How Does Property Location Influence Investment Risk and Return?*

Gregg Fisher[†]
Fisher Family Ventures

Eva Steiner[‡]
Cornell University

Sheridan Titman[§]
University of Texas at Austin

Ashvin Viswanathan[‖]
Gerstein Fisher

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Abstract

A property's location is often considered to be the ultimate determinant of its investment performance. But how exactly does a property's location influence its risk and return? We focus on the effects of location density on the risk and return of commercial real estate investments. We do this by studying the geographical characteristics of the property portfolios of U.S. equity REITs. We show that REITs with property holdings in high-density locations experience higher NOI growth, earn higher risk-adjusted returns, and carry higher systematic risk than their otherwise comparable peers in low-density locations. Those high-density REITs also have lower leverage, better access to public bond markets, and lower implied cap rates. Our results suggest that location density is an important determinant of REIT performance outcomes and financing choices, consistent with geographical characteristics playing a significant role in driving patterns of investment risk and return across commercial real estate markets.

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[†]Fisher Family Ventures, 1120 Avenue of the Americas, New York, NY 10036. (212) 796-0707. Gfisher@FisherFamilyVentures.com.

[‡]Cornell University, 465B Statler Hall, Ithaca, NY 14853. (607) 255-6697. ems457@cornell.edu.

[§]University of Texas at Austin, CBA 6.266, Austin, Texas 78712. (512) 232-2787. titman@mail.utexas.edu.

[‖]Gerstein Fisher, 565 Fifth Avenue, New York, NY 10017. (646) 971-2543. aviswanathan@gersteinfisher.com.

1 Introduction

Real estate is traditionally divided into several asset classes that depend on the usage of the property. These property types, which include retail, office, multi-family, and industrial, exhibit unique patterns of risk and return. For example, retail has higher volatility and systematic risk than multifamily on average.[1] However, regardless of these property types, real estate professionals are quick to point out that the ultimate determinant of a property's risk and return is its location.

While there are a number of ways to characterize a property's location, this paper focuses on density, and the relationship between the risk and return of real estate and the density of its location. Specifically, we characterize the density of a location as the number of employees per square mile. Our assumption is that in denser locations, the supply of new space is less elastic; i.e., the supply of property grows less in response to positive demand shocks. This is intuitive — in less dense suburban locations there tends to be "green field" space that can be relatively inexpensively developed when the demand for space grows. In contrast, adding supply in more urban locations may require the demolition of existing buildings, which of course, is much costlier.[2]

The differential supply responses in dense and less dense locations generates a number of implications, which we explore in this paper. The first implication is that real estate rents in denser locations benefit more from positive demand shocks, but may not be hurt more during downturns, implying higher NOI growth in denser locations on average. A related implication is that properties in denser locations have higher systematic risk than their counterparts in less dense locations. Furthermore, investments with greater systematic risk exposures should earn higher returns on average. That is the third hypothesis we will test. Finally, and following directly from the first implication discussed above, the cap rates of properties in denser locations are likely to be lower on average. However, the growth rate effect is offset somewhat by the higher systematic risk and thus higher required rate of return of properties in more supply-constrained locations. As a result, the effect of density on cap rates, which is the final implication we explore, can in theory go either way.

[1] Data from Nareit suggest that, over the 1994–2017 period, the standard deviation of monthly total returns of retail REITs in the U.S. was 6.33%, compared to 5.58% for multifamily REITs. The CAPM beta for retail REITs over that period was 0.71, compared to 0.63 for multifamily REITs.

[2] This difference in supply elasticities of more and less dense locations may not, however, carry over to economic downturns. Because existing buildings are only demolished during extreme downturns, we expect to see almost no supply elasticity during downturns, regardless of the density of the location.

Real Estate Investment Trusts (REITs), which are publicly traded portfolios of real estate, have readily available market prices, and thus provide a useful laboratory for testing our hypotheses. Because the data is straightforward to interpret, our focus is on multi-family and office REITs, which, as we show, tend to focus on either suburban (less dense) or CBD (denser) locations.

In our empirical analyses, we make use of two granular data sets. The first data set provides detailed information on the precise acquisition and disposition dates, as well as the exact address location and property market value of the commercial real estate assets held by public U.S. REITs over the 1994–2017 period. We use those data to construct the property portfolio holdings of each sample REIT by U.S. zip code over the study period. The second data set contains annual data on employment density by U.S. zip code. We combine the REIT property holdings data with the employment density data to estimate the weighted average density of each of our sample REITs across all U.S. zip codes in which those REITs hold any commercial real estate assets at a given time in the study period.

Using CBSA-level data on new commercial real estate construction starts, we first show that new real estate supply is indeed less elastic in locations with higher density. We then test our hypothesis that the rents of REITs with higher density scores exhibit stronger growth on average than those with low density scores. To do so, we study the quarterly growth rates in REIT net operating income (NOI). Consistent with our hypothesis, we present evidence that NOI growth for high-density REITs significantly exceeds NOI growth for low-density REITs. Using the quarterly growth rate in real GDP as a proxy for aggregate demand, we also document that NOI growth in response to higher GDP growth is stronger for high-density REITs. This finding is consistent with our hypothesis that location density amplifies the response of real estate rents to a positive demand shock.

Next, we turn to the relationship between location density and real estate systematic risk. We first estimate rolling annual regressions of the weekly total returns earned by equal-weighted indices of high- versus low-density multifamily and office REITs on the weekly total return on the broader market. From those regressions, we compile an annual time series of systematic risk estimates for multifamily and office REITs by density exposure category. Our results suggest that the returns of high-density REITs are, on average, more sensitive to variation in the return on the broader market than are the returns of their low-density counterparts. Our estimates indicate that these general patterns in systematic risk and density exposure hold across both REIT property types (multifamily and office REITs) and for different market benchmarks (a broad stock market benchmark and an all-equity REIT market benchmark).

We further examine the empirical association between location density and systematic risk at the REIT-level. This cross-sectional analysis allows us to better control for a set of REIT-specific covariates that reflect other important drivers of REIT systematic risk exposure; most notably, REIT location beta.[3] We include this variable to account for the possibility that denser locations are exposed to more pro-cyclical industries; such as, finance or technology. If that were the case, then an observed relationship between REIT density and systematic risk might be driven by the industry composition of different locations, rather than their densities. Our analysis yields the following results: (i) multifamily and office REITs on average exhibit systematic risk exposures of less than one, values which are typically associated with defensive stocks; (ii) the average risk exposure of office REITs exceeds that of multifamily REITs; (iii) REITs whose property portfolios are concentrated in higher density locations are generally exposed to higher levels of systematic risk; (iv) the results from the REIT-level analysis are consistent with our prior finding that the strength of the association between REIT density exposure and systematic risk depends on the REIT property type and market benchmark index employed. In all, our findings on the association between location density and systematic risk are consistent with our hypothesis that the investment returns on properties in denser locations are more sensitive to variation in the return on the market than are those in less dense locations.

Our finding that high-density REITs have higher systematic risk than low-density REITs suggests that the former REITs also have higher returns on average. At the same time, the Sharpe ratio of high-density REIT returns may be lower than that of low-density REIT returns because high-density REITs should also experience higher return volatility. However, we study a sample period where demand for real estate was favorable on average, and REITs performed well. As a result, the Sharpe ratio of high-density REITs may have been higher. To address these questions, we examine the performance of stock portfolios containing multifamily and office REITs with different density exposures. Notably, we estimate that the average annualized total return of the high-density office REIT portfolio is 11.9% with a Sharpe ratio of 0.43, while the low-density office REIT portfolio generates an average annualized total return of 9.5% with a Sharpe ratio of 0.31. The evidence presented here is consistent with the hypothesis that high-density REITs outperform low-density REITs in terms of total returns and Sharpe ratios.

[3] In our REIT-level analysis of systematic risk, we also control for a set of other firm characteristics commonly associated with REIT performance in prior literature; namely, leverage, short-term debt exposure, and REIT size. Letdin et al. (2019) provide a thorough review of the determinants of REIT returns established to date.

Prior research has established that leverage is a significant driver of REIT systematic risk (see Alcock and Steiner (2018)). While we control for the effect of leverage on REIT systematic risk in our analysis of the association between REIT betas and density exposure, we have to ask the question whether location density influences real estate financing choices. We test this hypothesis in our REIT sample and show that high-density multifamily REITs hold lower levels of leverage than do their low-density counterparts. We find no evidence for a similar association between REIT density and leverage levels in office REITs. Our findings suggest that high-density multifamily REITs, whose systematic risk exposure is already elevated due to the location characteristics of their property holdings, avoid increasing this exposure further by maintaining low levels of leverage. The lack of similar evidence in the office REIT sub-sample reflects that, as noted above, the relationship between office REIT density and systematic risk in our sample is weaker than that between multifamily REIT density and systematic risk. Further, we document that corporate credit markets respond favorably to the more conservative capital structure stance adopted by high-density REITs, as those REITs are more likely than otherwise similar low-density REITs to have a corporate credit rating outstanding, and that rating is also likely to be of higher quality. The empirical results discussed here suggest that REITs find it costly to have debt ratings of low quality, and because denser locations are riskier, debt rating agencies may require REITs with greater density exposure to have lower leverage levels for a given rating.

We conclude our empirical tests by assessing the relationship between location density and real estate cap rates. If density limits the local supply response to positive demand shocks, then the cash flows of investment properties in denser locations are — to a degree — protected from the dilution that would occur if new competing supply entered the market in an economic upturn. As a result of such supply restrictions, the cash flows of properties in denser locations should be more valuable to investors, leading to lower cap rates. To test this conjecture, we study the implied cap rates of REITs with property portfolio holdings in denser versus the cap rates of REITs whose investment properties are concentrated in less dense locations. Our estimates suggest that implied cap rates for high-density REITs are significantly lower than those of otherwise comparable low-density REITs. For instance, we estimate that the implied cap rate for high-density multifamily REITs is on average 44 basis points lower than that for low-density multifamily REITs. Our results are consistent with denser locations being subject to tighter supply constraints, which raise property values and, all else equal, are associated with lower cap rates.

Prior work has established that real estate capitalization (cap) rates differ substantially across locations (Bialkowski et al. (2019)). For example, office properties in the central business district (CBD) of a city have lower cap rates than otherwise equivalent suburban office properties.[4] These cap rate spreads reflect a combination of differences in expected income growth and differences in required rates of return for the underlying properties. Cap rates also vary over time, again reflecting changes in required rates of return and changes in expected income growth.[5] However, the fundamental drivers of cap rates for investment properties in different locations are still largely unknown. Our work adds to this literature by documenting the effect of location density on cap rates, and by providing evidence for the underlying economic rationale as it relates to the effect of local supply constraints on growth in real estate rents.

Empirical studies describing the return-generating process for REITs typically focus on conventional asset pricing factors, such as the Fama and French (2015) five factors (see, for instance, Bond and Xue (2017)). Prior work has also studied the impact of firm-level financial variables, such as leverage and exposure to short-term debt (see Giacomini et al. (2015), Sun et al. (2015) and Pavlov et al. (2018), among others). Critically, prior work ignores the geographical dispersion of the underlying property portfolios owned by REITs across different locations with varying geographical characteristics. The composition of firms' asset portfolios influences their systematic risk and stock performance. Tuzel (2010) shows that firms with larger real estate holdings have greater systematic risk. Tuzel and Zhang (2017) document that, conditional on a given level of corporate real estate holdings, the location of the properties owned affects firms' systematic risk. Our work expands on the prior evidence by focusing on the impact of a specific location characteristic; namely, local density, on the systematic risk of REITs.

We believe that our analysis of the link between property locations and systematic risk is the first study that examines the fundamental cross-sectional determinants of the systematic risk of real estate. This is important for at least two practical reasons: The first is that it helps us better understand the link between the fundamental nature of the real estate held by REITs and the observed return patterns of REITs. To what extent do REIT investors appreciate these relatively subtle location-level differences? The second is that by learning more about the determinants of systematic risk, we can help REIT portfolio managers, as well as investors in physical real estate, better optimize their portfolios.

[4] See Duranton and Puga (2014) for a review of the related theoretical and empirical literature.

[5] Studies documenting cross-sectional and time-series variation in cap rates include, amongst others: Sivitanidou and Sivitanides (1999), Sivitanides et al. (2001), Chervachidze et al. (2009), McDonald and Dermisi (2009), and Chervachidze and Wheaton (2013).

2 Data and Sample Selection

2.1 REIT Property Holdings

We start the sample selection process with a comprehensive database on the commercial real estate holdings of public U.S. equity REITs. The information is taken from the "Real Estate Properties" section of S&P Global, the leading provider of firm- and property-level financial data for the REIT industry. The S&P Global database is unique in that it provides, for each property either currently or historically owned by any public U.S. equity REIT, the start and end dates of the period during which a given REIT held the property in its portfolio. The database further provides extensive information on each property's physical and financial characteristics, including its property type, exact location coordinates, and property value. The S&P Global data cover all major REIT property types. From this database, we obtain the set of all properties owned by public U.S. multifamily and office equity REITs between 1994 and 2017.

The sample contains 15,682 unique mainland U.S. properties, held by 30 multifamily REITs and 44 office REITs during the study period. Figure 1 shows that the property holdings of the REITs in the sample are geographically dispersed across all 48 contiguous states and Washington, D.C. The top 20 CBSAs by total REIT property holdings contain 10,188 (65%) of all sample properties.[6] Those CBSAs are characterized by sustained economic growth over the last two decades. Data from the U.S. Census Bureau's annual County Business Patterns survey show that the mean rate of five-year employment growth for the top 20 REIT property CBSAs is 7% during that period, above the overall national average of 6.5%. Moreover, the mean rates of five-year employment growth for those top 20 CBSAs over the study period fall into a narrow interval of between 5% and 10%. These statistics suggest that the property holdings of multifamily and office REITs are concentrated in growth markets.

Figure 1 about here.

2.2 REIT Density

Our empirical analysis requires location-specific, time-varying measures of urban density relevant to both, multifamily and office REITs. We focus on those two property types because the choice of suitable

[6] CBSA stands for core-based statistical area and is a collective term for metropolitan and micropolitan statistical areas. The top 20 CBSAs by total REIT property holdings are: Atlanta, Austin, Baltimore, Boston, Charlotte, Chicago, Dallas, Denver, Houston, Los Angeles, New York, Orlando, Philadelphia, Phoenix, Raleigh/Durham, San Diego, San Francisco, Seattle, Tampa, and Washington, D.C.

density measures is intuitive. For multifamily REITs, the natural measure is population density; for office REITs, it is employment density. Location density can be measured at different geographical levels, such as a location's zip code, CBSA, county, or state. However, density may vary significantly across areas situated in close physical proximity to one another; for instance, across the central business district (CBD) and the suburban areas of the same city. To capture the granular nature of location density, we measure this variable at the zip code-level.

We begin by collecting annual data on zip code-level total employment from the U.S. Census Bureau's County Business Patterns survey. We compute employment density in zip code l at time t, denoted $\textit{Location Density}_{l,t}$, by scaling total employment in zip code l at time t (in thousands of employees) by zip code size (in square miles). Similar annual data on zip code-level total population aren't easily available. Thus, we use zip code-level employment density as a proxy for population density and apply the same location density measure to both, multifamily and office REITs.[7]

We estimate *Density* for REIT i at time t as the weighted average employment density across all L zip codes to which that REIT is exposed through its property holdings at time t:

$$\textit{Density}_{i,t} = \sum_{l=1}^{L} \omega_{i,l,t} \times \textit{Location Density}_{l,t} \tag{1}$$

where $\textit{Location Density}_{l,t}$ is zip code-level employment density, as defined above, and $\omega_{i,l,t}$ is the weight assigned to each zip code, measured as the exposure of REIT i to zip code l at time t. We compute this exposure as the total market value of properties held by REIT i in zip code l at time t, divided by the total market value of all properties held by REIT i at time t across all L zip codes.

For the computation of the weights, $\omega_{i,l,t}$, we estimate the market value of the properties in each REIT's portfolio at the end of a given week based on the asset-level information from S&P Global. In S&P Global, we observe the exact start and end dates of the holding period for each property in the sample REITs' portfolios. For each property owned by the sample REITs, we observe at least one of the following property value metrics periodically over the course of the holding period: acquisition price, sale

[7] The focus of our investigation is the scope for a location to adjust its supply of real estate to demand shocks, proxied by higher location density. Location density may be elevated due to higher numbers of employees per square mile, or higher numbers of residents. As a result, although higher numbers of employees may not coincide perfectly with higher population numbers (the unconditional correlation between zip code-level population and employment across all U.S. zip codes is 59% over the study period), higher values of either one of those variables likely imply lower local supply elasticity.

price, initial cost, historic cost, or net book value. We estimate the market value of a REIT's properties on dates other than when we observe one of those five value metrics by assuming that time-series variation in the market value of a given property tracks the Real Capital Analytics (RCA) quarterly commercial property price index (CPPI) in that property's region (East, West, Midwest, and South). We compute *Density* on a weekly basis, using the most recent data available on the market value of a REIT's properties and location density. Given the lower frequency at which we observe variation in RCA's CPPI (quarterly) and zip code-level employment density (annual), weekly fluctuations in *Density* are predominantly driven by changes in the composition of the sample REITs' property portfolio holdings.

2.3 REIT Location Beta

Our primary research objective is to document the relationship between REIT density and systematic risk exposure. In doing so, it is important to isolate the impact of density on REIT systematic risk exposure from the potentially confounding influence of the local industry composition in high- versus low-density locations. In other words, one might ask whether REITs with large property portfolio shares located in dense locations; for example, New York and San Francisco, are more exposed to systematic risk because they are in high-density locations — or because these locations have large exposures to highly pro-cyclical industries (in this example, finance and technology, respectively). In that case, it might be the underlying exposure of different locations to certain industries that is the real driver of any observed relationship between REIT density and systematic risk exposure, rather than density itself. We address this possibility by including in our analysis an additional REIT-level variable, denoted *Location Beta*.

To construct the variable *Location Beta*, we first identify, for each CBSA k, the publicly listed firms headquartered in that CBSA. We obtain information on the headquarter locations of the universe of publicly listed firms in the U.S. from Compustat. We then form market capitalization-weighted CBSA portfolios comprising the stock of all publicly listed firms headquartered in a given CBSA. We compute the weekly total return on those CBSA portfolios, in excess of the risk-free rate, denoted $CBSA\ Return_t^k$. We regress that return on the weekly excess return on the stock market, denoted

$Market\ Return_t$, separately for each CBSA k, as shown below.[8]

$$CBSA\ Return_t^k = \alpha + \beta Market\ Return_t + \epsilon_t \tag{2}$$

where α is a constant, β measures the sensitivity of the weekly excess return on a given CBSA portfolio to variation in the excess return on the stock market, and ϵ is the residual. We estimate Eq. (2) on a rolling quarterly basis. Each quarterly regression uses weekly return observations from the previous four quarters. From those regressions, we collect, for each CBSA k in each quarter t, the coefficient β. We denote the resulting CBSA×quarter-level variable *CBSA Systematic Risk*.

We then estimate *Location Beta* for REIT i at time t as the average *CBSA Systematic Risk* exposure across all K CBSAs in which REIT i holds properties at time t, weighted by REIT i's exposure to each of those K CBSAs through its property portfolio holdings at time t:

$$Location\ Beta_{i,t} = \sum_{k=1}^{K} \omega_{i,k,t} \times CBSA\ Systematic\ Risk_{k,t} \tag{3}$$

where $CBSA\ Systematic\ Risk_{k,t}$ is CBSA-level systematic risk, as defined above, and $\omega_{i,k,t}$ is the weight assigned to each CBSA, measured as the exposure of REIT i to CBSA k at time t. We compute this exposure as the total market value of properties held by REIT i in CBSA k at time t, divided by the total market value of all properties held by REIT i at time t across all K CBSAs. The variable *Location Beta* captures a given REIT's exposure to the pro-cyclicality of the local economies in the different CBSAs in which that REIT holds commercial property investments. By including this variable in our analysis, we are able to separate its effect on the systematic risk exposure of REITs with property holdings across different CBSAs from the effect of the density of those CBSAs on REIT systematic risk exposure.

2.4 REIT-Level Financial Variables

We include a number of REIT-level stock market performance measures and financial characteristics in our analyses. We compute the weekly *Total Return* for each of the sample REITs based on daily total return data from the CRSP Daily Stock File. We construct the weekly equity market capitalization of

[8] As outlined in Section 2.5, we use the value-weighted return on all U.S. firms listed on a major stock exchange as the stock market benchmark, and we use the return on the one-month Treasury bill rate as the risk-free rate.

each sample REIT, denoted *Size* and expressed in $ billion, as the product of the stock's closing price and the number of shares outstanding at week-end, both also obtained from the CRSP Daily Stock File.

For each sample REIT, we compute two capital structure characteristics, using Compustat data. We calculate *Leverage* as the ratio of total long-term debt plus preferred stock (Compustat items DLTT + PSTK) to total EBITDA (sum of items OIADP, NOPI, and DPC). This variable is observed quarterly. We compute each REIT's exposure to *Short-Term Debt* as the total amount of long-term debt due within one year (item DD1), scaled by the total amount of all long-term debt (item DLTT). This variable is observed annually. To match quarterly and annual data on firm characteristics to weekly return data, we carry forward the most recent observations of those characteristics until updated values become available with the next financial reporting cycle. This procedure allows us to avoid any look-ahead bias in our results.

We collect information on two additional REIT characteristics. We obtain quarterly estimates on each sample REIT's *Implied Cap Rate*, measured as the ratio of long-term property net operating income to the implied market valuation of real estate, from S&P Global. We also collect quarterly data on long-term corporate debt ratings, issued by S&P and Moody's for each sample REIT, from S&P Global. We then define the variable *Debt Rated* as an indicator that takes the value of one if REIT i has a debt rating from either one of those two issuers outstanding at time t. Again, we carry forward the most recent observation of those variables until the next financial reporting period.

2.5 Market-Level Financial Variables

We compute three weekly market-level return measures. The *Stock Market Return* is the value-weighted return on all CRSP firms incorporated in the U.S. and listed on the NYSE, AMEX, or NASDAQ stock exchanges, with CRSP share codes 10 or 11. The *REIT Market Return* is the value-weighted return on all public U.S. equity REITs, based on daily total return data from the CRSP Daily Stock File.[9]

[9] We compute the *REIT Market Return* as the value-weighted average return for all U.S. traded securities whose industry classification corresponds to equity REITs. The relevant industry classification codes vary over time due to periodic revisions of the underlying industry classification systems. Specifically, we include securities belonging to SIC code 6798 (classification used from the start of the study period until November 1995), GICS industry code 404010 and sub-industry 40401010 (used between December 1995 and April 2006), GICS industry code 404020 (except sub-industry 40402030 — denoting Mortgage REITs — used between May 2006 and August 2016), and GICS industry code 601010 (used from September 2016 until the end of the study period).

The return on the risk-free rate is proxied by the return on the one-month Treasury bill rate, denoted *1-Month T-Bill Return*, from Ibbotson Associates.[10]

2.6 Location-Level Variables

In addition to the zip code-level density data discussed in Section 2.2, we also compute employment density on an annual basis for all major metropolitan areas among the U.S. CBSAs. The CBSA-level employment data are also obtained from the U.S. Census Bureau's County Business Patterns Survey. To those CBSA–year observations of employment density we match annual CBSA-level data on new construction of commercial real estate. The data on new non-residential construction (total square footage of new construction starts) are obtained from Dodge Data and Analytics. The information on CBSA-level commercial real estate stock is from Costar.

3 Descriptive Statistics

The final sample contains 21,279 weekly observations from 30 unique multifamily REITs, and 27,243 weekly observations from 44 office REITs, over the 1994–2017 period. Figure 2 presents the number of multifamily and office REITs represented in the sample during each year of the study period. The figure shows that the number of multifamily REITs is stable at around 20 between 1994 and 2005, drops to 13 in the aftermath of the financial crisis in 2009 and 2010, and slightly increases during the subsequent recovery but fails to reach its prior peak. The figure further shows that the number of office REITs increases significantly after the introduction of the UPREIT regime in the early 1990s, reaches a maximum value of 31 in 2005, then drops to 18 at the height of the financial crisis in 2008 and 2009, and slowly recovers in the final years of the study period. Overall, the figure suggests a pro-cyclical pattern in the number of active multifamily and office REITs in the U.S.

FIGURE 2 ABOUT HERE.

Table 1 presents descriptive statistics on the sample REITs and the market-level financial variables used in our empirical analysis. All variables, except indicator variables, are winsorized at 1^{st} and 99^{th} percentiles. *Density* for multifamily (office) REITs averages 7,857 (44,426) employees per square mile. These

[10] Weekly return data on the stock market and the risk-free rate are taken from Kenneth French's Data Library.

statistics suggest that office REITs, on average, hold properties in locations with higher density than do multifamily REITs. Both multifamily and office REITs on average have a *Location Beta* of close to 1, implying that the stock returns of the firms headquartered in the CBSAs in which those REITs' property holdings are located vary in proportion with the overall U.S. stock market. The mean weekly *Total Return* is comparable across multifamily and office REITs, with 0.27% and 0.25%, respectively. Mean *Size* is also similar across the two types of REITs, with $2.51 billion and $2.42 billion, respectively. However, the median office REIT is substantially larger ($1.29 billion) than the median multifamily REIT ($0.84 billion). Multifamily REITs on average carry higher levels of *Leverage* (5.19 times EBITDA) than office REITs (4.32 times EBITDA). On the other hand, those former REITs carry lower levels of *Short-Term Debt* (7.20% compared to 10.86%). The mean *Implied Cap Rate* of multifamily REITs (7.44%) falls below that of office REITs (8.42%) by a significant margin of approximately 100 basis points. The multifamily REITs in the sample are more likely to have a long-term corporate debt rating outstanding, as the mean value of the *Debt Rated* indicator equals 50.95% for multifamily REITs, compared to 39.93% for office REITs.

The descriptive statistics on the market-level financial variables presented in Table 1 suggest that both, multifamily and office REITs, deliver higher weekly total returns than the stock market (0.21%) or the overall REIT market (0.20%) over the study period. During that period, the weekly return on the risk-free rate averages 0.05%.

TABLE 1 ABOUT HERE.

In Figure 3 we plot histograms for the distributions of mean *Density* across the multifamily REITs (Panel A) and office REITs (Panel B) in the sample. For the purposes of this figure, we compute mean *Density* for each REIT over its life in the sample. The figure shows a discernible difference between the two mean *Density* distributions. Consistent with the statistics reported in Table 1, the average density exposure of office REITs exceeds that of multifamily REITs. The difference in mean *Density* between the two REIT types is often substantial, as evidenced by the difference in the range of mean *Density* across the two distributions. Notably, mean *Density* for multifamily REITs ranges up to 25,000 employees per square mile, whereas it ranges up to over 250,000 employees per square mile for office REITs. The figure also shows significant cross-sectional variation in mean *Density* across individual multifamily REITs. The most heavily populated mean *Density* bucket in that distribution — the bucket for multifamily REITs with a weighted average density exposure of up to 5,000 employees per square mile — contains two thirds of all multifamily REITs in the sample (20 out of 30). The remaining third of multifamily REITs falls into higher density buckets. For office REITs, the mean *Density* distribution is more concentrated. Over 80% of those REITs (33 out of 40) fall into the density bucket representing firms with weighted average density exposure of up to approximately 50,000 employees per square mile. A small number of office REITs focus on very high-density locations. For instance, the office REIT with the highest mean *Density* exposure is SL Green Realty (mean density exposure of approximately 250,000 employees per square mile), whose property portfolio holdings are concentrated in New York City. In sum, the histograms depicted in Figure 3 suggest that there is significant cross-sectional dispersion in exposure to high-density locations across the sample REITs, especially in the multifamily REIT sector.

Figure 3 about here.

Table 2 presents pairwise correlation coefficients between the main variables used in this study. The statistics reported indicate a positive correlation between *Density* and *Location Beta* for multifamily REITs. This result suggests that the stock market performance of firms headquartered in denser locations is more sensitive to variation in the return on the stock market, making those local economies more procyclical. This finding reinforces the need to separate the influence of urban density on REIT financial outcomes from that of the industry composition of the CBSAs in which REIT property portfolios are located. Further, *Density* of multifamily REITs is positively correlated with REIT *Size* and the presence of REIT debt ratings (*Debt Rated*), while it is inversely correlated with REIT *Leverage* and the *Implied Cap Rate*. These patterns suggest that REITs in denser locations are larger, more conservatively financed, more likely to hold active debt ratings, and that their properties are more expensive than those of REITs in less dense locations. We document similar correlation patterns for office REITs, with two notable exceptions. First, we find no significant correlation between office REIT *Density* and *Location Beta*, possibly reflecting the greater concentration of office REITs in denser locations. Second, the relationship between office REIT *Density* and *Leverage* is positive but weak, suggesting little association between office REIT *Density* and the amount of debt capital used to finance those office REIT portfolios.

Table 2 about here.

4 Density and Real Estate Supply

We argue that patterns of real estate risk and return are driven by the density of the locations in which the investment properties are located. Our argument rests on the assumption that real estate supply is less elastic in denser locations. To test this assumption empirically, we estimate the following linear regression model relating new commercial real estate construction in a given CBSA–year to location density:

$$\begin{aligned} New\ Construction_{l,t} = \alpha + \beta_1 High\ Density_{l,t-1} + \beta_2 Aggregate\ New\ Construction_t + \\ \beta_3 High\ Density_{l,t-1} \times Aggregate\ New\ Construction_t + \epsilon_{l,t} \end{aligned} \tag{4}$$

where $New\ Construction_{l,t}$ measures unexpected shocks to the total square footage of new commercial construction for CBSA l in year t, scaled by lagged total stock. Those shocks are obtained as the residuals from CBSA-specific AR(1) models through which we filter the raw data on local new construction to account for the sticky nature of these time series. α is a constant term, and $High\ Density_{i,t-1}$ is an indicator that takes the value of one if CBSA l's *Density* at time $t-1$ was in the top 50% of the *Density* distribution across all CBSAs at time $t-1$. $Aggregate\ New\ Construction_t$ is the total square footage of new commercial construction across all U.S. CBSAs at time t, scaled by lagged aggregate stock. $\epsilon_{i,t}$ is the residual. We estimate Eq. (4) with standard errors clustered by CBSA. In alternative specifications, we first replace the main effect of $High\ Density_{i,t-1}$ with CBSA-fixed effects; then we replace the main effect of $Aggregate\ New\ Construction_t$ with year-fixed effects; lastly, we replace both sets of main effects with CBSA- and year- fixed effects, respectively.

Table 3 presents the estimation results for the CBSAs in our sample over the 1994–2017 period. The estimates in column (1) show that the coefficient on the interaction term between the*High Density* indicator and *Aggregate New Construction* is negative. This result implies that, given an increase in aggregate commercial real estate construction, locations with higher density experience a more sluggish response in new supply. The results reported in columns (2) through (4) suggest that this finding is qualitatively similar when replace the main effects of *High Density* and *Aggregate New Construction* with CBSA and year fixed effects, respectively. In sum, the findings presented in Table 3 are consistent with our hypothesis that new real estate supply is less elastic in locations with higher density. In the next section, we explore the implications of this finding for real estate rental growth across locations with different densities.

Table 3 about here.

5 Density and Real Estate Rents

The results presented in Section 4 indicate that the supply of real estate is less elastic in denser locations compared to less dense locations. This finding implies greater rental growth in denser locations on average. We expect this to be the case because a given positive demand shock has a greater impact on the rents generated by real estate investment properties situated in denser locations with less elastic supply.[11] In this section, we provide empirical support for both hypotheses. First, we analyze the relationship between location density and local rental growth. Then, we assess the response in real estate rents across locations with different density to aggregate demand shocks.

Since rents from a broad cross-section of real estate investment properties are difficult to observe, we use REIT net operating income (NOI) as a proxy for those rents. To test the first hypothesis stated above, we estimate the following linear regression model relating NOI growth to density exposure:

$$\begin{aligned} NOI_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 High\ Location\ Beta_{i,t-1} + \beta_3 Large\ Size_{i,t-1} + \\ \beta_4 Total\ Portfolio\ Area_{i,t} + \gamma_t + \epsilon_{i,t} \end{aligned} \tag{5}$$

where $NOI_{i,t}$ is the quarterly NOI growth rate for REIT i at time t, α is a constant term, and $High\ Density_{i,t-1}$ is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the *Density* distribution across all REITs of the same property type as REIT i at time $t-1$.[12] $High\ Location\ Beta_{i,t-1}$ is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was above the median of the *Location Beta* distribution across all REITs of the same property type as REIT i at time $t-1$. We also construct an indicator for $Large\ Size_{i,t-1}$ according to the same cut-off points, based on the REIT property type-specific distributions of *Size* at time $t-1$. $Total\ Portfolio\ Area_{i,t}$ measures the total amount of square feet in a REIT i's portfolio at time t. We control for this variable since growth in total NOI may partly be driven by changes in the property portfolio composition of a given REIT. γ_t are year-fixed effects. $\epsilon_{i,t}$ is the residual. We estimate Eq. (5) with standard errors clustered by firm-year.

[11] Note that the reverse is not necessarily true for the response in local rental growth to negative demand shocks. That is because, as we argue in Section 1, the elasticity of supply to negative demand shocks is likely to be similarly low in denser and less dense locations.

[12] All of our results presented throughout the paper are robust to choosing alternative thresholds for the definition of high- versus low-density REITs, such as the top versus bottom 33% or 25% of the *Density* distribution.

To test the second of the hypotheses stated above, we focus on real GDP growth as a proxy for aggregate demand shocks. Using this proxy, we estimate the following linear regression specification relating REIT NOI growth to density and variation in real GDP growth:

$$\begin{aligned} NOI_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 High\ Location\ Beta_{i,t-1} + \beta_3 Large\ Size_{i,t-1} \\ + \beta_4 GDP\ Growth_{t-4} + \beta_5 High\ Density_{i,t-1} \times GDP\ Growth_{t-4} + \gamma_t + \epsilon_{i,t} \end{aligned} \tag{6}$$

where variables and notation follow Eq. (5). $GDP\ Growth_{t-4}$ is the quarterly rate of growth in real U.S. GDP four quarters in the past.[13] We estimate Eq. (6) with standard errors clustered by firm-year.

Table 4 presents the results from estimating the regressions described in Eq. (5) and (6) for the REITs in our sample over the 1994–2017 period. The estimates reported in column (1) suggest that multifamily REITs with high density exposure on average experience significantly higher NOI growth than multifamily REITs with low density exposure. The results presented in column (2) suggest that NOI growth for multifamily REITs with high density exposure also increases relatively more in response to a positive aggregate demand shock than NOI growth for multifamily REITs with low density exposure. The results in columns (3) and (4) show qualitatively similar results for the office REITs in our sample.[14]

TABLE 4 ABOUT HERE.

Importantly, the results in Table 4 hold after controlling for a REIT's *Location Beta*, implying that they are not due to variation in the pro-cyclicality of the local economies to which a given REIT is exposed through its property portfolio holdings. In all, the estimates presented here are consistent with our assumption that new real estate supply is less elastic in denser locations, resulting in (i) higher rental growth in denser locations on average; and (ii) greater sensitivity of rents to positive demand shocks in high-density locations compared to low-density locations.

[13]We choose a longer lag for GDP growth to account for the fact that leasing activity, which drives NOI growth, is sluggish given typical lease terms of at least one year in the property types we include in this study. Our results are robust to various alternative lag choices.

[14]The coefficient estimate on the *High Density* indicator in column (3), pertaining to the office REIT sub-sample, is numerically positive but statistically insignificant. We note that the coefficient on *Total Portfolio Area* in the same regression specification is significantly negative. In combination, those results suggest that office REITs may have expanded into lower-growth, high-density locations during our study period, reducing the magnitude of the coefficient on the *High Density* indicator compared to the magnitude of the corresponding coefficient in the multifamily REIT sub-sample.

6 Density and Real Estate Risk and Return

6.1 Time-Series Patterns of Systematic Risk

Our finding that NOI growth of REITs in denser locations responds more strongly to positive aggregate demand shocks suggests that those REITs should have higher systematic risk exposures. In this section, we assess the relationship between location density and real estate systematic risk in the time-series. To do so, we first regress the weekly total return of the REITs belonging to a given property type on the weekly total return of a market benchmark index.We estimate the following regression model:

$$R_t^p = \alpha + \beta_t Market_t + \epsilon_t \tag{7}$$

where R_t^p is the equal-weighted average return at time t of all REITs in a given property type p, with $p \in \{\text{multifamily, office}\}$.[15] α is a constant term. β_t captures the time-varying sensitivity of the REIT property-type average return to variation in the return on the market benchmark index, which is denoted $Market_t$. In alternative specifications, we use the weekly *Stock Market Return* and, respectively, the weekly *REIT Market Return* as benchmark index. ϵ_t is the residual. The weekly returns on REITs, R_t^p, and the returns on the market benchmark indices, $Market_t$, are measured in excess of the weekly *1-Month T-Bill Return*. Using those weekly excess return data, we estimate Eq. (7) by REIT property type on a rolling annual basis for each calendar year in the 1994-2017 period. We then collect the estimated values of the coefficient β_t from each of those non-overlapping, annual regressions. In this way, we compile an annual series of time-varying REIT systematic risk exposures by REIT property type. We then break the estimation of Eq. (7) down further by considering different density exposures (high versus low *Density*) within each of the REIT property types in the sample. In those annual regressions by density exposure type, high (low) density REITs are those that fall into the top (bottom) 50% of the property type-specific *Density* distribution in a given year.

[15]The number of active REITs in each property type included in our analysis is small in some years of the study period. If we computed value-weighted average returns across the REITs in a given property type, instead of equal-weighted average returns, those value-weighted returns would be proportionately more influenced by the performance of the largest REITs, and wouldn't necessarily reflect the performance of the typical REIT in a given property type. For this reason, we focus our analyses on equal-weighted average returns. However, we provide separate results on REIT-level return and systematic risk measures, controlling for REIT size, in Section 6.2.

We summarize the estimation results for the time-varying REIT systematic risk exposures by REIT property and density type in Figure 4. Panel A depicts the time-series of annual systematic risk estimates for multifamily and office REITs relative to the *Stock Market Return* benchmark over the 1994-2017 period. The figure shows that the systematic risk exposures of multifamily and office REITs are positively correlated over time and follow similar time-series patterns. Notably, the time-series evolution of REIT systematic risk appears to be pro-cyclical. While the differences between the systematic risk exposures of multifamily and office REITs are numerically small in most sample years, office REITs generally appear to have slightly higher systematic risk exposures than multifamily REITs.

Figure 4 about here.

Panel B depicts annual estimates of REIT property type-specific systematic risk exposures relative to the *REIT Market Return* benchmark. The figure shows that the systematic risk exposures of multifamily and office REITs are close to one, reflecting the weights of those two REIT types in the overall equity REIT universe. The time-series patterns shown in this figure are consistent with the result from Panel A that the systematic risk exposure of office REITs exceeds that for multifamily REITs in most sample years.

Panel C of Figure 4 depicts the time-series of annual systematic risk exposures broken down by REIT property type and density type (above- versus below-median *Density* in a given year), using the *Stock Market Return* as benchmark. The figure shows that, within each of the two property types, the systematic risk exposures for REITs of both density types follow the same broad time-series patterns illustrated in Panel A. The estimates depicted in this figure further suggest significant differences in the levels of systematic risk exposures of REITs belonging to different density types. Notably, the figure shows that high-density multifamily REITs exhibit higher systematic risk exposure than their low-density counterparts in 14 out of 24 sample years. Consistent with the results outlined in Section 6, the differences in the systematic risk exposures of high- versus low-density office REITs appear to be smaller. In all, Panel C of Figure 4 provides some evidence consistent with our expectation that the returns of REITs with property holdings in higher-density locations are more sensitive to systematic demand shocks, proxied here by variation in the return on the stock market.

The final panel of Figure 4 (Panel D) replicates Panel C, using the *REIT Market Return* as benchmark. The figure shows that, within multifamily REITs and office REITs, respectively, the systematic risk exposures for REITs with high density generally exceed those for REITs with low density. High-density office (multifamily) REITs exhibit greater systematic risk exposure than their low-density counterparts in 22 (20) out of 24 sample years. The estimates depicted suggest that the magnitude of the difference in systematic risk exposures between REITs in the high- versus low-density categories is also significant for both, multifamily and office REITs. In conclusion, Panel D of Figure 4 provides evidence in support of our hypothesis that the returns of high-density REITs respond more strongly to systematic demand shocks, proxied by variation in the return on the overall REIT market, than those of low-density REITs.

6.2 Cross-Sectional Patterns of Systematic Risk

We dig deeper into our results pertaining to location density and real estate systematic risk by estimating REIT-level systematic risk exposures in the cross-section as a function of REIT-level *Density*. In this step of our empirical analysis, we control for a set of firm-characteristic covariates that capture other important determinants of REIT systematic risk identified in the prior literature.[16] Specifically, we employ the following regression specification:

$$\begin{aligned} R_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 Market_t + \beta_3 High\ Density_{i,t-1} \times Market_t \\ \beta_4 High\ Location\ Beta_{i,t-1} + \beta_5 High\ Location\ Beta_{i,t-1} \times Market_t \\ \beta_6 High\ Leverage_{i,t-1} + \beta_7 High\ Leverage_{i,t-1} \times Market_t \\ \beta_8 High\ Short\text{-}Term\ Debt_{i,t-1} + \beta_9 High\ Short\text{-}Term\ Debt_{i,t-1} \times Market_t \\ \beta_{10} Large\ Size_{i,t-1} + \beta_{11} Large\ Size_{i,t-1} \times Market_t + \gamma_t + \epsilon_{i,t} \end{aligned} \tag{8}$$

where $R_{i,t}$ is the weekly excess return over the *1-Month T-Bill Return* on REIT i at time t, α is a constant term, and $High\ Density_{i,t-1}$ is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the *Density* distribution across all REITs of the same property type as REIT i at time $t-1$. $Market_t$ is the weekly *Stock Market Return*, measured in excess of the *1-Month T-Bill Return*. $High\ Location\ Beta_{i,t-1}$ is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was above the median of the *Location Beta* distribution across all REITs of the same property type as REIT i at time $t-1$. We construct the indicators for $High\ Leverage_{i,t-1}$, $High\ Short\text{-}Term\ Debt_{i,t-1}$,

[16] For a discussion of firm characteristics that determine REIT return performance, see Letdin et al. (2019).

and *Large* $Size_{i,t-1}$ according to the same cut-off points, based on the REIT property type-specific distributions of *Leverage*, *Short-Term Debt*, and *Size* at time $t-1$, respectively. γ_t are year-fixed effects. $\epsilon_{i,t}$ is the residual. The value of the coefficient β_3 in Eq. (8) captures the degree to which a REIT's property portfolio's exposure to high-density locations modulates firm-level systematic risk after controlling for the effects of REIT location beta, leverage, refinancing risk exposure (through short-term debt holdings), and REIT size. We estimate Eq. (8) with standard errors clustered by firm-year. We replicate the estimation of Eq. (8) separately for multifamily and office REITs, and for the excess *Stock Market Return* and the excess *REIT Market Return* as the benchmark return indices.

Table 5 presents the results from estimating the regression described in Eq. (8) for the sample REITs over the 1994–2017 period, focusing on the main predictors of interest only. Table 6 presents the corresponding output from the full specification shown in Eq. (8). In both tables, columns (1) and (2) present the regression results using the *Stock Market Return* as benchmark. Columns (3) and (4) report the corresponding results using the *REIT Market Return* as benchmark. Even (odd) columns show output for multifamily (office) REITs, respectively.

Tables 5 and 6 about here.

The results presented in columns (1) and (2) of Table 5 indicate that the excess returns on high-density REITs are no different from those of low-density REITs, across both multifamily and office REITs. The estimates reported also indicate that the systematic risk exposure of multifamily (office) REITs with respect to the stock market benchmark (REIT market benchmark) is 0.52 (0.63). Furthermore, the results shown suggest that the systematic risk exposure of both multifamily and office REITs with high density exposure is numerically — though not statistically — higher than that of their low-density peers.

By contrast, the estimates shown in columns (3) and (4) of Table 5 suggest that the systematic risk exposure of high-density multifamily and office REITs is significantly greater than that of their peers with lower density exposures when we estimate systematic risk with respect to the REIT market benchmark. The evidence presented here is consistent with our conjecture that the returns on portfolios of real estate assets located in high-density locations are more sensitive to variation in the return on the market than are the returns on low-density real estate portfolios.

We now turn to the discussion of the results from estimating the full model specified in Eq. (8). The estimates reported in column (1) of Table 6 indicate that the systematic risk exposure of multifamily

REITs with low density exposure is 0.47. The coefficient estimate for the interaction term between the *High Density* indicator and the excess *Stock Market Return* benchmark indicates that the systematic risk exposure for multifamily REITs in denser locations is numerically higher than that for multifamily REITs whose property portfolios are situated in less dense locations. The economic magnitude of the marginal effect of high density exposure is substantial (0.05). Our estimates imply that the systematic risk exposure of multifamily REITs in denser locations is 0.52, or 11% above the systematic risk exposure for multifamily REITs in less dense locations. The estimates shown in column (2) indicate that the systematic risk exposure for office REITs in less dense locations is 0.60, over 10 basis points higher than that for multifamily REITs in less dense locations. Our results further show that the coefficient estimate for the interaction term between the *High Density* indicator and the excess *Stock Market Return* is close to zero. In all, our estimates imply that multifamily REITs in denser locations exhibit numerically higher systematic risk exposures than do those with property holdings in less dense locations. However, the estimated marginal effect of density exposure on REIT systematic risk is statistically insignificant.

The estimates shown in column (3) indicate that the sensitivity of multifamily REITs in less dense locations to variation in the return on the REIT market is 0.65. The results reported also show that the sensitivity to variation in the return on the REIT market for multifamily REITs with property holdings in denser locations is significantly higher. The coefficient estimate on the interaction term between the high density exposure indicator and the excess return on the REIT market (0.13) implies that the systematic risk exposure (with respect to the REIT market benchmark) of multifamily REITs in denser locations is 0.78, or 20% higher than the systematic risk exposure of multifamily REITs with properties in less dense locations. In contrast to the estimates reported for the *Stock Market Return* benchmark in column (1), the marginal effect of high density exposure on the systematic risk of multifamily REITs with respect to the *REIT Market Return* benchmark is statistically significant. The estimates reported in column (4) show that the sensitivity of low-density office REIT returns to variation in the return on the overall REIT market is 0.87, exceeding that of low-density multifamily REITs by over 20 basis points. The regression results further indicate that the sensitivity of the stock returns on office REITs with greater density exposure to fluctuations in the REIT market return is numerically and statistically higher than that of their low-density counterparts (0.93, or 7% higher than for low-density office REITs).

The regression results reported in Table 6 show a noticeable difference in the numerical magnitude and the statistical significance of the marginal effect of higher density exposure on the systematic risk estimates across the two REIT property types in the sample. The greater strength of the empirical association between density exposure and systematic risk in multifamily REITs compared to office REITs is partly driven by the greater cross-sectional dispersion of density exposure among multifamily REITs, and the greater clustering by density exposure among the office REITs in the sample, as illustrated by the histograms in Figure 3.

In sum, the evidence presented in Table 6 suggests that both multifamily and office REITs exhibit return performance properties generally associated with defensive stocks, as their systematic risk exposures are less than one, irrespective of the market benchmark employed (broad stock market or REIT market return benchmark). This result is consistent with prior findings; see, for instance, Chan et al. (1990), Glascock and Hughes (1995), and Howe and Shilling (1990). However, our results also imply that office REITs exhibit greater systematic risk exposure than multifamily REITs, suggesting that the return performance of office REITs on average is more sensitive to systematic demand shocks than that of multifamily REITs. When estimating systematic risk exposure by property type and density exposure type, we find that REITs with property portfolio holdings in locations characterized by higher density are exposed to higher systematic risk. However, the statistical significance of the association between density exposure and REIT-level systematic risk depends on the market benchmark chosen — the results are stronger when considering the REIT market benchmark instead of the stock market benchmark — and on the REIT property type — our findings are more pronounced for multifamily REITs than they are for office REITs.

In the analysis of the results presented in Table 6, it is noteworthy that multifamily and, to some extent, office REITs with greater exposures to pro-cyclical local economies — those with higher location betas — also appear to carry higher systematic risk. However, as shown in Table 6, the *Location Beta* variable does not supersede the statistical and economic significance of the *Density* variable, suggesting that density and industry composition represent two separate channels through which location characteristics affect the performance of real estate investments. Further, REIT capital structure characteristics; namely, leverage and short-term debt exposure, appear to have no significant association with REIT-level systematic risk. This finding stands in contrast to prior results on the empirical relationships between REIT performance and leverage (and short-term debt exposure), as established, for instance, in Giacomini et al. (2015), Sun et al. (2015), and Pavlov et al. (2018). However, as suggested in the analysis of pairwise correlation coefficients in Table 2, (multifamily) REITs whose properties are situated in locations with higher density carry lower levels of leverage than their otherwise comparable peers. At lower debt levels, the observed relationship between leverage and systematic risk may be weaker.

6.3 Total Returns and Risk-Adjusted Returns

The results we present on the positive association between REIT density exposure and systematic risk imply that high-density REITs should experience higher rates of return on average. However, since those REITs should also experience higher return volatility, their Sharpe ratios may not necessarily be higher than those of low-density REITs. We address these questions by comparing total and risk-adjusted return patterns across multifamily and office REITs with varying degrees of exposure to high- versus low-density locations. To do so, we construct three equal-weighted test portfolios for each REIT property type.[17] Within a given property type, each portfolio invests in a sub-set of REITs, determined by their density exposure. The REIT holdings of all test portfolios are updated on a monthly basis over the study period. In each month t, the first multifamily test portfolio, denoted *High*, buys — and holds for the subsequent 12 months — the multifamily REITs in the top tercile of the density distribution. For the purposes of this analysis, the density distribution is computed across the mean *Density* exposures of all multifamily REITs over the month in which the portfolio is formed. The second (third) multifamily test portfolio, denoted *Middle* (*Low*), analogously buys and holds the multifamily REITs in the middle (bottom) tercile of the density distribution. This bootstrapping methodology allows us to control portfolio turnover and to minimize the effect of seasonality relative to a simple monthly or quarterly re-balancing strategy. We proceed in an analogous fashion to construct the three office test portfolios by density exposure. We summarize the performance characteristics of the multifamily and office test portfolios by density exposure category in Figure 5.

Figure 5 about here.

Panel A of Figure 5 shows the average annualized total returns and standard deviations of those returns for the test portfolios. A few patterns readily stand out. First, the figure shows that average

[17] The main conclusions drawn from this analysis are robust to constructing value-weighted portfolios, instead of equal-weighted portfolios. However, within each of the two REIT property types included in our analysis, the number of unique REITs active in each year is small. If we construct portfolios on a value-weighted basis, the results are disproportionately driven by the largest REITs in the sample, and thus less representative of the performance delivered by the "typical" REIT in each category of *Density* exposure.

annualized total returns decline in portfolio density. For the multifamily REIT portfolios, average annualized total returns are highest for the *High* portfolio (13.8%), followed by the *Middle* portfolio (13.0%), and the *Low* portfolio (12.0%). We document a similar pattern for the total returns earned by the three office portfolios, with total returns of 11.9% for the *High* portfolio, followed by 9.9% for the the *Middle* portfolio, and 9.5% for the *Low* portfolio, respectively. Second, figure also shows that the standard deviation of the average annualized returns earned by the multifamily test portfolios is higher when the density exposure of the underlying REIT investments is higher. Conversely, the estimates for the standard deviations of the total returns earned by the three office test portfolios are numerically close to one another.

Panel B of Figure 5 depicts the average annual risk-adjusted returns earned by the test portfolios. We proxy for risk-adjusted returns using the Sharpe ratio of each test portfolio. The figure shows that the test portfolio holding the highest-density office REITs earns the highest risk-adjusted returns. Notably, the *High* office test portfolio generates an average Sharpe ratio of 0.43, 12 basis points higher than the *Low* portfolio with an average Sharpe ratio of 0.31. By contrast, the *High* and *Low* multifamily test portfolios generate an average Sharpe ratio of 0.52.

The analysis of the return patterns generated by portfolios of REITs with varying degrees of exposure to high- versus low-density locations suggests two conclusions. First, REIT stock performance, both in terms of total returns and volatility, varies significantly with density exposure; and second, higher density exposure is associated with stronger risk-adjusted performance, especially for office REITs.

7 Density and Real Estate Financing

7.1 Leverage Levels

Our results on the positive association between location density and systematic risk could be driven by leverage. That's because it is possible that the amount of leverage employed to finance real estate investments differs between properties in high- and low-density locations. While we control for leverage in the regression specifications used to document the relationship between location density and systematic risk, we take our analysis one step further. In this section, we test whether there is also an empirical association between location density and the amount of leverage used to finance real estate investment properties. Again, we use REITs as a proxy for real estate investments more generally. Specifically, we test whether high-density REITs carry higher or lower (or, indeed, similar) levels of leverage than their low-density counterparts. To implement this test, we estimate the following regression using quarterly data on REIT leverage, density exposure, and control variables for the systematic risk exposures of different locations as well as for REIT size:

$$\begin{aligned} Leverage_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 High\ Location\ Beta_{i,t-1} + \\ \beta_3 Large\ Size_{i,t-1} + \gamma_t + \epsilon_{i,t} \end{aligned} \tag{9}$$

where $Leverage_{i,t}$ is the ratio of total long-term debt plus preferred stock to total EBITDA for REIT i at time t, α is a constant term, $High\ Density_{i,t-1}$, $High\ Location\ Beta_{i,t-1}$, and $Large\ Size_{i,t-1}$ are indicators defined as under Eq. (8), γ_t are year-fixed effects, and $\epsilon_{i,t}$ is the residual. We estimate Eq. (9) with standard errors clustered by firm-year. We replicate the estimation of Eq. (9) for the underlying REIT characteristics of *Density*, *Location Beta*, and *Size* measured continuously, instead of the $High\ Density$, $High\ Location\ Beta$, and $Large\ Size$ indicators in the original specification shown above.

Table 7 presents the regression results from estimating Eq (9). The estimates reported in columns (1) and (2) refer to multifamily REITs. The estimates in columns (3) and (4) pertain to the office REITs in the sample. The estimates shown in column (1) indicate that *High Density* multifamily REITs carry significantly lower leverage than their peers with property portfolio holdings in less dense locations. We estimate that *Leverage* levels of *High Density* multifamily REITs are 67 basis points lower than are those of their low-density counterparts. The results reported in column (2) suggest that for an increase in density exposure by one unit (corresponding to 1,000 additional employees per square mile), REIT leverage declines by 4 basis points. A one-standard deviation increase in density is thus associated with a decline in leverage of over 40 basis points. The estimates shown in columns (1) and (2) also suggest that *High Location Beta* multifamily REITs have higher leverage than their low beta counterparts. This result stands in contrast to the inverse relationship we document between density exposure and multifamily REIT leverage, again suggesting that density and the pro-cyclicality of the local economies to which a given REIT is exposed through its property portfolio holdings have different impacts on REIT firm-level outcomes; in this case, capital structure choices.

Table 7 about here.

The results reported in columns (3) and (4) suggest that *High Density* office REITs carry higher leverage than their peers with lower density exposure. The estimates shown in column (3) imply that leverage is 68 basis points higher for *High Density* office REITs compared to their peers with lower density exposure. The estimates reported in column (4) imply that a one standard deviation increase in density is associated with an increase in leverage of 39 basis points. The estimates shown in columns (3) and (4) further indicate that *High Location Beta* office REITs employ lower levels of leverage than their peers with property portfolio holdings in less pro-cyclical locations.

It is worth noting that our estimates of the effect of density exposure on REIT leverage levels is not the mechanical result of high-density REITs being larger and holding more valuable properties, for two reasons. First, our measure of leverage is scaled by firm EBITDA, not (the book or market value of) total assets. Second, we control for firm size in the estimation of Eq. (9). In unreported results, we confirm that the findings presented in Table 7 are robust to employing the ratio of total long-term debt plus preferred stock to the book or market value of total assets as an alternative measure of leverage.

To wit, the results presented in Table 7 suggest that multifamily REITs with higher density exposure adopt a more conservative capital structure strategy and carry lower levels of leverage than their otherwise comparable counterparts. By contrast, we find that office REITs with higher density exposure have higher leverage levels relative to their low-density peers. The difference in the direction of the empirical association between REIT density exposure and leverage across multifamily and office REITs is consistent with the earlier findings reported in Table 6. In those earlier results, we documented that multifamily REITs with higher density exposure have significantly higher systematic risk. We also showed that the relationship between office REIT density exposure and systematic risk is weaker in statistical and economic terms. Prior literature has established that higher leverage levels are associated with greater systematic risk exposure (see, for instance, Alcock and Steiner (2018)). Combined with the estimates shown in Table 6, the results presented here suggest that REITs whose returns are already more sensitive to variation in the return on the market due to their exposure to high-density locations — notably, the multifamily REITs in the sample — avoid increasing their sensitivity to those market returns further by keeping leverage levels low. By contrast, our results suggest that density exposure has a relatively weak effect on systematic risk for office REITs, allowing those REITs to carry higher leverage without reaching excessive levels of systematic risk exposure. Our findings imply that

REITs modulate the systematic risk exposure emanating from the geographical characteristics of their property holdings by adopting a more conservative stance in terms of their capital structure choices.

7.2 Credit Ratings

We take our analysis on the implications of location density for real estate financing choices one step further and ask how the public bond markets perceive the credit quality of high- versus low-density REITs. Specifically, we examine the empirical association between density exposure and the availability as well as quality of REIT credit ratings. To do so, we estimate the following logistic regression model using quarterly data on active REIT debt ratings and the predictors from Eq. 9:

$$\begin{aligned} Debt\ Rated_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 High\ Location\ Beta_{i,t-1} + \\ \beta_3 Large\ Size_{i,t-1} + \epsilon_{i,t} \end{aligned} \tag{10}$$

where $Debt\ Rated_{i,t}$ is an indicator that takes the value of one if REIT i has a long-term corporate debt rating, issued by S&P or Moody's, outstanding at time t, and the remaining variables and notation are defined as outlined under Eq. (9). We estimate Eq. (10) with standard errors clustered by firm-year. As for Eq. (9), we replicate the estimation of Eq. (10) for *Density*, *Location Beta*, and *Size* measured continuously. We then re-estimate Eq. (10) as an ordered logit model for *Rating Category*, which denotes the category of debt rating outstanding for REIT i at time t. Data on debt rating categories are from S&P Global and refer to the long-term corporate debt ratings issued by S&P.

Table 8 presents the regression results from estimating Eq. (10). Columns (1) through (4) show the results from the logit estimation for *Debt Rated*. Those results refer to the likelihood that a given REIT has a long-term corporate debt rating outstanding. The estimates reported in columns (5) through (8) refer to the ordered logit model for *Rating Category*; that is, the quality category of the long-term corporate debt rating outstanding. Columns (1) and (2), as well as columns (5) and (6) (columns (3) and (4) as well as (7) and (8)), present the results for multifamily (office) REITs.

TABLE 8 ABOUT HERE.

The results presented in columns (1) and (2) suggest that multifamily REITs with higher density exposure are numerically more likely to have a long-term corporate debt rating outstanding as their low-density peers, but the coefficient on *High Density* in column (1) and that on *Density* in column (2) are statistically insignificant. By contrast, the coefficient estimate on the *High Density* indicator in the office REIT sub-sample reported in column (3) is numerically and statistically significant. Notably, we estimate that the odds of having a long-term corporate debt rating outstanding for high-density office REITs over the corresponding odds for low-density office REITs are exp(1.92). This coefficient estimate implies that high-density office REITs are almost seven times as likely to have an active debt rating as their low-density peers. Further, we estimate that a one-unit increase in *Density* increases the odds of office REITs having a long-term corporate debt rating outstanding by a factor of approximately 2.69 (column (4)). The results shown in columns (5) through (8) of Table 8 indicate that — across the two REIT property types in the sample and across the different measures of density employed — long-term corporate debt ratings are of higher quality for REITs with higher density exposure than they are for otherwise comparable REITs with lower density exposure.[18]

The estimates reported in Table 8 are also consistent with the hypothesis that variation in *Location Beta* is associated with differential odds for a REIT to have an active debt rating. However, the direction of the effect, its economic magnitude, and its statistical significance vary across REIT property types and the different density measures. Importantly, the results we document for the relationship between density exposure and REIT credit ratings are net of any potentially confounding influence stemming from a given REIT's location beta exposure.

To conclude, the results presented here suggest that REITs with property holdings in denser locations generally have better access to corporate credit markets (through the availability of debt ratings) and are perceived to be of higher credit quality, as implied by stronger long-term corporate debt ratings.

8 Density and Real Estate Cap Rates

In the final step of our data analysis, we estimate the empirical association between location density and real estate cap rates. Our conjecture is that properties in high-density locations are more valuable,

[18]The exception to this finding is the coefficient estimate on *Density* for the category of debt rating held by office REITs (column (8)), which takes a value of close to zero. In unreported results we find that office REITs in high density locations have lower leverage when they have a debt rating outstanding, compared to their unrated peers. This result suggests that rated REITs target risk characteristics, including systematic risk, known to be used by credit agencies to manage their cost of capital, which may mitigate any separate effect on the quality of debt ratings we explored here.

as local supply is more constrained. If this conjecture is true, then we expect to observe lower cap rates for real estate investment properties in denser locations. To test our hypothesis, we study REIT implied cap rates as a proxy for real estate cap rates. We estimate the following linear regression model using quarterly data on real estate implied cap rates, density exposures, and the familiar set of control variables we employed in our earlier regression models:

$$\begin{aligned} Implied\ Cap\ Rate_{i,t} = \alpha + \beta_1 High\ Density_{i,t-1} + \beta_2 High\ Location\ Beta_{i,t-1} + \\ \beta_3 Large\ Size_{i,t-1} + \gamma_t + \epsilon_{i,t} \end{aligned} \tag{11}$$

where $Implied\ Cap\ Rate_{i,t}$ is the ratio of long-term property net operating income to the implied market valuation of real estate for REIT i at time t, and the remaining variables and notation are defined as outlined under Eq. (9). We estimate Eq. (11) with standard errors clustered by firm-year. In alternative specifications, we replicate the estimation of Eq. (11) for *Density*, *Location Beta*, and *Size* measured continuously.

Table 9 presents the regression results from estimating Eq. (11) for the multifamily REITs (columns (1) and (2)) and office REITs (columns (3) and (4)) in the sample. The results reported across all four columns of Table 9 indicate that REITs with higher density exposure exhibit lower implied cap rates. The documented results are consistent across multifamily and office REITs, and across the dichotomous and continuous measures of REIT density exposure, albeit with some variation in statistical significance.

TABLE 9 ABOUT HERE.

The coefficient estimates reported in column (1) suggest that the implied cap rate for high-density multifamily REITs — those in the top 50% of the density distribution — is on average 44 basis points lower than that for their low-density counterparts. The estimates shown in column (2) suggest that for a unit-increase in density exposure, which corresponds to an increase in local employment density by 1,000 employees, implied cap rates for multifamily REITs decline by 2.2 basis points. The results reported in column (3) indicate that implied cap rates for high-density office REITs are 14 basis points below those of their low-density peers, but the coefficient is statistically insignificant. Further, we estimate that a one-unit increase in density exposure for office REITs is associated with a 0.6 basis points decline in implied cap rates (column (4)). In sum, the estimates presented in Table 9 provide empirical evidence consistent with the conjecture that — all else equal — REIT properties in denser locations are more valuable, due to tighter local supply constraints, leading to lower implied cap rates for high-density REITs relative to low-density REITs.

9 Concluding Remarks

In this study, we characterize the relationship between location density and the patterns of risk and returns in commercial real estate investments. To do so, we use a sample of multifamily and office REITs, which are publicly traded portfolios of real estate investment properties. For those REITs, we can easily observe granular information on asset holdings across denser and less dense locations as well as a broad set of investment performance measures. Using this empirical setting, we first estimate each REIT's weighted average density exposure across the locations in which their real estate investments are situated. We then relate this REIT-specific, time-varying measure of density exposure to a variety of REIT financial outcomes.

In all, we document five salient facts about the association between location density and REIT performance: (i) high-density REITs experience higher NOI growth — on average and after a positive aggregate demand shock — than their low-density peers; (ii) high-density REITs are more exposed to systematic risk than otherwise similar low-density REITs; (iii) portfolios of high-density REITs earn higher (risk-adjusted) returns than portfolios of low-density REITs; (iv) high-density REITs, whose systematic risk is elevated due to their exposure to denser locations, carry lower levels of leverage, which is perceived favorably in the public bond markets; and (v) REITs holding properties in high-density locations, where new supply is restricted, experience lower implied cap rates.

Our results suggest that location density is a significant driver of real estate investment risk and return. The evidence we present in this paper is consistent with geographical characteristics playing an important role in determining local rates of return in commercial real estate by modulating the sensitivity of local real estate investment performance to systematic demand shocks.

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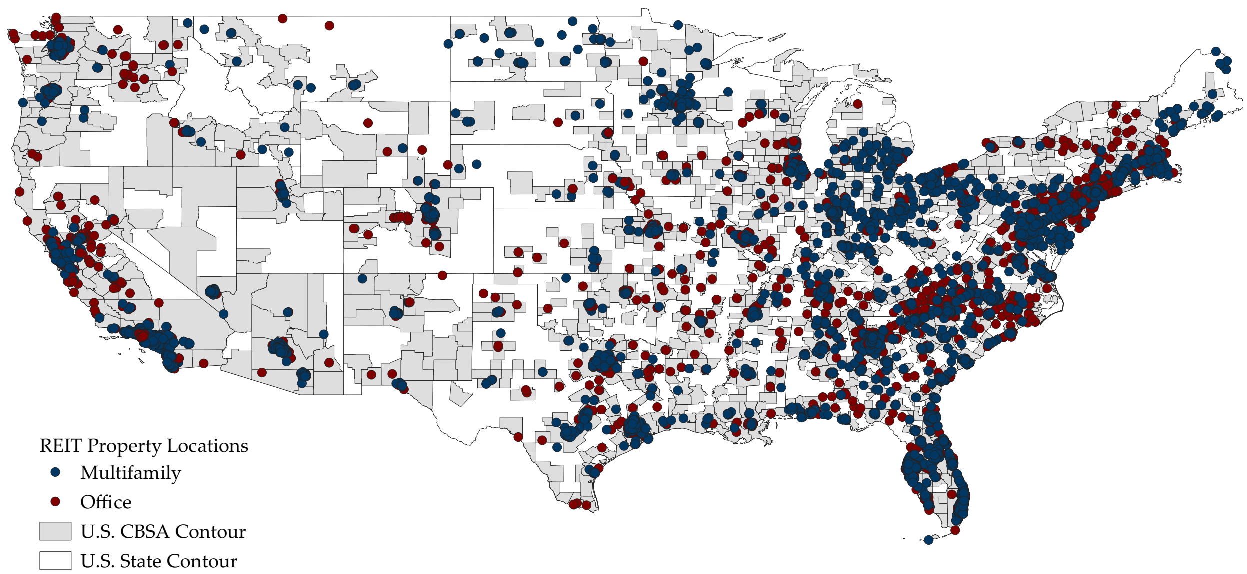


Figure 1. Real Estate Holdings Locations of Sample REITs by Property Type. The figure shows the geographical distribution across U.S. CBSAs of the commercial real estate assets held by the multifamily REITs (blue circles) and office REITs (red circles) in our sample. Sources: S&P Global and U.S. Census.

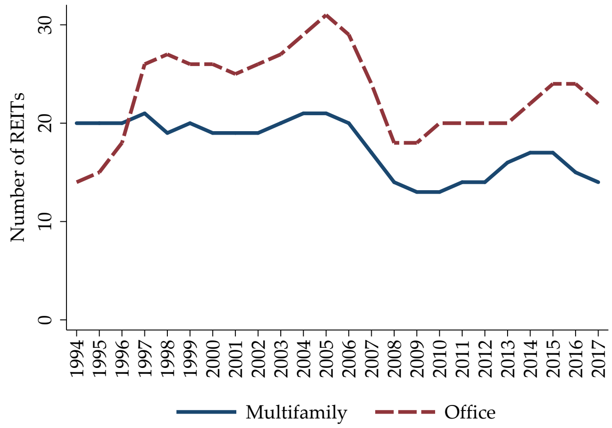
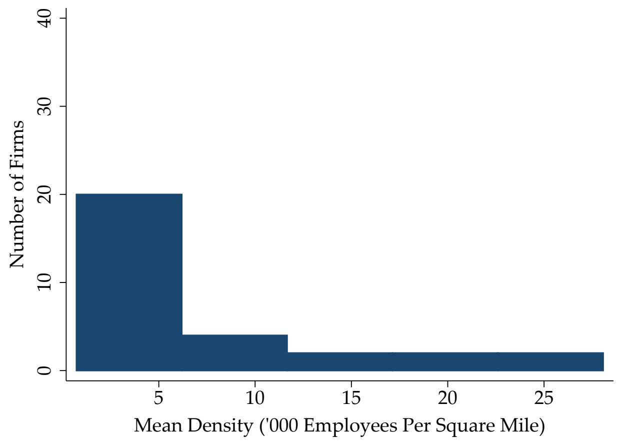
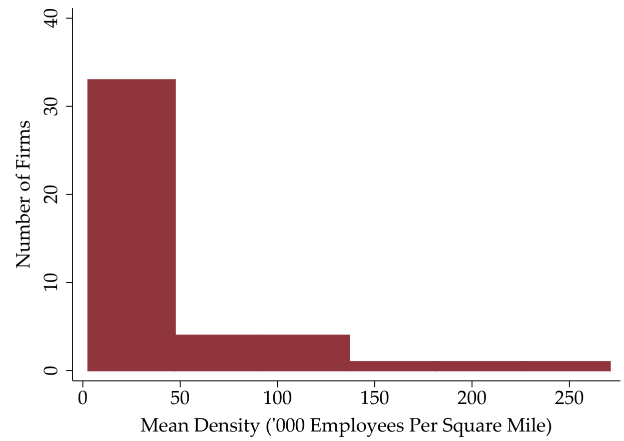


Figure 2. Annual Numbers of Sample REITs by Property Type. The figure shows the number of unique multifamily and office REITs in our final sample in each year of the 1994–2017 period.

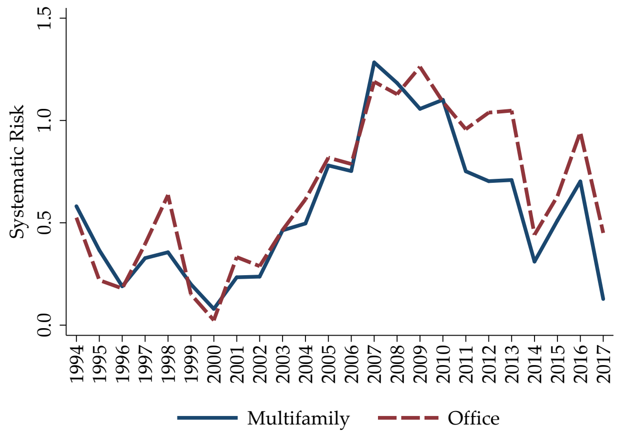


(A) Multifamily REITs

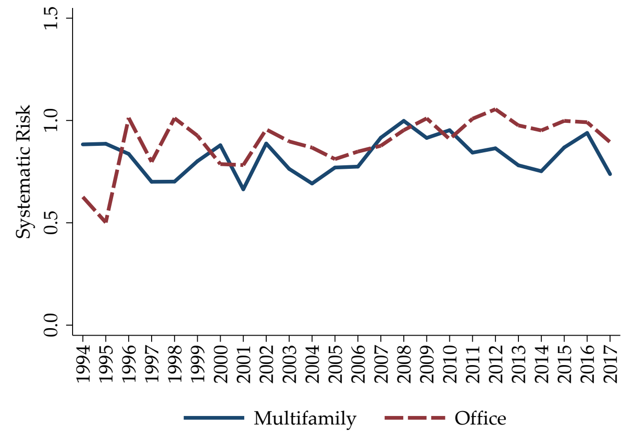


(B) Office REITs

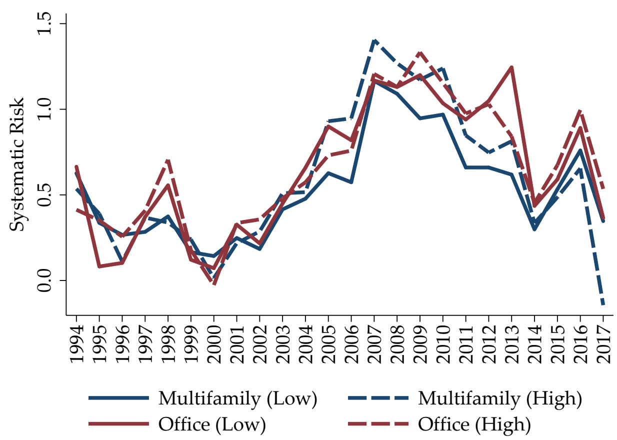
Figure 3. Histograms of Mean *Density* by Property Type. The figure shows the number of firms in each bucket of mean *Density* for the multifamily REITs (Panel A) and office REITs (Panel B) in the sample. *Density* is the property market value-weighted average of zip code-level employment density (in thousands of employees per square mile) to which a REIT is exposed through its property portfolio holdings across different zip codes. The figure depicts the mean values of *Density*, computed for each REIT over its life in the sample.



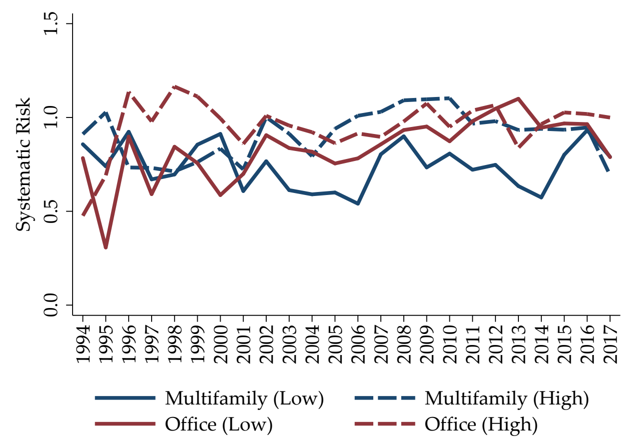
(A) Property Type Exposures (Stock Market)



(B) Property Type Exposures (REIT Market)

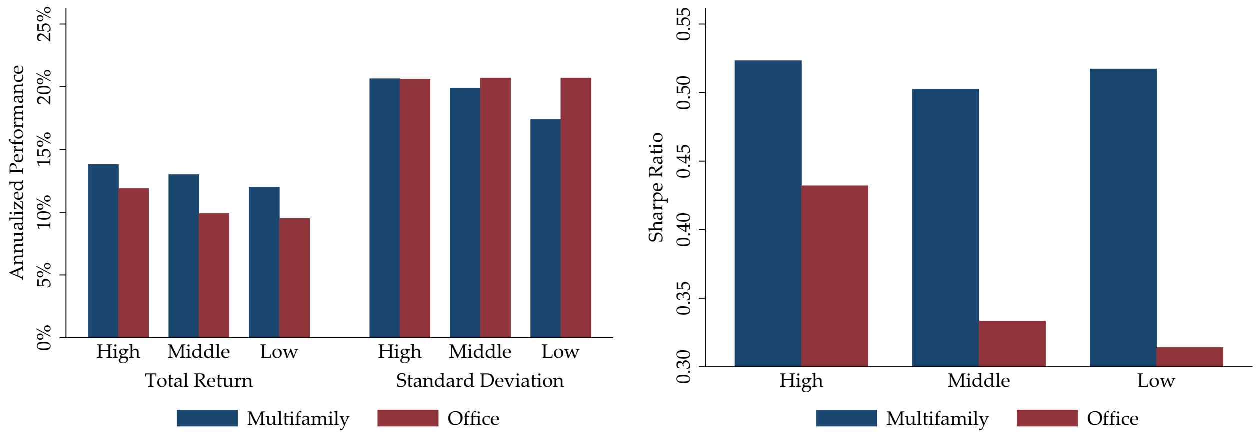


(C) Density Exposures (Stock Market)



(D) Density Exposures (REIT Market)

Figure 4. REIT Systematic Risk Exposures by Property Type and *Density*. Panel A (B) depicts the time-series of annual REIT systematic risk exposures by property type for the *Stock Market Return* (*REIT Market Return*) as market return benchmark. Panel C (D) depicts the time-series of annual REIT systematic risk exposures by property and *Density* type for the *Stock Market Return* (*REIT Market Return*) as market return benchmark. The annual estimates of systematic risk exposures are derived from the estimation of Eq. (7).



(A) Total Return and Standard Deviation

(B) Risk-Adjusted Return

Figure 5. Annualized Performance of Test Portfolios. The figure shows the annualized performance in terms of *Total Return* and *Standard Deviation* of the multifamily and office REIT test portfolios (Panel A), as well as their corresponding *Sharpe Ratios* (Panel B), over the study period. Within each REIT property type, the *High*, *Middle*, and *Low* test portfolios include the REITs in the top, middle, and bottom terciles of the density distribution, respectively. We compute the density distribution by REIT property type across the mean *Density* exposures of all REITs in a given property type over 12 months on a rolling monthly basis.

Table 1. Descriptive Statistics

This table presents descriptive statistics for the main variables used in our empirical analyses over the 1994–2017 period. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Total Return* is the weekly total return on a given REIT's stock. *Size* is a REIT's stock price, multiplied by the number of shares outstanding, both measured at week-end. Data on stock returns, stock prices, and the number of shares outstanding are from the CRSP Daily Stock File. *Leverage* is the sum of total long-term debt outstanding (Compustat item DLTT) and preferred stock (item PSTK), scaled by total EBITDA (item EBITDA). This variable is observed on a quarterly basis. *Short-Term Debt* is the principal amount of long-term debt outstanding that matures within one year (item DD1), scaled by total long-term debt outstanding (item DLTT). This variable is observed annually. *Implied Cap Rate* is long-term property net operating income, scaled by the implied market valuation of real estate. This variable is observed quarterly, and data are from S&P Global. *Debt Rated* is an indicator that takes the value of one if a REIT has a long-term corporate debt rating, issued by S&P or Moody's, outstanding at quarter-end. We carry forward the most recent values of variables observed quarterly or annually until updated values become available. *Stock Market Return* is the value-weighted return on the stocks in the CRSP universe. *REIT Market Return* is the value-weighted return on all REITs in the CRSP universe. *1-Month T-Bill Return* proxies for the risk-free rate. Data on the stock market return and the return on the risk-free rate are taken from Kenneth French's Data Library. All variable definitions are provided in Section 2.

	N	Mean	SD	Median	Min	Max
Multifamily						
Density	21,279	7.8572	10.3513	3.8109	0.6931	65.5359
Location Beta	21,279	0.9446	0.1584	0.9776	0.4839	1.4227
Total Return	21,279	0.0027	0.0319	0.0021	-0.1027	0.1089
Size	21,279	2.5057	4.0428	0.8435	0.0111	19.9937
Leverage	20,120	5.1885	3.5185	4.3082	0.0000	22.4187
Short-Term Debt	16,708	0.0720	0.0858	0.0496	0.0000	0.8339
Implied Cap Rate	13,271	7.4418	1.5844	7.4368	4.5608	11.7213
Debt Rated	21,279	0.5095	0.4999	1.0000	0.0000	1.0000
Office						
Density	27,243	44.4262	65.6687	18.8915	0.6931	290.9172
Location Beta	27,243	0.9995	0.1438	0.9996	0.4839	1.4227
Total Return	27,243	0.0025	0.0348	0.0023	-0.1027	0.1089
Size	27,243	2.4154	3.5781	1.2938	0.0080	19.9937
Leverage	27,127	4.3180	2.9893	3.8155	0.0000	22.4187
Short-Term Debt	18,492	0.1086	0.1636	0.0458	0.0000	0.8339
Implied Cap Rate	17,148	8.4230	1.8748	8.3828	4.5608	12.6487
Debt Rated	27,243	0.3993	0.4898	0.0000	0.0000	1.0000
Market-Level Variables						
Stock Market Return	1,252	0.0021	0.0217	0.0030	-0.0644	0.0624
REIT Market Return	1,252	0.0020	0.0243	0.0030	-0.0768	0.0708
1-Month T-Bill Return	1,252	0.0005	0.0005	0.0004	0.0000	0.0013

Table 2. Pairwise Correlation Coefficients

This table presents pairwise correlation coefficients between the main variables used in our empirical analyses over the 1994–2017 period. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Total Return* is the weekly total return on a given REIT's stock. *Size* is a REIT's stock price, multiplied by the number of shares outstanding, both measured at week-end. Data on stock returns, stock prices, and the number of shares outstanding are from the CRSP Daily Stock File. *Leverage* is the sum of total long-term debt outstanding (Compustat item DLTT) and preferred stock (item PSTK), scaled by total EBITDA (item EBITDA). This variable is observed on a quarterly basis. *Short-Term Debt* is the principal amount of long-term debt outstanding that matures within one year (item DD1), scaled by total long-term debt outstanding (item DLTT). This variable is observed annually. *Implied Cap Rate* is long-term property net operating income, scaled by the implied market valuation of real estate. This variable is observed quarterly, and data are from S&P Global. *Debt Rated* is an indicator that takes the value of one if a REIT has a long-term corporate debt rating, issued by S&P or Moody's, outstanding at quarter-end. We carry forward the most recent values of variables observed quarterly or annually until updated values become available. *Stock Market Return* is the value-weighted return on the stocks in the CRSP universe. *REIT Market Return* is the value-weighted return on all REITs in the CRSP universe. *1-Month T-Bill Return* proxies for the risk-free rate. Data on the stock market return and the return on the risk-free rate are taken from Kenneth French's Data Library. All variable definitions are provided in Section 2.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Multifamily								
(1) Density	1.0000							
(2) Location Beta	0.1945	1.0000						
(3) Total Return	-0.0015	0.0067	1.0000					
(4) Size	0.5904	0.2385	0.0106	1.0000				
(5) Leverage	-0.2471	0.2000	0.0052	-0.1803	1.0000			
(6) Short-Term Debt	0.0653	0.0911	-0.0012	0.0182	0.0350	1.0000		
(7) Implied Cap Rate	-0.3822	-0.3530	0.0205	-0.5714	0.0157	-0.0659	1.0000	
(8) Debt Rated	0.3892	0.3858	0.0020	0.4769	0.0281	0.0316	-0.3242	1.0000
Office								
(1) Density	1.0000							
(2) Location Beta	-0.0276	1.0000						
(3) Total Return	-0.0025	0.0011	1.0000					
(4) Size	0.7559	0.0578	0.0106	1.0000				
(5) Leverage	0.0706	-0.0064	-0.0220	0.0258	1.0000			
(6) Short-Term Debt	-0.0417	0.2215	0.0072	-0.0886	-0.0353	1.0000		
(7) Implied Cap Rate	-0.3819	-0.1402	0.0273	-0.5049	-0.1118	0.0932	1.0000	
(8) Debt Rated	0.3121	-0.0189	-0.0022	0.4738	-0.1239	-0.0666	0.0329	1.0000

Table 3. Real Estate Supply Elasticity as a Function of Location Density

This table reports output from Eq. (4). The dependent variable is unexpected shocks to the total square footage of new commercial real estate construction in CBSA l at time t, scaled by lagged total commercial real estate stock. We obtain those unexpected shocks by filtering local new construction through an AR(1) model and collecting the residuals. *High Density* is an indicator that takes the value of one if CBSA l's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual CBSA-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile. *Aggregate New Construction* is the total square footage of new commercial construction across all U.S. CBSAs at time t, scaled by lagged aggregate stock. Data on new construction are from Dodge Data and Analytics. Data on commercial real estate stock are from Costar. All regressions are estimated over the 1994–2017 period. CBSA- and time-fixed effects are included as indicated. Robust standard errors, clustered by CBSA, are reported in parentheses.

	(1)	(2)	(3)	(4)
High Density	0.003**		0.003**	
	(0.001)		(0.001)	
Aggregate New Construction	0.723***	0.684***		
	(0.065)	(0.049)		
High Density × *Aggregate New Construction*	-0.135**	-0.093*	-0.135**	-0.085*
	(0.068)	(0.048)	(0.068)	(0.048)
Constant	-0.015***	-0.012***	0.000	0.001*
	(0.001)	(0.000)	(0.000)	(0.001)
Observations	7,875	7,875	7,875	7,875
R-squared	0.10	0.11	0.11	0.12
CBSA-Fixed Effects	No	Yes	No	Yes
Year-Fixed Effects	No	No	Yes	Yes
Standard Errors Clustered By	CBSA	CBSA	CBSA	CBSA

Statistical significance is indicated as follows: *** p <0.01, ** p <0.05, * p <0.1.

Table 4. REIT NOI Growth as a Function of Density

This table reports output from Eq. (5) and (6). The specifications reported in columns (1) and (2) ((3) and (4)) refer to the estimation of *NOI Growth* for multifamily (office) REITs, respectively. Odd (even) columns present the results from estimating Eq. (5) (Eq. (6)), respectively. *NOI Growth* is the quarterly rate of growth in REIT-level net operating income (NOI). *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *High Location Beta* is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was in the top 50% of the underlying distribution. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Large Size* is an indicator that takes the value of one if REIT i's *Size* at time $t-1$ was in the top 50% of the underlying distribution. *Size* is a REIT's market capitalization, measured as its stock price multiplied by the number of shares outstanding. *Total Portfolio Area* is the quarterly total amount of square feet in REIT i's portfolio at time t. *GDP Growth* is the quarterly rate of growth in real U.S. GDP, measured four quarters in the past and obtained from the Federal Reserve Bank of St. Louis's Economic Database. Data on stock prices and the number of shares outstanding are from the CRSP Daily Stock File. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Multifamily		Office	
	(1)	(2)	(3)	(4)
High Density	0.025**	-0.004	0.008	-0.011
	(0.011)	(0.005)	(0.007)	(0.007)
High Location Beta	0.017	0.000	0.004	0.001
	(0.013)	(0.005)	(0.007)	(0.006)
Large Size	-0.007	-0.008	0.001	-0.019***
	(0.011)	(0.006)	(0.007)	(0.007)
Total Portfolio Area	-0.008		-0.024***	
	(0.007)		(0.006)	
GDP Growth		-0.224		0.197
		(0.151)		(0.247)
High Density × *GDP Growth*		0.308**		0.413*
		(0.153)		(0.230)
Constant	0.004	0.003	0.061***	0.137***
	(0.027)	(0.010)	(0.014)	(0.039)
Observations	280	1,325	992	1,772
R-squared	0.09	0.13	0.04	0.12
Year-Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5. REIT-Level Systematic Risk as a Function of Density (Simple Specification)

This table reports output from Eq. (8), focusing on the main predictors of interest only. The specifications reported in columns (1) and (2) ((3) and (4)) refer to the estimation of REIT-level systematic risk with respect to the *Stock Market Return* (*REIT Market Return*) as benchmark, respectively. Even (odd) columns refer to the estimation results for multifamily (office) REITs. In each set of regression results, systematic risk is estimated based on weekly total return data for the sample REITs and for the respective *Benchmark Return*. *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Stock Market Benchmark		REIT Market Benchmark	
	Multifamily (1)	Office (2)	Multifamily (3)	Office (4)
High Density	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Benchmark Return	0.517***	0.626***	0.748***	0.884***
	(0.034)	(0.037)	(0.028)	(0.025)
High Density × *Benchmark Return*	0.082	0.033	0.225***	0.099***
	(0.052)	(0.052)	(0.034)	(0.031)
Constant	0.000	0.001	0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	21,249	27,199	21,249	27,199
R-squared	0.147	0.166	0.399	0.407
Year-Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** p <0.01, ** p <0.05, * p <0.1.

Table 6. REIT-Level Systematic Risk as a Function of Density (Full Specification)

This table reports output from Eq. (8). The specifications reported in columns (1) and (2) ((3) and (4)) refer to the estimation of REIT-level systematic risk with respect to the *Stock Market Return* (*REIT Market Return*) as benchmark, respectively. Even (odd) columns refer to the estimation results for multifamily (office) REITs. In each set of regression results, systematic risk is estimated based on weekly total return data for the sample REITs and for the respective *Benchmark Return*. *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *High Location Beta* is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was in the top 50% of the underlying distribution. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *High Leverage* is an indicator that takes the value of one if REIT i's ratio of total long-term debt plus preferred stock to total EBITDA at time $t-1$ was in the top 50% of the underlying distribution. *High Short-Term Debt* is an indicator that takes the value of one if REIT i's ratio of long-term debt due within one year to total long-term debt at time $t-1$ was in the top 50% of the underlying distribution. *Large Size* is an indicator that takes the value of one if REIT i's market capitalization at time $t-1$ was in the top 50% of the underlying distribution. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Stock Market Benchmark		REIT Market Benchmark	
	Multifamily (1)	Office (2)	Multifamily (3)	Office (4)
High Density	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Benchmark Return	0.470***	0.597***	0.647***	0.866***
	(0.060)	(0.059)	(0.039)	(0.036)
High Density × *Benchmark Return*	0.052	-0.020	0.133***	0.059*
	(0.063)	(0.069)	(0.036)	(0.032)
High Location Beta	0.001*	0.001	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
High Location Beta × *Benchmark Return*	0.114**	0.071	0.130***	-0.005
	(0.056)	(0.054)	(0.032)	(0.029)
High Leverage	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
High Leverage × *Benchmark Return*	0.032	0.037	-0.022	-0.068**
	(0.056)	(0.057)	(0.033)	(0.033)
High Short-Term Debt	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
High Short-Term Debt × *Benchmark Return*	0.021	0.021	0.037	-0.015
	(0.055)	(0.054)	(0.029)	(0.032)
Large Size	-0.001***	-0.001*	-0.001***	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Large Size × *Benchmark Return*	0.061	0.022	0.167***	0.195***
	(0.060)	(0.060)	(0.035)	(0.033)
Constant	-0.001	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	16,699	18,464	16,699	18,464
R-squared	0.171	0.178	0.437	0.429
Year-Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7. REIT Leverage as a Function of Density

This table reports output from Eq. (9). The specifications reported in columns (1) and (2) ((3) and (4)) refer to the estimation of *Leverage* for multifamily (office) REITs, respectively. *Leverage* is the sum of total long-term debt outstanding (Compustat item DLTT) and preferred stock (item PSTK), scaled by total EBITDA (item EBITDA). *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *High Location Beta* is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was in the top 50% of the underlying distribution. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Large Size* is an indicator that takes the value of one if REIT i's *Size* at time $t-1$ was in the top 50% of the underlying distribution. *Size* is a REIT's market capitalization, measured as its stock price multiplied by the number of shares outstanding. Data on stock prices and the number of shares outstanding are from the CRSP Daily Stock File. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Multifamily		Office	
	(1)	(2)	(3)	(4)
High Density	-0.668**		0.676***	
	(0.268)		(0.199)	
High Location Beta	0.629**		-0.309*	
	(0.279)		(0.164)	
Large Size	-0.528*		-0.149	
	(0.272)		(0.211)	
Density		-0.042***		0.006***
		(0.011)		(0.001)
Location Beta		3.837***		-1.488**
		(0.962)		(0.637)
Size		-0.554***		-0.085
		(0.157)		(0.117)
Constant	5.019***	8.124***	2.259***	4.829***
	(0.469)	(1.737)	(0.637)	(1.638)
Observations	1,489	1,488	2,014	2,013
R-squared	0.16	0.23	0.07	0.08
Year-Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** p <0.01, ** p <0.05, * p <0.1.

Table 8. REIT Debt Ratings as a Function of Density

This table reports output from Eq. (10). The specifications reported in columns (1) through (4) refer to the logit estimation of *Debt Rated* for multifamily REITs ((1) and (2)) and office REITs ((3) and (4)), respectively. $\textit{Debt Rated}_{i,t}$ is an indicator that takes the value of one if REIT i has a long-term corporate debt rating, issued by S&P or Moody's, outstanding at time $t-1$. The specifications reported in columns (5) through (8) refer to the ordered logit estimation of *Rating Category* for multifamily REITs (columns (5) and (6)) and office REITs (columns (7) and (8)), respectively. *Rating Category* refers to the category of long-term corporate debt ratings issued by S&P. Data on the availability and category of REIT debt ratings are from S&P Global. *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *High Location Beta* is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was in the top 50% of the underlying distribution. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Large Size* is an indicator that takes the value of one if REIT i's *Size* at time $t-1$ was in the top 50% of the underlying distribution. *Size* is a REIT's market capitalization, measured as its stock price multiplied by the number of shares outstanding. Data on stock prices and the number of shares outstanding are from the CRSP Daily Stock File. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Likelihood of Debt Rating Outstanding (*Debt Rated*)				Category of Debt Rating Outstanding (*Rating Category*)			
	Multifamily		Office		Multifamily		Office	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High Density	1.254		1.920***		1.691***		1.065***	
	(0.297)		(0.365)		(0.290)		(0.241)	
High Location Beta	1.135		1.222		0.086		0.111	
	(0.219)		(0.194)		(0.206)		(0.202)	
Large Size	10.165***		5.044***		2.521***		1.200***	
	(2.321)		(0.950)		(0.268)		(0.231)	
Density		1.021		0.993***		0.064***		0.003
		(0.020)		(0.002)		(0.022)		(0.005)
Location Beta		0.842		0.135**		-2.436***		-1.157
		(0.783)		(0.121)		(0.757)		(1.361)
Size		4.777***		8.016***		1.574***		1.318***
		(0.856)		(1.519)		(0.178)		(0.178)
Constant	0.308***	0.000***	0.194***	0.000***				
	(0.059)	0.000	(0.035)	0.000				
Observations	1,513	1,511	2,036	2,035	787	787	806	806
Pseudo R-squared	0.23	0.43	0.15	0.41	0.16	0.16	0.16	0.11
Year-Fixed Effects	No	No	No	No	No	No	No	No
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 9. REIT Implied Cap Rates as a Function of Density

This table reports output from Eq. (11). The specifications reported in columns (1) and (2) ((3) and (4)) present the results for multifamily (office) REITs. *Implied Cap Rate*$_{i,t}$ is the ratio of long-term property net operating income to the implied market valuation of real estate observed for REIT ii at time t. Data on implied cap rates are from S&P Global. *High Density* is an indicator that takes the value of one if REIT i's *Density* at time $t-1$ was in the top 50% of the underlying distribution. *Density* is based on annual zip code-level employment density data from the Census Bureau's County Business Patterns survey, measured in thousands of employees per square mile, and weighted by a given REIT's exposure to different zip codes through its property portfolio holdings. *High Location Beta* is an indicator that takes the value of one if REIT i's *Location Beta* at time $t-1$ was in the top 50% of the underlying distribution. *Location Beta* is the average systematic risk exposure of the CBSAs where the sample REITs hold properties at the end of a given quarter, weighted by each REIT's exposure to different CBSAs through its property portfolio holdings. *Large Size* is an indicator that takes the value of one if REIT i's *Size* at time $t-1$ was in the top 50% of the underlying distribution. *Size* is a REIT's market capitalization, measured as its stock price multiplied by the number of shares outstanding. Data on stock prices and the number of shares outstanding are from the CRSP Daily Stock File. All regressions are estimated over the 1994–2017 period. Time-fixed effects are included as indicated. Robust standard errors, clustered by firm-year, are reported in parentheses.

	Multifamily		Office	
	(1)	(2)	(3)	(4)
High Density	-0.436***		-0.141	
	(0.110)		(0.141)	
High Location Beta	0.009		0.073	
	(0.080)		(0.128)	
Large Size	-0.735***		-0.907***	
	(0.110)		(0.144)	
Density		-0.022***		-0.006***
		(0.004)		(0.001)
Location Beta		-0.885**		-0.446
		(0.402)		(0.513)
Size		-0.229***		-0.339***
		(0.046)		(0.109)
Constant	8.850***	11.956***	8.934***	12.816***
	(0.155)	(0.666)	(0.946)	(1.745)
Observations	964	964	1,277	1,277
R-squared	0.78	0.80	0.43	0.50
Year-Fixed Effects	Yes	Yes	Yes	Yes
Standard Errors Clustered By	Firm-Year	Firm-Year	Firm-Year	Firm-Year

Statistical significance is indicated as follows: *** p <0.01, ** p <0.05, * p <0.1.