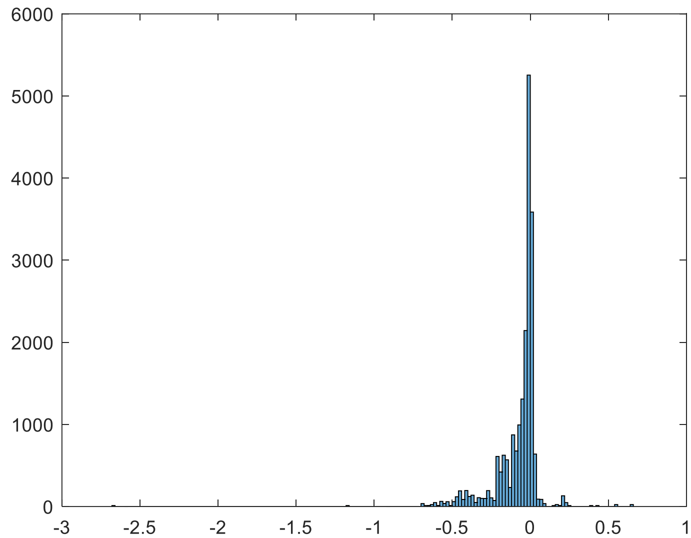
Note: This graph shows the average turnover rate based on NCREIF data across 144 MSAs from 1996 to 2005. For comparison and robustness testing, we include the average of an alternative liquidity measure, developed by van Dijk and Francke (2019), based on RCA data. The latter indices cover 31 U.S. regions; however, Dijk and Francke's liquidity measurement is only available since 2015.

Figure 4: Number of REITs in our sample and their market capitalization between 1996 and 2015



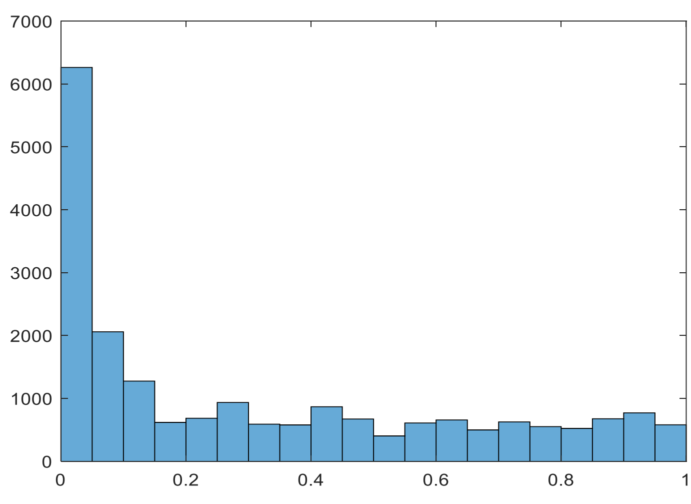
Note: This graph shows the number of REITs in our sample (left axis) and total market capitalization (right axis) in billion USD.

Figure 5: Coefficient of Distance as the Instrument



Note: This figure plots the distribution of the coefficient for the distance in the auxiliary regression for the instrumented proportion of properties in each MSA. The proportion of properties for a certain MSA is regressed on the average distance of all properties held by this firm located in a certain MSA to the headquarters of the firm. The regression is run separately for each firm.

Figure 6: F-test for the Relevance of Distance



Note: This graph shows F statistics for the relevance test of the instrument. The x-axis is the p-value of the test and the y-axis is the frequency of each p-value. Of the 20,431 month-firm observations, 8,332 (40.73%) have a p-value lower than 10%.

Table 1: MSAs with Highest Turnover

The table shows summary statistics for MSAs with the highest turnover and return statistics in these MSAs. Mean stands for the average annual returns of NCREIF total returns, and std stands for the standard deviation of NCREIF total returns. GDP stands for the average gross domestic product for all industries for each MSA from 2001 to 2015 (millions of current dollars). Ump. rate stands for the average unemployment rate for each MSA from 2001 to 2015. HP stands for the average FHFA house price index change during this period.

CBSA/ DIV		Turn-over	Mean	Std	No. Prop.	GDP	Ump	HP
12060	Atlanta-Sandy Springs-Marietta, GA	0.107	2.10%	2.13%	181	276695	5.78	0.7%
38060	Phoenix-Mesa-Scottsdale, AZ	0.107	2.23%	2.87%	88	181825	5.25	1.0%
47894	Washington-Arlington-Alexandria, DC-VA-MD-WV	0.099	2.24%	2.37%	159	400773	4.17	1.3%
31084	Los Angeles-Long Beach-Anaheim, CA	0.097	2.56%	3.09%	197	750884	7.10	1.5%
16974	Chicago-Naperville-Joliet, IL-IN-WI	0.094	2.03%	2.13%	201	532513	6.65	0.6%
19124	Dallas-Fort Worth-Arlington, TX	0.094	1.97%	2.41%	168	360164	5.32	0.9%
41940	San Jose-Sunnyvale-Santa Clara, CA	0.088	2.92%	3.33%	74	158279	6.12	1.5%
26420	Houston-Baytown-Sugar Land, TX	0.086	1.66%	2.86%	103	362057	5.68	1.2%
11244	Anaheim-Santa Ana-Irvine, CA Metropolitan Division	0.079	2.38%	2.89%	91	750884	7.10	1.4%
15764	Cambridge-Newton-Framingham, MA Metropolitan Division	0.074	2.42%	2.57%	49	317974	4.58	1.1%
19740	Denver-Aurora, CO	0.072	2.07%	3.22%	85	149277	5.17	1.2%
41740	San Diego-Carlsbad-San Marcos, CA	0.064	2.38%	2.75%	72	175391	5.89	1.4%
22744	Miami-Fort Lauderdale-Miami Beach, FL	0.063	2.07%	2.40%	60	256776	6.03	1.2%
42644	Seattle-Tacoma-Bellevue, WA	0.062	2.36%	2.37%	116	236810	5.61	1.2%
48424	Miami-Fort Lauderdale-Miami Beach, FL	0.060	1.81%	3.00%	37	256776	6.03	1.2%
35614	New York-Newark-Edison, NY-NJ-PA	0.059	2.66%	5.07%	117	1287693	6.29	0.9%
12420	Austin-Round Rock, TX	0.059	1.63%	2.88%	70	85079	4.58	1.2%
12580	Baltimore-Towson, MD	0.057	2.34%	2.27%	54	146022	5.37	1.0%
33460	Minneapolis-St. Paul-Bloomington, MN-WI	0.054	1.86%	1.89%	75	197426	4.33	0.9%
36740	Orlando, FL	0.052	2.21%	2.45%	43	98633	5.59	0.9%

Table 2: Descriptive Statistics

This table shows descriptive statistics. Turnover stands for MSA turnover rate according to NCREIF transaction records. RCA liquidity is based on indices derived from demand and supply reservation prices. MSA level unemployment rate is collected from the Bureau of Labor Statistics, and house price change is based on FHFA MSA house price index. Stock illiquidity measures, including Amihud, Roll illiquidity, and price spread, are described in Section 4.2. Exposure to property market illiquidity risk is calculated as the MSA property market illiquidity multiplied by percentage of properties located in the corresponding MSA (Section 4.1). We also use instrumented variables to address potential self-selection and/or reversal causality issues (See section 5.1). Three asset liquidity measures are defined according to Gopalan et al. (2012). Other firm-level variables include REIT monthly return, volatility, debt to equity ratio, size (in million USD), Herfindahl index for property geographic (MSA) concentration, book to market ratio, and real estate investment growth (in percentage).

	Mean	Std. Dev.	Max	Min
Property Market Variables				
Turnover	0.0214	0.0536	0.4290	0
RCA Liquidity	-0.0131	0.1553	0.2802	-0.5363
Unemployment Rate	0.0607	0.0286	0.4000	0.0070
House Price Change	0.0083	0.0278	0.1321	-0.1657
Firm Characteristics				
Stock Illiquidity				
Amihud Illiquidity Measure	0.2092	0.2608	9.9178	0
Roll Illiquidity	0.0055	0.0106	0.2829	0
Price Spread	0.0252	0.0201	0.2852	0.0011
Exposure to Property Market Illiquidity Risk				
Property Market Illiquidity_NCREIF	0.8928	0.0713	1.0000	0.4742
Property Market Illiquidity_RCA	0.4069	0.1755	0.9161	0.0255
Property Market Illiquidity_self-selection	0.9154	0.0622	1.0094	0.4742
Property Market Illiquidity_reversal causality	0.7814	0.0853	0.9803	0.2852
Property Market Illiquidity_self-selection and reversal causality	0.7809	0.0847	0.9803	0.2852
Asset Liquidity				
Weighted Asset liquidity (WAL1)	0.0292	0.0534	0.6683	0.0000
Weighted Asset liquidity (WAL2)	0.0450	0.0625	0.8745	0.0000
Weighted Asset liquidity (WAL3)	0.5988	0.6941	1.0000	0.1048
Other Variables				
Return	0.0077	0.0988	1.1511	-1.1996
Volatility	0.3824	0.3929	9.6864	0
Debt to Equity	1.5648	1.8395	14.2105	0
Market Capitalization (Million USD)	2920	4501	57337	0.3500
MSA Herfindahl Index	0.1982	0.2407	1.0000	0.0148
Book to Market Ratio	0.8269	1.3236	50.0000	0
RE Investment Growth (%)	0.1800	0.3861	3.6612	-0.9838
Institutional ownership (%)	72.47	29.20	107.04	0.000

Table 3: REIT stock illiquidity and underlying property market illiquidity

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Amihud illiquidity measure. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Control variables include debt to equity ratio; three asset liquidity measures: the percentage of cash and equivalent to past total assets (WAL1), the percentage of cash and other current assets to previous total asset (WAL2), and the percentage of cash, other current assets, and fixed assets to previous total asset (WAL3); return volatility in last month; return in past 6 months (MOM); market value (size); book to market ratio; real estate investment growth rate; MSA focus; and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model 1:	Model 2:	Model 3:	Model 4:	Model 5:	Model 6:
RE Mkt Illiq	0.1239***	0.1205***	0.1209**			
(NCREIF)	(0.0519)	(0.0503)	(0.0529)			
RE Mkt Illiq				0.2328***	0.2323***	0.2329***
(RCA)				(0.0213)	(0.0212)	(0.0212)
WAL1	-0.0364			0.0065		
	(0.0931)			(0.0302)		
WAL2		-0.0290			0.0299	
		(0.1075)			(0.0330)	
WAL3			0.0324*			0.0031
			(0.0179)			(0.0120)
Volatility	0.1358***	0.1371***	0.1354***	0.1644***	0.1644***	0.1644***
	(0.0218)	(0.0214)	(0.0226)	(0.0069)	(0.0069)	(0.0069)
MOM	-0.1122***	-0.1115***	-0.1136***	-0.0827***	-0.0828***	-0.0828***
	(0.0194)	(0.0192)	(0.0207)	(0.0068)	(0.0068)	(0.0068)
Debt to Equity	-0.0016	-0.0015	-0.0009	0.0050***	0.0050***	0.0050***
	(0.0023)	(0.0024)	(0.0021)	(0.0010)	(0.0010)	(0.0010)
Size	-0.0159***	-0.0158***	-0.0159***	-0.0266***	-0.0265***	-0.0265***
	(0.0044)	(0.0044)	(0.0046)	(0.0034)	(0.0034)	(0.0034)
Book to Market	0.0294***	0.0295***	0.0282***	0.0114***	0.0113***	0.0114***
	(0.0090)	(0.0089)	(0.0079)	(0.0032)	(0.0032)	(0.0032)
RE Investment	-0.0191***	-0.0196***	-0.0249***	-0.0029	-0.0030	-0.0034
Growth	(0.0046)	(0.0047)	(0.0058)	(0.0042)	(0.0042)	(0.0047)
HHI_MSA	0.0071	0.0083	0.0023	-0.0129	-0.0160	-0.0125
	(0.0334)	(0.0342)	(0.0293)	(0.0212)	(0.0213)	(0.0209)
Institutional	-0.0056	-0.0048	-0.0049	-0.1118***	-0.1120***	-0.1117***
Ownership	(0.0159)	(0.0158)	(0.0160)	(0.0118)	(0.0118)	(0.0118)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	9,011	9,011	9,011	5,265	5,265	5,265
Adj. R2	0.9164	0.9165	0.9164	0.9428	0.9428	0.9428

Table 4: Instrumented Regressions

*Note: This table reports results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Amihud illiquidity measure. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Model 4 is based on the instrumented weights, Model 5 is based on the instrumented NCREIF turnover rate, and Model 6 uses both instrumented weights and instrumented NCREIF turnover rate. Control variables include debt to equity ratio, weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. REIT common illiquidity is the average Amihud illiquidity of all REITs. RE Mkt Illiquidity_Av is average illiquidity of all MSAs. MSA_ump is the weighted average MSA level unemployment rate according to the firm's property allocation. Clustered standard errors are reported in parentheses. The F-test for Model 4 is illustrated in Figure 6. In Models 5 and 6, firms and periods with an insignificant F-test for the instrument at the 10% level are excluded. The F-test for Model 7 is the F test for the instrument in the first-stage regression (Eq 31). The standard error for RE Mkt Illiquidity is measured using 100 bootstraps. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model 7: Instrumented Weights	Model 8: Instrumented Weights (Sig. F-test)	Model 9: Instrumented Weights (Sig. F-test)	Model 10: Instrumented Turnover	Model 11: Instrumented Turnover (ex. Home)	Model 12: Instrumented Turnover (ex. Residential)	Model 13: Instrumented Weights and Turnover	Model 14: Instrumented Weights and Turnover
RE Mkt	0.1727***	0.2898***	0.2284***	0.2738***	0.3076***	0.2531***	0.2742***	0.3335***
Illiquidity	(0.0198)	(0.0285)	(0.0389)	(0.0166)	(0.0174)	(0.0171)	(0.0374)	(0.0211)
WAL3	0.0325*	0.0774	0.0843	0.0255	0.0168	0.0233***	0.0259	0.0163
	(0.0178)	(0.0489)	(0.0616)	(0.0170)	(0.0184)	(0.0090)	(0.0168)	(0.0117)
Volatility	0.1326***	0.1638***	0.1781***	0.1418***	0.1374***	0.1360***	0.1415***	0.0639***
	(0.0226)	(0.0263)	(0.0293)	(0.0158)	(0.0152)	(0.0050)	(0.0164)	(0.0046)
MOM	-0.1133***	-0.1419***	-0.2096***	-0.0981***	-0.1023***	-0.0937***	-0.0953***	-0.0550***
	(0.0207)	(0.0291)	(0.0612)	(0.0169)	(0.0169)	(0.0058)	(0.0168)	(0.0062)
Debt to Equity	-0.0011	0.0003	0.0242***	-0.0011	0.0024	-0.0011	-0.0012	-0.0004
	(0.0021)	(0.0087)	(0.0072)	(0.0018)	(0.0030)	(0.0008)	(0.0018)	(0.0012)
Size	-0.0165***	-0.0202***	-0.0184**	-0.0176***	-0.0213***	-0.0166***	-0.0184***	-0.0011
	(0.0046)	(0.0087)	(0.0081)	(0.0047)	(0.0048)	(0.0022)	(0.0048)	(0.0027)
Book to Market	0.0286***	0.0235	0.0059	0.0191***	0.0188***	0.0216***	0.0176***	0.0101***
	(0.0076)	(0.0187)	(0.0224)	(0.0073)	(0.0072)	(0.0027)	(0.0073)	(0.0037)
RE Investment	-0.0255***	-0.0336***	-0.0775***	-0.0231***	-0.0197***	-0.0218***	-0.0231***	-0.0219***
Growth	(0.0057)	(0.0134)	(0.0310)	(0.0056)	(0.0057)	(0.0032)	(0.0054)	(0.0041)

HHI_MSA	0.0060	-0.0319	-0.2504**	0.0045	0.0049	0.0132	0.0036	-0.0003
	(0.0296)	(0.0675)	(0.1241)	(0.0240)	(0.0278)	(0.0143)	(0.0247)	(0.0228)
Institutional	-0.0060	0.0316	0.0188	-0.0276*	-0.0261*	-0.0337***	-0.0291**	-0.0024
Ownership	(0.0161)	(0.0296)	(0.0260)	(0.0143)	(0.0149)	(0.0072)	(0.0141)	(0.0104)
Prob_Sig			2.2005*					
F_test			(1.1530)					
REIT common								0.6675***
Illiquidity								(0.0132)
RE Mkt								0.4867***
Illiquidity_Av								(0.0640)
MSA_ump								0.0020***
								(0.0008)
Density								-0.0406***
								(0.0095)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	8987	3599	3073	8507	8202	7940	8506	8506
Adj. R2	0.9168	0.8987	0.9000	0.9242	0.9248	0.9265	0.9243	0.4769
F-test in First Stage	-	-	-	8.29***			-	

Table 5: Alternative Stock Illiquidity Measure

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Roll illiquidity measure (Panel A) and interday price spread (Panel B). RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Models 9 and 10 are based on the instrumented weights. Model 11 is based on the instrumented NCREIF turnover rate. Control variables include debt to equity ratio, weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The F-test for Model 11 is illustrated in Figure 6. In Model 12, firms and periods with an insignificant F-test for the instrument at 10% level are excluded. F-test for Mode 13 is the F test for the instrument in the first stage regression (Eq 32). The standard error for RE Mkt Illiquidity is measured using bootstrapping. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model 15: No Instrument	Model 16: RCA property illiquidity	Model 17: Instrumented Weights	Model 18: Instrumented Weights (Sig. F-test_Heckman)	Model 19: Instrumented Turnover (ex. Home)	Model 20: Instrumented Turnover (ex. Residential)	Model 21: Instrumented Weights and Turnover
Panel A: Roll							
RE Mkt	0.0048***	0.0084***	0.0033***	0.0039**	0.0125***	0.0108***	0.0107***
Illiquidity	(0.0021)	(0.0018)	(0.0013)	(0.0021)	(0.0012)	(0.0012)	(0.0010)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	9480	5510	9456	3397	8566	8273	8874
Adj. R2	0.7541	0.8180	0.7531	0.7526	0.7734	0.7923	0.7729
Panel B: Spread							
RE Mkt	0.0067***	0.0314***	0.0073***	0.0121***	0.0340***	0.0262***	0.0303***
Illiquidity	(0.0023)	(0.0024)	(0.0027)	(0.0033)	(0.0022)	(0.0020)	(0.0031)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	9478	5509	9454	3397	8565	8272	8873
Adj. R2	0.9250	0.9606	0.9250	0.9146	0.9338	0.9331	0.9315

Table 6: Time Difference in the Impact

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as Amihud Illiquidity Measure (Panel A), Roll Illiquidity Measure (Panel B) and interday price spread (Panel C). RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes, instrumented by distance to headquarters and MSA level house price changed. Control variables include debt to equity ratio, weighted average asset liquidity measure(WAL3), return volatility, return in past 6 months (MOM), market value (Size), book to market ratio, real estate investment growth rate, MSA focus and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The standard error for RE Mkt Illiquidity is measured using bootstrapping. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model 22: 1996-2006	Model 23: 2007-2009	Model 24: 2010-2015
Panel A: Amihud			
RE Mkt Illiquidity	0.0212***	0.9275***	0.1219***
	(0.0072)	(0.1487)	(0.0162)
Control Variables	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
No. of obs	3510	1554	3354
Adj. R2	0.9112	0.9466	0.9406
Panel B: Roll			
RE Mkt Illiquidity	0.0024***	0.0445***	0.0064***
	(0.0004)	(0.0060)	(0.0013)
Control Variables	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
No. of obs	3728	1679	3373
Adj. R2	0.5253	0.8295	0.7305
Panel C: Spread			
RE Mkt Illiquidity	0.0019	0.0843***	0.0127***
	(0.0013)	(0.0079)	(0.0005)
Control Variables	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
No. of obs	3727	1679	3373
Adj. R2	0.8797	0.9644	0.9707

Table 7: Liquidity and Information Advantage

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Amihud illiquidity measure, Roll illiquidity measure, and interday price spread. Panel A groups REITs according to size and Panel B according to the proportion of properties located in the same MSA as the headquarters of the firm. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes, instrumented by distance to headquarters and MSA-level house price change. Control variables include debt to equity ratio, weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The standard error for RE Mkt Illiquidity is measured using bootstrapping. Diff. Coef. is the difference in the coefficient for RE Mkt Illiquidity between the gray column and the white column. Significance is based on one-tailed T statistics. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Panel A: Size					
	Amihud		Roll		Spread	
	Size >1816	Size ≤1816	Size >1816	Size ≤1816	Size >1816	Size ≤1816
RE Mkt	0.2021***	0.3133***	0.0087***	0.0096***	0.0260***	0.0265***
Illiquidity	(0.0228)	(0.0411)	(0.0011)	(0.0012)	(0.0027)	(0.0035)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	4114	4392	4262	4612	4261	4612
Adj. R2	0.9633	0.9029	0.8712	0.7075	0.9628	0.9143
Diff. Coef.		0.1112**		0.0009		0.0005
	Panel B: Proportion of Assets in Home MSAs					
	Amihud		Roll		Spread	
	HQ MSA > 0.058	HQ MSA ≤0.058	HQ MSA > 0.058	HQ MSA ≤0.058	HQ MSA > 0.058	HQ MSA ≤0.058
RE Mkt	0.1872***	0.5775***	0.0068***	0.0247***	0.0223***	0.0551***
Illiquidity	(0.0212)	(0.0620)	(0.0007)	(0.0030)	(0.0020)	(0.0133)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	5314	3192	5555	3319	5554	3319
Adj. R2	0.9273	0.9253	0.8032	0.7440	0.9352	0.9363
Diff. Coef.		0.3903***		0.0179***		0.0328**

Table 8: Liquidity and Investment Growth

*Note: This table reports results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Amihud illiquidity measure. Roll illiquidity measure, and interday price spread. Panel A groups REITs according to the dividend to taxable income ratio, and Panel B according to real estate investment growth ratio. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes, instrumented by distance to headquarters and MSA-level house price change. Control variables include debt to equity ratio, weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The standard error for RE Mkt Illiquidity is measured using bootstrapping. Diff. Coef. is the difference in the coefficient for RE Mkt Illiquidity between the gray column and the white column. Significance is based on one-tailed T statistics. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Panel A: FFO payout Ratio						
	Amihud		Roll		Spread	
	Payout <67%	Payout ≥67%	Payout <67%	Payout ≥67%	Payout <67%	Payout ≥67%
RE Mkt Illiquidity	0.2184***	0.4049***	0.0089***	0.0156***	0.0292*	0.0398***
	(0.0203)	(0.0766)	(0.0007)	(0.0061)	(0.0182)	(0.0034)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	4570	3936	4699	4175	4699	4174
Adj. R2	0.9348	0.9148	0.7976	0.7562	0.9354	0.9325
Diff. Coef.		0.1865**		0.0067		0.0106
Panel B: Real Estate Investment Growth						
	Amihud		Roll		Spread	
	RE Invest <16%	RE Invest ≥16%	RE Invest <16%	RE Invest ≥16%	RE Invest <16%	RE Invest ≥16%
RE Mkt Illiquidity	0.1802***	0.3548***	0.0061***	0.0146***	0.0205***	0.0391***
	(0.0421)	(0.0282)	(0.0013)	(0.0013)	(0.0037)	(0.0035)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	3172	5334	3312	5562	3312	5561
Adj. R2	0.9117	0.9347	0.7589	0.7890	0.9173	0.9440
Diff. Coef.		0.1746***		0.0085***		0.0186***

Table 9: Liquidity and Financial Constraints

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Amihud illiquidity measure, Roll illiquidity measure, and interday price spread. Panel A divides REITs according to debt to equity ratio. Panel B uses cash interest coverage ratio. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes, instrumented by distance to headquarters and MSA-level house price change. Control variables include debt to equity ratio, the weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The standard error for RE Mkt Illiquidity is measured using bootstrapping. Diff. Coef. is the difference in the coefficient for RE Mkt Illiquidity between the grey column and the white column. Significance is based on one-tailed T statistics. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Panel A: Debt to Asset Ratio						
	Amihud		Roll		Spread	
	Debt Ratio < 55%	Debt Ratio ≥ 55%	Debt Ratio < 55%	Debt Ratio ≥ 55%	Debt Ratio < 55%	Debt Ratio ≥ 55%
RE Mkt Illiquidity	0.2146***	0.3381***	0.0090***	0.0121***	0.0292***	0.0309***
	(0.0308)	(0.0412)	(0.0011)	(0.0016)	(0.0029)	(0.0046)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	4776	3730	5001	3873	5000	3873
Adj. R2	0.9446	0.9094	0.8169	0.7405	0.9443	0.9236
Diff. Coef.		0.1235**		0.0031		0.0017
Panel B: Cash Interest Coverage Ratio						
	Amihud		Roll		Spread	
	Cash Ratio >3.1	Cash Ratio ≤3.1	Cash Ratio >3.1	Cash Ratio ≤3.1	Cash Ratio >3.1	Cash Ratio ≤3.1
RE Mkt Illiquidity	0.1618***	0.3485***	0.0083***	0.0124***	0.0242***	0.0285***
	(0.0354)	(0.0316)	(0.0017)	(0.0008)	(0.0025)	(0.0061)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	4746	3760	4904	3970	4903	3970
Adj. R2	0.9448	0.9118	0.8055	0.7517	0.9624	0.9127
Diff. Coef.		0.1876***		0.0041**		0.0043

Table 10: REIT Value and Real Estate Market Illiquidity

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is the REIT's annual Tobin's Q. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes, instrumented by distance to headquarters and MSA-level house price change. Control variables include debt to equity ratio, the weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The standard error for RE Mkt Illiquidity is measured using bootstrapping. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model 25: Tobin's Q	Model 26: Tobin's Q 1996-2006	Model 27: Tobin's Q 2007-2009	Model 28: Tobin's Q 2010-2015
RE Mkt Illiquidity	-0.2121*	0.1456	-3.7516***	-0.8034***
	(0.1102)	(0.2071)	(0.1908)	(0.1328)
WAL3	1.0003***	1.4120***	1.8394***	0.3108
	(0.1726)	(0.3401)	(0.3770)	(0.2002)
Volatility	-0.4669***	-1.1083***	0.6341***	-0.0015
	(0.1189)	(0.4052)	(0.2680)	(0.1157)
MOM	0.5385***	1.5111***	1.1083***	0.4075***
	(0.1224)	(0.3234)	(0.2394)	(0.1155)
Debt to Equity	-0.0010	0.0072	-0.0400	-0.0268***
	(0.0066)	(0.0121)	(0.0294)	(0.0103)
Size	0.0837***	0.0656	0.3119***	0.0644***
	(0.0249)	(0.0653)	(0.0845)	(0.0273)
RE Invest. Growth	-0.1480***	-0.1750***	-0.6088***	-0.2659***
	(0.0444)	(0.0719)	(0.1050)	(0.0629)
MSA Focus	-0.1660	-0.7880***	1.2058***	0.2032
	(0.1639)	(0.3289)	(0.3985)	(0.1802)
Institutional	-0.2981***	-0.2257	-0.9613***	0.0875
Ownership	(0.0997)	(0.2532)	(0.2189)	(0.1366)
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of obs	830	293	142	395
Adj. R2	0.9602	0.9493	0.9918	0.9850

Appendix 1: Stock Turnover

*Note: This table reports the results of the unbalanced panel with fixed effects. The dependent variable is REIT stock liquidity, which is measured as the Roll illiquidity measure (Panel A) and interday price spread (Panel B). RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Models 9 and 10 are based on instrumented weights. Model 11 is based on the instrumented NCREIF turnover rate. Control variables include debt to equity ratio, the weighted average asset liquidity measure (WAL3), return volatility, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. The F-test for Model 11 is illustrated in Figure 6. In Model 12, firms and periods with an insignificant F-test for the instrument at the 10% level are excluded. The F-test for Model 13 is the F test for the instrument in the first-stage regression (Eq 32). The standard error for RE Mkt Illiquidity is measured using bootstrapping. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model A1: No Instrument	Model A2: RCA property market illiquidity	Model A3: Instrumented Weights	Model A4: Instrumented Weights (Sig. F-test_Heckman)	ModelA5: Instrumented Turnover (ex. Home)	Model A6: Instrumented Turnover (ex. Residential REITs)	Model A7: Instrumented Weights and Turnover
RE Mkt	-0.0491***	-0.0168*	-0.0336***	-0.0236***	-0.0065	-0.0071	-0.0125***
Illiquidity	(0.0069)	(0.0093)	(0.0082)	(0.0083)	(0.0062)	(0.0068)	(0.0039)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	9,539	5,509	9,515	3,397	8,870	8,272	8,872
Adj. R2	0.7600	0.6345	0.7595	0.8139	0.7605	0.7514	0.7606

Appendix 2: Alternative RE Market Illiquidity

*Note: This table reports results of the unbalanced panel with fixed effects. The dependent variable is REIT annual stock liquidity, which is measured as the Amihud illiquidity measure, Roll illiquidity measure, and interday price spread, respectively. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Control variables include debt to equity ratio, the weighted average asset liquidity measure (WAL3), return volatility in last month, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model A8: Amihud	Model A9: Roll	Model A10: Spread	Model A11: Amihud	Model A12: Roll	Model A13: Spread
RE Mkt Illiq	0.0885***	0.0038***	0.0116***			
(adjusted cost)	(0.0170)	(0.0012)	(0.0021)			
RE Mkt Illiq				0.1326***	0.0036***	0.0075***
(size)				(0.0191)	(0.0013)	(0.0023)
WAL3	0.0240***	-0.0004	0.0006	0.0379***	-0.0003	0.0015
	(0.0081)	(0.0006)	(0.0010)	(0.0090)	(0.0006)	(0.0011)
Volatility	0.1538***	0.0084***	0.0219***	0.1536***	0.0082***	0.0223***
	(0.0047)	(0.0003)	(0.0006)	(0.0050)	(0.0003)	(0.0006)
MOM	-0.0874***	-0.0016***	-0.0112***	-0.0966***	-0.0023***	-0.0118***
	(0.0053)	(0.0004)	(0.0006)	(0.0056)	(0.0004)	(0.0007)
Debt to Equity	-0.0025***	-0.0000	-0.0001	-0.0028***	-0.0000	-0.0002*
	(0.0008)	(0.0001)	(0.0001)	(0.0008)	(0.0001)	(0.0001)
Size	-0.0197***	-0.0002	-0.0011***	-0.0207***	-0.0003**	-0.0017***
	(0.0019)	(0.0001)	(0.0002)	(0.0022)	(0.0001)	(0.0003)
Book to Market	0.0002	-0.0001	0.0002*	-0.0008	-0.0001**	0.0001
	(0.0008)	(0.0001)	(0.0001)	(0.0010)	(0.0001)	(0.0001)
RE Investment	-0.0161***	-0.0000	-0.0024***	-0.0207***	-0.0000	-0.0024***
Growth	(0.0029)	(0.0002)	(0.0004)	(0.0032)	(0.0002)	(0.0004)
HHI_MSA	-0.0284**	-0.0026***	-0.0126***	-0.0299*	-0.0024***	-0.0156***
	(0.0142)	(0.0010)	(0.0017)	(0.0156)	(0.0010)	(0.0018)
Institutional	-0.0075	0.0006	0.0001	-0.0204***	0.0011**	0.0015*
Ownership	(0.0065)	(0.0005)	(0.0008)	(0.0073)	(0.0005)	(0.0009)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	8,712	9,146	9,144	8,904	9,325	9,323
Adj. R2	0.9315	0.7797	0.9352	0.8743	0.7607	0.9241

Appendix 3: Fama MacBeth Cross-Sectional Regression with Annual Data

*Note: This table reports the results of Fama MacBeth cross-sectional regression with annual data. The dependent variable is REIT annual stock liquidity, which is measured as the Amihud illiquidity measure, Roll illiquidity measure and interday price spread, respectively. RE Mkt Illiquidity stands for the average illiquidity of the underlying property market each REIT exposes. Control variables include debt to equity ratio, the weighted average asset liquidity measure (WAL3), return volatility in last month, return in past 6 months (MOM), market value (size), book to market ratio, real estate investment growth rate, MSA focus, and institutional ownership. Firm fixed effect and time fixed effect are also included. Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

	Model A14: Amihud	Model A15: Roll	Model A16: Spread
RE Mkt Illiq	0.2245**	0.0027**	0.0104**
	(0.1260)	(0.0015)	(0.0046)
WAL3	0.1015**	-0.0022***	0.0059
	(0.0404)	(0.0006)	(0.0062)
Volatility	0.4105***	0.0099***	0.0519***
	(0.0742)	(0.0013)	(0.0103)
MOM	-0.1360**	-0.0011**	-0.0435*
	(0.0627)	(0.0006)	(0.0307)
Debt to Equity	0.0038***	-0.0001	0.0000
	(0.0009)	(0.0001)	(0.0001)
Size	-0.0266***	-0.0002	-0.0006***
	(0.0042)	(0.0002)	(0.0001)
Book to Market	0.0211**	0.0001	0.0025**
	(0.0093)	(0.0003)	(0.0010)
RE Investment	-0.0515***	0.0002	-0.0026
Growth	(0.0099)	(0.0002)	(0.0020)
HHI_MSA	-0.0039	-0.0001	-0.0022*
	(0.0127)	(0.0005)	(0.0013)
Institutional	-0.0284**	-0.0011***	0.0007
Ownership	(0.0110)	(0.0003)	(0.0008)
Constant	-0.0034	0.0022	0.0002
	(0.0703)	(0.0018)	(0.0008)
No. of obs	769	798	797
Adj. R2	0.8169	0.8592	0.9059