Finding Cap Rates: A Property Level Analysis of Commercial Real Estate Pricing

Liang Peng*

Department of Finance
University of Colorado at Boulder
Leeds School of Business
419 UCB, Boulder, CO 80309-0419
Phone: (303) 492-8215
Fax: (303) 492-5962
E-mail: liang.peng@colorado.edu

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Abstract

Capitalization rate plays an important role in real estate investment decision-making. Using about 10,000 transaction cap rates of institutional grade apartment, industrial, office, and retail properties in the U.S. market from 1980s to 2012, this paper empirically analyzes two questions. First, how are cap rates of individual properties affected by macroeconomic conditions, local market conditions, and property attributes? Second, what drives the *uncertainty* in property cap rates? Regression results suggest that location fixed effects and macroeconomic conditions play a dominating role in explaining property cap rates. The four most impactful macroeconomic variables are: (1) the credit availability, which is measured with the development of the CMBS market; (2) risk-adjusted investment performance of real estate in the past, which is measured with the ex post Jensen's Alpha; (3) the lagged house price index appreciation; and (4) the nonresidential construction spending. Time varying local market conditions and property attributes have very weak explanatory power, and their effects vary across property types. This paper also finds a strong positive relationship between pricing risk and values for all property types: the higher is the cap rate, the higher is the uncertainty in cap rate.

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I. Introduction

Commercial real estate constitutes a large portion of the total wealth in the United States, and the pricing of commercial properties is an important but relatively less studied area. Capitalization rate (cap rate), the ratio of income to the property value, is among the most widely used variables to quantify property values. It plays an important role in real estate investment decisions. For example, the going-out cap rate is a key input in the classic Net Present Value (NPV) analysis for investment. Modest changes in the cap rate may produce substantially different NPVs, and eventually lead to different investment decisions. Therefore, a good understanding of the determinants of cap rates, particularly at the property level, has direct implications for commercial real estate investments.

This paper aims to shed light on two fundamental questions regarding cap rates *at the property level*. First, how are cap rates of *individual properties* affected by three types of variables – macroeconomic conditions, local market conditions, and property attributes (age, size, etc.)? Second, what drives the *uncertainty* in property cap rates? Note that the first question pertains to the first moment (expectation), or point estimates, of cap rates, and the second question concerns the second moment (variation) of cap rates.

Research on the pricing of *individual* properties is particularly important for real estate investors due to the following two reasons. First, real estate is well known for being heterogeneous in pricing and in risk and returns for a variety of reasons, including differences in property types (see, e.g. Peng (2012)), local market conditions (se, e.g. and Plazzi, Torous and Valkanov (2008) for evidence in commercial real estate and Peng and Thibodeau (2012) for evidence in housing), and property attributes (see, e.g. Pivo and Fisher (2011)). Second, it is not easy to mitigate the impact of property heterogeneity, or "idiosyncrasy", on the performance of real estate portfolios, since individual properties often represent a non-trivial share of investors' portfolios. Therefore, better understanding of the pricing at the property level is crucial for investors.

Using about 10,000 transaction cap rates of institutional grade apartment, industrial, office, and retail properties from 1980s through 2012 in the database of National Council of Real Estate Investment Fiduciaries (NCREIF), we find that macroeconomic conditions and time-invariant of local market attributes, measured with fixed effects of Core Business Statistic Areas (CBSA) where properties are located, play a dominating role in explaining property level cap rates, though their effects can vary across property types. The four most impactful macroeconomic variables are: (1) the credit availability, which is measured with the development of the CMBS market; (2) risk-adjusted investment performance of real estate in the past, which is measured with the ex post Jensen's Alpha estimated from past NCREIF Price Index (NPI) total returns; (3) the lagged house price index appreciation; and (4) nonresidential construction spending. The first three significantly affect cap rates for all property types, and the last, the nonresidential construction spending, has significant impact except for offices. We find very weak explanatory power of time varying local market conditions and property attributes. While having low incremental explanatory power, rent growth affects cap rates for apartment and industrial properties, but the direction of the impact differs and is related to occupancy. In terms of the impact of property attributes, older apartment and retail properties tend to have higher cap rates, and larger properties, except apartment, tend to have lower cap rates.

We find original evidence regarding the uncertainty in property cap rates, which is measured with the squared value of the component of property cap rate that is not explained by CBSA fixed effects and macroeconomic conditions. First, there is a significant positive relationship between property cap rates and uncertainty in cap rates for all property types. This seems to suggest that properties with lower risk have higher values. Second, property age and size have no impact on cap rates, with the only exception being that larger office properties have lower cap rate risk.

This paper makes two important and novel contributions to the literature. While cap rates have long been a subject of research and many valuable insights have been gained, most existing works study time series properties of market *average* cap rates, not cap rate of *individual properties*. Further, virtually all studies in the literature analyze the first moment of cap rates, not their second moment. Therefore, this project expands the literature of the research on cap rates in two dimensions: from analyses of market averages to analyses of individual properties, and from the first moment to higher moments of cap rates.

This project not only contributes to the academic literature, but also has direct implications on the practice of commercial real estate investors. This project aims to identify variables that affect property cap rates and their uncertainty in a statistically and economically significant way, which can then be used to guide investors in estimating cap rates corresponding to different scenarios of future economic conditions at both the national and regional levels and for properties with specific sets of attributes. It is an important advantage to be able to utilize relationships identified from a large sample of property cap rates over a long sample period that covers both booming and busting markets to estimate cap rates, particularly when the market is thin and lacks sales of comparable properties and when forecasted future economic conditions drastically differ from the current market conditions.

The rest of this paper is organized as follows. Section II reviews the literature. Section III describes the research design. Section IV discusses the data. Section V presents the empirical results. Conclusions are presented in the last section.

II. Literature review

The literature on the determinants of commercial real estate cap rates consists of aggregate level research (i.e. average cap rates for certain property types at the national or regional level) and property level research. The two lines of research have different focuses. Research at the aggregate level sheds light on the pricing of commercial real estate as an "asset class", focuses on the relationship between macroeconomic variables and the *average* pricing of properties. This line of research has implications for the role of well-diversified real estate in a mixed asset portfolio. Research at the property level, on the other hand, focuses on the pricing of individual properties. Such research investigates not only macroeconomic variables but also other factors, such as local market conditions, property attributes, and transaction structures, which might affect the pricing of individual properties. This line of research has direct implications for the valuation of individual properties, which is a critical component of real estate investment decision-making.

Some earlier studies along the line of aggregate level research focus on the relationship between cap rates and expected investment returns of real estate. Froland (1987) studies the movements of quarterly cap rates for apartments, retail, office, and industrial properties for the first quarter of 1970 through the second quarter of 1986. He finds positive correlations of the cap rate with mortgage rates, ten-year bond rates, and the earnings/price ratio, and negative correlations with inflationary expectations, which is measured by the Treasury bond-bill spread, and indicators of economic cycles, including GNP changes. Evans (1990) investigates the correlation between the quarterly average cap rate of commercial and multifamily properties from American Council of Life Insurance (ACLI) data and the S&P 500 earning/price ratio for the 1975 to 1988 period. He finds that the cap rate is correlated with lagged S&P 500 earning/price ratio. Ambrose and Nourse (1993) also use the ACLI quarterly cap rates, and regress the cap rates of six property types against the term spread, which measures expected inflation, and the S&P 500 earning price ratio. They find a negative relationship of the cap rate with the S&P 500 earning price ratio and a positive relationship with the term spread. Jud and Winkler (1995) analyze a panel dataset of quarterly cap rates from 1985:4 to 1992:4 for 22 MSAs, and find that the cap rate is related to contemporaneous credit spread and the stock market risk premium in the previous quarter.

More recent studies investigate not only the relationship between cap rates and expected investment returns of commercial real estate, but also the relationship between cap rate and rent growth. Sivitanidou and Sivitanides (1999) study average office cap rates from 1985 to 1995 in 17 office markets. They find that cap rates are related to not only lagged stock market returns and the term spread, but also local conditions, such as rent growth and vacancy rate. Sivitanides, Southard, Torto and Wheaton (2001) analyze appraisal-based capitalization rates from the NCRIEF database in the U.S. market, and Hendershott and MacGregor (2005) analyze U.K. office and retail cap rates. Both studies find evidence of significance impact of local rent growth expectation on the cap rate, but the signs are different across the two markets. Plazzi, Torous and Valkanov (2010) study quarterly value-weighted cap rates in 53 U.S. metropolitan areas from 1994:Q2 to 2003:Q1. They find that the cap rate captures time variation in expected returns but not expected rent growth rates of apartments as well as retail and industrial properties. By contrast, offices cap rates are not able to capture the time variation in expected returns but somewhat track expected office rent growth rates. An and Deng (2009) build a dynamic cap rate model that links cap rate to multi-period expected returns and rent growths. Using quarterly series of NCREIF current-value cap rates, which are from properties that were revalued but not limited to those sold, and Real Estate Research Corporation (RERC) monthly average transaction cap rates, they estimate the model with Kalman filter, and find that the cap rate is significantly related to both future expected return and expected rent growth. Noting that rent growth is affected by not only demand but also supply of space, Chichernea, Miller, Fisher, White and Sklarz (2008) expand the literature by relating average cap rates of multifamily properties in 34 MSAs to not only demand side variables, such as expected employment growth and GMP growth, but also space supply constraints. Their cross-sectional analyses provide robust evidence that supply constraints significantly affect cap rates. They also find cap rates are lower in market with greater liquidity.

Recent evidence shows that the cap rate is driven by not only expected investment returns and expected rent growth, but also investor sentiment and credit availability. Clayton, Ling and Naranjo (2009) use a vector-error correction model and the RERC quarterly series of surveyed cap rates from 1996:Q1 to 2007:Q2 to investigate the role of investor sentiment in commercial real estate valuation. They derive a measurement of investor sentiment towards commercial real estate and find this measurement being related to property cap rates. Arsenault, Clayton and Peng (2012) find very strong and robust evidence for the effects of mortgage supply/credit availability and property prices on each other in the U.S. commercial real estate market from 1991:Q1 to 2011:Q2. Using the growth of the CMBS market as a proxy for exogenous changes in mortgage supply and use quarterly NCREIF national average current-value cap rates, they find that the larger is the percentage of mortgages backed by CMBS, the lower is the average property cap rate. Chervachidze and Wheaton (2011) use a quarterly panel dataset of capitalization rates over 30 MSAs to determine if national macro factors or local market conditions were the primary drivers in the recent swing of the CRE prices. They find that the expansion of national debt, which they use to measure the credit availability, is one of the key variables that explain the majority of the recent swing.

Despite the importance of the pricing of commercial real estate at the property level, the literature along this line is almost nonexistent. Wiley (2013) uses about 500 transactions from CoStar and finds evidence that corporate investors, companies buying commercial real estate for use in their operations, tend to buy at a premium and sell for a discount. However, his focus is on price per square foot, not the cap rate. Elliehausen and Nichols (2012) analyze over 8,000 samples of cap rates of offices between 2001 and 2009 in the Real Capital Analytics (RCA) database. The regress cap rates against macro fundamentals, property-level characteristics, type of buyers, type of sellers, and local market conditions, and find that macroeconomic conditions and local market fundamentals explain the greatest part of variation in capitalization rates.

While both analyzing property level cap rates, our paper has a few distinctions from Elliehausen and Nichols (2012). First, we analyze four property types – apartment, industrial, office, and retail, while they focuses on offices. Second, our sample period is longer – from 80s to the second quarter of 2012 – and covers multiple cycles, while their sample period is from 2001 to 2009. Third, we include past risk-adjusted investment performance and credit availability as potential factors, which turn out to be among the most influential factors, while they do not. Fourth, they observe the financing arrangements and types of buyers, and thus are able to analyze their effects on cap rates. We, on the other hand, work on a dataset with relatively homogeneous buyers (the NCREIF dataset, by design, covers institutional buyers only). Finally, we analyze the determinant of not only cap rate level, but also the uncertainty in cap rate, while they focus on the level of cap rates.

III. Research design

The determinants of cap rates

The first research question pertains to the impact of macroeconomic conditions, local market conditions, and property attributes on transaction cap rates. In developing the empirical model for this analysis, we first recognize the roles played by expected/required investment returns (opportunity cost/discount rate) and the expected income growth. Following the literature (see, e.g. Hendershott and MacGregor (2005), Clayton, Ling and Naranjo (2009), Arsenault, Clayton and Peng (2012), and others), we assume that the equilibrium property price equals the present value of future net operating income (NOI). Assume that the NOI is a growing perpetuity, the property value at time period t is a function of three variables: expected NOI in next period NOI_{t+1}, the discount rate for future NOI r_t, and the expected NOI growth rate g_t.

$$P_t = \frac{NOI_{t+1}}{r_t - g_t} \tag{1}$$

Equation (1), which is essentially the Gordon (1962) model, suggests that the cap rate at time period t, Cap_t, which is the ratio of the expected NOI to the property price, equals the discount rate minus the expected NOI growth rate.

$$Cap_t = \frac{NOI_{t+1}}{P_t} = r_t - g_t \tag{2}$$

To accommodate the impact of investor sentiment (Clayton, Ling and Naranjo (2009)) and mortgage supply/credit availability (Arsenault, Clayton and Peng (2012) and Chervachidze and Wheaton (2011)) on the pricing of real, we augment equation (2) with variables that help measure investor sentiment, s_t, and mortgage supply, m_t.

$$Cap_t = r_t - g_t + f\left(s_t\right) + g\left(m_t\right) \tag{3}$$

Equation (3) is the foundation of our empirical analyses.

In specifying the model in (3), we first include the following variables that previous studies have often considered likely affecting the required return/discount rate of real estate investors: (1) the risk free interest rate (T-yield), which is measured with the 10-

Year Treasury Constant Maturity Rate; (2) the expected inflation (Term Spread), which is measured with the difference between the 10-Year and 1-Year Treasury Constant Maturity Rates; (3) the credit risk (Credit Spread), which is the difference between Moody's Seasoned AAA Corporate Bond Yield and BAA Corporate Bond Yield; and (4) stock market factors, which are the Fama-French factors (FF: Rm-Rf, FF: SMB, and FF: HML).

Furthermore, Arsenault, Clayton and Peng (2012) find that cap rates are significantly related to recent performance of commercial real estate investments. Particularly, ex post Jensen's Alpha estimated from past commercial investment returns and stock market risk premium significantly reduces cap rates, likely because they reduce the required risk premium. Following this study, we include in the model in (3) two performance measurements of commercial real estate investments: ex post Jensen's Alpha and CAPM Beta (NPI: Alpha and NPI: Beta) that are jointly estimated from a regression of the NCREIF Price Index (total return) in the past 8 quarters against an intercept and the stock market risk premium, which is measured with the Rm-Rf of Fama-French factor in those quarters. The intercept term is interpreted as the ex post Jensen's Alpha and the coefficient of the stock market risk premium is the CAPM Beta.

We investigate three property attributes that are likely affecting cap rates: (1) the age of the property when traded (Age); the size of the property (Size) when traded, which is measured with log of thousand gross square feet; and (3) the "class" of the property (Rent Premium), which is measured with the median of the historical ratio of the rent (dollar per square foot per quarter) of the property and the median rent in the CBSA for the same property type in the sample period. The variable Age likely measures a variety of factors. For example, newer properties may better utilize new technologies and provide more amenities. However, Age may also be related to the desirability of the location. For instance, older office buildings tend to be located in more desirable location, as land in such location tends to be developed earlier. Therefore, the impact of Age on cap rates can be complicated and may vary across property types. The variable Size might be related to possible "clientele effects" – larger buildings more likely host larger corporations, which might react differently to economic shocks than smaller companies. This might translate into different perceptions of income stability, and thus affect investors' required returns. The variable Rent Premium is also possibly related to "clientele effects" – tenants who afford higher rents might be more resilient to economic shocks and thus rents might be more stable. However, it is important to note that it is ultimately an empirical question whether these property attributes affect cap rates.

We consider the following macroeconomic variables that likely influence real estate investors' expectation of future income growth: (1) the growth of GDP in the previous quarter (GDP Growth); and (2) the NBER-based recession indicator (Recession). Regional/local market conditions that might affect investors' expectation of income growth include (1) the median occupancy rate of the CBSA where the property is located (Occupancy); (2) the growth in the occupancy rate in the present quarter (Occupancy Growth); (3) the rent growth in the present quarter (Rent Growth); and (4) the interaction between Rent Growth and Occupancy. We use the interaction term to accommodate possible nonlinear effect of rent growth on the expected future income growth. When the occupancy rate is higher, the current rent growth is more likely persistent in the future due to the limited supply of space.

Clayton, Ling and Naranjo (2009) provide evidence that investor sentiment likely affect real estate pricing. We use the following variables to measure the sentiment, or optimism, of investors: (1) total private construction spending on nonresidential properties normalized with GDP (Construction: Nonresidential); (2) the one-quarter lag of the NPI total return for the property type (NPI Return); (3) total private construction spending on residential properties normalized with GDP (Construction: Residential); and (4) the one-quarter lag of the growth rate of the Standard and Poor's National Composite Home Price Index for the United States (HPI Growth). We include construction spending as it likely reflects the market expectation of future demand for space, which may or may not be accurate/rational. Note that even though we categorize construction spending as a variable measuring sentiment, it might be also related to the require return of investors and their expected future returns. For example, overbuilding might reduce expected future income growth. We include the lagged NPI total return, as investors might extrapolate past returns into the future (see Goetzmann, Peng and Yen (2009) for evidence for such behavior of home buyers). We include residential construction spending and lagged growth in house price index, as commercial real estate investor sentiment might be related to residential real estate investor sentiment - Levitin and Wachter (2012) point out connections between residential and commercial real estate bubbles. We choose not to include the mortgage flow, which is used in Clayton, Ling and Naranjo (2009) to measure sentiment, for two reasons. First, it is likely not exogenous, as mortgage amount is related to values. Second, unreported robustness checks indicate that mortgage flow has no significant impact on transaction cap rates.

Arsenault, Clayton and Peng (2012) and Chervachidze and Wheaton (2011) find evidence that mortgage supply/credit availability affects commercial property pricing. Following Arsenault, Clayton and Peng (2012), we use the development of the CMBS market to measure the mortgage supply. We measure the CMBS market development for industrial, office, and retail properties with the ratio of the Federal Flow of Funds Account variable "Issuers of asset-backed securities; commercial mortgages; asset" to "All sectors; commercial mortgages; asset". For apartment, the measurement equals "Issuers of asset-backed securities; multifamily residential mortgages; asset" divided with "All sectors; multifamily residential mortgages; asset". The two measurements are essentially the percentage of mortgages backed by CMBS. We believe they are superior measurements of exogenous changes in mortgage supply/credit availability than the total mortgage debt, as the total mortgage debt is endogenous and jointly determined with property prices.

Finally, time invariant location specific market conditions may affect property cap rates through their impact on the required returns, expected rent growth, sentiment, and local credit availability. For example, apartment properties in markets with inelastic land supply may have lower cap rates, as expected rent growth might be higher with limited land supply. Such variables are different to measure individually, but it is relatively easy to control their aggregate effect. We use CBSA dummy variables to capture unobserved local time invariant variables that affect cap rates.

The determinants of cap rate uncertainty

The second research question of this paper is what drives the *uncertainty* in property cap rates. While this is a very important question for real estate investors, the literature is essentially silent on this issue in both theoretical and empirical fronts. This paper aims to provide initial evidence on this issue.

This paper measures cap rate uncertainty with the magnitude of the component of the cap rate that is not explained by our model in (3), or more specifically, the squared regression residuals. We build an empirical model based on the notion that, in a perfect world in which all factors that affect cap rates have been identified and can be observed for each individual property, cap rates would be completely explained without residuals, and thus there is no cap rate uncertainty. Therefore, the uncertainty we measure is primarily driven by heterogeneity in required returns or expected future income growth, or other factors, due to the omission of explanatory variables at the national, regional, property, and transaction level.

Due to the lack of theoretical guidance in searching for the "omitted" variables, we focus on the possible relationship between the uncertainty in cap rates and the level of cap rates. We conjecture that investors are risk averse and thus have lower values for properties with higher risk. Therefore, there might be a positive relationship between the level of cap rates and the uncertainty in cap rates. To mitigate mechanical relationship between property cap rates and regression residuals, our analysis measures property values with the fitted cap rates from estimation of model (3). In this analysis, we include CBSA dummies to control for risk related to unobserved time invariant local market conditions. We further control possible effects of property attributes, such as age and size, on cap rate uncertainty.

IV. Data

Cap rates

This paper analyzes actual transaction cap rates of acquisitions and dispositions of the four main types of institutional grade properties (apartment, industrial, office, and retail) in the NCREIF database from the third quarter of 1977 to the second quarter of 2012. We calculate the transaction cap rates for acquisitions and dispositions using similar approaches with the key difference being the NOI used. For acquisitions, we use the stabilized annual NOI *after* the acquisition to calculate cap rates. However, NOI is not observed after dispositions; therefore, we use the stabilized annual NOI *before* the disposition for the cap rate calculation, under the assumption that the NOI after disposition is proportional in expectation to the NOI before. Our analyses address the difference in the cap rate definitions for acquisitions and dispositions by including a dummy variable for dispositions in regressions.

The acquisition cap rates are calculated following the procedure below. First, we identify acquisitions between 1977:3 and 2012:2 with observed purchase prices ("InitialCost" of NCREIF database) and transaction time. Second, we identify the quarterly NOI for the eight quarters (or until the end of the sample period if the acquisition took place within eight quarters before 2012:2) after each acquisition. For us to proceed with the calculation of the cap rate, NOI needs to be observed for all the eight quarters; there need to be at least six quarters that have stabilized NOI, which is defined as NOI when the occupancy rate (LeasePercent) is above 85%; and the median of the stabilized quarterly NOI needs to be between 0.5% and 5% of the purchase prices (annual NOI being between 2% and 20% of the purchase prices). Third, we identify the maximum and the minimum of the quarterly stabilized NOI, and remove them if they are 50% greater and less than the median quarterly stabilized NOI. Finally, we calculate the cap rate as four times the average of the remaining quarterly stabilized NOI, which is intended to capture the stabilized annual NOI, divided with the purchase prices.

The disposition cap rates are calculated in the same manner, but we use sale prices ("GrossSalePrice" in NCREIF database) instead of purchase prices, and use the stabilized NOI before instead of after the disposition. To mitigate possible data errors, we calculate the cap rate for a disposition only if both "GrossSalePrice" and "NetSalePrice" are observed and their difference is less than 15% of the "NetSalePrice".

After calculating the acquisition and disposition cap rates, we remove outliers for each type by excluding the lowest 1% and highest 1% cap rates for each type. Our final sample consists of 2,891 cap rates (1,608 acquisitions and 1,283 dispositions) for apartment, 3,113 cap rates (1,961 acquisitions and 1,152 dispositions) for industrial, 2,190 cap rates (1,308 acquisitions 882 dispositions) for office, and 1,832 cap rates (1,059 acquisitions and 773 dispositions) for retail properties. Table 1 summarizes the mean, standard deviation, minimum, median, and maximum cap rates for each of the four property types. Figures 1 to 4 plot the cap rates against the time periods when the transactions take place for the four property types respectively.

Macro variables

Macro level variables used in our analyses are from four sources: the Federal Reserve Economic Data (FRED), the Federal Flow of Funds Account, the NCREIF website, and the data library on the website of Kenneth French.

We obtain the following quarterly variables from the FRED: the 10-Year Treasury Constant Maturity Rate, the term spread (the difference between the 10-Year and 1-Year Treasury Constant Maturity Rates), the credit spread (the difference between Moody's Seasoned AAA Corporate Bond Yield and BAA Corporate Bond Yield), the growth rate of GDP (GDP being seasonally adjusted annual rate), the Standard and Poor's National Composite Home Price Index for the United States, NBER-based Recession Indicators, the total private construction spending on residential properties (seasonally adjusted annual rate), and the total private construction spending on nonresidential properties (seasonally adjusted annual rate). We normalize the construction spending with the GDP. Figure 5 plots the time series of the Treasury yield, the term spread, and the credit spread from 1977:3 to 2012:2. Figures 6 and 7 plot the Home Price Index and the normalized construction spending for residential and nonresidential properties for this period.

We calculate the following quarterly time series using information from the Federal Flow of Funds Account: the development of the CMBS market for industrial, office, and retail properties ("Issuers of asset-backed securities; commercial mortgages; asset" divided with "All sectors; commercial mortgages; asset" for commercial mortgages), the development of the CMBS market for apartment ("Issuers of asset-backed securities; multifamily residential mortgages; asset" divided with "All sectors; multifamily residential mortgages; asset" for multifamily mortgages). The time series of the two measurements of the CMBS market development are plotted in Figure 8.

We download the quarterly Fama-French factors – Rm-Rf, SMB, and HML – from Kenneth French's website, and the quarterly total returns of NCREIF Price Indices for the four property types from the website of NCREIF. Figure 9 plots the NPI total returns. We construct ex post Jensen's Alpha and CAPM Beta for each property type in each quarter using the NPI total returns and the stock market risk premium (Rm-Rf of the Fama-French factors) in the past eight quarters. Specifically, for quarter t, we regress the NPI total returns in quarters $t-8$ to $t-1$ against an intercept term and the stock market risk premium in those quarters. The intercept term is the ex post Jensen's Alpha and the coefficient of the stock market risk premium is the Beta. Figure 10 and Figure 11 respectively plot the estimated ex post Jensen's Alpha and the estimated CAPM Beta for the four property types.

Regional and property-level variables

We calculate the medians of the occupancy rate, rent, and their respective growth rate for each Core Business Statistic Area (CBSA) for each property type using the NCREIF database, following the procedure below. We first identify property/quarter observations with the occupancy rate being observed and greater than 70%. For these property/quarter observations, we estimate the rent as the gross operating income in that quarter divided by leased space, which equals the gross square feet times the occupancy rate. For each CBSA/quarter, if there are at least 6 observations of property occupancy rates or rent in that CBSA/quarter, we remove possible outliers (2 standard deviations away from the mean) and then calculate the median occupancy rate or the median rent. To obtain the median growth rate in the occupancy rate and the median growth rate in rents, we used rents estimated above and the occupancy rate for each property to calculate the growth rates for each property/quarter. We then eliminate growth rates that are greater 20% or lower than -20%. If there are at least 6 observations left for that CBSA/quarter, we remove possible outliers (2 standard deviations away from the mean) and then calculate the median of the growth rate in occupancy rate and the median in rent growth.

The NCREIF database often contains "YearBuilt" for properties, which is used to calculate the property age (age being in quarters with the quarter of being built assumed to be the 2nd quarter of the year when the property was built) when a transaction takes place. The NCREIF database also often contains information on property size. We use "GrossSquareFeet" to measure property size, if this information is available and the value is greater than 5,000 square feet (values lower than 5,000 could be data errors or indicate properties that are too small). If the value of "GrossSquareFeet" changes over time for a property, we use the available value of the quarter that is closest to the transaction date. We also calculate the "rent premium" for each property whenever possible. We first calculate the property-to-market rent ratio for each quarter that allows such a calculation. Given the time series of such a ratio, which may contain internal missing information, we calculate the median of the observed ratios. Summary statistics of Age, Size, and Rent Premium are reported in Table 1.

V. Empirical results

Determinants of cap rates

It is important to note that there is the well-known "clustering" problem in all of our regressions in this paper. There could be unobserved common shocks for all properties in the same quarter, or for all properties in the same CBSA when CBSA dummies are not included. To mitigate the impact of the unobserved common shocks on the calculation of the standard deviation (see, e.g. Petersen (2009) for the importance of the correction to the OLS standard deviation), in all reported results, we calculate one-way (sale quarter) clustering-robust standard deviations when CBSA dummies are included, and two-way (quarter and CBSA) clustering-robust standard deviations when CBSA dummies are not included.[2]

In estimating the model in equation (3), we first include only macroeconomic variables and run OLS for each property type separately. The reason is that, while all cap rate observations have corresponding macroeconomic variables, CBSA level or property level variables are sometimes missing. Using macroeconomic variables only will allow us to investigate the impact of such variables using the full sample.

Table 2 reports the results for each property type. Four variables – the ex post Jensen's Alpha, the development of the CMBS market, the lagged house price index appreciation, and the construction spending on nonresidential properties – show statistically significant explanatory power for cap rates for all four property types. Specifically, the higher is the ex post Jensen's Alpha, the lower is the cap rate. This is consistent with Arsenault, Clayton and Peng (2012). Further, the more developed is the CMBS, which indicates greater credit availability, the lower is the cap rate. This corroborates Arsenault, Clayton and Peng (2012) and Chervachidze and Wheaton (2011). It is interesting to see that higher lagged house price index appreciation and more nonresidential construction spending seem bad news for property pricing. The negative impact of construction on property values may indicate that investors reduce their expectation for future income growth when they expect an increase in space supply. It is worth noting that other macroeconomic variables, including the term spread, the credit spread, the stock market factors, and investor sentiment as measured with the lagged NPI total return, do not show consistent effects on cap rates across property types.

Table 3 reports results from similar regressions, with the only difference being that the regressions include CBSA dummy variables to capture CBSA specific average cap rates (CBSA fixed effects). Two results are worth noting. First, it is clear that including CBSA fixed effects dramatically increase the explanatory power of our model. The adjusted R2 increases from 0.48 to 0.56 for apartment, from 0.28 to 0.36 for industrial,

[2] The R functions we use are from Mahmood Arai's website.

from 0.30 to 0.35 for office, and from 0.36 to 0.44 for retail properties. Second, the four most influential macroeconomic variables remain significant, except that the nonresidential construction spending now has insignificant impact on office cap rates.

Tables 4 report results of three regressions of cap rates for apartment, all of which include CBSA dummies. The first regression includes macroeconomic variables that are significant at 5% level in Table 3 for apartment. The second includes both these macroeconomic variables and local time varying market variables. The third includes these macroeconomic variables, local market conditions, and property attributes. For each property type, we use the same sample for the three regressions. The sample consists of cap rate observations that have explanatory variables in all three regressions observed. A disadvantage of using these "complete" observations is the smaller sample size. An advantage is that when we run the three types of regressions using the same sample, any gain in goodness of fit is not likely due to a larger sample size, but due to the inclusion of new independent variables.

Table 4 provides a few important findings. First, local time varying market conditions and property attributes add very little to the goodness of fit. The adjusted R-square is 0.38, 0.39, and 0.40 for the three regressions respectively, which means including local market conditions and property attributes does not explain much of the cap rates. Second, in addition to ex post Jensen's Alpha, the development of the CMBS market, and the nonresidential construction spending, the NBER-based recession dummy has a significant negative effect on the cap rate. This seems to indicate that apartments have relatively higher values in recessions. This is consistent with that households more likely rent than own in recessions; therefore, the demand for apartment is higher and thus apartments might have higher expected future income growth. Third, the lagged house price index appreciation is no longer significant, likely due to the smaller sample size. Fourth, rent growth rate has a nonlinear relationship with the cap rate. Rent growth rate has greater negative impact on the cap rate, which means positive effect on the property value, when the occupancy rate is higher. Finally, older apartment buildings tend to have higher cap rates, possibly due to outdated amenities.

Table 5 reports the same three regressions, but for industrial properties. The macroeconomic variables included are those significant for industrial in Table 3. All three regressions are also based on the same sample of "complete" observations. Table 5 indicates that the four key macroeconomic variables – ex post Jensen's Alpha, the CMBS development, the lagged house price index appreciation, and the construction spending of nonresidential properties – remain significant. Moreover, the construction spending of residential properties is also significant, and has a negative coefficient. This seems to suggest that a better prospect of the housing market, which is indicated by the greater construction spending, is good news for values of industrial properties. This seems consistent with Miller, Peng and Sklarz (2011), which provide evidence that house transaction volume, which predicts higher house prices in the future, stimulates economic production. Table 5 also indicates the same nonlinear impact of rent growth on cap rates. However, now rent growth seems less effective when the occupancy is high. This seems puzzling, and contrasts with the results for apartment. Finally, property attributes contribute modestly to the explanatory power of the model. The adjusted R-square increased from 0.38 to 0.43 when property age, size, and rent premium are included as explanatory variables. Table 5 shows that larger and lower class (lower rent premium) industrial properties tend to have lower cap rates.

Table 6 reports results of the same three regressions based on "complete" observations for office properties. First, while the CMBS development remain significant, Jensen's Alpha and lagged house price index appreciation are no longer significant, possibly due to the smaller sample size. Second, the term spread has a significant positive impact on office cap rates. This is consistent with the notion that, when the expected inflation is high, office investors requires higher returns. Third, older and larger office properties tend to have lower cap rates, likely because they have more desirable location, but alternative explanations cannot be ruled out.

Results of the same three regressions based on "complete" observations for retail properties are reported in Table 7. Note that the ex post Jensen's Alpha, the lagged house price index appreciation, and the construction spending of nonresidential properties are no longer significant. It is also interesting to note that rent growth has no detectable impact on the cap rate. Finally, both age and size affect cap rates – younger and larger retail properties tend to have lower cap rates.

We also conduct a few alternative analyses using different measurements of macroeconomic variables and local market conditions, such as the level of occupancy rate instead of/in addition to the change of the occupancy rate. These alternative specifications do not change the main findings reported above, and do not provide better explanation of property cap rates.

Determinants of cap rate uncertainty

The second part of our empirical analysis is the determinants of the uncertainty in cap rates, which we measure with squared residuals from the regressions in Table 3. Note that regressions in Table 3 include CBSA dummies and macroeconomic variables, but not local market conditions or property attributes. We use residuals from Table 3 instead of residuals from some regressions in Tables 4 to 7 for two reasons. First, as Tables 4 to 7 indicate, local market conditions and property attributes tend to add modest or little explanatory power for cap rates. Omitting them does not have meaningful impact on the residuals. Second, using residuals from Table 2 allows us to maintain a larger sample size, and gives our analysis more power.

Table 8 reports results of OLS regressions of squared residuals on CBSA dummy variables, the corresponding fitted values of cap rates, which are from the same regressions that generate the residuals, as well as the age and the size of properties. Rent premium is not significant in robustness checks so we do not include it as an explanatory variable. Since age and size information is sometimes missing, the sample size in Table 8 is smaller than the sample size in Table 3.

Table 8 provides three interesting results. First, the higher is the fitted cap rate, the lower is the uncertainty in cap rate. This relationship is statistically significant for all properties, and is consistent with the conjecture that investors have higher values for properties with lower pricing risk. Second, age and size has virtually no relationship with uncertainty in cap rates, except that larger offices have less cap rate uncertainty. Third, the adjusted R2 is virtually 0 in all regressions. This calls for more theoretical and empirical work on the determinants of cap rate uncertainty.

VI. Conclusions

Better understanding of the determinants of cap rates of commercial properties is crucial for economists. Asset pricing is a central question in economics and finance, and the pricing of large, heterogeneous, and not dividable assets such as commercial properties is challenging and important given the large size of commercial properties in the economy. The knowledge on the determinants of property cap rates is also essential for investors to make provident acquisition and disposition decisions. For example, a slight change in a going-out cap rate could dramatically affect the valuation of a target of acquisition, and lead to very different decisions.

This paper makes two important contributions to our understanding of commercial real estate pricing. First, it provides novel evidence regarding how cap rates of individual properties are affected by macroeconomic conditions, local market conditions, and property attributes. It finds that CBSA fixed effects and macroeconomic conditions, particularly the ex post Jensen's Alpha, the credit availability, the lagged house price appreciation, and the nonresidential construction spending, play a dominating role in explaining cap rates. It finds weak explanatory power of local market conditions and property attributes, the effects of which vary across property types.

Second, this paper provides an original finding regarding the determinants of uncertainty in cap rates. Specifically, there is positive relationship between uncertainty in cap rates and the level of cap rates, which seem to indicate that investors pay more for properties with less pricing risk.

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Table 1 Summary of cap rates, age, size, and rent premium

This table summarizes the transaction cap rate, age when traded, size (1,000 gross square feet) when traded, and the rent premium, which is the historical median of the ratio between the property rent to the median rent of same property type in the CBSA in which the property is located, of apartment, industrial, office, and retail properties in the NCREIF database for which we are able to calculate transaction cap rates.

	Apartment	Industrial	Office	Retail
		Cap rates		
Observations	2,891	3,113	2,190	1,832
Mean	0.065	0.086	0.082	0.079
Standard dev.	0.018	0.022	0.023	0.020
Minimum	0.031	0.041	0.033	0.042
Median	0.063	0.086	0.080	0.076
Maximum	0.137	0.168	0.159	0.164
		Age (years since built when traded)		
Observations	2,695	2,680	2,008	1,668
Mean	14.56	14.90	17.75	16.52
Standard dev.	14.22	10.84	15.55	14.10
Minimum	0.25	0.25	0.25	0.25
Median	11.25	13.5	15.38	13.50
Maximum	110.25	76.00	137.25	128.50
		Size (1,000 square feet)		
Observations	2,585	3,078	2,173	1,820
Mean	289	305	256	245
Standard dev.	171	558	301	287
Minimum	16	7	5	6
Median	263	188	168	140
Maximum	3,312	22,119	5,535	2,610
		Rent Premium		
Observations	1,799	2,108	1,419	844
Mean	1.053	1.135	1.053	1.063
Standard dev.	0.263	0.396	0.301	0.339
Minimum	0.409	0.418	0.414	0.388
Median	1	1.025	1.023	1
Maximum	2.813	2.855	2.793	2.661

Table 2 Cap rates and macro variables

This table reports results of property level OLS regressions of cap rates against macro-level variables. “Sale” is a dummy variable if the cap rate is for a disposition. “T-yield” is the 10-Year Treasury Constant Maturity Rate. “Term Spread” is the difference between the 10-Year and 1-Year Treasury Constant Maturity Rates. “Credit Spread” is the difference between Moody's Seasoned AAA Corporate Bond Yield and BAA Corporate Bond Yield. “FF: Rm-Rf”, “FF: SMB”, and “FF: HML” are the Fama-French factors. “NPI: Alpha” and “NPI: Beta” are ex post Jensen’s Alpha and CAPM Beta estimated using the NPI property type total returns and the “FF: Rm-Rf” in the past 8 quarters. “GDP Growth” is one-quarter lag of the growth rate of GDP. “Recession” is the NBER-based recession indicator. “CMBS” is the development of the CMBS market, which equals “Issuers of asset-backed securities; commercial mortgages; asset” divided with “All sectors; commercial mortgages; asset” for industrial, office, and retail properties, and equals “Issuers of asset-backed securities; multifamily residential mortgages; asset” divided with “All sectors; multifamily residential mortgages; asset” for apartment. “Construction: Residential” is the total private construction spending on residential properties normalized with GDP. “HPI growth” is the one-quarter lag of the growth rate of the Standard and Poor's National Composite Home Price Index for the United States. “Construction: Nonresidential” is the total private construction spending on nonresidential properties normalized with GDP. “NPI return” is the one-quarter lag total return of the property type NPI. Two-way (CBSA and sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

Table 2 (continued)

	Apartment	Industrial	Office	Retail
Intercept	0.058***	0.081***	0.080***	0.048***
	(0.009)	(0.011)	(0.012)	(0.015)
Sale	-0.002	-0.002	-0.003*	0.001
	(0.001)	(0.001)	(0.002)	(0.001)
T-yield	0.278**	0.116	0.292*	0.321*
	(0.141)	(0.169)	(0.161)	(0.178)
Term Spread	0.142	0.101	0.217**	0.326***
	(0.091)	(0.094)	(0.096)	(0.103)
Credit Spread	-0.002	0.359	0.049	0.904**
	(0.243)	(0.330)	(0.292)	(0.466)
FF: Rm-Rf	-0.018**	-0.001	-0.005	-0.012
	(0.008)	(0.008)	(0.008)	(0.015)
FF: SMB	0.020	-0.002	-0.000	0.000
	(0.014)	(0.013)	(0.013)	(0.018)
FF: HML	-0.011	-0.002	-0.015**	-0.000
	(0.008)	(0.006)	(0.007)	(0.011)
NPI: Alpha	-0.027*	-0.071**	-0.046***	-0.060**
	(0.016)	(0.028)	(0.017)	(0.023)
NPI. Beta	0.002	-0.004*	-0.002	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)
GDP Growth	-0.072	-0.052	-0.236	0.168
	(0.120)	(0.120)	(0.177)	(0.180)
Recession	-0.007***	0.002	0.002	-0.003
	(0.002)	(0.002)	(0.003)	(0.004)
CMBS	-0.236***	-0.080***	-0.098***	-0.084***
	(0.027)	(0.021)	(0.026)	(0.025)
Construction:	-0.076*	-0.095**	-0.028	-0.117*
Residential	(0.041)	(0.047)	(0.043)	(0.065)
HPI Growth	0.175***	0.320***	0.186***	0.205***
	(0.054)	(0.050)	(0.060)	(0.055)
Construction:	0.443***	0.320***	0.191**	0.368***
Nonresidential	(0.138)	(0.108)	(0.093)	(0.104)
NPI Return	0.007	-0.028	-0.099**	0.124
	(0.042)	(0.070)	(0.048)	(0.082)
Sample size	2,729	2,863	2,065	1,670
Adjusted R	0.48	0.28	0.30	0.34

Table 3 Cap rates, CBSA fixed effect, and macro variables

This table reports results of property level OLS regressions of cap rates against dummy variables of CBSAs where properties are located and macro-level variables. “Sale” is a dummy variable if the cap rate is for a disposition. “T-yield” is the 10-Year Treasury Constant Maturity Rate. “Term Spread” is the difference between the 10-Year and 1-Year Treasury Constant Maturity Rates. “Credit Spread” is the difference between Moody's Seasoned AAA Corporate Bond Yield and BAA Corporate Bond Yield. “FF: Rm-Rf”, “FF: SMB”, and “FF: HML” are the Fama-French factors. “NPI: Alpha” and “NPI: Beta” are ex post Jensen’s Alpha and CAPM Beta estimated using the NPI property type total returns and the “FF: Rm-Rf” in the past 8 quarters. “GDP Growth” is one-quarter lag of the growth rate of GDP. “Recession” is the NBER-based recession indicator. “CMBS” is the development of the CMBS market, which equals “Issuers of asset-backed securities; commercial mortgages; asset” divided with “All sectors; commercial mortgages; asset” for industrial, office, and retail properties, and equals “Issuers of asset-backed securities; multifamily residential mortgages; asset” divided with “All sectors; multifamily residential mortgages; asset” for apartment. “Construction: Residential” is the total private construction spending on residential properties normalized with GDP. “HPI growth” is the one-quarter lag of the growth rate of the Standard and Poor's National Composite Home Price Index for the United States. “Construction: Nonresidential” is the total private construction spending on nonresidential properties normalized with GDP. “NPI return” is the one-quarter lag total return of the property type NPI. One-way (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

Table 3 (continued)

	Apartment	Industrial	Office	Retail
CBSA dummies	Yes	Yes	Yes	Yes
Sale	-0.003***	-0.002**	-0.005***	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
T-yield	0.251**	0.100	0.343**	0.108
	(0.1220)	(0.152)	(0.157)	(0.186)
Term Spread	0.136	0.150	0.267***	0.225**
	(0.082)	(0.094)	(0.094)	(0.107)
Credit Spread	0.080	0.273	0.330	0.972
	(0.244)	(0.307)	(0.360)	(0.611)
FF: Rm-Rf	-0.014*	0.004	-0.005	-0.002
	(0.007)	(0.009)	(0.008)	(0.012)
FF: SMB	0.016	-0.003	-0.000	0.010
	(0.012)	(0.012)	(0.014)	(0.017)
FF: HML	-0.010	-0.003	-0.017*	-0.012
	(0.007)	(0.006)	(0.009)	(0.014)
NPI: Alpha	-0.035**	-0.073***	-0.051***	-0.078***
	(0.014)	(0.027)	(0.016)	(0.026)
NPI. Beta	0.002	-0.002	-0.002	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
GDP Growth	-0.072	-0.030	-0.158	-0.027
	(0.093)	(0.114)	(0.178)	(0.240)
Recession	-0.006**	0.002	0.003	-0.004
	(0.002)	(0.003)	(0.003)	(0.003)
CMBS	-0.214***	-0.073***	-0.080***	-0.105***
	(0.024)	(0.019)	(0.021)	(0.026)
Construction:	-0.097***	-0.094**	-0.040	-0.063
Residential	(0.032)	(0.039)	(0.037)	(0.069)
HPI Growth	0.192***	0.288***	0.217***	0.166***
	(0.046)	(0.049)	(0.051)	(0.059)
Construction:	0.450***	0.357***	0.209	0.369***
Nonresidential	(0.109)	(0.106)	(0.130)	(0.108)
NPI Return	0.008	-0.027	-0.084*	0.084
	(0.031)	(0.059)	(0.047)	(0.075)
Sample size	2,729	2,863	2,065	1,670
Adjusted R	0.56	0.36	0.35	0.44

Table 4 Apartment: cap rates and macroeconomic, regional, and property variables

This table reports results of property level OLS regressions of apartment cap rates against CBSA dummies, macroeconomic variables, local market conditions, and property attributes. "Rent Growth" is the median property rent growth rate for the CBSA where the property is located in the quarter when the transaction takes place. "Occupancy Growth" is the median property occupancy growth rate. "Rent Growth * Occupancy" is an interaction between the "Rent Growth" and the median occupancy rate (not its growth). "Age" and "Size" are respectively the log of the property age (in quarters) and the log of gross square feet when the transaction takes place. "Rent Premium" is the historical median of the ratio between the property rent to the median rent of the CBSA. One (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

	I	II	III
CBSA dummies	Yes	Yes	Yes
Sale	-0.003 (0.002)	-0.002 (0.002)	-0.003* (0.001)
T-yield	0.207 (0.152)	0.212 (0.143)	0.220 (0.140)
NPI: Alpha	-0.054*** (0.007)	-0.051*** (0.008)	-0.053*** (0.008)
Recession	-0.006*** (0.002)	-0.007*** (0.002)	-0.007*** (0.002)
CMBS	-0.419*** (0.054)	-0.444*** (0.052)	-0.457*** (0.052)
Construction: Residential	-0.039 (0.030)	-0.039 (0.020)	-0.039 (0.030)
HPI Growth	0.054 (0.044)	0.037 (0.043)	0.042 (0.039)
Construction: Nonresidential	0.505*** (0.133)	0.527*** (0.127)	0.548*** (0.124)
Occupancy Growth		0.104*** (0.039)	0.102*** (0.038)
Rent Growth		2.366** (1.191)	2.345** (1.170)
Rent Growth * Occupancy		-2.535** (1.252)	-2.509** (1.231)
Age			0.001*** (0.000)
Size			-0.001 (0.001)
Rent Premium			0.001 (0.002)
Sample size	1,386	1,386	1,386
Adjusted R	0.38	0.39	0.40

Table 5 Industrial: cap rates and macroeconomic, regional, and property variables

This table reports results of property level OLS regressions of industrial cap rates against CBSA dummies, macroeconomic variables, local market conditions, and property attributes. "Rent Growth" is the median property rent growth rate for the CBSA where the property is located in the quarter when the transaction takes place. "Occupancy Growth" is the median property occupancy growth rate. "Rent Growth * Occupancy" is an interaction between the "Rent Growth" and the median occupancy rate (not its growth). "Age" and "Size" are respectively the log of the property age (in quarters) and the log of gross square feet when the transaction takes place. "Rent Premium" is the historical median of the ratio between the property rent to the median rent of the CBSA. One-way (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

	I	II	III
CBSA dummies	Yes	Yes	Yes
Sale	-0.000	-0.000	0.000
	(0.001)	(0.000)	(0.001)
NPI: Alpha	-0.097***	-0.098***	-0.094***
	(0.020)	(0.021)	(0.020)
CMBS	-0.177***	-0.170***	-0.193***
	(0.038)	(0.039)	(0.039)
Construction: Residential	-0.072**	-0.068**	-0.075**
	(0.031)	(0.031)	(0.034)
HPI Growth	0.187***	0.190***	0.186***
	(0.061)	(0.061)	(0.066)
Construction: Nonresidential	0.413***	0.411***	0.413***
	(0.096)	(0.099)	(0.103)
Occupancy Growth		-0.395	-0.562
		(1.319)	(1.304)
Rent Growth		-12.168***	-13.178***
		(3.210)	(3.329)
Rent Growth * Occupancy		12.255***	13.284***
		(3.268)	(3.388)
Age			0.001
			(0.000)
Size			-0.003***
			(0.001)
Rent Premium			0.006***
			(0.001)
Sample size	1,550	1,550	1,550
Adjusted R	0.38	0.39	0.43

Table 6 Office: cap rates and macroeconomic, regional, and property variables

This table reports results of property level OLS regressions of office cap rates against CBSA dummies, macroeconomic variables, local market conditions, and property attributes. "Rent Growth" is the median property rent growth rate for the CBSA where the property is located in the quarter when the transaction takes place. "Occupancy Growth" is the median property occupancy growth rate. "Rent Growth * Occupancy" is an interaction between the "Rent Growth" and the median occupancy rate (not its growth). "Age" and "Size" are respectively the log of the property age (in quarters) and the log of gross square feet when the transaction takes place. "Rent Premium" is the historical median of the ratio between the property rent to the median rent of the CBSA. One-way (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

	I	II	III
CBSA dummies	Yes	Yes	Yes
Sale	-0.000 (0.000)	-0.000 (0.002)	0.000 (0.002)
T-yield	0.113 (0.152)	0.119 (0.150)	0.049 (0.155)
Term Spread	0.299*** (0.084)	0.295*** (0.084)	0.239*** (0.091)
NPI: Alpha	-0.026 (0.026)	-0.026 (0.026)	-0.030 (0.025)
CMBS	-0.309*** (0.045)	-0.315*** (0.044)	-0.316*** (0.046)
HPI Growth	-0.049 (0.037)	-0.057 (0.036)	-0.038 (0.042)
Occupancy Growth		-0.113 (0.092)	-0.153 (0.095)
Rent Growth		1.820 (1.573)	1.281 (1.535)
Rent Growth * Occupancy		-2.007 (1.700)	-1.431* (1.666)
Age			-0.001 (0.001)
Size			-0.005*** (0.001)
Rent Premium			-0.005** (0.002)
Sample size	1,036	1,036	1,036
Adjusted R	0.36	0.36	0.41

Table 7 Retail: cap rates and macroeconomic, regional, and property variables

This table reports results of property level OLS regressions of retail cap rates against CBSA dummies, macroeconomic variables, local market conditions, and property attributes. "Rent Growth" is the median property rent growth rate for the CBSA where the property is located in the quarter when the transaction takes place. "Occupancy Growth" is the median property occupancy growth rate. "Rent Growth * Occupancy" is an interaction between the "Rent Growth" and the median occupancy rate (not its growth). "Age" and "Size" are respectively the log of the property age (in quarters) and the log of gross square feet when the transaction takes place. "Rent Premium" is the historical median of the ratio between the property rent to the median rent of the CBSA. One-way (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

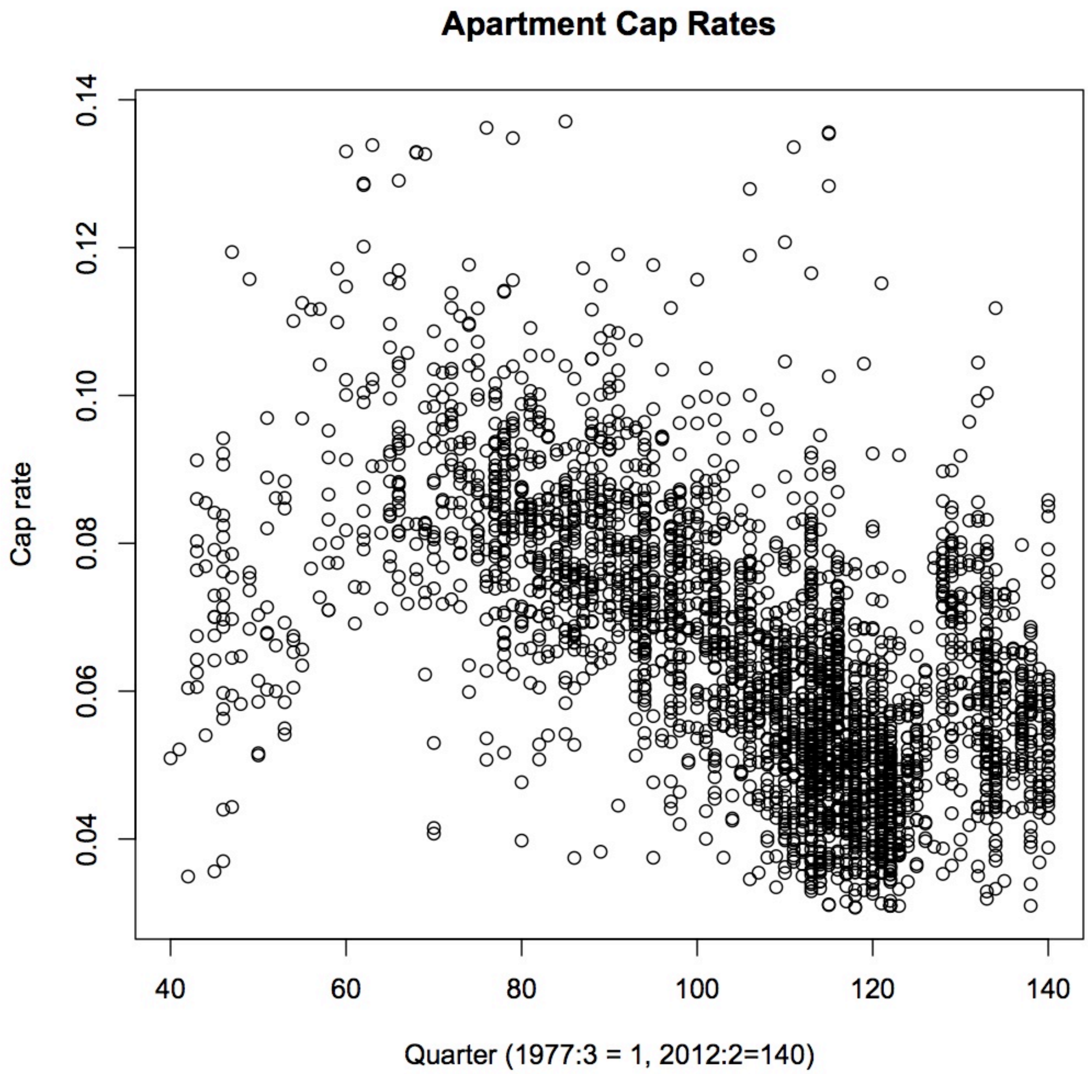
	I	II	III
CBSA dummies	Yes	Yes	Yes
Sale	-0.004*** (0.001)	-0.004*** (0.001)	-0.004*** (0.002)
Term Spread	0.201** (0.100)	0.218** (0.100)	0.225** (0.102)
NPI: Alpha	-0.080*** (0.025)	-0.077*** (0.025)	-0.075*** (0.024)
CMBS	-0.185*** (0.049)	-0.186*** (0.049)	-0.192*** (0.045)
HPI Growth	-0.031 (0.068)	-0.039 (0.068)	-0.042 (0.065)
Construction: Nonresidential	0.136 (0.120)	0.124 (0.118)	0.123 (0.116)
Occupancy Growth		-0.230 (0.371)	-0.309 (0.392)
Rent Growth		-2.745 (2.605)	-3.572 (2.828)
Rent Growth * Occupancy		2.860 (2.679)	3.700 (2.911)
Age			0.001** (0.001)
Size			-0.002* (0.001)
Rent Premium			3.464 (2.939)
Sample size	6,26	6,26	6,26
Adjusted R	0.33	0.33	0.34

Table 8 Cap rate uncertainty

This table reports results of property level OLS regressions of the squared regression residuals from Table 3 against corresponding fitted cap rates from Table 3, CBSA dummies, and property level variables. "Fitted Cap Rate" is the fitted cap rate. "Age" and "Size" are respectively the log of the property age (in quarters) and the log of gross square feet when the transaction takes place. One-way (sale quarter) cluster-robust standard deviations are in parentheses. *** indicates significance at the 1% level. ** and * are for 5% and 10% respectively.

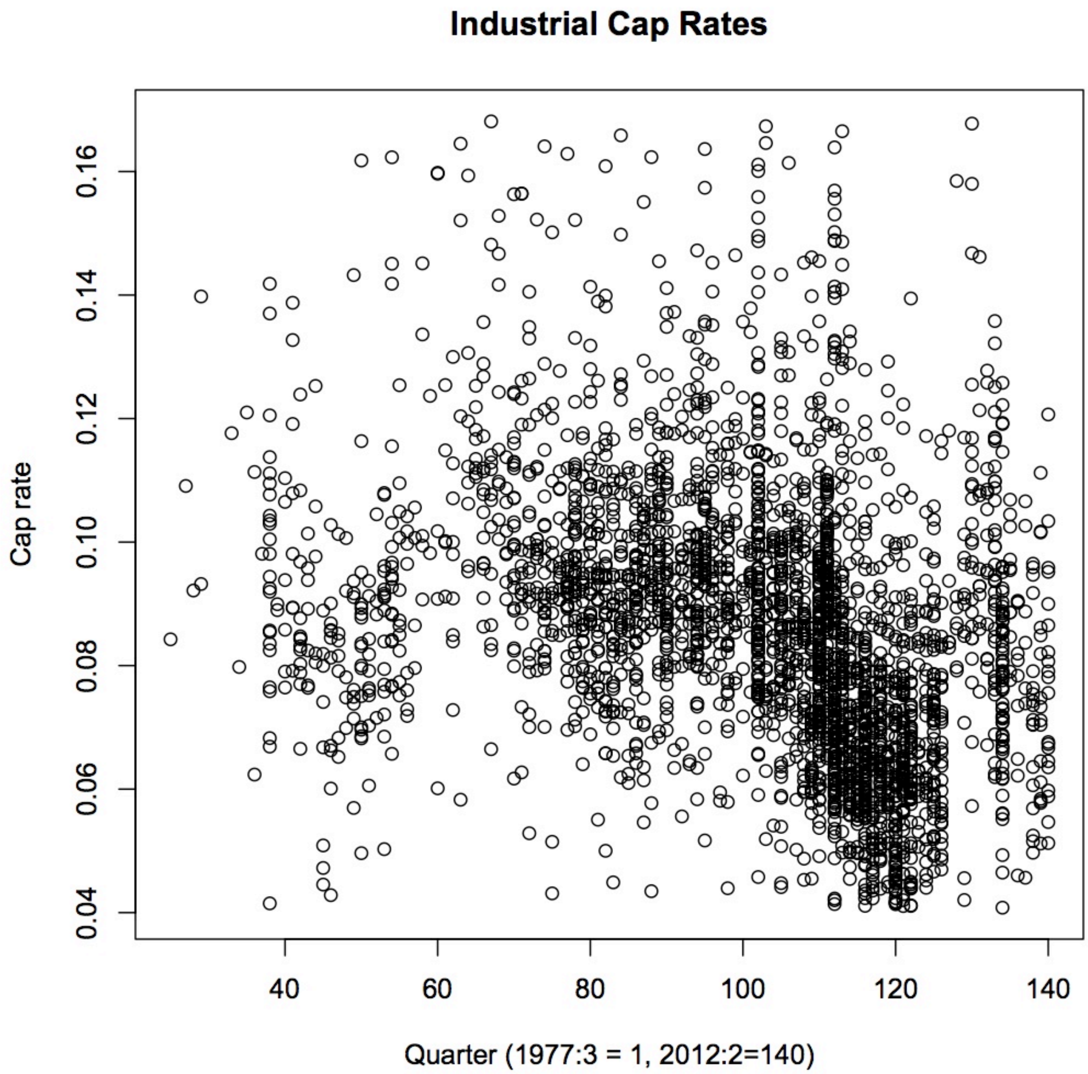
	Apartment	Industrial	Office	Retail
CBSA dummies	Yes	Yes	Yes	Yes
Fitted Cap Rate	2.012**	3.463**	3.187***	2.716**
	(0.852)	(1.364)	(1.130)	(1.305)
Age	-0.009	0.015	0.026	0.023
	(0.008)	(0.012)	(0.018)	(0.017)
Size	-0.032	-0.025	-0.044**	0.003
	(0.020)	(0.021)	(0.022)	(0.031)
Sample size	2,340	2,513	1,909	1,550
Adjusted R2	0.00	0.03	0.01	-0.04

Figure 1



Apartment Cap Rates
Cap rate
0.04
0.06
0.08
0.10
0.12
0.14
40
60
80
100
120
140
Quarter (1977:3 = 1, 2012:2=140)

Figure 2



Industrial Cap Rates
Cap rate
0.04
0.06
0.08
0.10
0.12
0.14
0.16
40
60
80
100
120
140
Quarter (1977:3 = 1, 2012:2=140)

Figure 3

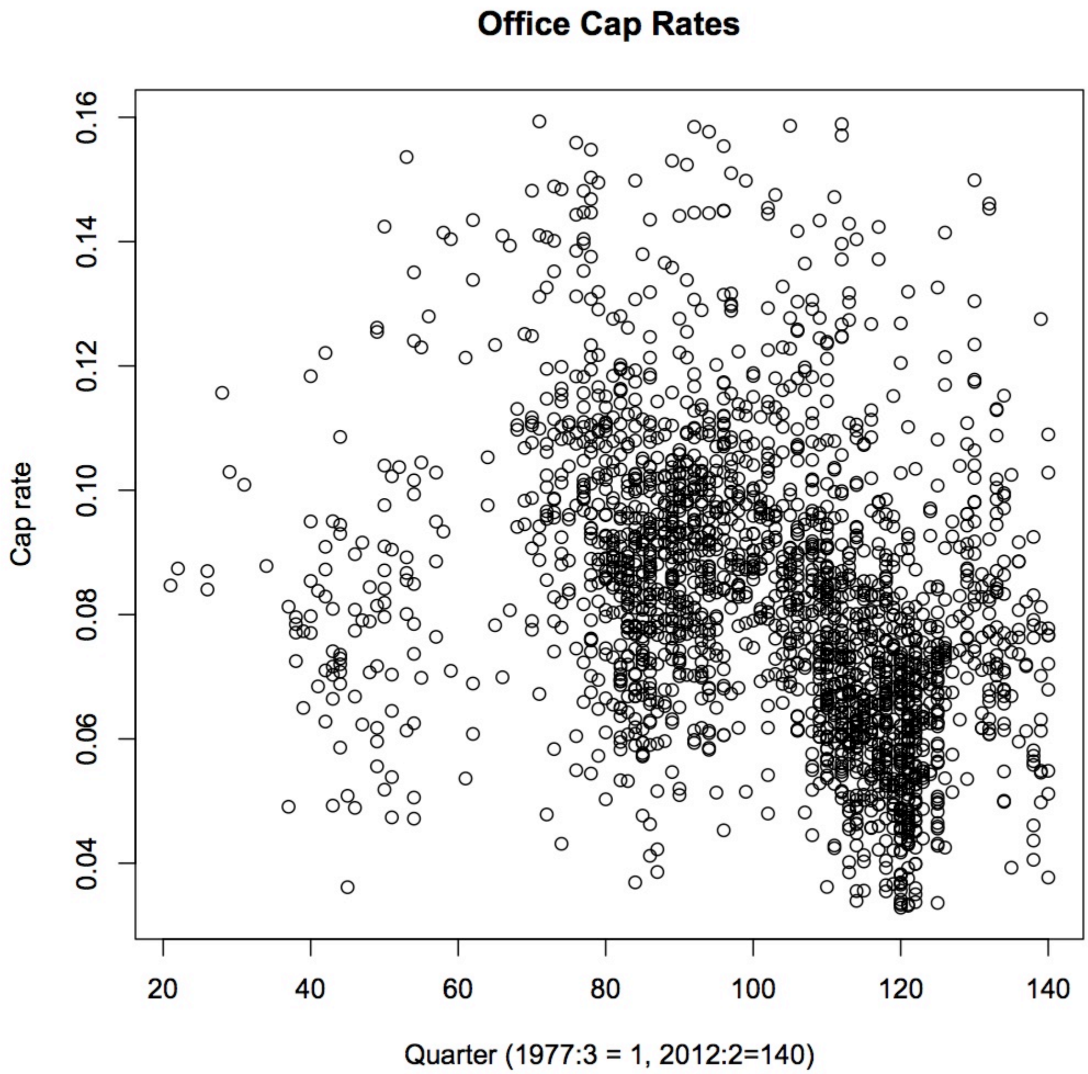
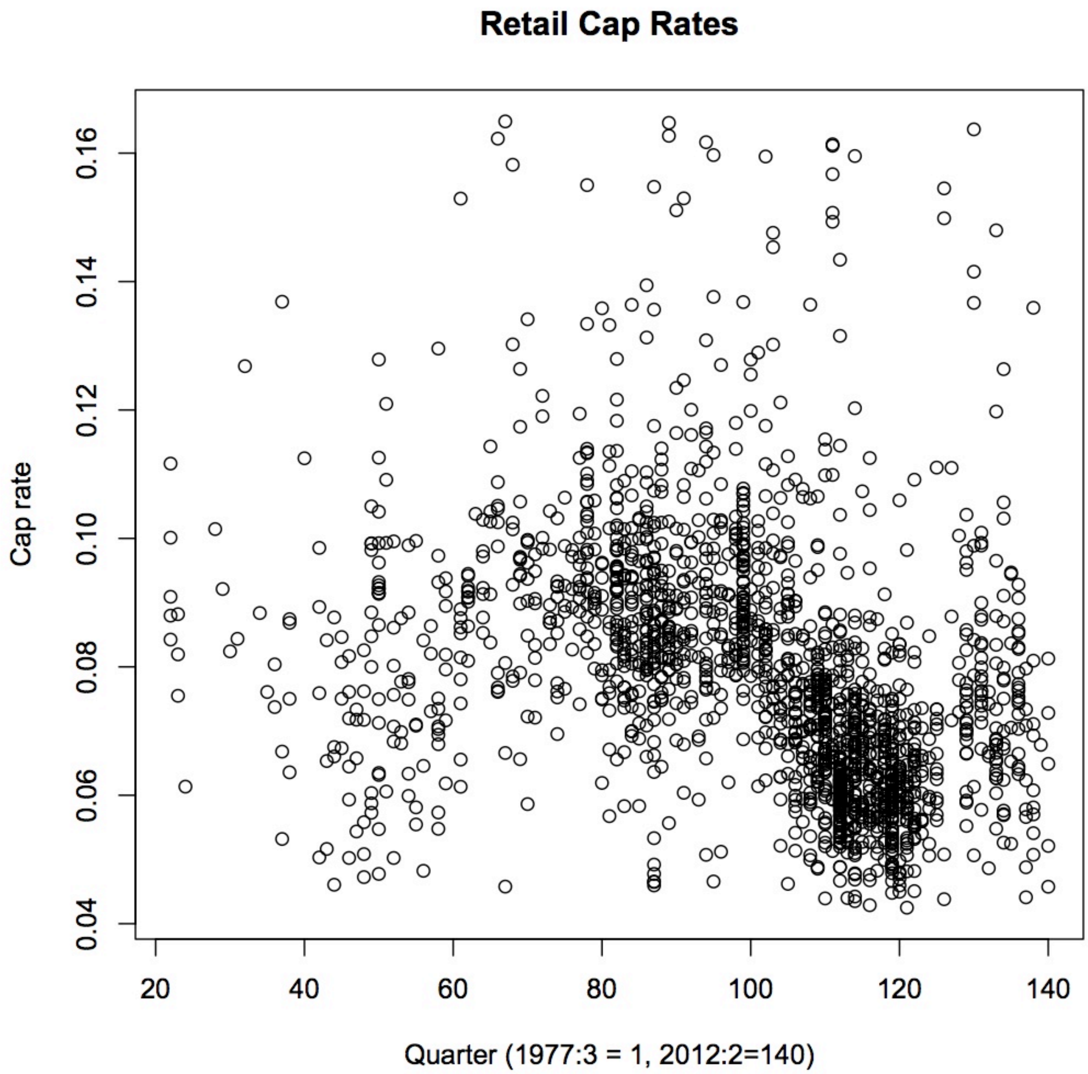

Office Cap Rates
Cap rate
0.04
0.06
0.08
0.10
0.12
0.14
0.16
20
40
60
80
100
120
140
Quarter (1977:3 = 1, 2012:2=140)

Figure 4



Retail Cap Rates
Cap rate
0.04
0.06
0.08
0.10
0.12
0.14
0.16
20
40
60
80
100
120
140
Quarter (1977:3 = 1, 2012:2=140)

Figure 5

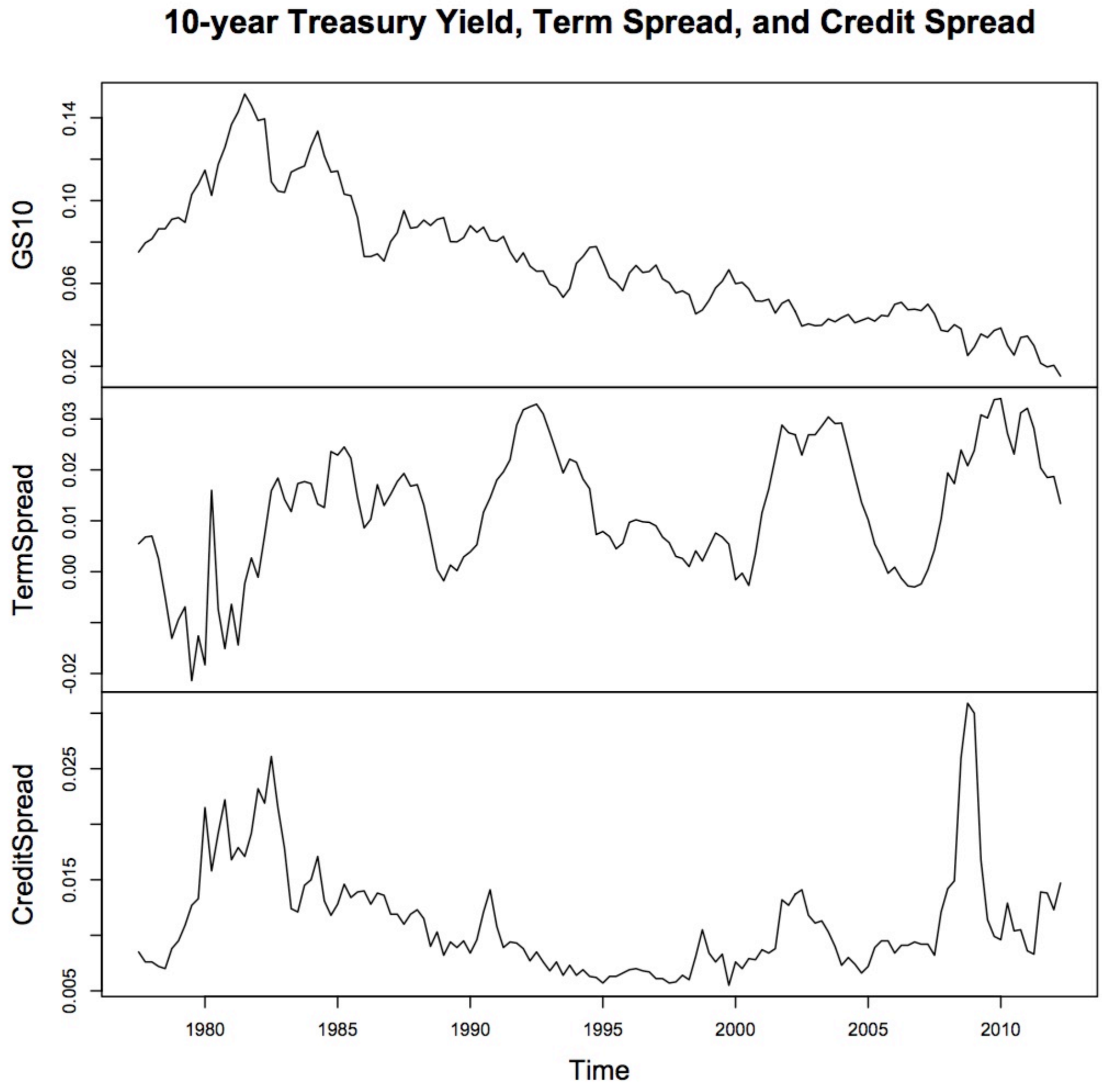

10-year Treasury Yield, Term Spread, and Credit Spread
GS10
0.02
0.06
0.10
0.14
TermSpread
-0.02
0.00
0.01
0.02
0.03
CreditSpread
0.005
0.015
0.025
1980
1985
1990
1995
2000
2005
2010
Time

Figure 6

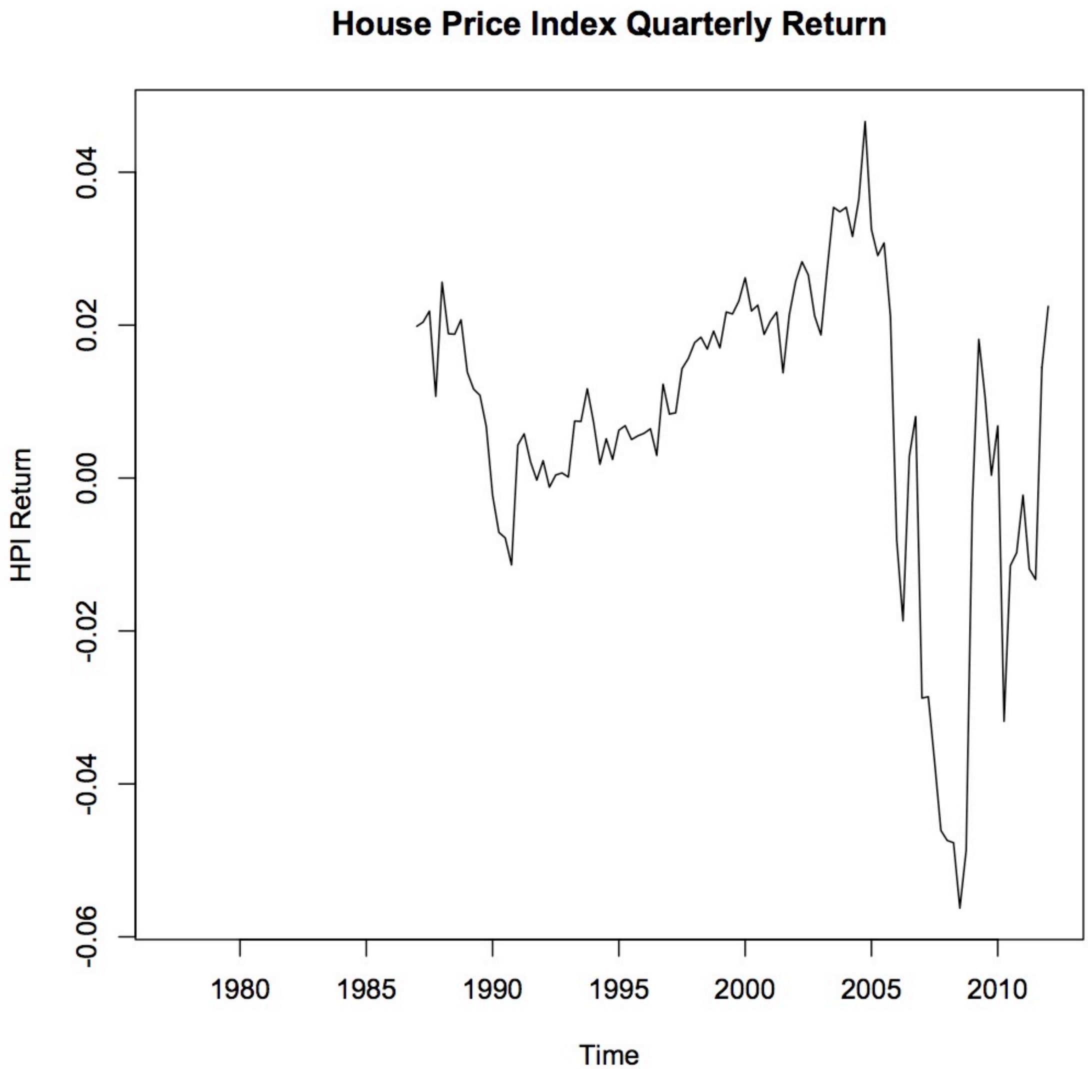

House Price Index Quarterly Return
HPI Return
0.04
0.02
0.00
-0.02
-0.04
-0.06
1980
1985
1990
1995
2000
2005
2010
Time

Figure 7

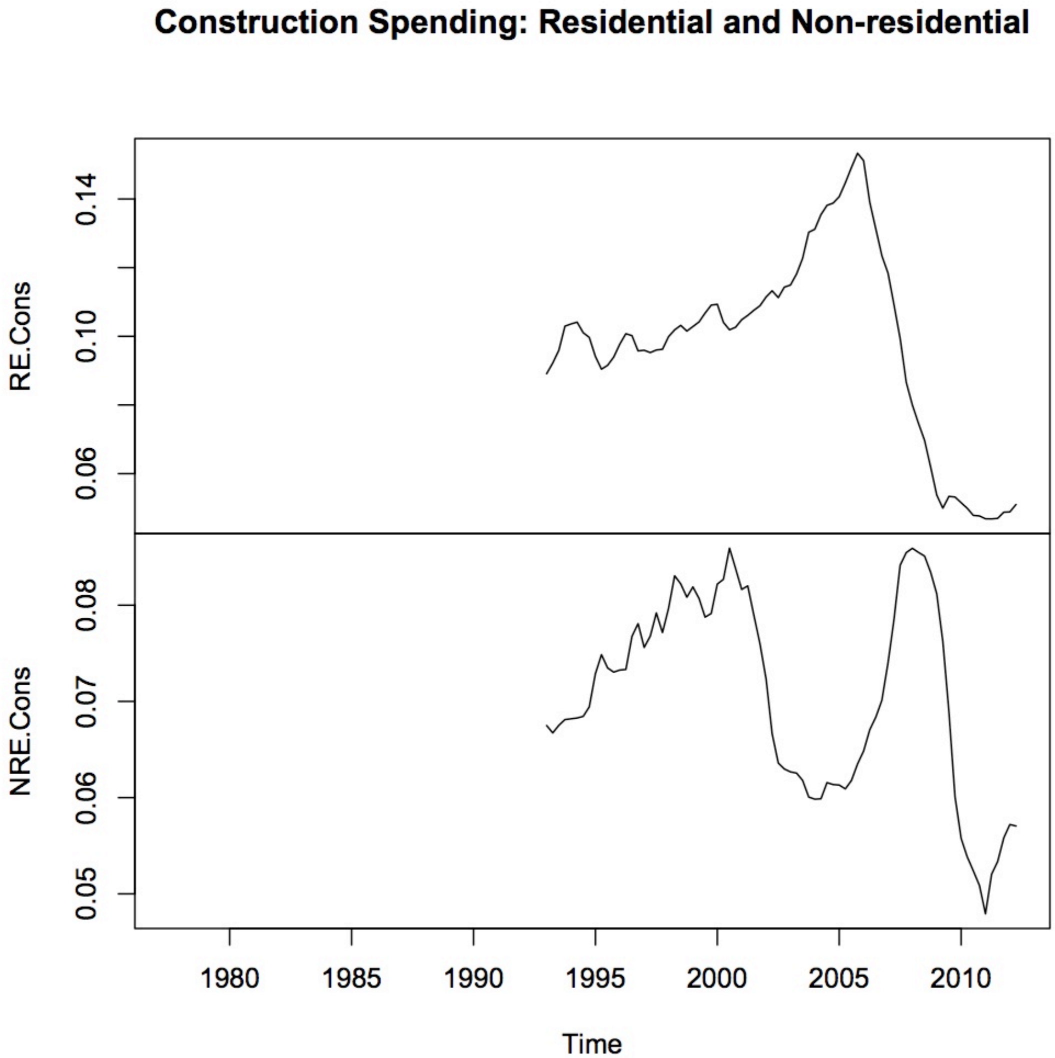

Construction Spending: Residential and Non-residential
RE.Cons
0.06
0.10
0.14
NRE.Cons
0.05
0.06
0.07
0.08
1980
1985
1990
1995
2000
2005
2010
Time

Figure 8

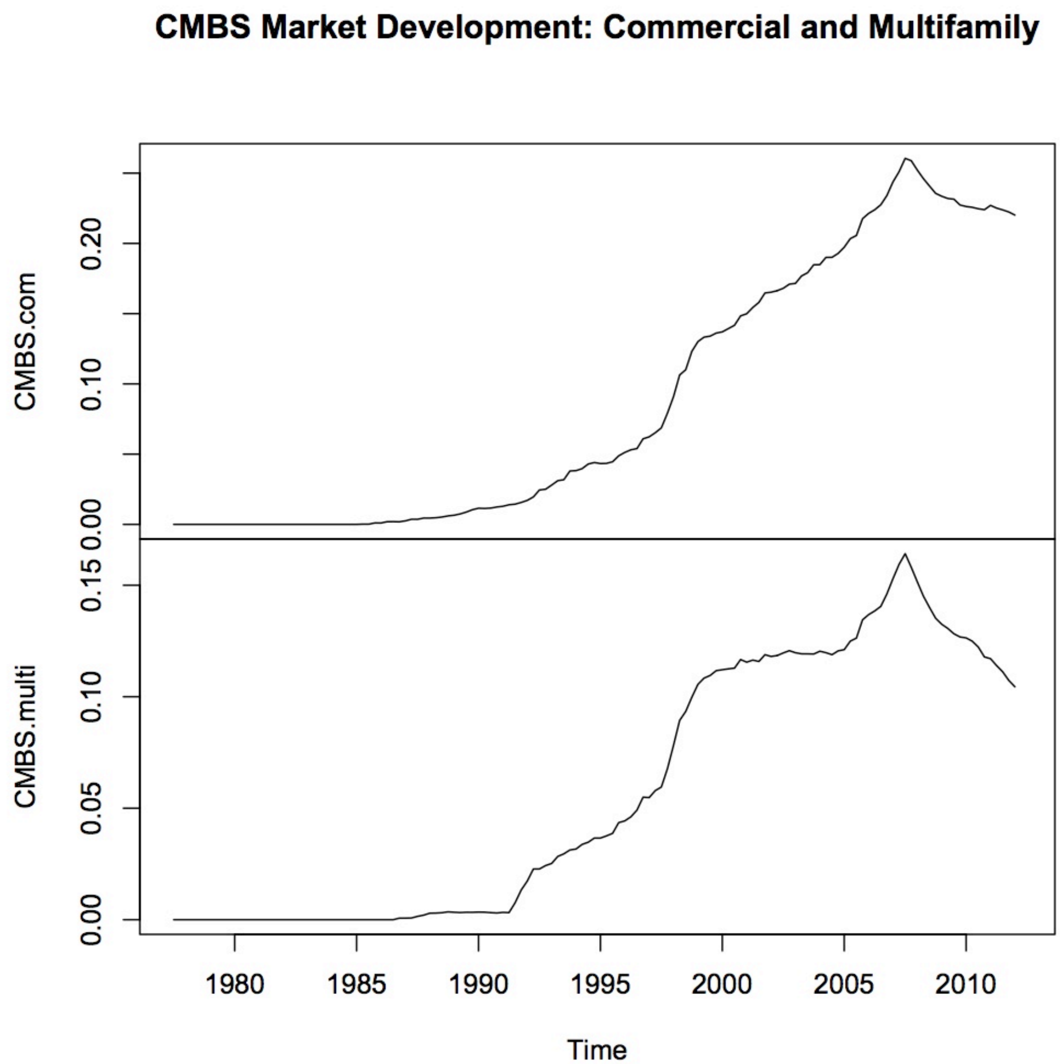

CMBS Market Development: Commercial and Multifamily
CMBS.com
0.00
0.10
0.20
CMBS.multi
0.00
0.05
0.10
0.15
1980
1985
1990
1995
2000
2005
2010
Time

Figure 9

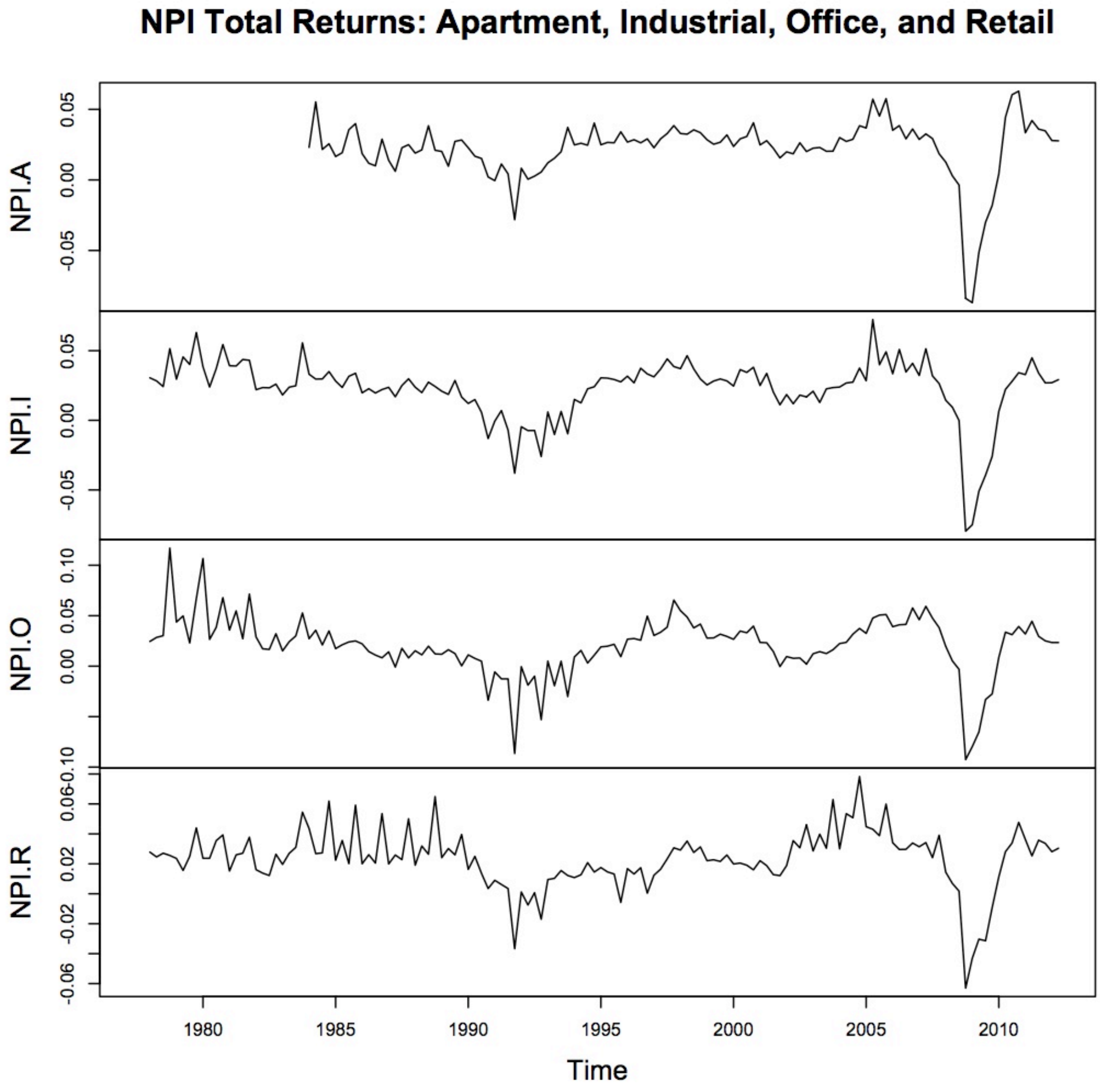

NPI Total Returns: Apartment, Industrial, Office, and Retail
NPI.A
NPI.I
NPI.O
NPI.R
0.05
0.00
-0.05
0.10
-0.10
0.06
0.02
-0.02
-0.06
1980
1985
1990
1995
2000
2005
2010
Time

Figure 10

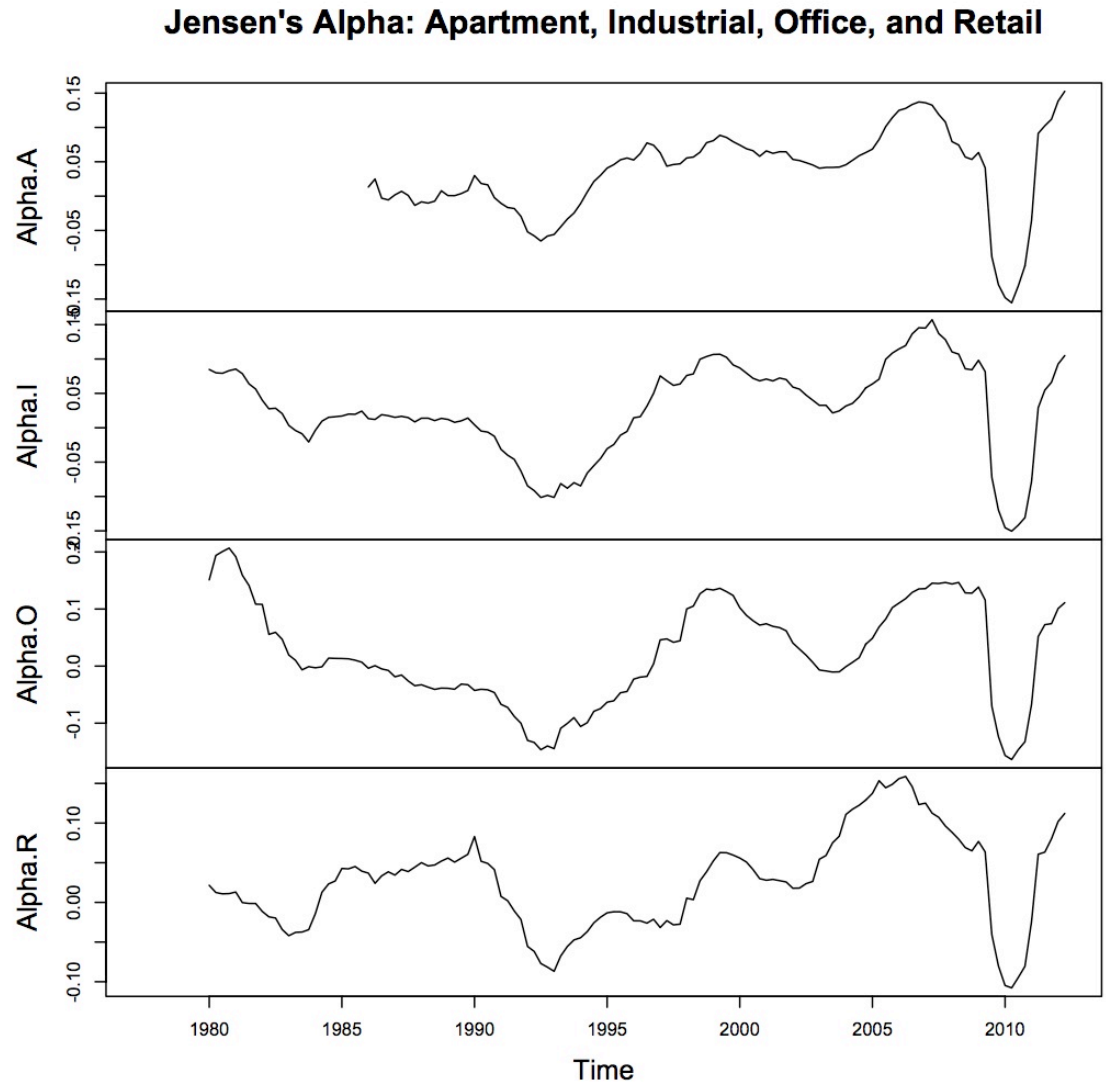

Jensen's Alpha: Apartment, Industrial, Office, and Retail
Alpha.A
Alpha.I
Alpha.O
Alpha.R
0.15
0.05
-0.05
-0.15
0.10
0.1
0.0
-0.1
0.2
0.00
-0.10
1980
1985
1990
1995
2000
2005
2010
Time

Figure 11


Beta: Apartment, Industrial, Office, and Retail
Beta.A
Beta.I
Beta.O
Beta.R
Time
1980
1985
1990
1995
2000
2005
2010