Risk and Returns of Commercial Real Estate: A Property Level Analysis

Executive Summary Prepared for the Real Estate Research Institute

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While private equity in commercial real estate represents a large portion of the total wealth in the United States, its risk and return characteristics are not as well understood as the risk and returns of stocks and bonds. Since *property level* real estate investment data are generally not accessible to academic researchers, most research in the literature relies on real estate *indexes* to analyze the risk and returns of commercial real estate. However, investors seldom hold portfolios that are as well diversified as the indexes, and the risk of return characteristics at the property level are not necessarily similar with the risk of returns of indexes. Therefore, research focusing on individual property investments, instead of indexes, is crucial to measure of the actual risk taken and returns earned by commercial real estate investors.

This paper aims to answer a few fundamental questions regarding the risk and returns of commercial real estate at the *property* level. First, what are the alphas of commercial real estate returns and their loadings on the conventional Fama-French factors and two macroeconomic factors – the term spread and the credit spread? Second, do the alphas and the factor loadings vary across time? Finally, how to measure the idiosyncratic risk of commercial real estate investments and what are the determinants of the idiosyncratic risk?

The empirical analyses in this paper are based on detailed cash flows of 2,845 apartments, offices, industrial and retail properties acquired for $89 billion (CPI adjusted 2009:3 dollar) and then disposed by institutional investors of National Council of Real Estate Investment Fiduciaries (NCREIF) between 1981:3 to 2009:3. This paper first develops a novel empirical model to estimate the factor loadings of commercial real estate returns using cross-sectional regressions. This new model overcomes the problem of missing property market values in conventional factor loading estimation that is based on time series regressions of asset returns on factors. Second, this paper measures the idiosyncratic risk of each property using the component of its total return that is not explained by the Fama-French and macroeconomic factors and property type indexes and MSA level deviations, which are constructed to capture all other unknown factors, and then analyzes the determinants of the risk.

This paper provides the following original results. First, quarterly returns of commercial real estate (except retail properties) have significantly positive alphas in the sample period: 0.027 for apartments, 0.054 for offices, and 0.044 for industrial properties. Second, commercial real estate returns have insignificant stock market betas except for apartments, but significant loadings on the Fama-French factors and the term spread and the credit spread. Specifically, the loadings on the SMB factor are 0.164 for apartments, 0.954 for offices, 0.848 for industrial properties, and 0.783 for retails. The loadings on the HML factor are 0.289 for apartments, 0.320 for offices, 0.288 for industrial properties, and 0.227 for retail properties. The loadings on the term spread are -0.403 for apartments, -2.929 for offices, -2.182 for industrial and -0.765 for retail properties. The loadings on the credit spread are -1.445 for apartments, -2.356 for offices, -1.815 for industrial properties, and 0.159 for retail properties. Third, the alphas and the factor loadings vary across time within the sample period. For example, the alphas for offices and industrial properties are significantly negative before but significantly positive after 1993:4. Finally, the idiosyncratic risk has a significant time-invariant component, which is possibly related to valuation errors in the acquisition or the disposition of properties. Further, the idiosyncratic risk is negatively related to the performance of commercial real estate investments. A 10% increase in the national real estate return would reduce the risk by about 0.8%.

This paper seems to make two important contributions to the literature. First, the empirical results provide original evidence regarding the risk and returns of commercial real estate as an important asset class. Second, the novel empirical models developed in this paper, particularly the model that uses cross-sectional regressions to overcome missing property values and estimate factor loadings, and the model that measures the idiosyncratic risk, can be easily applied to other illiquid assets such as venture capital and buyouts.

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Abstract

Using detailed cash flow information of 2,845 large commercial properties ($89 billion acquisition cost) acquired by institutional investors of National Council of Real Estate Investment Fiduciaries from 1981:3 to 2009:3, this paper estimates factor loadings of total returns of four categories of commercial real estate - apartments, offices, industrials and retails - and analyzes the relationship between their idiosyncratic risk and macroeconomic and real estate market conditions. This paper finds that, first, commercial real estate (except retail properties) has positive alphas, insignificant betas (except apartments), positive loadings on the SMB and HML factors, negative loadings on the term spread and the credit spread (except retail properties). Second, alphas and factor loadings are time variant. Third, the idiosyncratic risk has a time invariant component, and negatively correlates with commercial real estate investment returns.

JEL classification: C51, G11, G12

Key words: commercial real estate, return, idiosyncratic risk

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I. Introduction

Private equity in commercial real estate represents a large portion of the total wealth in the United States. However, comparatively little is known about its risk and return characteristics. The scarcity of empirical evidence is not due to the lack of interests or efforts, but mostly due to the lack of suitable data and methods. Since *property* level investment data are generally not accessible to academic researchers, most research in the literature relies on real estate *indexes* to analyze the risk and returns of commercial real estate (see, e.g. Fuerst and Marcato (2009), Geltner (1989), Geltner and Goetzmann (2000), Goetzmann and Ibbotson (1990), Ling and Naranjo (2007), Pai and Geltner (2007), Plazzi, Torous and Valkanov (2008), Peyton (2009), among others). While such research provides insights on the return and risk dynamics of real estate *indexes*, which are essentially *portfolios*, it does not directly analyze the actual returns earned by and the risk exposure of many investors because investors seldom hold portfolios that are as well diversified as the indexes. Fisher and Goetzmann (2005) points out that commercial real estate investors are likely exposed to a large amount of idiosyncratic risk, and finds that the median property investment IRR is significantly different from the average NCREIF index return across time. Therefore, index based research is not sufficient in measuring the risk and returns of private equity in commercial real estate.

Using a unique data set of detailed cash flows of 2,845 apartments, offices, industrial and retail properties acquired for $89 billion (CPI adjusted 2009:3 dollar) and then disposed by institutional investors of National Council of Real Estate Investment Fiduciaries (NCREIF) between 1981:3 to 2009:3, this paper investigates the returns and risk of commercial real estate at the *property* level. This paper aims to shed light on the following questions. First, what are the alphas of commercial real estate returns and their loadings on the conventional Fama-French factors and two macroeconomic factors – the term spread and the credit spread? Second, do the alphas and the factor loadings vary across time? Finally, how to measure the idiosyncratic risk of commercial real estate investments and what are the determinants of the idiosyncratic risk?

To answer the above questions, this paper first develops a novel empirical model to estimate the factor loadings of commercial real estate returns using cross-sectional regressions. This new model overcomes the problem of missing property market values in conventional factor loading estimation that is based on time series regressions of asset returns on factors. Second, this paper measures the idiosyncratic risk of each property using the component of its total return that is not explained by the Fama-French and macroeconomic factors and property type indexes and MSA level deviations, which are constructed to capture all other unknown factors, and then analyzes the determinants of the risk.

This paper provides the following original results. First, quarterly returns of commercial real estate (except retail properties) have significantly positive alphas: 0.027 for apartments, 0.054 for offices, and 0.044 for industrial properties. Second, commercial real estate returns have insignificant stock market betas except for apartments, but significant loadings on the Fama-French factors and the term spread and the credit spread. Specifically, the loadings on the SMB factor are 0.164 for apartments, 0.954 for offices, 0.848 for industrial properties, and 0.783 for retails. The loadings on the HML factor are 0.289 for apartments, 0.320 for offices, 0.288 for industrial properties, and 0.227 for retail properties. The loadings on the term spread are -0.403 for apartments, -2.929 for offices, -2.182 for industrial and -0.765 for retail properties. The loadings on the credit spread are -1.445 for apartments, -2.356 for offices, -1.815 for industrial properties, and 0.159 for retail properties. Third, the alphas and the factor loadings vary across time within the sample period. For example, alphas are significantly positive after but significantly negative before 1993:4 for offices and industrial properties. Finally, the idiosyncratic risk has a significant time-invariant component, which is possibly related to valuation errors in the acquisition or the disposition of properties. Further, the idiosyncratic risk is negatively related to the performance of commercial real estate investments. A 10% increase in the national real estate return would reduce the risk by about 0.8%.

This paper is the first, to our knowledge, that estimates alphas and factor loadings of commercial real estate returns and analyzes the idiosyncratic risk of commercial real estate investment at the *property* level. This paper seems to make two important contributions to the literature. First, the empirical results provide original evidence regarding the risk and returns of commercial real estate as an important asset class. Second, the novel empirical models developed in this paper, particularly the model that uses cross-sectional regressions to overcome missing property values and estimate factor loadings, and the model that measures the idiosyncratic risk, can be easily applied to other illiquid assets such as venture capital and buyouts.

The rest of this paper is organized as follows. Section II discusses an empirical model for the estimation of commercial real estate factor loadings. Section III discusses the construction of idiosyncratic risk measurements. Section IV describes the data. Section V presents and interprets the empirical results. Our conclusions are presented in Section VI.

II. Factor Estimation in Cross-sectional Regressions

This section first defines quarterly unlevered total gross returns of investing in a commercial property, as if the market value of the property were observed at the quarterly frequency. The total return of investing in a commercial property i from quarter t to $t+1$ is determined by not only the property values at the end of quarters t and $t+1$, but also cash flows between the quarters, including the net sale proceeds from a possible partial sale of the property $P_{i,t+1}$, the Net Operating Income (NOI) $I_{i,t+1}$, and the Capital Expenditure (CapEx) $E_{i,t+1}$. This paper assumes that the NOI is received, the CapEx is spent, and the possible partial sale takes place at the end of each quarter. Further, we assume that partial sales always take place before the final disposition if both of them take place in the same quarter.

Denote by buy_i the quarter in which property i is acquired and $sell_i$ the quarter in which it is completely disposed. Denote by B_{i,buy_i} the acquisition cost in quarter buy_i and by $S_{i,t}$ the net sale proceeds the owner would have received if she had sold 100% of the property (or 100% of the remaining part of the property if there is a partial sale) in an arm's length transaction at the end of quarter t. Note that $S_{i,t}$ is only observed in the disposition quarter $sell_i$. We define the total gross return from the acquisition quarter to the first quarter after it, R_{i,buy_i+1}, as

$$R_{i,buy_i+1} = \frac{P_{i,buy_i+1} + I_{i,buy_i+1} - E_{i,buy_i+1} + S_{i,buy_i+1}}{B_{i,buy_i}}, \tag{1}$$

and the total gross return from a later quarter t to quarter $t+1$, $R_{i,t+1}$, as

$$R_{i,t+1} = \frac{P_{i,t+1} + I_{i,t+1} - E_{i,t+1} + S_{i,t+1}}{S_{i,t}}. \tag{2}$$

This paper models the risk premium of $\log(R_{i,t})$ as a function of a vector of factors $\{F_{k,t}\}_{k=1}^{K}$,

$$\log(R_{i,t}) - \log(T_t) = \alpha + \sum_{k=1}^{K} \beta_k F_{k,t} + \varepsilon_{i,t}, \tag{3}$$

where T_t is the risk free rate in quarter t, and $\{\beta_k\}_{k=1}^{K}$ are factor loadings. Note that the intercept term α captures the time invariant component of the risk premium, which is not related to the factors. When (3) is correctly specified and includes all factors, α measures the risk adjusted return.

If property values were always observed, a time series regression based on equation (3) can be estimated for each property to obtain its factor loadings. However, $\log\left(R_{i,t}\right)$ is unobserved at quarterly frequency. Instead, we observe the sum of the dependent variable over the entire duration of the investment because the acquisition cost, all intermediate cash flows, as well as the final net sale proceeds are known. To see this, denote by R_i the total return from the acquisition quarter B_{i,buy_i} to the disposition quarter $sell_i$ for property i,

$$R_i \equiv \frac{P_{i,buy_i+1} + I_{i,buy_i+1} - E_{i,buy_i+1} + S_{i,buy_i+1}}{B_{i,buy_i}} \times \prod_{t=buy_i+1}^{sell_i-1} \frac{P_{i,t+1} + I_{i,t+1} - E_{i,t+1} + S_{i,t+1}}{S_{i,t}}. \qquad (4)$$

It is apparent that

$$R_i = \prod_{t=buy_i+1}^{sell_i} R_{i,t} \qquad (5)$$

Note that R_i can be calculated from the quarterly internal rate of total return, r_i, using the following equation,

$$R_i = r_i^{sell_i - buy_i}. \qquad (6)$$

Further, r_i can be obtained from solving the following present value equation

$$B_{i,buy_i} = \sum_{t=buy_i+1}^{sell_i-1} \frac{P_{i,t} + I_{i,t} - E_{i,t}}{r_i^{t-buy_i}} + \frac{P_{i,sell_i} + I_{i,sell_i} - E_{i,sell_i} + S_{i,sell_i}}{r_i^{sell_i - buy_i}}. \qquad (7)$$

All variables in (7) except r_i are observable. Therefore, r_i can be solved, and so is R_i from (6).

A cross-sectional regression can be derived from equations (3) and (5) to estimate the factor loadings, under the assumption of identical factor loadings across properties. To see this, add equation (3) over the investment duration for property i and then replace $\sum_{t=buy_i+1}^{sell_i} \log\left(R_{i,t}\right)$ with $\log\left(R_i\right)$, we have

$$\log\left(R_i\right) - \sum_{t=buy_i+1}^{sell_i} \log\left(T_t\right)$$
$$= \left(sell_i - buy_i\right)\alpha + \sum_{k=1}^{K} \beta_k \left(\sum_{t=buy_i+1}^{sell_i} F_{k,t}\right) + \sum_{t=buy_i+1}^{sell_i} \varepsilon_{i,t}. \tag{8}$$

Note both the dependent variable and the explanatory variables are observed, and thus (8) can be estimated using a cross-sectional regression, assuming that the factor loadings are identical across properties. The factor loadings are identifiable because different properties have different acquisition and disposition time; therefore, the sums of factors $\sum_{t=buy_i+1}^{sell_i} F_{k,t}$ vary across properties. The variation in the explanatory variables helps identify the coefficients.

Two caveats in estimating factor loadings based on (8) are worth noting. First, it is possible that there are omitted factors, which the regression does not include. Consequently, the estimated factor loadings may be biased if the included factors are correlated with the omitted factors. Second, the estimated factor loadings are average loadings across properties in the cross-sectional regression. Any deviations of individual properties' loadings from the averages are captured by the error term in the regression. To mitigate the heterogeneity in factor loadings, this paper estimates (8) for the four property types separately, hoping the same type of properties have similar factor loadings.

The commercial real estate market seems to have experienced some significant structural changes, which might lead to temporal variation of factor loadings. To investigate such variation, we denote by α and β_k the intercept term and factor loadings before, and by $\alpha + d$ and $\beta_k + e_k$ the same parameters after the quarter C, in which a structural change takes place. It is trivial to see that equation (8) changes to

$$
\begin{aligned}
&\log\left(R_i\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(T_t\right) \\
&=\left(sell_i-buy_i\right)\alpha+I\left(sell_i>C\right)\left(sell_i-\max\left(C,buy_i\right)\right)d \\
&+\sum_{k=1}^{K}\beta_k\left(\sum_{t=buy_i+1}^{sell_i}F_{k,t}\right)+I\left(sell_i>C\right)\sum_{k=1}^{K}e_k\left(\sum_{t=\max\left(C,buy_i\right)+1}^{sell_i}F_{k,t}\right) \\
&+\sum_{t=buy_i+1}^{sell_i}\varepsilon_{i,t},
\end{aligned}
\tag{9}
$$

where $I\left(sell_i>C\right)$ is an indicator function that equals 1 if the disposition quarter $sell_i$ is after the breaking point C and 0 otherwise. Equation (9) is easy to estimate using dummy variables to capture d and e_k. In the empirical analyses discussed in a later section, the breaking point is chosen as 1993:4, for the real estate market seems to begin a new cycle since 1993:4.

III. Construction of Idiosyncratic Risk Measurements

A growing finance literature studies the possible relationship between idiosyncratic risk and asset returns, which may exist if investors are unable to hold perfectly diversified portfolios (see, e.g. Fu (2009), Boehme, Danielsen, Kumar and Sorescu (2009), Ang, Hodrick, Xing and Zhang (2006)). Since real estate investors are often unable to hold diversified portfolios due to the large market values of commercial properties and limited financial resources, idiosyncratic risk of real estate investments likely plays an important role in pricing real estate. This paper aims to contribute to this research by proposing a measurement for the idiosyncratic risk of commercial real estate investments and conducting preliminary analysis on the determinants of the risk.

This paper uses the component of the risk premium $\log\left(R_i\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(T_t\right)$ in (8) that is orthogonal to all factors to measure the idiosyncratic risk of commercial real estate investment. Empirically, the component is estimated with the regression residual from (8). Note that the risk premium is likely affected by not only the included Fama-French factors and the term spread and the credit spread, but also unknown or unobserved factors. Therefore, it is important to control for the unknown factors to obtain accurate measurements of the idiosyncratic risk.

This paper constructs and includes in (8) two real estate specific asset pricing factors to capture the effects of unknown factors on the risk premium. The first is called the index factor and is constructed from property type total return indexes. A total return index captures national level factors that affect total returns of properties, which are not necessarily observed or completely captured by the Fama-French and macroeconomic factors. This paper allows each property type to have its own index, to accommodate possible heterogeneity in total returns across property types. The second factor is called the local factor, which captures systematic deviations of total returns in each MSA from the national index returns. Denote by θ_l the parameter that captures the local deviations of returns in MSA l, which is called the local sensitivity parameter. For each property type, both the index $\left\{\log\left(M_t\right)\right\}_{t=1}^{T}$ and local sensitivity parameters θ_l are jointly estimated using the algorithm proposed by Peng (2008) based on the following equation,

$$\log\left(R_i\right)=\theta_l \sum_{t=buy_i+1}^{sell_i}\log\left(M_t\right)+\sum_{t=buy_i+1}^{sell_i}\upsilon_{i,t} \ . \tag{10}$$

Note that regression (10) is a generalized version of the repeat sales regression that is widely used to estimate house price indexes such as the S&P Case/Shiller house price indexes (see, e.g. Bailey, Muth and Nourse (1963), Case and Shiller (1989), Goetzmann (1992)).

The algorithm proposed by Peng (2008) iterates two steps in estimating (10). The first step pools the same type properties across all MSAs, holds constant θ_l for each MSA, which was estimated from the previous iteration, and estimates (10) to obtain the national index $\left\{\log\left(M_t\right)\right\}_{t=1}^{T}$. The initial value of θ_l in the first round of iteration is 1 for all MSAs. The second step consists of MSA level regressions based on (10), which are estimated for each MSA separately. In each

MSA level regression, the national index $\left\{\log\left(M_t\right)\right\}_{t=1}^{T}$ estimated in step one is treated as known, and (10) is estimated to obtain θ_l for the MSA. The two steps are iterated until both $\left\{\log\left(M_t\right)\right\}_{t=1}^{T}$ and θ_l for all MSAs converge. Once both the index and the local sensitivity parameters are estimated, the index factor for a property i in MSA l equals

$$\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right), \tag{11}$$

And the local factor, which captures the systematic deviations of MSA returns from national index returns, equals

$$\hat{\theta}_l\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right). \tag{12}$$

Four empirical issues are worth discussions. First, in estimating the index and local sensitivity parameters, some MSAs have small numbers of transactions. Therefore, for these MSAs, the estimation of θ is not reliable due to the small degree of freedom in the second step of the iteration. To overcome this problem, in estimating (10) for each property type, we let θ remain 1 for MSAs with fewer than 10 property observations for the property type, and do not update the value of θ for such MSAs in the iteration.[1] The deviation of the true value of θ from 1 is captured by the error term for each of these MSAs.

Second, multicollinearity sometimes presents in the first step regression of the iteration. As a result, some consecutive quarters cannot be distinguished from each other. That is, while the regression provides an estimate for the aggregate index value (sum of quarterly index values) over these consecutive quarters, the index value for each quarter cannot be determined. However, it is important to note that this does not affect the construction of the index factor and the local

[1] All results are robust if we increase the number of observations required for us to estimate θ.

factor. Equations (11) and (12) indicate that, when constructing the factors for each property, it is the aggregate index value (the sum of quarterly index values) over the investment duration that matters. The very reason why some consecutive quarters cannot be distinguished from each other is that these quarters are within the duration for all properties. Empirically, to facilitate the illustration of the indexes in figures, in the presence of multicollinearity, we simply divide the estimated aggregate index values with the number of consecutive quarters, and assign this average quarterly index value to each of the consecutive quarters. Note that this procedure does not affect the calculation of the index and local factors based on equations (11) and (12).

Third, earlier quarters in the sample period contain fewer property observations and thus the corresponding index values are estimated with larger standard deviations. To mitigate the effects of these inaccurate index values on the idiosyncratic measurements, for each property type, we only use index values for quarters after (including) the first quarter in which the index begins to contain at least 75 property observations.[2] Therefore, the used index returns start in 1990:2 for apartments, 1982:1 for offices, 1981:3 for industrial properties, and 1989:4 for retail properties. All properties acquired before these starting quarters are excluded from the sample.

Finally, as Case and Shiller (1987), Goetzmann (1992), and others propose, the variance of the error term $\sum_{t=buy_i+1}^{sell_i} \upsilon_{i,t}$ in equation (10) may grow with the investment duration. However, using regression residuals from a simple diagnostic regression based on (10), we find no relationship between the squared residuals and the duration. This seems to support the interpretation developed by Goetzmann and Peng (2006) that the increasing variance may capture the unobserved changes in property attributes due to improvements and renovations. Since our data contain detailed CapEx information, the error terms no long capture changes in property

[2] The results are generally robust to the choice of the property numbers.

attributes, which might be the reason why the variance of the error term does not increase with the duration.

After including real estate factors and estimating (8), the residuals provide a measurement for the idiosyncratic risk of commercial real estate. To simply the notation, we define

$$u_i \equiv \sum_{t=buy_i+1}^{sell_i} \varepsilon_{i,t} \ . \tag{13}$$

We analyze the determinants of the idiosyncratic risk using the following regression,

$$\hat{u}_i^2 = \tau + \left(sell_i - buy_i\right)\alpha + \sum_{k=1}^{K}\left(\sum_{t=buy_i+1}^{sell_i} \beta_k F_{k,t}\right) + \sum_{t=buy_i+1}^{sell_i} \varepsilon_{i,t} + \upsilon_i \, , \tag{14}$$

where $\left\{F_{k,t}\right\}_{k=1}^{K}$ is a vector of explanatory variables for the property level idiosyncratic risk.

IV. Data

The commercial real estate data used in this paper are provided by the NCREIF, which is a not-for-profit institutional real estate industry association. Established in 1982, NCREIF serves the real estate investment industry by collecting, processing, validating and then disseminating information on the risk/return characteristics of commercial real estate assets owned by institutional investors. The NCREIF database comprises institutional-quality commercial real estate, as the observations are populated by investment managers and plan sponsors who own or manage real estate in a fiduciary setting.

The dataset contains quarterly property observations from 1978:1 to 2009:3. Each observation corresponds to the physical and financial status of a property in a specific quarter, and mainly contains two types of information. The first type of information pertains to physical attributes of the property, including the property type (e.g. apartments, offices, industrial properties, retail properties, hospitality properties, etc), age, location, etc. The location information includes the

MSA where the property is located. The second type of information pertains to the investment and operation of the property, including the net operating income, the total capital expenditure, the initial acquisition cost, and net sale proceeds from partial sales or the final disposition. All numbers are non-levered.

This paper cleans the data using the following filters. First, we exclude properties with identical IDs but have conflicting location information (e.g. multiple zip codes), which leads to 23,771 properties. Second, we only keep apartments, offices, industrial, and retail properties, for other property types do not have sufficient observations for the construction of real estate indexes. As a result, the number of properties reduces to 22,313. Third, we only keep properties that have been completely disposed by the end of the sample period and have the final dispositions marked as “true sales”. The exclusion of properties with appraised terminal values significantly reduces the sample size to 8,508. Note that we are not arguing that appraised values are not valuable. We simply choose to work with market values for they are less likely subject to possible valuation biases, and analyses based on appraised values would constitute a different paper. Fourth, we remove properties with missing acquisition years and quarters, initial acquisition costs, disposition years and quarters, and net sale proceeds. The resulting sample size is 7,443. Fifth, we exclude three properties with self-conflicting investment duration. Sixth, we exclude the properties acquired before 1979:1, mainly because of the small numbers of transactions in the first four quarters of the sample period resulted from subsequent cleaning. The sample size is now 7,044. Seventh, we exclude properties with missing NOI or CapEx for at least one quarter, and properties with 0 for NOI or CapEx for all quarters, which are likely errors. As a result, the sample size is 3,775. Eighth, we try to identify typos and misreported values possibly due to misunderstanding of the variable definitions by NCREIF members. Particularly, we exclude properties with the maximum of NOI being more than 20% of initial purchase cost, with the simple sum of quarterly capital improvement being more than the initial purchase cost, with the top and bottom 2% of the ratio of average quarterly NOI to initial purchase cost, with the top 2% of the ratio of average quarterly capital improvement to initial purchase cost, with at least 10 identical values of capital improvements during the investment quarters. After excluding the above properties, the sample size is 3,512.

We then calculate the quarterly internal rate of returns (IRRs) for each of the 3,512 properties based on equation (8). Since the R function we use to solve equation (8) caps the number of periods at 48, we exclude properties (fewer than ten) of which the investment duration is longer than 48 quarters (12 years) from the IRR calculation. After the calculation, we further remove properties with missing IRRs and properties with the top and bottom 1.5% of the IRR to mitigate possible errors in IRR outliers. The sample size becomes 3,177. Finally, after truncating the sample periods to exclude some earlier quarters with less accurate real estate index estimation (discussed in the previous section), the final sample size is 2,845. Figure 1 visualizes the histogram of the IRRs of the final sample.

Table 1 reports summary statistics for the four property types. First, the table reports the sample size for each property type. Industrial properties have the most properties (1,012), while retail properties have the fewest properties (347). Note that about 4% of the sample properties experienced partial sales during their holding periods. Second, the table reports the distribution of acquisition costs, which are adjusted using national CPI from the acquisition quarter to 2009:3 and denominated in 2009:3 dollars. Offices have the highest average acquisition cost ($49.46 million), and also the largest standard deviation ($72.57 million). Industrial properties have the lowest average acquisition cost ($17.54 million). Apartments and retail properties have similar averages ($30.85 million dollars and $31.73 million), but retail properties have a slightly higher standard deviation ($35.56 million) than apartments ($17.92 million). Third, Table 1 also reports the distribution of quarterly IRRs for the four property types. Retail properties have the highest average quarterly IRR (3.36%), followed by apartments (2.76%), industrial properties (2.51%), and offices (2.46%). Note that retail properties, which have the highest average quarter IRR, have the smallest standard deviation (2.18%), while offices, which have the lowest average quarter IRR, have the largest standard deviation (2.51%). Finally, Table 1 reports the distribution of investment duration for the four property types. The average duration is very similar across the property types: 17 for apartments, 20 for offices, 19 for industrial and 17 for retail properties. Note that the duration is capped at 48 quarters due to the constraint of the R function that calculates IRRs.

Table 2 reports the number of properties in the final 2,845 samples that were acquired and disposed in each quarter from 1981:2 to 2009:3. Clearly, apartments and retail properties do not have observations in earlier quarters, for their index values for the earlier quarters are excluded from our analyses due to the smaller number of properties (fewer than 75) contained in the indexes and only properties purchased after the excluded quarters are included in the final sample. The acquisitions and dispositions have obvious patterns: there are more acquisitions but fewer or no dispositions in earlier quarters, and fewer or no acquisition but more dispositions in later quarters. This is due to the fact that this paper only analyzes properties that have been completely disposed in the sample period. Since the investment duration of real estate is relatively long (18 quarters on average), properties acquired near the end of the sample period are less likely disposed and thus less likely included in the sample.

Analyses in this paper also use the following financial and macroeconomic variables: the risk free rate (T), the three Fama-French factors (Rm-Rf, SMB, and HML), the term spread (TSPR), and the credit spread (CSPR). The Fama-French factors are downloaded from Kenneth French's website, and all other variables are constructed from the FRED database. Among the three Fama-French factors, the Rm-Rf factor is the total return on the value-weighted stock market portfolio minus the corresponding quarterly return on U.S. Treasury securities from the CRSP. SMB is the total return on a portfolio of small-cap stocks in excess of the return on a portfolio of large-cap stocks. HML is the total return on stocks with high ratios of book-to-market value in excess of the returns on a portfolio of stocks with low book-to-market ratios. The risk free rate is the quarterly 3-year Treasury constant maturity annual rates. This paper chooses 3-year Treasury rate to roughly match the investment duration of properties (18 quarters). Note that, in estimating regressions (8) and (9), the annual risk free rates are converted to quarterly rates to match the quarterly real estate returns in (8). The term spread, TSPR, is the difference between the annual yields on 10-year and 1-year Treasuries. The credit spread, CSPR, is the difference between the annual yields on BAA and AAA rated corporate bonds. Plazzi, Torous and Valkanov (2008) suggest that the TSPR and CSPR likely affect commercial real estate returns. Table 3 reports summary statistics for the Fama-French factors and the TSPR and CSPR, including the minimum, median, maximum, mean, standard deviation, and the AR(1) coefficient for each variable, as well as the correlations among the variables.

V. Empirical Results

This section first reports the results of factor loading estimation based on the cross sectional regression (8). The dependent variable in (8) is the aggregate log risk premium for a property over its investment duration, and the explanatory variables include the investment duration and the respective sums of Fama-French factors and the term spread and the credit spread over the investment duration. Table 4 reports results from three specifications of (8) for each of the four property types respectively. The first specification includes the Fama-French factors. The second specification includes the term spread (TSPR) and credit spread (CSPR). The third specification includes both the Fama-French factors and the TSPR and CSPR.

Table 4 provides a few novel results. First, apartments, offices, and industrial properties all have significant and positive coefficients of the investment duration in the third specification, which includes both Fama-French factors and the TSPR and CSPR. If the included explanatory variables sufficiently capture the systematic risk of commercial real estate, the significant and positive coefficients indicate that commercial real estate has positive risk adjusted returns. Note that commercial real estate investors likely bear significant amount of idiosyncratic risk and liquidity risk, due to the fact that they have significant amount of capital invested in a small number of assets and they may not always be able to sell the assets at times when they want to sell. Therefore, the positive risk adjusted return might be expected by investors to compensate for the idiosyncratic risk and the liquidity risk. However, we do not rule out the possibility that there may be other factors omitted in the regression, and the coefficient of the investment duration may capture the effects of the omitted variables.

Second, Table 4 shows that commercial real estate has low or insignificant stock market beta. The coefficient of the market risk premium, β, is 0.135 for Apartments, and not significant for the three other property types. The low β seems to indicate that commercial real estate can effectively help diversify away the risk in the stock market. Third, the four property types have similar coefficients of other explanatory variables. Specifically, in the third specification, all types have significantly positive loadings on the SMB factor and the HML factors, and significantly negative loadings on the TSPR. Except retail properties, which have a positive loading on the CSPR, all property types have negative loading on the CSPR. Finally, it is worth noting that regressions in Table 4 tend to have reasonably high adjusted R squares, particularly for the third specifications. For example, the adjusted R square is 0.58 for apartments, 0.37 for offices, 0.39 for industrial properties, and 0.61 for retail properties.

This paper then analyzes possible temporal variation in the loading on Fama-French factors and the TSPR and CSPR using regression (9). Based on the NCREIF property index returns, the real estate market seemed to recover and enter a new cycle after 1993:4. Consequently, the breaking point is chosen to be 1993:4. Note that regression (9) has an important distinction from (8): explanatory variables in quarters after the breaking point can have additional effects on the risk premium of commercial real estate. The additional effects are captured by the coefficients of interaction terms between dummy variables for quarters after the breaking point and the variables for those quarters. Therefore, the total effect of an explanatory variable after the breaking point equals the coefficient for the variable for quarters before the breaking point plus the coefficient of the interaction term.

Table 5 reports the regressions results for each of the four property types. The same three specifications in (6) are adopted for each property type. A few results are worth noting. First, many explanatory variables that are significant in Table 4 are insignificant in Table 5. For example, the TSPR is always significant in Table 4, in all specifications and for all property types. However, it is insignificant in Table 5 except in the second specification for Industrial properties. The insignificance can be caused by multicollinearity in the variables. Note that the explanatory variables, such as the TSPR, are positively correlated with their interaction terms with quarters after the breaking point, which increases the standard deviations of coefficient estimates and thus reduces the t-statistics. Second, despite the presence of multicollinearity, Table 5 substantiates significant temporal variation in the coefficient of the investment duration and the loading on the SMB factor for offices and industrial properties. Both coefficients are either significantly negative or insignificant before, but significantly positive after the breaking point. This suggests that, for offices and industrial properties, the risk adjusted return significantly increases and the real estate returns are more similar with small stock returns since 1993:4. This also suggests that the positive risk adjusted returns in Table 4 are mostly from the period from 1993:4 to 2009:3. If the current market down turn continues, the risk adjusted return might disappear in future research with an extended sample period. Finally, it is also worth noting that the evidence for temporal variation in other explanatory variables seems weak.

This paper estimates national property type total return indexes and MSA level return deviations from the index returns based on the general repeat sales regression (10), and then constructs the two real estate factors, the index factor and the local factor, based on equations (11) and (12). Table 6 reports summary statistics for the property type indexes. Retail properties have the highest average quarterly index returns: 4.91% but also the largest standard deviation: 23.44%, while apartments have the lowest average quarterly returns: 2.23%, but also the smallest standard deviation: 8.71%. However, note that the indexes have different starting points due to the truncation based on the number of properties that constitute the indexes; therefore, direct comparisons of the summary statistics across property types may be misleading. Figures 2 to 5 visualize the indexes for the four property types.

Table 7 reports the local sensitivity parameters θ_l from estimating (10), each of which measures systematic return deviations for a property type in a MSA from the national property type index returns. Note that θ_l is estimated only for a property type in a MSA if this MSA has more than 10 properties in this type. Table 7 shows that 37 MSAs have more than 10 properties in at least one property type. The MSAs in Table 7 are ranked based on the total number of properties each MSA contributes to the final sample. The top ranked MSAs with more than 100 total properties in all four property types are Washington D.C., Chicago, Atlanta, Los Angeles, Dallas, Phoenix, Houston, Boston. These MSAs have estimated sensitivity parameters for all four property types except for Retail properties in Boston. While this paper does not intend to analyze the determinants of the sensitivity parameters, the parameters across different property types seem to be correlated within MSAs. We leave this for future research.

Table 8 reports the regressions based on (8) for each property type with the real estate factors included, and the regression residuals are used to measure the idiosyncratic risk of commercial real estate investments. Two specifications are adopted in the regressions. Both specifications include the investment duration, the Fama-French factors, and the TSPR and the CSPR. The difference between the two specifications is that the first one includes the index factor only, while the second one includes both the index and the local factors. The main results in Table 8 are the following. First, the real estate factors take away the explanatory power of most explanatory variables in Table 4. The only exceptions are the SMB factor and the CSPR for industrial properties. Note that this result seems sensible given that, as Table 1 shows, industrial properties tend to be smaller properties (lower acquisition costs). The fact that the index and the local factors dominate the Fama-French factors and the TSPR and CSPR in Table 8 indicates that the real estate factors already capture the effects of these variables. Second, regressions in Table 9 always have higher adjusted R squares than regressions in Table 4, and the increases in R squares are often significant. For example, for Offices, the adjusted R square is 0.65 and 0.71 for the two specifications in Table 9 while it is 0.61 in Table 4. The R square increases from 0.37 to 0.53 and 0.61 for Apartments, from 0.39 to 0.52 and 0.59 for Industrial properties, and from 0.61 to 0.75 and 078 for Retail properties. This indicates that the real estate factors very likely capture factors that are omitted in Table 4, and residuals in Table 8 are likely more accurate in measuring the idiosyncratic risk than residuals in Table 4.

By analyzing MSA level property indexes constructed from appraised values, Pai and Geltner (2007) find evidence that real estate returns seem to relate to the price level of properties and the liquidity of the market where properties are located. Using a dataset of 557 US properties, Fuerst and Marcato (2009) analyzes the determinants of the risk adjusted return (Sharpe's alpha) and the CAPM beta of artificial portfolios that comprise randomly selected 50 properties. They find that property size is the dominating variable in explaining portfolio returns, followed by the cap rate, which is constructed from appraised values, and tenant concentration. This paper tests if the price level and the market liquidity provides incremental explanatory power once the real estate factors are included, by including interaction terms between the explanatory variables in Table 8 and dummies for the largest and the smallest 10% properties (CPI adjusted acquisition cost in 2009:3 dollars) respectively, and interaction terms with dummies for illiquid MSAs (the bottom 10% MSAs with fewest properties). The coefficients for the interaction terms are insignificant, which indicates that, if there are any size/price level effects or liquidity effects, they are completely captured by the index factor and the local factor. Results are not reported since the coefficients we intend to analyze are all insignificant. Note that, since this paper is based on market values and actual cash flows, we do not construct and test the explanatory power of appraisal based cap rates. Further, the NCREIF data, which do not include the number of tenants in each property, does not allow the construction of tenant concentration. Therefore, this paper does not investigate the effects of tenant concentration on property returns documented by Fuerst and Marcato (2009).

Finally, this paper constructs the risk measurement for each property over its investment duration using the squared residuals from the second regression in Table 8. Figure 6 plots the histogram of the residuals. The squared residuals are then regressed on explanatory variables based on equation (14). The explanatory variables include an intercept term, the investment duration (quarters), aggregate values of the Fama-French factors, the TSPR, the CSPR, and the index factor: the property type index return over the investment duration. The intercept term captures the time invariant component of the risk that does not correlate to other explanatory variables. The investment duration is to capture possible positive relationship between duration and the risk that Case and Shiller (1987), Goetzmann (1992), and others find in residential properties.

Table 9 reports the results of the following five specifications of the regression. The first specification includes the intercept term and the duration only. The second, third, and fourth specifications include not only these two variables, but also the Fama-French factors, the TSPR and the CSPR, and the property type index return respectively. The fifth specification includes all variables. Table 9 offers two robust results. First, the intercept term is always positive and significant in all specifications. This provides strong evidence for a time invariant risk component, which is possibly related to valuation errors in the acquisition or the disposition of properties. Second, the real estate index returns significantly mitigate the risk – the coefficient is negative and about -0.08. This means that a 10% increase in the national real estate return over the investment duration would reduce the risk over the duration by about 0.8%. It is worth noting that the relationship between the investment duration and the risk is not robust. In the first, the second, and the fourth specifications, the coefficient of the duration is positive and significant, which is consistent with the Case and Shiller (1987) finding. However, the coefficient is insignificant in the third specification, and more importantly the fifth specification, which includes all explanatory variables.

A variety of other specifications are also investigated. For example, we separate the positive and negative values of the explanatory variables and try to identify possible asymmetric effects of these variables on the risk. We also introduce squared explanatory variables to capture possible nonlinearity. However, there is no robust evidence to support the asymmetric effects or nonlinearity. Therefore, these results are not reported.

VI. Conclusion

Investors of commercial real estate are often unable to hold well diversified real estate portfolios. However, comparatively little is known regarding the return and risk characteristics of commercial real estate at the property level. This paper utilizes property level cash flow information of 2,845 apartments, offices, industrial and retail properties acquired and disposed by NCREIF members between 1981:3 to 2009:3, and estimates the loadings of their total returns on the Fama-French factors and the term spread and the credit spread. This paper further measures the idiosyncratic risk of commercial real estate using the component of the returns that is not explained by the above factors and property type indexes and MSA level deviations, which are constructed to capture all other unknown factors, and analyzes the determinants of the risk.

This paper finds significant loadings of commercial real estate returns on the Fama-French factors and macroeconomic factors, as well as positive alphas in the sample period. Particularly, real estate returns tend to have insignificant or small market betas, positive loadings on the SMB factor and negative loadings on the HML factor, the term spread, and the credit spread. This paper also finds that the factor loadings and alphas are both time variant – alphas are significantly higher after 1993:4. Another important finding is that property type indexes and MSA level deviations provide incremental explanatory power for commercial real estate returns than the Fama-French factors and the macroeconomic factors, and significantly increase adjusted R squares of the regressions. This is consistent with the existence of unknown factors. Finally, this paper finds that the idiosyncratic risk of real estate private equity has a time-invariant component, which is likely related to valuation errors in acquisition or disposition, and is significantly lower when commercial real estate earns higher returns.

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Table 1 Property Summary Statistics

This table summarizes the number of properties, the number of properties with partial sales, the acquisition costs, the total return quarterly IRRs, and the duration of investments for four types of properties: apartments, offices, industrial properties and retail properties. The costs were inflation adjusted and in $million (2009:3 dollars). The quarterly IRRs are calculated using the acquisition costs, the quarterly net operating income, capital expenditure, and partial sales, and the net sale proceeds. The duration is in quarters.

	Apartments	Offices	Industrial	Retail	Total
Properties: total	705	781	1,012	347	2,845
Properties: partial sale	6	19	85	7	117
Cost: minimum	$1.62	$0.68	$0.71	$1.41	$0.68
Cost: median	$26.15	$27.50	$10.94	$20.49	$20.45
Cost: maximum	$131.63	$1,073.33	$213.47	$278.04	$1,073.33
Cost: mean	$30.86	$49.46	$17.54	$31.73	$31.33
Cost: standard deviation	$17.92	$72.57	$19.50	$35.56	$44.40
IRR: minimum	-4.47%	-4.75%	-4.66%	-3.28%	-4.75%
IRR: median	2.54%	2.44%	2.31%	3.16%	2.52%
IRR: maximum	11.26%	11.34%	11.42%	10.41%	11.42%
IRR: mean	2.76%	2.46%	2.51%	3.36%	2.66%
IRR: standard deviation	2.19%	2.51%	2.30%	2.18%	2.34%
Duration: minimum	1	1	1	2	1
Duration: median	15	17	15	13	15
Duration: maximum	48	48	48	48	48
Duration: mean	17	20	19	17	18
Duration: standard deviation	11	12	12	10	11

Table 2 Properties Acquired and Disposed in Each Quarter

This table summarizes the number of properties acquired and disposed in each quarter from 1981:3 to 2009:3 for apartments, offices, industrial and retail properties.

Year	Q.	Apartments		Offices		Industrial		Retails		All	
		Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
1981	2	0	0	0	0	17	0	0	0	17	0
1981	3	0	0	0	0	16	0	0	0	16	0
1981	4	0	0	9	0	8	0	0	0	17	0
1982	1	0	0	5	0	8	0	0	0	13	0
1982	2	0	0	4	0	4	0	0	0	8	0
1982	3	0	0	6	0	3	0	0	0	9	0
1982	4	0	0	2	0	2	0	0	0	4	0
1983	1	0	0	6	0	2	0	0	0	8	0
1983	2	0	0	2	0	2	0	0	0	4	0
1983	3	0	0	2	2	3	1	0	0	5	3
1983	4	0	0	3	1	1	1	0	0	4	2
1984	1	0	0	7	0	4	1	0	0	11	1
1984	2	0	0	5	0	5	1	0	0	10	1
1984	3	0	0	5	0	3	3	0	0	8	3
1984	4	0	0	2	2	3	3	0	0	5	5
1985	1	0	0	9	0	3	0	0	0	12	0
1985	2	0	0	6	0	7	0	0	0	13	0
1985	3	0	0	2	1	5	0	0	0	7	1
1985	4	0	0	7	4	7	3	0	0	14	7
1986	1	0	0	3	0	12	0	0	0	15	0
1986	2	0	0	0	0	4	2	0	0	4	2
1986	3	0	0	3	3	7	3	0	0	10	6
1986	4	0	0	6	3	15	1	0	0	21	4
1987	1	0	0	4	1	5	0	0	0	9	1
1987	2	0	0	2	1	7	1	0	0	9	2
1987	3	0	0	1	2	5	2	0	0	6	4
1987	4	0	0	7	3	10	2	0	0	17	5
1988	1	0	0	6	1	4	0	0	0	10	1
1988	2	0	0	8	0	4	4	0	0	12	4
1988	3	0	0	5	4	5	2	0	0	10	6
1988	4	0	0	2	0	9	2	0	0	11	2
1989	1	0	0	2	1	9	6	0	0	11	7
1989	2	0	0	2	5	2	1	0	0	4	6
1989	3	0	0	7	1	8	8	5	0	20	9
1989	4	0	0	9	1	6	8	12	0	27	9
1990	1	5	0	5	2	6	3	4	0	20	5
1990	2	2	0	2	2	5	0	5	0	14	2
1990	3	5	0	3	1	9	0	2	0	19	1
1990	4	5	0	10	5	7	7	5	0	27	12
1991	1	2	0	2	4	10	2	4	0	18	6
1991	2	4	0	1	4	3	9	2	0	10	13
1991	3	3	0	3	4	5	2	3	0	14	6
1991	4	6	0	1	6	3	3	7	0	17	9
1992	1	3	0	2	0	0	0	4	0	9	0
1992	2	5	0	0	0	2	3	0	0	7	3
1992	3	2	0	1	1	0	3	2	1	5	5
1992	4	6	1	1	4	1	6	0	4	8	15
1993	1	4	0	0	2	2	2	0	1	6	5

1993	2	0	0	0	2	0	3	5	1	5	6
1993	3	8	0	0	5	0	3	1	1	9	9
1993	4	10	3	2	3	4	4	4	1	20	11
1994	1	1	1	0	1	6	4	4	0	11	6
1994	2	5	3	1	2	0	3	2	1	8	9
1994	3	4	3	2	0	4	2	6	0	16	5
1994	4	4	2	8	3	4	9	1	2	17	16
1995	1	2	2	2	4	2	4	0	0	6	10
1995	2	15	0	4	7	6	4	6	3	31	14
1995	3	6	1	8	3	0	4	1	0	15	8
1995	4	5	1	6	5	9	7	4	2	24	15
1996	1	5	0	9	3	6	3	6	3	26	9
1996	2	7	0	8	3	4	7	4	0	23	10
1996	3	19	3	10	5	7	8	6	1	42	17
1996	4	24	5	10	9	19	16	6	2	59	32
1997	1	9	5	9	8	10	14	0	2	28	29
1997	2	7	1	17	7	15	20	1	2	40	30
1997	3	12	6	12	10	7	15	0	0	31	31
1997	4	19	5	29	12	9	10	4	12	61	39
1998	1	13	1	14	5	6	9	2	6	35	21
1998	2	10	4	17	6	20	6	14	2	61	18
1998	3	20	4	16	6	10	6	2	2	48	18
1998	4	14	8	19	10	16	24	5	3	54	45
1999	1	7	4	7	7	5	7	7	5	26	23
1999	2	18	10	14	4	14	8	3	3	49	25
1999	3	10	6	17	4	16	6	2	0	45	16
1999	4	20	9	17	9	21	9	1	3	59	30
2000	1	8	7	14	13	5	6	3	7	30	33
2000	2	13	8	18	4	12	6	4	3	47	21
2000	3	21	17	16	15	7	6	4	8	48	46
2000	4	36	11	21	11	33	7	11	2	101	31
2001	1	11	1	4	7	5	8	5	6	25	22
2001	2	8	7	20	4	24	4	4	3	56	18
2001	3	13	15	5	5	8	5	2	3	28	28
2001	4	12	4	15	4	73	9	1	1	101	18
2002	1	4	11	10	10	3	8	60	2	77	31
2002	2	6	9	12	10	1	15	1	7	20	41
2002	3	21	23	4	11	10	19	4	12	39	65
2002	4	19	0	19	0	46	0	11	0	95	0
2003	1	7	5	13	4	5	7	3	5	28	21
2003	2	7	6	12	5	25	9	4	4	48	24
2003	3	10	12	13	11	93	28	7	6	123	57
2003	4	17	15	8	16	6	9	7	10	38	50
2004	1	13	13	5	7	17	20	2	8	37	48
2004	2	14	21	19	13	17	7	9	6	59	47
2004	3	12	10	12	19	17	22	9	2	50	53
2004	4	18	22	24	32	20	71	17	13	79	138
2005	1	10	14	7	17	19	4	5	4	41	39
2005	2	9	21	13	20	24	25	4	66	50	132
2005	3	44	34	16	29	13	22	6	6	79	91
2005	4	6	41	12	26	17	29	0	8	35	104
2006	1	17	36	5	13	6	8	2	3	30	60
2006	2	8	26	5	23	4	93	4	11	21	153

2006	3	3	24	2	19	9	26	1	9	15	78
2006	4	1	35	10	44	4	21	2	7	17	107
2007	1	1	12	1	25	1	25	0	13	3	75
2007	2	2	21	1	25	0	57	0	8	3	111
2007	3	7	25	5	44	0	30	1	14	13	113
2007	4	0	25	2	21	0	26	1	5	3	77
2008	1	1	13	0	12	0	6	1	3	2	34
2008	2	0	7	0	6	0	12	0	3	0	28
2008	3	0	16	0	17	0	15	0	7	0	55
2008	4	0	10	0	8	0	6	0	0	0	24
2009	1	0	3	0	4	0	7	0	0	0	14
2009	2	0	14	0	4	0	8	0	3	0	29
2009	3	0	23	0	9	0	16	0	6	0	54

Table 3 Conditional Variable Summary Statistics

This table summarizes quarterly time series of six conditional variables: the risk free rate (T), the three Fama-French factors – Rm-Rf, SMB, and HML, the term spread (TSPR), and the credit spread (CSPR). The risk free rate, T, is the quarterly 3-year Treasury constant maturity annual rates. The Rm-Rf factor is the total return on the value-weighted stock market portfolio minus the corresponding quarterly return on U.S. Treasury securities from the CRSP. SMB is the total return on a portfolio of small-cap stocks in excess of the return on a portfolio of large-cap stocks. HML is the total return on stocks with high ratios of book-to-market value in excess of the returns on a portfolio of stocks with low book-to-market ratios. The term spread, TSPR, is the difference between the annual yields on 10-year and 1-year Treasuries. The credit spread, CSPR, is the difference between the annual yields on BAA and AAA rated corporate bonds. Panel A reports the minimum, median, maximum, mean, standard deviation, and the AR(1) coefficient of each of the six variables. Panel B reports the correlations among the variables.

Panel A

	T	Rm-Rf	SMB	HML	TSPR	CSPR
Minimum	0.28%	-24.32%	-10.83%	-32.01%	-2.14%	0.55%
Median	1.49%	2.6%	0.09%	0.69%	1.18%	0.95%
Maximum	3.67%	20.64%	19.1%	23.85%	3.29%	3.09%
Mean	1.61%	1.70%	0.72%	0.78%	1.17%	1.13%
Standard deviation	0.79%	8.63%	5.26%	7.31%	1.18%	0.51%
AR(1)	0.96	0	0	0.15	0.86	0.87

Panel B

	T	Rm-Rf	SMB	HML	TSPR	CSPR
T	1	0.00	-0.07	-0.00	-0.48	0.33
Rm-Rf		1	0.48	-0.23	0.03	-0.20
SMB			1	-0.04	0.20	0.08
HML				1	0.19	-0.02
TSPR					1	-0.00

Table 4 Real Estate Returns and Economic Conditions

This table reports results of the following linear regression for Apartments, Offices, Industrial and Retail properties respectively,

$$\log\left(R_i\right) - \sum_{t=buy_i+1}^{sell_i} \log\left(T_t\right) = \left(sell_i - buy_i\right)\alpha + \sum_{k=1}^{K}\left(\sum_{t=buy_i+1}^{sell_i} \beta_k F_{k,t}\right) + u_i \,,$$

where R_i is the gross total return from the acquisition quarter buy_i to the disposition quarter $sell_i$ for property i; T_t is the quarterly rate of the 3-year Treasury constant maturity rate in quarter t; $F_{k,t}$ is the kth factor in quarter t. The factors include the three Fama-French factors (Rm-Rf, SMB, and HML), the term spread (TSPR), and the credit spread (CSPR). Heteroskedasticity consistent standard deviations are in parentheses. *** denotes significance at the 1% level, ** at the 5% level, and * at 10% level.

	Apartments			Offices			Industrial			Retail		
α	***0.010	***0.024	***0.027	**-0.003	**0.036	***0.054	0.000	***0.027	***0.044	***0.012	***-0.025	0.018
	(0.001)	(0.003)	(0.005)	(0.002)	(0.006)	(0.006)	(0.001)	(0.003)	(0.004)	(0.002)	(0.009)	(0.011)
Rm-Rf	***0.204		***0.135	0.000		0.043	0.078		0.079	-0.070		0.025
	(0.044)		(0.050)	(0.066)		(0.073)	(0.048)		(0.050)	(0.082)		(0.102)
SMB	0.054		**0.164	***0.878		***0.954	***0.822		***0.848	***0.613		***0.783
	(0.064)		(0.083)	(0.102)		(0.100)	(0.071)		(0.073)	(0.149)		(0.166)
HML	***0.248		***0.289	***-0.233		***0.320	***-0.137		***0.288	0.100		**0.227
	(0.040)		(0.045)	(0.068)		(0.065)	(0.059)		(0.054)	(0.110)		(0.103)
TSPR		***0.514	**-0.403		***-0.893	***-2.929		***-0.652	***-2.182		*0.443	***-0.765
		(0.120)	(0.196)		(0.217)	(0.230)		(0.153)	(0.168)		(0.232)	(0.243)
CSPR		**-1.831	**-1.445		***-2.443	***-2.356		***-1.466	***-1.815		***4.202	***0.159
		(0.454)	(0.589)		(0.693)	(0.621)		(0.363)	(0.358)		(1.133)	(1.177)
Sample	705	705	705	781	781	781	1,012	1,012	1,012	347	347	347
Adj. R2	0.598	0.577	0.606	0.192	0.064	0.372	0.247	0.097	0.392	0.600	0.542	0.607

Table 5 Structural Changes in Real Estate Returns

This table reports results of the following linear regression for Apartments, Offices, Industrial and Retail properties respectively,

$$\log(R_i) - \sum_{t=buy_i+1}^{sell_i} \log(T_t) = (sell_i - buy_i)\alpha + I(sell_i > C)(sell_i - \max(C, buy_i))d + \sum_{k=1}^{K}\left(\sum_{t=buy_i+1}^{sell_i} \beta_k F_{k,t}\right)$$

$$+ I(sell_i > C)\sum_{k=1}^{K}\left(\sum_{t=\max(C,buy_i)+1}^{sell_i} e_k F_{k,t}\right) + \sum_{t=buy_i+1}^{sell_i} \varepsilon_{i,t},$$

where $I(sell_i > C)$ is an indicator function that equals 1 if the disposition quarter $sell_i$ is after the breaking point C (1993:4) and 0 otherwise; R_i is the gross total return from the acquisition quarter buy_i to the disposition quarter $sell_i$ for property i; T_t is the quarterly rate of the 3-year Treasury constant maturity rate in quarter t; $F_{k,t}$ is the kth factor in quarter t. The factors include the three Fama-French factors (Rm-Rf, SMB, and HML), the term spread (TSPR), and the credit spread (CSPR). The factor values for quarters later than the breaking points are denoted as I*factor (e.g. I*Rm-Rf). Heteroskedasticity consistent standard deviations are in parentheses. *** denotes significance at the 1% level, ** at the 5% level, and * at 10% level.

	Apartments			Offices			Industrial			Retail		
α	0.006	0.137	0.164	***-0.042	-0.036	*-0.057	***-0.030	-0.006	**-0.048	0.008	0.087	0.203
	(0.023)	(0.100)	(0.130)	(0.007)	(0.019)	(0.031)	(0.005)	(0.013)	(0.020)	(0.009)	(0.180)	(0.218)
Rm-Rf	-0.703		-0.127	0.519		0.309	***0.622		**0.512	-0.609		0.170
	(0.717)		(0.779)	(0.329)		(0.393)	(0.229)		(0.258)	(0.754)		(1.168)
SMB	0.855		-0.237	***-1.250		**-0.994	***-1.315		***-1.311	-0.179		-1.088
	(0.936)		(1.139)	(0.310)		(0.476)	(0.239)		(0.319)	(1.346)		(1.246)
HML	0.303		-0.406	*0.470		0.220	**0.415		0.200	-0.411		-0.617
	(0.500)		(0.703)	(0.252)		(0.321)	(0.192)		(0.332)	(0.398)		(1.251)
TSPR		-0.717	0.249		-0.992	0.068		**-1.243	0.699		-4.200	-2.536
		(2.757)	(2.795)		(0.652)	(1.150)		(0.519)	(0.761)		(2.821)	(6.130)
CSPR		**-14.285	-18.565		**2.446	1.864		*1.109	1.002		-0.470	-16.550
		(6.392)	(11.559)		(1.171)	(1.775)		(0.653)	(1.192)		(13.763)	(17.616)
d	0.005	-0.107	-0.138	***0.055	***0.071	**0.082	***0.044	***0.036	***0.082	0.006	-0.075	-0.180
	(0.024)	(0.101)	(0.130)	(0.008)	(0.021)	(0.033)	(0.005)	(0.014)	(0.021)	(0.010)	(0.183)	(0.220)
I*Rm-Rf	0.959		0.268	-0.290		-0.118	**0.469		-0.393	0.771		-0.158
	(0.720)		(0.782)	(0.330)		(0.401)	(0.232)		(0.264)	(0.758)		(1.168)
I*SMB	-0.809		0.242	***1.070		*0.870	***1.282		***1.585	0.625		1.278
	(0.931)		(1.142)	(0.311)		(0.487)	(0.239)		(0.320)	(1.333)		(1.243)
I*HML	-0.051		0.647	-0.269		0.009	-0.206		0.081	*0.680		0.823
	(0.502)		(0.705)	(0.257)		(0.326)	(0.196)		(0.331)	(0.386)		(1.261)
I*TSPR		1.474	0.050		***0.945	-0.310		**1.367	**-1.666		**5.807	3.458
		(2.752)	(2.770)		(0.679)	(1.192)		(0.530)	(0.798)		(2.818)	(6.111)
I*CSPR		*11.473	16.756		-4.701	-2.877		***-2.795	*-2.330		-0.689	14.675
		(6.512)	(11.621)		(1.527)	(2.128)		(0.937)	(1.414)		(14.049)	(17.826)
Sample	705	705	705	781	781	781	1,012	1,012	1,012	347	347	347
Adj. R2	0.606	0.598	0.613	0.471	0.457	0.471	0.447	0.420	0.459	0.667	0.670	0.674

Table 6 Total Return Indexes

This table summarizes the quarterly total return indexes for Apartments, Offices, Industrial and Retail properties. For each property, the index is jointly estimated with the systematic return deviation for each MSA based on the following specification,

$$\log(R_i) = \theta_l \sum_{t=buy_i+1}^{sell_i} \log(M_t) + \sum_{t=buy_i+1}^{sell_i} \upsilon_{i,t} ,$$

where R_i is the gross total return from the acquisition quarter buy_i to the disposition quarter $sell_i$ for property i; $\log(M_t)$ is the log index total return from quarter $t-1$ to quarter t; θ_l captures the sensitivity of total returns of properties in MSA l with respect to the index total returns. Each index is first estimated using the EM algorithm proposed by Peng (2008) from 1979:1 to 2009:3, and then is truncated and excludes quarters before the first quarters in which the index contains at least 75 properties, before the calculation of summary statistics.

	Apartments	Offices	Industrial	Retail
Beginning quarter	1990:2	1982:1	1981:3	1989:4
Total returns: minimum	-20.89%	-55.01%	-44.82%	-44.14%
Total returns: median	1.18%	1.55%	1.83%	4.65%
Total returns: maximum	24.41%	85.99%	63.14%	75.88%
Total returns: mean	2.23%	3.27%	2.90%	4.91%
Total returns: stand. Deviation	8.71%	22.68%	17.35%	23.44%
Total returns: AR(1)	-0.27	-0.56	-0.50	-0.52

Table 7 Local Sensitivity Parameters

This table summarizes the number of properties and MSA level local sensitivity parameters θ_l for Apartments, Offices, Industrial and Retail properties in the 35 MSAs that have estimated sensitivity parameters. For each property type, the MSA sensitivity parameters are jointly estimated with the index based on the following specification,

$$\log\left(R_i\right)=\theta_l\sum_{t=buy_i+1}^{sell_i}\log\left(M_t\right)+\sum_{t=buy_i+1}^{sell_i}\upsilon_{i,t}\ ,$$

where R_i is the gross total return from the acquisition quarter buy_i to the disposition quarter $sell_i$ for property i; $\log\left(M_t\right)$ is the log index total return from quarter $t-1$ to quarter t; θ_l captures the sensitivity of total returns of properties in MSA l with respect to the index total returns. For each property type, the index returns and MSA sensitivity parameters are estimated using the EM algorithm proposed by Peng (2008). For MSAs with fewer than 10 properties for each of the four property types, the sensitivity parameter is set to be 1 and not reported.

MSA	Properties	Sensitivity Parameters			
		Apartments	Offices	Industrial	Retail
DC - Washington	199	1.27	1.58	1.25	1.06
IL - Chicago	193	0.98	0.89	0.93	0.93
GA - Atlanta	192	0.83	0.78	0.94	1.15
CA - Los Angeles	183	1.13	1.39	1.34	1.71
TX - Dallas	183	0.78	0.69	0.81	0.71
AZ - Phoenix	107	1.21	1.19	1.13	0.77
TX - Houston	106	0.80	1.36	0.92	1.15
MA - Boston	103	0.66	1.03	0.86	
CA - Santa Ana	99	1.24	1.12	1.18	
CA - San Diego	97	1.16	1.41	1.50	1.09
WA - Seattle	85	1.05	1.62	1	0.83
CO - Denver	82	0.97	0.55	0.91	0.64
MN - Minneapolis	66	0.96	0.62	0.77	0.96
MD - Baltimore	64	1.24		1.14	1.10
CA - Oakland	61		1.06	0.95	1.05
CA - Riverside	61	1.22		1.34	
NJ - Camden	58	1.11	0.84	1.02	
FL - Fort Lauderdale	52	1.23		0.43	
FL - Orlando	50	0.98			0.82
CA - San Francisco	48		1.01	1.51	
CA - San Jose	48		0.95	1.05	
FL - West Palm Beach	47	1.11	0.78		1.06
TX - Austin	47	0.81	1.14		
FL - Tampa	44	1.08		1.31	
OR - Portland	40	0.93	1.59	1	
IN - Indianapolis	37	1.05		1.14	
FL - Miami	35	1.06		1.11	
MO - St. Louis	34		1.15	0.79	
NC - Charlotte	34	0.51		1.29	
NY - New York	33		2.31		
TX - Fort Worth	32	0.75		0.84	
NC - Raleigh	30	0.63			
TN - Memphis	29			0.42	
OH - Cincinnati	26			0.69	
OH - Columbus	25			1.22	
TN - Nashville	26	1.04			
MO - Kansas City	24		0.88		

Table 8 Real Estate Returns, Economic Conditions, and Real Estate Factors

This table reports results of the following linear regression for apartments, offices, industrial and retail properties respectively,

$$\log\left(R_i\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(T_t\right)=\left(sell_i-buy_i\right)\alpha+\rho\left(\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)\right)$$
$$+\lambda\left(\hat{\theta}_l\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)\right)+\sum_{k=1}^{K}\left(\sum_{t=buy_i+1}^{sell_i}\beta_k F_{k,t}\right)+u_i,$$

where R_i is the gross total return from the acquisition quarter buy_i to the disposition quarter $sell_i$ for property i; T_t is the quarterly rate of the 3-year Treasury constant maturity rate in quarter t; $F_{k,t}$ is the kth factor in quarter t; $\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)$ is the index factor - the estimated index return in the same period (Index); $\hat{\theta}_l\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)-\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)$ is the local factor - estimated MSA deviation in the same period (MSA). The factors include the three Fama-French factors (Rm-Rf, SMB, and HML), the term spread (TSPR), and the credit spread (CSPR). Heteroskedasticity consistent standard deviations are in parentheses. *** denotes significance at the 1% level, ** at the 5% level, and * at 10% level.

	Apartments		Offices		Industrial		Retail	
α	***-0.020	***-0.022	-0.005	-0.005	-0.003	-0.005	-0.016	-0.016
	(0.007)	(0.006)	(0.007)	(0.006)	(0.004)	(0.004)	(0.009)	(0.008)
Index factor	***0.989	***1.068	***1.136	***1.085	***1.090	***1.069	***0.910	***0.949
	(0.109)	(0.101)	(0.080)	(0.076)	(0.077)	(0.074)	(0.085)	(0.074)
Local factor		***1.049		***1.038		***1.017		***0.952
		(0.078)		(0.087)		(0.118)		(0.194)
Rm-Rf	0.038	0.014	-0.051	-0.074	-0.059	-0.045	0.048	0.055
	(0.046)	(0.042)	(0.065)	(0.059)	(0.049)	(0.046)	(0.086)	(0.079)
SMB	-0.001	0.006	0.131	0.125	***0.246	***0.254	0.183	*0.202
	(0.076)	(0.072)	(0.109)	(0.101)	(0.074)	(0.070)	(0.131)	(0.122)
HML	0.043	0.044	0.024	0.033	-0.042	-0.038	0.124	0.104
	(0.049)	(0.045)	(0.061)	(0.058)	(0.056)	(0.053)	(0.084)	(0.080)
TSPR	0.127	0.005	-0.154	-0.171	0.049	-0.032	-0.102	-0.195
	(0.179)	(0.170)	(0.256)	(0.239)	(0.193)	(0.186)	(0.175)	(0.174)
CSPR	0.760	1.087	-0.685	-0.769	***-1.316	***-1.085	0.689	0.695
	(0.558)	(0.533)	(0.580)	(0.239)	(0.324)	(0.308)	(0.869)	(0.777)
Sample	705	705	781	781	1,012	1,012	347	347
Adj. R2	0.650	0.711	0.529	0.606	0.524	0.585	0.753	0.783

Table 9 Determinants of the Risk in Real Estate Investments

This table reports the following regression regarding the determinants of property level risk,

$$\hat{u}_i^2 = \tau + \left(sell_i - buy_i\right)\alpha + \sum_{k=1}^{K}\left(\sum_{t=buy_i+1}^{sell_i}\beta_k F_{k,t}\right) + \rho\left(\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)\right) + \upsilon_i,$$

where, for property i, $\hat{u}_i$ is the residual from the regressions in Table 8 (the second specification for each property type); buy_i is the acquisition quarter and $sell_i$ is the disposition quarter; $F_{k,t}$ is the kth factor in quarter t, which include the three Fama-French factors (Rm-Rf, SMB, and HML), the term spread (TSPR), and the credit spread (CSPR); $\sum_{t=buy_i+1}^{sell_i}\log\left(\hat{M}_t\right)$ is the index factor – the estimated index return from buy_i to $sell_i$ (Index). Heteroskedasticity consistent standard deviations are in parentheses. *** denotes significance at the 1% level, ** at the 5% level, and * at 10% level.

	I	II	III	IV	V
τ	***0.021	***0.022	***0.020	***0.030	***0.027
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
α	***0.002	***0.002	-0.001	***0.003	0.001
	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)
Rm-Rf		0.005			*0.034
		(0.014)			(0.018)
SMB		-0.035			0.031
		(0.027)			(0.034)
HML		**0.034			0.024
		(0.017)			(0.016)
TSPR			0.028		-0.080
			(0.032)		(0.055)
CSPR			**0.294		0.264
			(0.141)		(0.164)
Index				***-0.074	***-0.078
				(0.015)	(0.019)
Sample size	2,845	2,845	2,845	2,845	2,845
Adj. R2	0.033	0.036	0.038	0.047	0.050

Figure 1. Histogram of IRRs

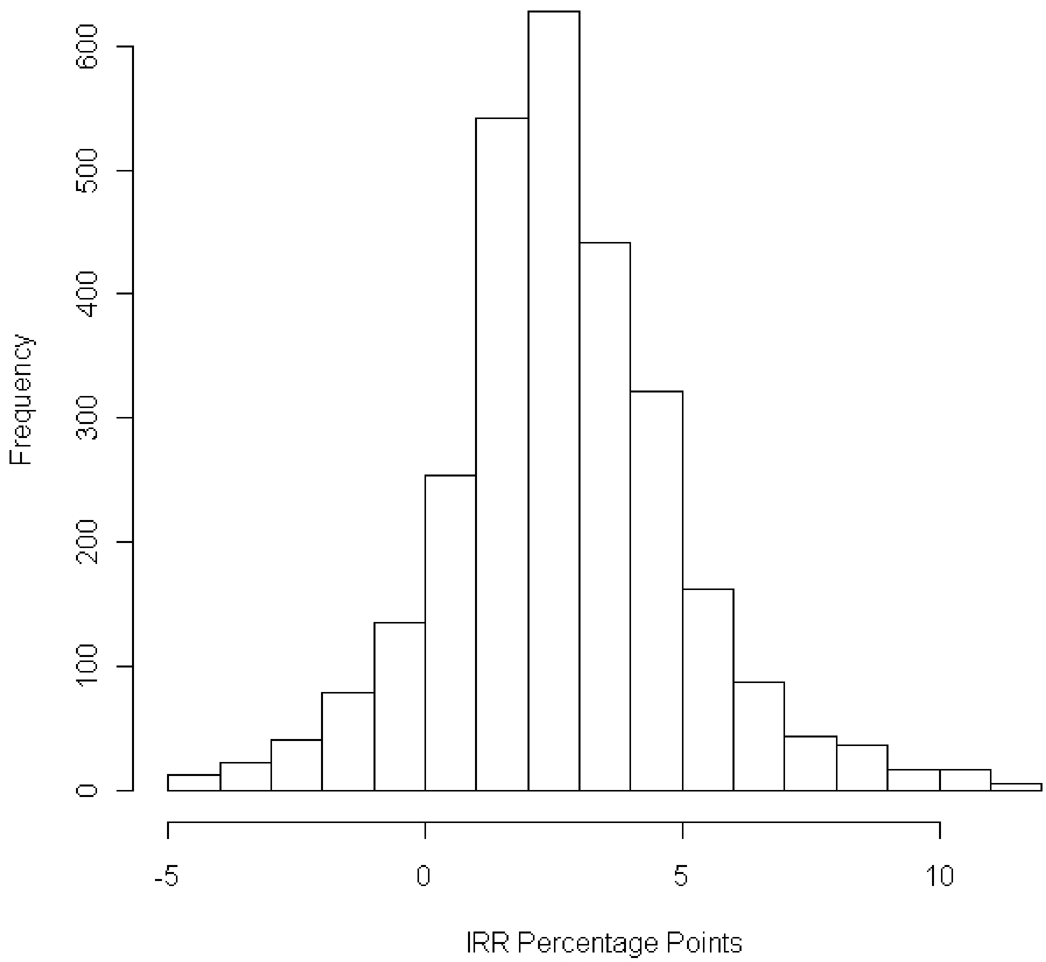
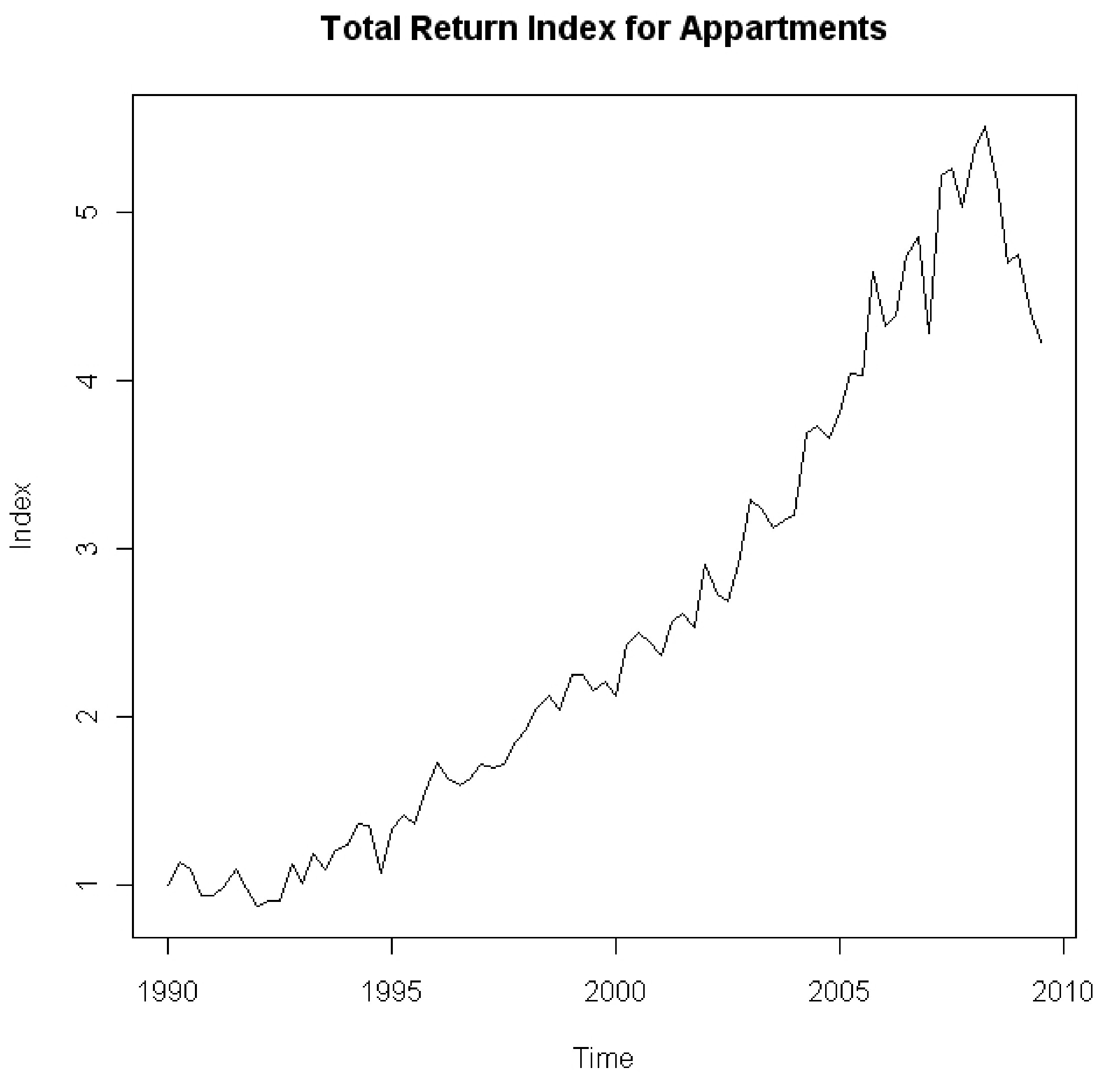


Figure 2.



Total Return Index for Appartments
Index
1
2
3
4
5
1990
1995
2000
2005
2010
Time

Figure 3.

Total Return Index for Offices
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Index
1985
1990
1995
2000
2005
2010
Time

Figure 4.

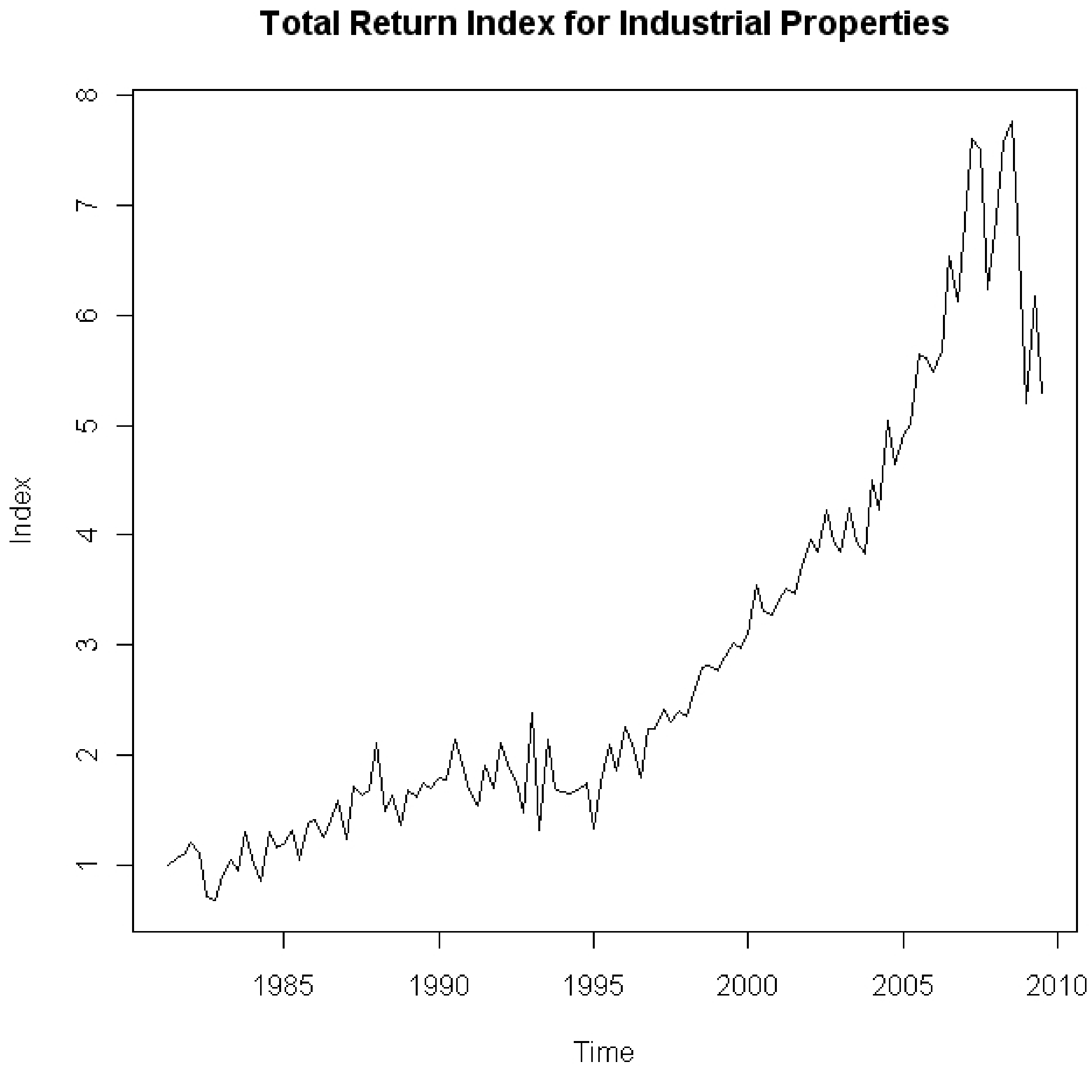

Total Return Index for Industrial Properties
Index
1
2
3
4
5
6
7
8
1985
1990
1995
2000
2005
2010
Time

Figure 5.

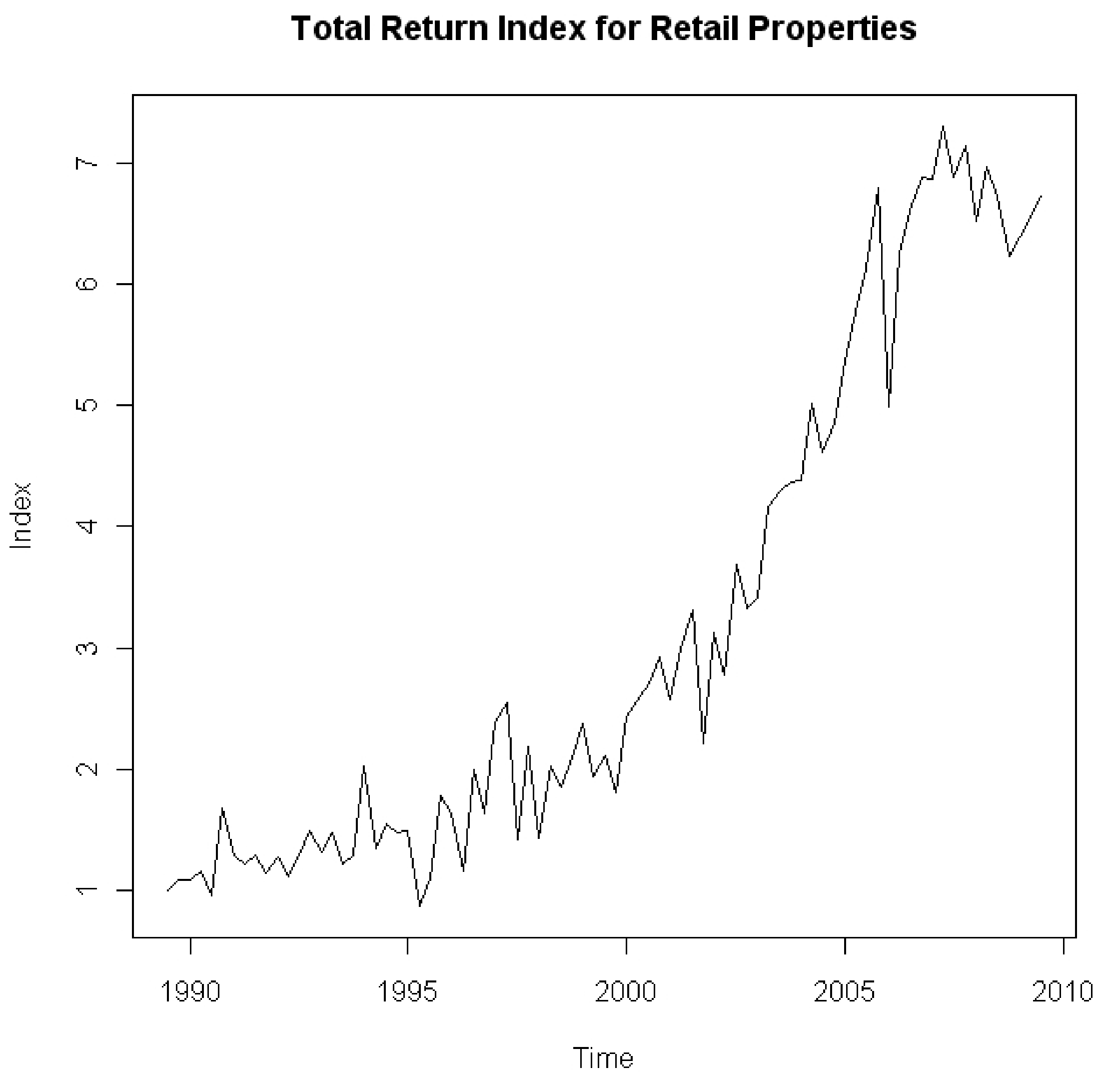

Total Return Index for Retail Properties
Index
1
2
3
4
5
6
7
1990
1995
2000
2005
2010
Time

Figure 6. Histogram of Residuals