Risk and Return in Institutional Commercial Real Estate: *A Fresh Look with New Data*

By

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B.S. Finance and Real Estate, Florida State University, 2006

Submitted to the Program in Real Estate Development in Conjunction with the Center for Real Estate
In Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

Commercial Real Estate is a large asset class, increasingly owned by professional investment managers. Investment managers need a thorough understanding of the risk-return relationship and tools to adequate implement sound investing, portfolio management and risk management strategies. Equilibrium asset pricing models are tools that identify and quantify the risk factors priced by the capital market and establish risk adjusted long-run expected returns. This thesis creates portfolios of properties by property type, geographic location and asset size. Total return indices are created for each portfolio to test single factor and multifactor asset pricing models cross-sectionally within the commercial real estate asset class. Historical total return data is used from three sources including: NCREIF; the stock market-based FTSE NAREIT PureProperty Index Series; and a novel "synthetic" total return index created by the researcher from the repeat sale transaction-based Moody's/RCA CPPI Indices.

The asset pricing model test results for the NCREIF and PureProperty indices show that a substantial amount of the variation in long-run total return can be explained by a portfolio's beta with respect to a market index and property specific variables such as property type, location and asset size. The asset pricing model test results for the RCA indices were poor and failed to explain the cross-section of commercial real estate returns. Thus, it appears that certain parts of the commercial real estate market may be operating without a systematic relationship of risk and return.

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Chapter 1: Introduction

Commercial real estate represents a significant portion of the investable universe of assets, recently estimated at $6.5 trillion in market value out of a total $52.8 trillion in the United States[1]. Investments in commercial real estate are often categorized in four quadrants: private debt or equity and public debt or equity. As of 2004, private equity represented 24% of market value, public equity 17%, private debt 50%, and public debt (CMBS) 17%. (Hudson-Wilson et al., 2005)

Increasingly, commercial real estate assets are owned by sophisticated institutions such as Real Estate Investment Trust (REIT) stocks, private equity firms, insurance companies and sovereign wealth funds. Additionally, pension funds and similar organizations typically invest with investment managers via commingled funds and separate accounts or in REIT stocks. *Why do they invest in commercial real estate?* An article in the 2005 special real estate edition of the Journal of Portfolio Management (JPM), summarized the benefits of commercial real investments for institutions: 1) portfolio diversification and risk reduction; 2) absolute-return-enhancement; 3) inflation hedging; 4) no allocation is equivalent to a bet against real estate; and 5) strong current cash flows relative to stocks and bonds. Although, the recent financial crisis caused a spike in asset class correlations and raised questions about the diversification benefits, real estate investments will continue to be a major component of institutional investment portfolios in the years ahead. Institutional Real Estate's 2011 Annual Survey reported a 10.3% target allocation for tax exempt institutional investors in real estate, up from 9.7% in the 2008 survey.

Despite the growing history of institutional ownership in commercial real estate, academic research into the fundamental risk and return relationship is still in its adolescence compared with other asset classes. *And perhaps, also well less understood by many industry professionals…* Commenting in a JPM article on some of the high profile, peak-of-the-cycle investments that performed poorly during the late 2000s, Kaiser and Clayton [2008] note that it appears institutional investors "do not have a great understanding of either the identification or quantification of the components of risk in private commercial property investment."

The ultimate risk in commercial real estate, like any other asset class, is in the total return. Total return is comprised of income return and capital return. Accordingly, for commercial real estate assets, cash flow risk and asset valuation risk are the two components of total return risk. Cash flow risk, or the

[1] "The Case of Commercial Real Estate." Prudential Real Estate Investors (March 2011)
[2] Although not quite as well as Li and Price [2005]

income return component, is derived from the "space" market where landlords and tenants contract for real estate and is exogenous to the capital market. Research has shown that the cash flow forecast does not change much from one period the next. Asset valuation risk, or the capital return component, is derived from the "capital" market where investors buy, sell and finance real estate assets and is a function of the expected return investors demand for a given level of risk. Time variation of the expected return results in a significant portion of changes in asset valuation (and hence total return). Expected returns, also known as opportunity costs of capital or discount rates, are the subject of this thesis.

In finance, asset pricing models are used for several purposes. First and foremost, they help investors determine reasonable or equilibrium (long-run) expected rates of return for investments of varying risks. Second, they allow investors to identify mispriced assets, or assets that offer higher expected returns (in the medium or short-run) than justified by corresponding risk levels. And third, asset pricing models allow investors to more accurately measure investment performance by adjusting portfolio returns to control for risk (Geltner and Miller, 2007).

This thesis hopes to shed some light on relevant issues for institutional commercial real estate investors by exploring single and multifactor equilibrium asset pricing models. Portfolios are sorted by property characteristics from the National Council of Real Estate Investment Fiduciaries (NCREIF) dataset and two new novel sources. The first is a "synthetic" total return index constructed from the Moody's/RCA CPPI repeat sale indices and capitalization rates collected by Real Capital Analytics (RCA). The second is the recently launched FTSE NAREIT PureProperty Index Series that utilizes public REIT stock prices to capture commercial real estate property returns. Thus, this thesis tests asset pricing models with property level commercial real estate returns measured by three unique sources and methods: 1) NCREIF's institutional appraisal-based returns; 2) RCA's transaction-based returns; and 3) stock market-based returns. And just for fun, this thesis will test whether a classical single-factor model can explain the cross-section of returns across the broad brush level of asset classes (i.e. stocks, bonds and real estate). With this information, we seek to explore: (1) risk factors priced by the market; (2) the equilibrium opportunity cost of capital for commercial real estate investments; and (3) the expected return-risk relationship cross-sectionally within commercial real estate. Or using a question as an illustrative example, *Should apartment buildings in major metropolitan cities (e.g. San Francisco) have different expected returns than suburban office buildings in tertiary metropolitan cities (e.g. Kansas City). And if so, why and by how much?*

This study found that the that a National Wealth Portfolio-based capital asset pricing model works reasonably well[2] to explain the risk-return relationship between stocks, bonds, and real estate (see Appendix A). However, things became a little less clear when looking *within* the commercial real estate asset class, as has often been the case with tests within the stock market. The models using NCREIF and PureProperty returns worked quite well, particularly when property characteristics such as location, size and type (e.g. CBD Office properties in major metros) were added into the analysis. These models found a small and insignificant intercept, a positive and significant relationship with beta, and high adjusted R^2s. Additionally, we found a strong and persistent positive risk premium for apartments and properties located in major metropolitan areas. The latter is interesting given the frequent articulation of institutional investor's preference to invest in larger MSAs due to their *lower* perceived risks! However, the models do not work well for the broader transactions-based RCA indices. Thus we are left with a choice: either the dispersion of ex post real estate returns is a result of idiosyncratic performance because investors can't or don't distinguish between the relative risk of different properties or, at least in some parts of the market, the dispersion in returns can be explained in terms of a systematic risk and return relationship.

The rest of this paper is organized in the following order. The next chapter includes a review of the relevant literature on these topics and lays out the objective of this study in more detail. The third chapter introduces the data, portfolio, and index creation methods. The fourth chapter describes the portfolio expansion for the equilibrium asset pricing model tests and describes the historical performance between 2001 and 2012 of commercial real estate as measured by the indices. The fifth chapter describes the equilibrium asset pricing models and the sixth chapter analyzes the results of the NCREIF and RCA tests. The seventh chapter discusses the FTSE NAREIT PureProperty indices, models and test results. The eighth chapter summarizes the results and offers a conclusion, and the paper concludes with recommendations for further study.

[2] Although not quite as well as Li and Price [2005]

Chapter 2: Literature Review

The basis for the thesis begins with asset pricing models. Asset pricing models are used by investors to value financial assets. Financial assets are valued by discounting future cash flows at interest rates or "discount rates" that reflect the risks associated with the cash flows. Asset pricing models help investors to determine appropriate discount rates for a particular asset – be that a stock, bond, or real estate. Discount rates can be separated into two components: a *risk-free rate* accounting for the time-value of money and a *risk premium* reflecting the riskiness of the underlying asset. Asset pricing models are all about understanding or predicting risk premia.

Perhaps the most famous model in finance, the Capital Asset Pricing Model or the "CAPM" was developed by William Treynor, Jack Sharpe, and John Linter in the 1960s, building upon Harry Markowitz's earlier work on portfolio theory. In this model, expected returns are explained as a linear function of risk, defined as the relationship (covariance) between a financial asset's expected return with the market return, with the market return representing the entire universe of investable assets. The formula for the CAPM is given below:

$$E(r_i) = r_f + \beta_{i,M}(r_M - r_f)$$

where:

$E(r)_i$ = Expected return on asset *i*
r_f = Return on risk free asset
r_M = Return on the market return
$\beta_{i,M}$= Beta of asset *i* with respect to the market return

At its most fundamental level, the CAPM is about dividing risk into two components: systematic and nonsystematic (or idiosyncratic) risk. Idiosyncratic risk or firm-specific risk can be diversified away by owning a broad set of assets in a portfolio and is not "rewarded" or priced by the capital markets in the form of a risk premium. Systematic risk cannot be diversified away and is rewarded in the form of a risk premium by the capital markets. Systematic risk for a given financial asset is measured by *Beta*:

$$Beta\ (\beta) = COV(r_{i,} r_M)/\sigma_M^2$$

The CAPM depends on a large number of assumptions that are beyond the scope of this thesis. Numerous scholars, notably John Linter in 1965, Merton Miller and Myron Scholes in 1972, Richard Roll 1977, Fischer Black, Michael Jensen and Myron Scholes in 1972, Eugene Fama and James MacBeth in

1973, have tested the CAPM and its many assumptions for empirical validation. The results can be summarized in a few points. First, expected rates of return are linear and increase with beta, and expected rates of return are not influenced by idiosyncratic risk. Second, the expected return-beta relationship is not consistent with historical observations. Thus, the CAPM appears *qualitatively* correct, but ex post studies do not confirm its predictions *quantitatively*. However, it remains the fundamental understanding of expected return-risk in academia and industry practice (Bodie, Kane and Marcus, 2011).

Arbitrage Pricing Theory (APT) was proposed by Steven Ross in 1976. As with the CAPM, APT says that the expected return of a security or financial asset is a linear function of risk. Further, financial assets must lie upon the security market line – a linear function extending outward in an upwardly sloping line from the risk free rate across the increasingly risky spectrum of investments. They must lie on the line because any asset that offered a return above the SML would offer investors an arbitrage opportunity to make riskless profits. In well-functioning markets, financial participants will buy and sell securities until no arbitrage opportunities are possible. Thus APT arrives at the same conclusion (a linear function of risk) as the CAPM from a different construct. In contrast to the CAPM, APT expands the purview of risk beyond a single factor, the market return relationship (beta), and introduces multifactor models, which can include any systematic or macro factor affecting an investment. (In fact, they should include all systematic risk factors.) Factors that have been found to explain the return of stocks (and demand a risk premium) include: surprises in inflation; surprises in Gross National Product; corporate bond premia; and shifts in the interest rate yield curve (Ross and Roll, 1984). The formula for a multifactor model is given below:

$$r_i = E(r_i) + \beta_{i1}F_1 + \beta_2 F_2 + \cdots + \beta_{\mathrm{i}N}F_N + e_i$$

where:

r_i = Return on asset i
$E(r_i)$= Expected return on asset *i*
F_k = Deviation of the common factor from its expected value
β_{ik} = Beta of asset *i* with respected to Factor *k*
e_i= Asset specific risk

University of Chicago Professors' Eugene Fama and Kenneth French famously developed a three factor model that successfully explained a substantial amount of the variation in common stock returns (Fama and French, 1992). The three factors were the market return, company size, and book-to-market equity ratio. In their analysis, Fama and French created portfolios that sorted individual stocks by size (market capitalization) and book-to-market ratios. The portfolios were then tested with the following equation:

$$r_i = \alpha_i + \beta_{iM} R_{Mt} + \beta_{iSMB} SMB_t + \beta_{iHML} HML_t + e_{it}$$

where:

r_i = Expected return on stock i
β_{iM}= Beta of stock i with respect the Market
R_M = Excess Return on the Market
SMB = Size factor, return on small-firm portfolio of stocks less return on large-firm portfolio of stocks
β_{iSMB} = Beta of stock i with respect to SMB
HML = Book-to-market factor, return on high book-to-market portfolio of stocks less return on low book-to market portfolio of stocks
β_{iHML} = Beta of stock i with respect to HML

The test involved a two pass regression analysis. In the first pass, betas for each portfolio are estimated in a time series regression. In the second pass, the model is tested for explanatory power in a cross-sectional regression combining all the portfolio betas from the first past. In their study, Fama and French found significant explanatory power (R-square statistics greater than .9) and large t-statistics on size and value factors suggesting that these factors contributed significantly to the explanatory power of the model. The conclusions of this were twofold: work was that the size and book-to-market ratios were risks not accounted for in the CAPM beta, and, consistent with APT, as risk factors they should command a risk premium. A Fama-French style multifactor model will be used extensively in this thesis (Bodie, Kane and Marcus, 2011).

From Stocks to Real Estate

Among its many industry altering implications, The Employee Retirement Income Security Act of 1974 (ERISA) required pensions funds to hold diversified investment portfolios, including diversification out of stocks and into alternatives such as real estate (Geltner and Miller, 2007). This helped to create a new institutional ownership class in real estate and a new audience for academic research on commercial real estate. As a result, beginning in the 1980s and early 1990s, academics began applying the previously described models to commercial real estate returns. The early research focused on REIT stocks and later on private real estate as an asset class.

Mei and Lee [1994] investigated the predictability of expected returns on five different asset portfolios in a multifactor model. They found the presence of a real estate factor in addition to a stock and bond factor in asset pricing. This was significant because it suggested that investment managers "should seriously consider including real estate asset[s] in their portfolios since one cannot make up a portfolio that carries any desirable risk level in all three risk factors without having some kind of real estate exposure" (p. 113).

In a pair of papers, Ling and Naranjo [1997 and 1998] addressed the systematic risk factors that applied to real estate. They tested multifactor models on various real estate portfolio groups including, REIT stock returns and various portfolios constructed with NCREIF property-level data. They found several systematic or macro-level factors that influenced real estate returns including: 1) real per capita growth rate of consumption expenditures; 2) real treasury bill rates; 3) term structure of interest rates; and 4) unanticipated inflation. Interestingly, they found positive risk premia and negative betas for several factors including the term structure of interest rates and unanticipated inflation, suggesting that real estate investors "pay more (accept lower returns) for assets that have such exposures…because these exposures smooth out their expected wealth or welfare volatility across time, due to their counter cyclicality with the macro economy" (p. 19). Thus, there were able to identify and quantify some of the diversification benefits for investors owning real estate.

Li and Price [2005] built upon earlier work by Geltner to test whether asset pricing models could be used to price risk across multiple asset classes including the four quadrants of real estate (public and private, debt and equity). They found that a National Wealth Portfolio-based CAPM overwhelmingly explained the variation in returns of multiple asset classes including real estate. A multifactor, Fama-French style model was found to explain a high percentage of variation as well. An update of the National Wealth Portfolio CAPM model is included in Appendix A.

With a growing body of research, improving commercial real estate datasets, and an expanding institutional real estate audience, academics began to apply the classical asset pricing tools cross-sectionally within the real estate sector with important implications for risk mitigation and portfolio construction policies.

Pai and Geltner [2007] investigated the historical performance of core institutional real estate properties (using the NCREIF dataset) to identify systematic determinants of long-run investment performance. They extended the previous work of Li and Price to the cross-section of return performance within real estate, and they found that property specific variables, such as market location tier, asset size, and property type explained the vast majority of long-run returns. Interesting findings were that large properties and top tier markets commanded higher return premia than small properties and tertiary markets. The topic and methodology of this paper was a major influence on this thesis.

In a recent white paper by MSCI researchers Suryanarayanan and Stefek [2011], the authors describe a new multifactor forecasting tool for core real estate portfolios. Much like the models developed by Pai and Geltner [2007], this model attributes risk to "intuitive property type and location factors." It also incorporates more timely public market information capturing the correlation between private and public markets. This interesting paper shows how multifactor models can be used by market participants to forecast volatility, a key risk management concern, over short and long-term horizons.

Plazzi, Torous and Valkanov [2008] investigated the risk dynamics in commercial real estate by studying the cross-sectional dispersions of commercial real estate returns across time. They found evidence of time varying fluctuations that can be explained by macroeconomic variables such as term spreads, credit spreads, inflation and short-term interest rates. They also tested whether commercial real estate investors are compensated for their idiosyncratic risk exposure and found that the "the total risk-return trade-off is positive and statistically significant for three of the four commercial property types: apartments, offices and retail properties.

Esrig, Hudson and Cerreta [2011] updated earlier work by Ziering and McIntosh [1994] to study the impact of size on real estate returns for office, multifamily and retail assets. The authors created property-specific definitions of large assets and compared their return history against the broader asset class. After correcting for overrepresentation in six major markets, they found that large assets have outperformed other properties in the NCREIF database on an absolute and risk-adjusted basis.

Many of the most recent articles on commercial real estate have focused on the dispersion of returns at the property level. As discussed in the introduction, real estate investors are not able to purchase indices, and must purchase individual properties. The following series of articles highlight the inherent differences in this reality.

Fisher and Goetzmann [2005] simulated Internal Rates of Return (IRR) using actual property histories to imitate total returns for active investors using the NCREIF database. Then they examined the cross-sectional distribution of real estate returns over a single time period under varying assumptions. They found several interesting conclusions. First, the median IRR differed significantly from the compound time-weighted rate of return of the industry benchmark - the NCREIF NPI total return index. Second, significant reductions in the cross-sectional dispersions of returns were possible with portfolios of 100 properties – highlighting the substantial capital necessary for diversification. Finally, diversification across property types reduced cross-sectional variation more than geographic diversification.

In an unpublished working paper, Peng [2010] analyzed the risks and returns of direct commercial real estate investments using property level cash flows to create indices. He found that commercial real estate risk premiums are: 1) correlated to GDP growth and the change in the credit spread; 2) negatively related to inflation, the stock market premium, and the change in the term spread (highlighting diversification benefits); 3) returns on all property types are negatively related to the inflation rate; and 4) strong evidence for time variation in the factor loadings and more specifically that loadings were significantly lower in an economic expansion (higher stock market premiums), suggesting that real estate diversification benefits are greater when the stock market performs well.

Boudry, Edward, Kallberg and Liu [2012] examined a sample of 10,454 repeat sale transactions from the CoStar database to test how representative commercial real estate indices are to returns of individual properties. They concluded that real estate indices do a poor job of explaining individual property returns and that index appreciation is significantly lower than estimated property level appreciation. They found that a moderate portion of the difference between indices and property level returns can be explained by property level characteristics such as holding period, property size, land leverage, building age, market liquidity (transaction volume), location and year of sale. However, they concluded a large portion of the property price appreciation is "truly random" suggesting a large idiosyncratic risk in commercial real estate.

Objective

The objective of this thesis is to build upon the work of Pai and Geltner [2007], wherein the authors found that an equilibrium asset pricing model consisting of Fama-French-like factors for property size and market tier, along with dummy variables for property type, accurately explained the cross-section of long run total return performance within the real estate sector. Their study only used NCREIF data, which, while presenting an accurate long-run history, is biased towards institutional owners and high value properties and subject to appraisal-based issues. This thesis will test whether previous findings are robust with respect to additional datasets and index methodologies, notably an

RCA-based “synthetic” total return set of indices and the recently launched stock market-based FTSE NAREIT PureProperty set of indices. NCREIF portfolios will be created to test the Pai and Geltner results with respect to recent property performance between the years of 2001 and 2012.

Chapter 3: Data and Portfolios

The methodology for this study entails organizing historical return performance of commercial real estate properties into various portfolios, constructing income, capital and total return indices, and testing the data with traditional equilibrium asset pricing models via regression analysis. The portfolios are organized by property type, location, and size. Previous research has indicated these factors are important for determining risk and return relationships within commercial real estate.

Real Capital Analytics (RCA)

RCA is a global research and consulting firm focused exclusively on the commercial real estate investment market. RCA collects transactional information on global property sales greater than $2.5 million. Their information is relied upon by all segments of the real estate community, including buyers, developers, brokers, and lenders.

The RCA dataset employed in this study includes detailed information on 22,785 repeat sale transactions from 1988 through April 2012. The RCA dataset is widely used by industry professionals and serves as the underlying information for the Moody's/RCA CPPI Indices (CPPI). The CPPI indices measure price changes in U.S. commercial real estate, based on completed sales of the same commercial properties over time. The indices begin with a set of ten equal-weighted "building block" sub-indices organized by property type and major or non-major market location. The ten major and non-major "building block" sub-indices are combined into a set of value-weighted property type indices (Office CBD, Office Suburban, Industrial, Retail and Apartment). The property type indices roll up into two higher level value-weighted indices, Core Commercial and Apartment. Finally, the National index is a value-weighted combination of the Core Commercial and Apartment indices. Equal-weighting at the "building block" level prevents individual properties from overwhelming the index, and value-weighting at the higher levels allows a market segment to influence higher level indices in correct proportion to their market share of dollar-based transaction volume.[3]

[3] More information about the creation of the CPPI Indices can be found on Moody's and RCA's websites and in a white paper available by request from Moody's.

The index creation in this study starts with the ten "building block" sub-indices as "portfolios" to calculate the capital return component. Each "building block" is deemed a portfolio of properties. They are organized[4] as shown below:

Major Markets	Non-Major Markets
(Boston, Chicago, DC, NYC, LA & SF)	(Everywhere else)
Office CBD, Office Suburban, Industrial, Retail, Apartments	Office CBD, Office Suburban, Industrial, Retail, Apartments

There were 21,732 repeat sale transactions as of the May 2012 release of the CPPI. The Non-Major Apartment portfolio contributed the most transactions (5,186), while the Non-Major CBD Office portfolio contributed the least (531).

Repeat Sales by Portfolio

	CBD Office	Suburban Office	Industrial	Retail	Apartment	Total
Major	949	1,863	1,889	1,042	2,706	**8,449**
Non-Major	531	2,688	2,315	2,563	5,186	**13,283**
Total	**1,480**	**4,551**	**4,204**	**3,605**	**7,892**	**21,732**[5]

Table 3.1

In order to generate a total return, a "synthetic" income return component was estimated by using monthly capitalization (cap) rates[6] collected by RCA to infer aggregate property level cash flows in a portfolio. (Charts of the cap rates are included in Appendix B). To calculate the current periodic income return, the cap rate reported for the preceding period was multiplied by the ending index value in the preceding period and divided by the number of index periods per year. An adjustment is necessary to account for capital expenditures, as cap rates represent a cash flow level prior to ownership costs for items such as tenant improvements, leasing commissions and building repairs. Annual capital expenditures were estimated using the NCREIF database because of its long, detailed cash flow history and broad exposure to property types and geographies.

[4] This is different than in Pai and Geltner (2007) where metro tier rankings were sorted within each property type based on asset value.
[5] Transactions through March 2012
[6] Cap rates are forward looking projections of the ratio of a property's net operating income to value (i = NOI/value)

The average annual capital expenditures were first estimated for each property type from 1978-2012 using the NCREIF custom query function. As a fraction of net operating income (NOI), capital expenditures ranged from 25.32% for Apartment properties to 38.62% for Office properties in the NCREIF database.

Gross Capital Expenditure Ratios

Property Type	CapEx/NOI
Apartments	25.32%
Industrial	32.90%
Office	38.62%
Retail	26.61%

Table 3.2

Next, after further investigation it was necessary to reduce the total capital expenses for non-traditional expenses included in the NCREIF database. The capital expenditures for each product type were broken down into several categories (Leasing Commissions, Tenant Improvements, Additional Acquisition Costs, Building Improvements, Building Expansion, and Other) using the Detailed Capital Expense query in NCREIF's database system. (NCREIF began collecting detailed data on income and expenses in 2000). The results for Industrial properties are shown in Figure 3.1 below.

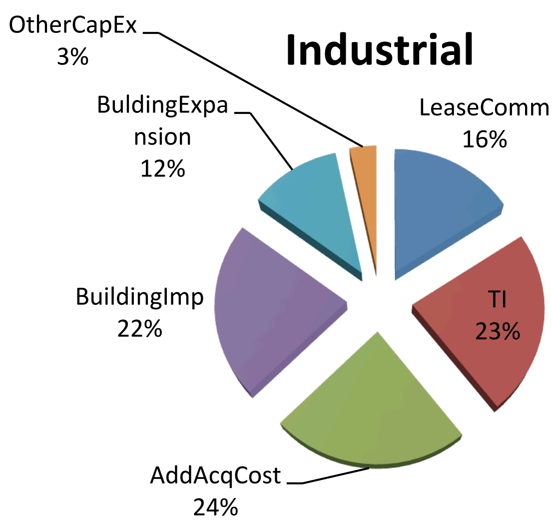


Figure 3.1

The categories "Additional Acquisition" and "Building Expansion" were not representative of capital expenditures and were omitted. The total capital expenditures less the two omitted categories were used to approximate the annual cost of capital expenditures for the RCA-based income indices.

The final capital expenditure to net operating income ratios ranged from 21.37% for Industrial properties to 33.33% for Office properties.

Final Capital Expenditures Ratios

Property Type	Haircut	CapEx/NOI
Apartments	13.09%	22.00%
Industrial	35.05%	21.37%
Office	13.71%	33.33%
Retail	17.70%	21.90%

Table 3.3

In summary, the income return component was calculated by dividing the cap rate in the previous period by the number of periods per year, multiplying the ending balance of the index in the previous period and multiplying by one minus the CapEx ratio,[7]. The periodic total return was calculated as the capital return component plus the income return component. From these quarterly total returns, an index was created for each portfolio from 2001-2012. The index began at a level of 100 in 200. Each quarter the ending value of the index in the previous period was multiplied by the current quarterly total return to generate the new index level. Table 3.4 includes descriptive statistics of the RCA indices and Table 3.5 is a cross-correlation matrix of the ten indices.

RCA Based Indices Q12001 – Q12012

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
Office CBD Major	0.027	0.025	0.141	-0.170	0.062	0.217	-0.273	0.770
Non-Major	0.018	0.016	0.140	-0.131	0.064	0.195	-0.076	0.588
Office-Sub Major	0.019	0.017	0.162	-0.088	0.057	0.173	0.290	0.616
Non-Major	0.014	0.013	0.081	-0.103	0.039	0.140	0.385	0.782
Industrial Major	0.024	0.024	0.075	-0.071	0.034	0.120	0.357	0.741
Non-Major	0.022	0.021	0.130	-0.095	0.042	0.120	0.409	0.443
Apartment Major	0.030	0.029	0.079	-0.050	0.030	0.109	0.359	0.766
Non-Major	0.022	0.021	0.091	-0.115	0.047	0.168	0.048	0.176
Retail Major	0.030	0.029	0.144	-0.058	0.048	0.163	0.095	0.628
Non-Major	0.020	0.019	0.139	-0.070	0.040	0.133	0.548	0.467
Average	0.023	0.022	0.114	-0.067	0.046	0.154	0.214	0.598
Standard Deviation	0.005	0.005	0.039	0.090	0.012	0.035	0.256	0.192
Max	0.030	0.029	0.162	0.168	0.064	0.217	0.548	0.782
Min	0.014	0.013	0.047	-0.170	0.030	0.109	-0.273	0.176

Table 3.4

[7] Income Return = Cap $rate_{t-1}$/n * $Index_{t-1}$* (1-CapEx)

The first column reports an arithmetic average of the quarterly total return for each index. The second column reports a geometric average calculated by dividing the ending value of each index by the beginning value raised to one divided by the number of periods and subtracting one (End/Beginning$^{1/T}$ - 1). The geometric average represents a compound growth rate that gives the correct ending index value. The third and fourth columns report the maximum and minimum quarterly return for each index. The fifth and sixth column report the quarterly and annual standard deviation of the returns from 2001-2012. And the seventh and eighth columns report the quarterly and annual first order autocorrelation. This measures (from 0-1) how much of the return in the current period is explained by the return in the previous period.

RCA Descriptive Statistics. All Major indices exhibited stronger average growth than their Non-Major property type counterpart in the 2001-2012 study period. The spread was most pronounced in the Retail category, with a difference of 1% per quarter and least pronounced in the Industrial category where it was only .3% per quarter. The differences in returns were mixed: the Major index return annual volatility was higher for CBD Office, Suburban Office, and Retail, equal for Industrial, and less than the Non-Major for Apartments. CDB Office Major had the highest annual volatility (21.7%) and lowest negative quarterly return (-17%) while Major Apartments had the lowest annual volatility (10.9%).

RCA: Cross-Correlation Matrix

	CBD Major	Non	Sub Major	Non	Ind Major	Non	Ret Major	Non	Apt Major	Non
CBD Major	1.000	0.875	0.914	0.905	0.902	0.907	0.756	0.821	0.894	0.892
Non-Major		1.000	0.926	0.935	0.893	0.912	0.644	0.793	0.842	0.861
Sub Major			1.000	0.970	0.946	0.962	0.756	0.874	0.914	0.930
Non-Major				1.000	0.935	0.957	0.704	0.836	0.896	0.911
Ind Major					1.000	0.985	0.757	0.893	0.934	0.948
Non-Major		Average	0.877			1.000	0.751	0.882	0.927	0.946
Retail Major		Max	0.985				1.000	0.898	0.780	0.767
Non-Major		Min	0.644					1.000	0.876	0.884
Apt Major									1.000	0.960
Non-Major										1.000

Table 3.5

RCA Correlation Statistics. The indices tended to move together exhibiting an average cross-correlation of .877. The Industrial indices were the most closely correlated (.985), and the Retail Major and CBD Office Non-Major had the lowest correlation (.644).

Chapter 4: Expanded Portfolios

National Council of Real Estate Investment Fiduciaries

NCREIF is a not-for-profit trade association of institutional real estate professionals that acts as a non-partisan collector, processor, validator and disseminator of real estate performance information. NCREIF has collected quarterly property level data since 1978 from institutional real estate owners. It publishes the NCREIF Property Index (NPI), a quarterly time series composite total rate of return measure of investment performance of a large pool of individual commercial real estate properties acquired in the private market for investment purposes only.

This study focused on office, retail, industrial and apartment properties in the NCREIF database from 2000-2012. As of the end of the 1st quarter in 2012, this included 6,863 properties. Available information includes detailed data on appraised values and property level cash flows including net operating income and capital expenditures. Portfolios were constructed to match the previously described RCA-based portfolios using the Advanced Query interface on NCREIF's website. Specifically, the Equal Weighted NPI Cash Flow Returns option was utilized to prevent any individual property performance from overwhelming a portfolio, similar to the equal weighted "building block" level indices in the RCA portfolios described in Chapter 3. The index values were calculated with the same methodology using NCREIF reported income and capital returns per period. Descriptive statistics and cross-correlations for the ten Major and Non-Major metro portfolios are reported in Table 4.1 and Table 4.2.

NCREIF Descriptive Statistics. As with the RCA portfolios, the Major metro portfolios tended to outperform their Non-Major counterparts. Apartment indices were the only exception, where the returns were equal in arithmetic average, but Non-Major was slightly higher in geometric mean. The Retail Major index exhibited the highest average quarterly total return (2.7%) and Suburban Office Non-Major had the lowest (1.3%). Average returns were slightly lower in the NCREIF indices (1.9%) compared to the RCA portfolios (2.2%) and had tighter range (1.4%) compared to RCA (1.6%). Volatilities were lower in NCREIF portfolios as well, mostly as a result of "appraisal smoothing" in the NCREIF portfolios and more "noise" in the RCA-based transaction indices. Interestingly, all Major metro volatilities were higher than their Non-Major metro counterparts in the NCREIF indices. CBD Office Major had the highest annual volatility again (13.2%) and Retail Non-Major had the lowest (9.6%).

NCREIF Based Indices 2001-2012

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
Office CBD Major	0.025	0.024	0.115	-0.129	0.040	0.132	0.302	0.688
Non-Major	0.017	0.016	0.083	-0.110	0.039	0.134	0.259	0.816
Office-Sub Major	0.017	0.016	0.066	-0.091	0.034	0.123	0.319	0.857
Non-Major	0.014	0.013	0.050	-0.071	0.028	0.100	0.370	0.860
Industrial Major	0.021	0.020	0.082	-0.083	0.031	0.110	0.419	0.807
Non-Major	0.018	0.017	0.068	-0.080	0.029	0.102	0.371	0.806
Retail Major	0.028	0.027	0.118	-0.068	0.030	0.100	0.430	0.578
Non-Major	0.024	0.023	0.059	-0.065	0.026	0.096	0.510	0.805
Apartment Major	0.021	0.019	0.067	-0.117	0.036	0.120	0.292	0.790
Non-Major	0.021	0.020	0.060	-0.069	0.028	0.102	0.244	0.855
Average	0.021	0.019	0.077	-0.089	0.032	0.112	0.352	0.786
Standard Deviation	0.004	0.004	0.023	0.023	0.005	0.014	0.084	0.088
Max	0.028	0.027	0.118	-0.065	0.040	0.134	0.510	0.860
Min	0.014	0.013	0.050	-0.129	0.026	0.096	0.244	0.578

Table 4.1

NCREIF Correlation Statistics. The NCREIF based portfolios had a substantially lower (.575) average cross-correlation than the RCA indices (.877). Perhaps, this suggests that RCA captures more timely integration of capital markets. The Apartment Non-Major and Suburban Office Non-Major exhibited the highest (.801) correlation and CBD Major and Retail Non-Major exhibited the lowest (.233).

NCREIF: Cross-Correlation Matrix

	CBD Major	Non	Sub Major	Non	Ind Major	Non	Retail Major	Non	Apt Major	Non
CBD Major	1.000	0.609	0.286	0.701	0.558	0.531	0.435	0.233	0.547	0.763
Non-Major		1.000	0.335	0.530	0.617	0.331	0.585	0.345	0.721	0.585
Sub Major			1.000	0.548	0.537	0.510	0.440	0.660	0.554	0.592
Non-Major				1.000	0.624	0.766	0.462	0.630	0.707	0.801
Ind Major					1.000	0.514	0.646	0.556	0.557	0.657
Non-Major		Average	0.575			1.000	0.537	0.735	0.595	0.628
Retail Major		Max	0.801				1.000	0.648	0.758	0.539
Non-Major		Min	0.233					1.000	0.685	0.516
Apt Major									1.000	0.753
Non-Major										1.000

Table 4.2

Total Return Graphs

This section of the paper displays the previously described total return indices in cumulative time series graphs. Each of the five property types has a separate exhibit displaying the RCA and NCREIF Major and Non-Major indices.

Generally RCA and NCREIF tell the "same story" at the broad brush level, with some interesting differences. First, the transactions-based RCA series tends to lead the NCREIF-based series in time. This is likely a result of the backward looking nature of appraisal values. Second, there appears to be a larger spread between Major and Non-Major markets in the RCA-based indices. Third, the Major Apartment total return performance is stronger in the RCA-based synthesized returns than in the corresponding NCREIF index (Figure 4.5). This is in spite of the fact that the synthesized RCA Major Apartment income returns are similar to (and generally slightly lower than) the NCREIF Major income returns. Thus, the difference is due to substantially greater Major Apartment price gain in the RCA properties than in the NCREIF. The price gain out-performance seems to have persisted, before, during, and after the crash. Two possible explanations[8] are that RCA based values account for condominium conversions in the mid-2000s that are not reflected in NCREIF appraisal values, and that the mix of apartment assets in the NCREIF database was mostly garden-style (suburban walk-up) properties in 2000 before shifting towards urban as the decade progressed. (Urban apartments tended to outperform garden-style during the study period.)

[8] Thank you to Bob White from RCA for helping to analyze this issue.

Table 4.4 shows the cross-correlation of the RCA and NCREIF indices. The property types (office, industrial, retail, and apartments) are boxed and the paired indices (RCA vs. NCREIF) are shaded grey. The paired indices track reasonably well with an average correlation of .699 across the ten paired portfolios. The Apartment Non-Major correlation was the highest (.902) and the Retail Major correlation was the lowest (.524).

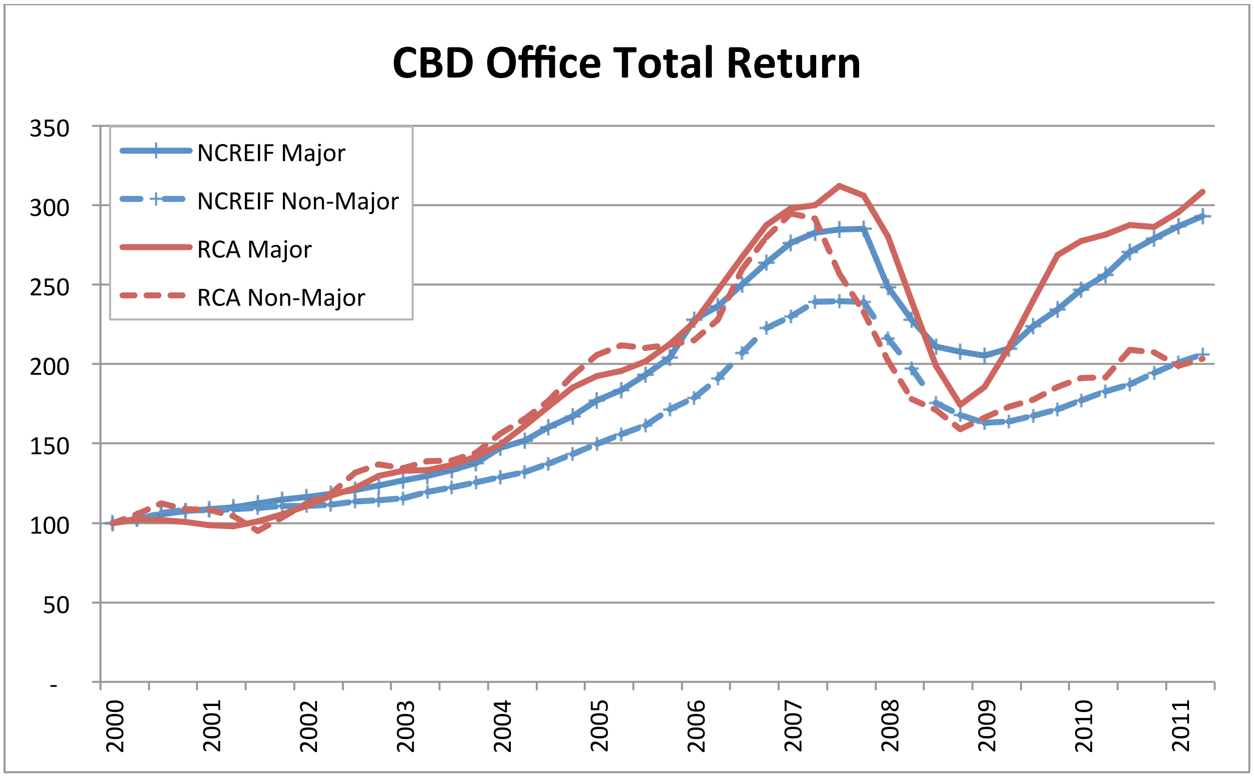


Figure 4.1

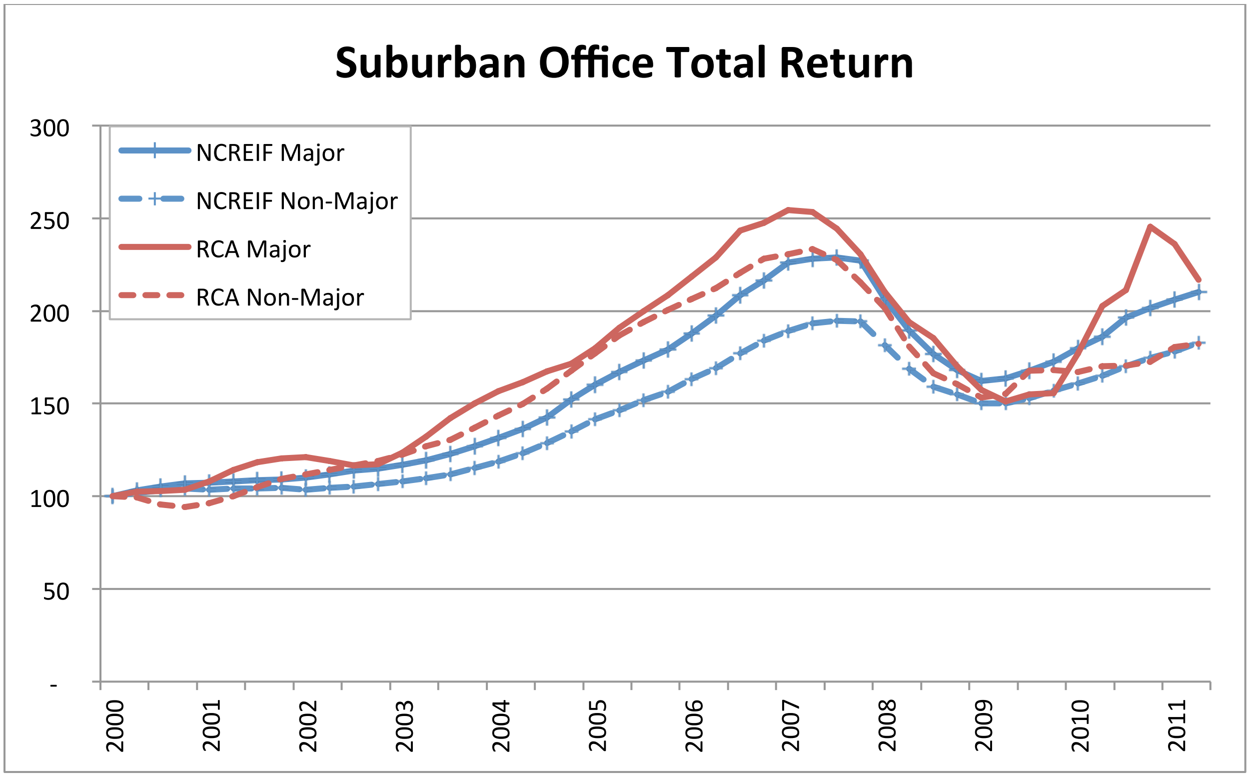


Figure 4.2

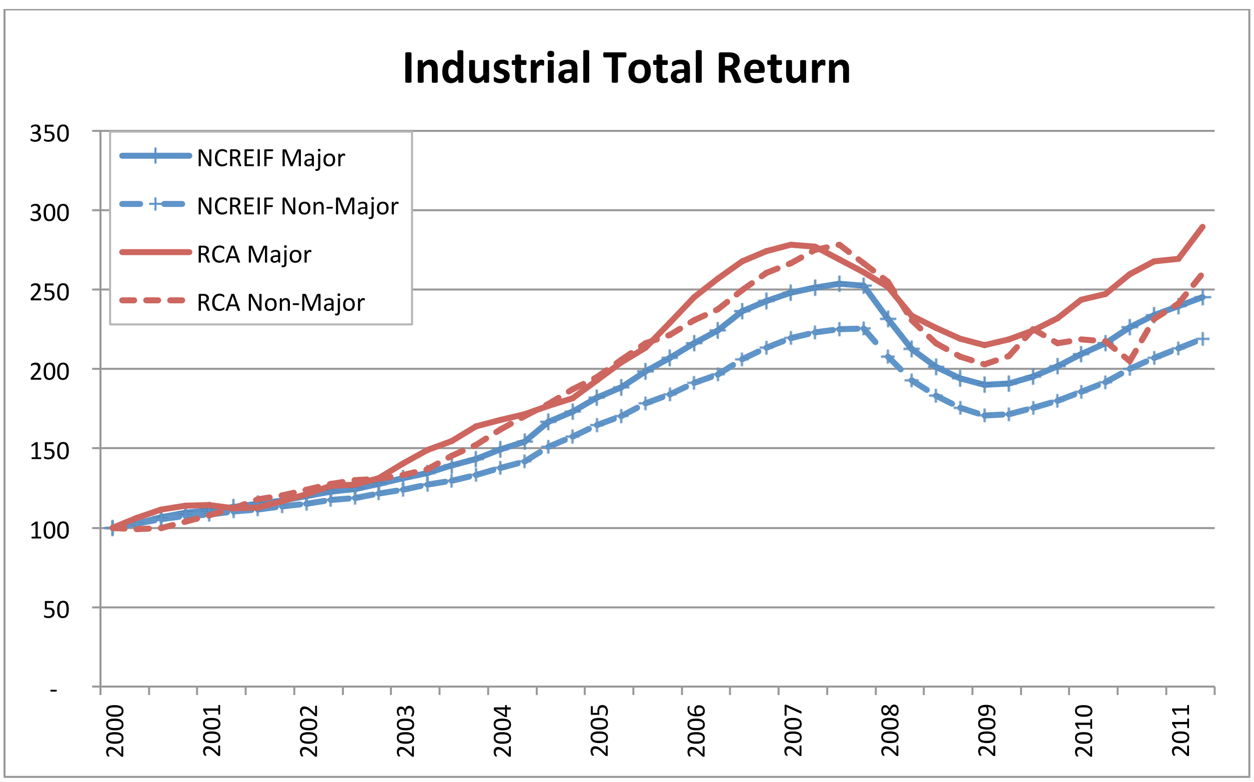


Figure 4.3

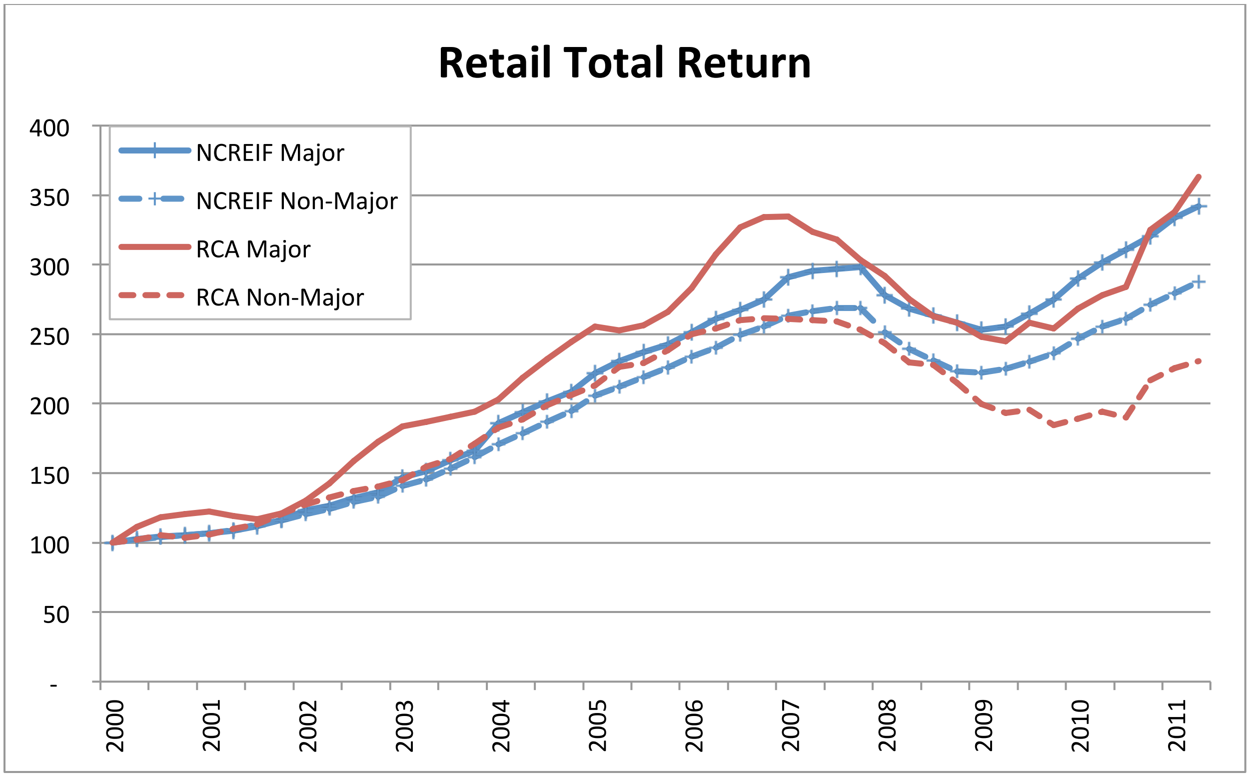


Figure 4.4

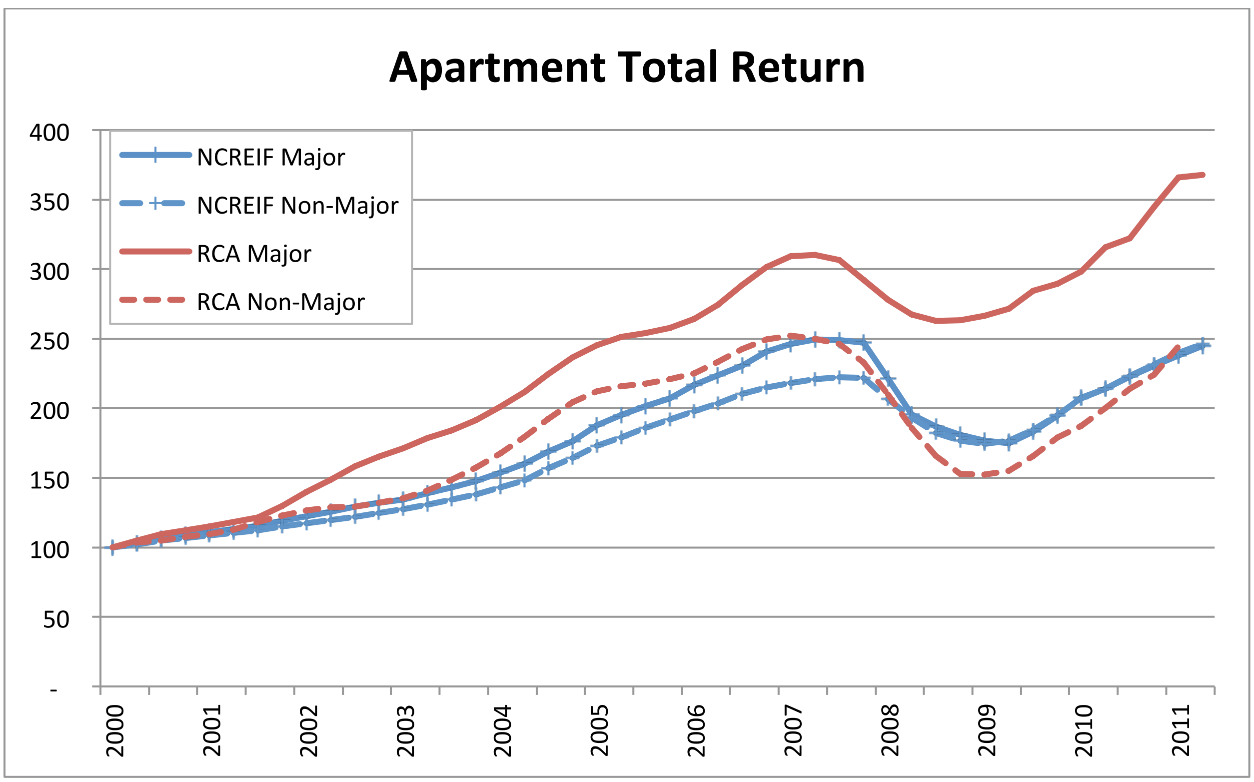


Figure 4.5

RCA vs. NCREIF Correlation Matrix

RCA

NCREIF	CBD Major	CBD Non	Sub Major	Sub Non	Ind Major	Ind Non	Retail Major	Retail Non	Apt Major	Apt Non
CBD Major	0.721	0.597	0.589	0.740	0.710	0.578	0.490	0.445	0.595	0.766
Non-Major	0.719	0.597	0.596	0.731	0.707	0.647	0.519	0.490	0.597	0.759
Sub Major	0.717	0.667	0.662	0.767	0.764	0.607	0.565	0.521	0.638	0.827
Non-Major	0.696	0.596	0.616	0.778	0.736	0.647	0.527	0.516	0.576	0.789
Ind Major	0.694	0.638	0.661	0.769	0.771	0.631	0.577	0.574	0.679	0.837
Non-Major	0.690	0.627	0.652	0.772	0.749	0.646	0.570	0.582	0.665	0.831
Retail Major	0.549	0.576	0.591	0.708	0.632	0.540	0.524	0.602	0.683	0.733
Non-Major	0.682	0.609	0.671	0.808	0.749	0.686	0.607	0.677	0.739	0.846
Apt Major	0.690	0.644	0.643	0.774	0.749	0.618	0.572	0.551	0.710	0.863
Non-Major	0.750	0.617	0.655	0.781	0.739	0.614	0.557	0.522	0.678	0.902

Table 4.3

Same Type Average	0.699
Same Type Max	0.902
Same Type Min	0.524

Table 4.4

Portfolio Expansion

Following the lead of Pai and Geltner [2007] this paper also expanded the portfolios by two further dimensions, first into metro tier portfolios (Major, Secondary, and Tertiary), and second into size based portfolios (Big, Medium, and Small). The expansion allowed for increased power in the regression analysis described later in this paper. For the metro tiers, the Major markets remained the same and the Non-Major markets were split into Secondary and Tertiary markets. The Secondary markets were determined by transaction volume and generally accepted marketplace definitions with input from RCA.

Major Markets	Secondary Markets
Boston, Chicago, DC, LA, NYC & SF	South Florida, Phoenix, Atlanta, San Diego, Seattle, Denver, Dallas, Philadelphia, Houston, and Minneapolis

The sized-based portfolios will be described separately for the RCA and NCREIF indices.

RCA Metro Tier Portfolios

The indices were created with the same methodology described in the Chapter 3. However, new capital return indices and cap rates were required. The CPPI Index methodology and software program was used to generate the capital return component[9] for the new portfolios and RCA provided monthly cap rates for each index (detailed in Appendix). Due to the smaller number of observations in some of the indices, a 12-month rolling average (current month +/- six months) was used to calculate each monthly cap rate. Monthly income return components were then accumulated into the quarterly total return as described in Chapter 3.

Major Apartment portfolios had the most repeat sale transactions with 2,804, and combined, Apartments had the most with more than one third of the total. Tertiary CBD Office had the fewest with only 257 transactions.

[9] The Author would like to thank Geltner Associates and Leighton Kaina for assistance with these calculations.

RCA Metro Tier Portfolio Repeat Sales

	Office CBD	Office Suburban	Industrial	Retail	Apartment	Total
Major	1,033	1,979	1,979	1,102	2,804	8,897
Secondary	302	1,757	1,398	1,224	2,803	7,484
Tertiary	257	1,093	1,005	1,456	2,593	6,404
Total	1,592	4,829	4,382	3,782	8,200	22,785[10]

Table 4.5

RCA Descriptive Statistics. Major metro tiers dominated the property type total returns again in this dataset. Apartment and Retail Major exhibited the highest mean quarterly total return (2.9%). Compared to the Major/Non-Major indices, the RCA Metro Tier indices exhibit a slightly greater range of average total return (1.7% vs. 1.6%). The quarterly volatility in the Metro Tier indices (11.6% - 2.9%) exhibited a larger range than the Major/Non-Major indices (6.4% - 3.0%). CBD Office Secondary had the highest quarterly (11.6%) and annual (37%) standard deviation and the dispersion within the CBD indices was very high was well as evident in Figure 4.6. Apartment Major had the lowest annual volatility at 10.5%.

[10] Includes sales through April 2012 and is larger than Major/Non-Major dataset.

RCA Metro Tier Portfolios

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
CBD Office Major	0.027	0.025	0.147	-0.183	0.064	0.224	-0.284	0.792
Secondary	0.023	0.015	0.283	-0.331	0.116	0.373	-0.420	0.740
Tertiary	0.020	0.015	0.189	-0.207	0.092	0.262	-0.625	0.538
Suburban Office Major	0.019	0.017	0.169	-0.088	0.053	0.163	0.320	0.585
Secondary	0.015	0.014	0.093	-0.113	0.042	0.138	0.533	0.738
Tertiary	0.013	0.012	0.086	-0.103	0.045	0.146	0.097	0.685
Industrial Major	0.024	0.024	0.072	-0.069	0.034	0.114	0.358	0.741
Secondary	0.022	0.021	0.140	-0.105	0.046	0.124	0.274	0.307
Tertiary	0.023	0.022	0.124	-0.081	0.043	0.107	0.414	0.578
Retail Major	0.030	0.029	0.150	-0.058	0.048	0.152	0.108	0.584
Secondary	0.018	0.017	0.093	-0.098	0.041	0.136	0.362	0.592
Tertiary	0.021	0.020	0.194	-0.102	0.050	0.163	0.084	0.390
Apartment Major	0.030	0.029	0.079	-0.049	0.029	0.105	0.359	0.769
Secondary	0.019	0.018	0.113	-0.132	0.054	0.187	0.156	0.804
Tertiary	0.021	0.020	0.194	-0.102	0.050	0.163	0.084	0.390
Average	0.022	0.020	0.142	-0.121	0.054	0.170	0.121	0.616
Standard Deviation	0.005	0.005	0.058	0.072	0.022	0.071	0.328	0.158
Max	0.030	0.029	0.283	-0.049	0.116	0.373	0.533	0.804
Min	0.013	0.012	0.072	-0.331	0.029	0.105	-0.625	0.307

Table 4.6

RCA Metro Time Series Graphs. As described above, the Major metro tiers tended to outperform over time as shown in Figures 4.6-4.10, especially in the Retail and Apartment categories. The CBD Office figure is interesting for a few reasons. First, it is obviously much more volatile than the others (especially compared to Industrial and Apartment), and second it appears the Tertiary markets peaked, declined and recovered first during the last cycle, but have faltered as of late. The Industrial metro tiers appear very highly correlated and moved in-sync throughout the cycle, although Major metros appear to have outperformed since 2010.

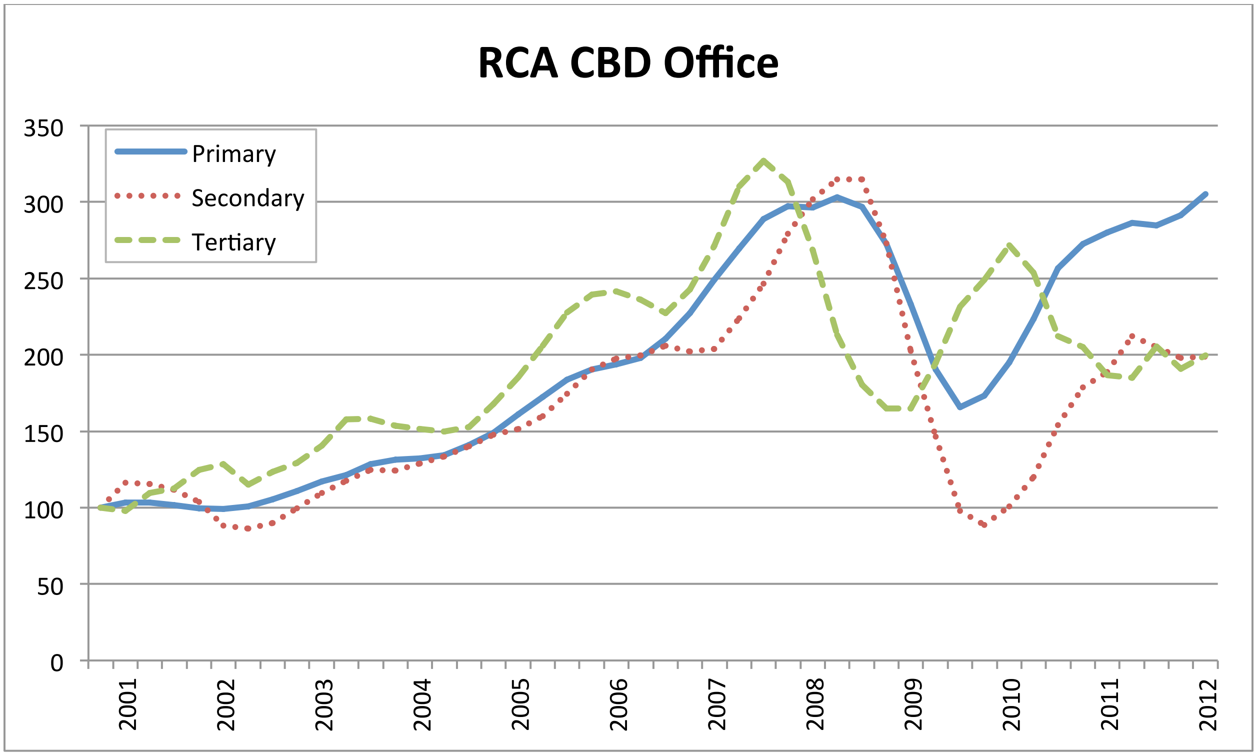


Figure 4.6

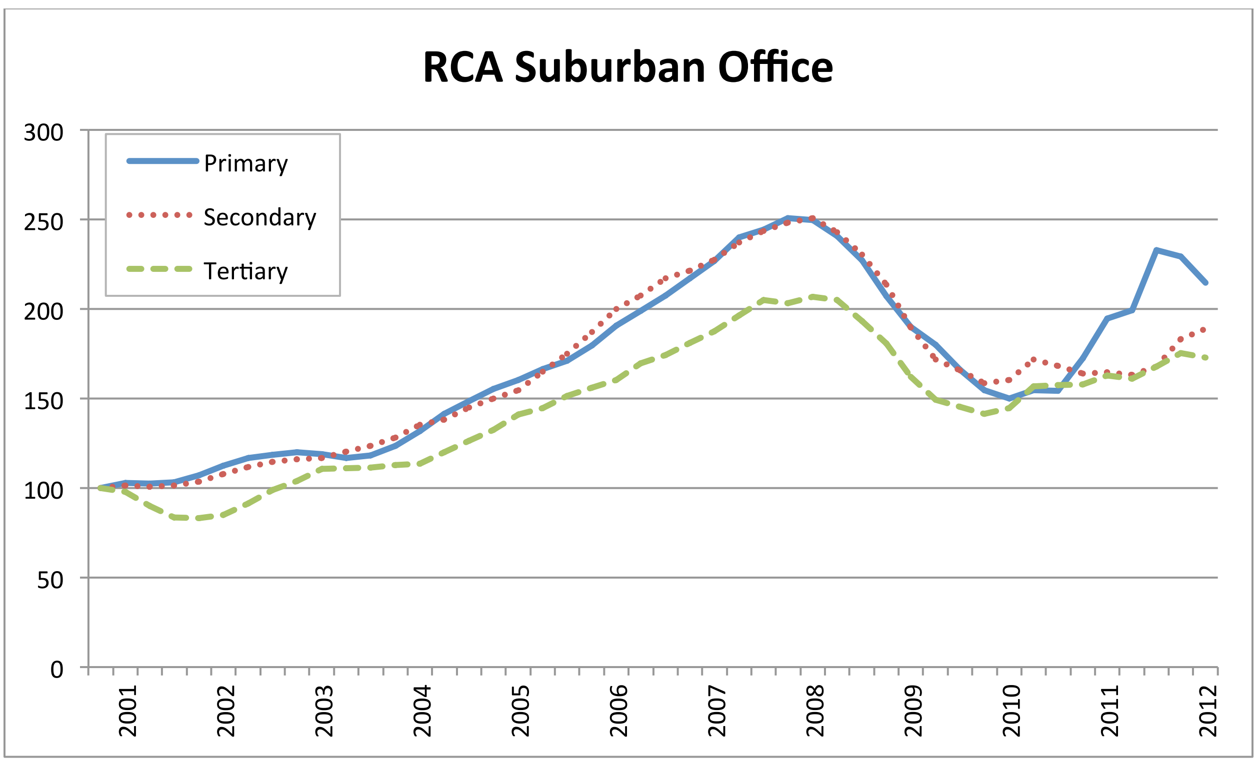


Figure 4.7

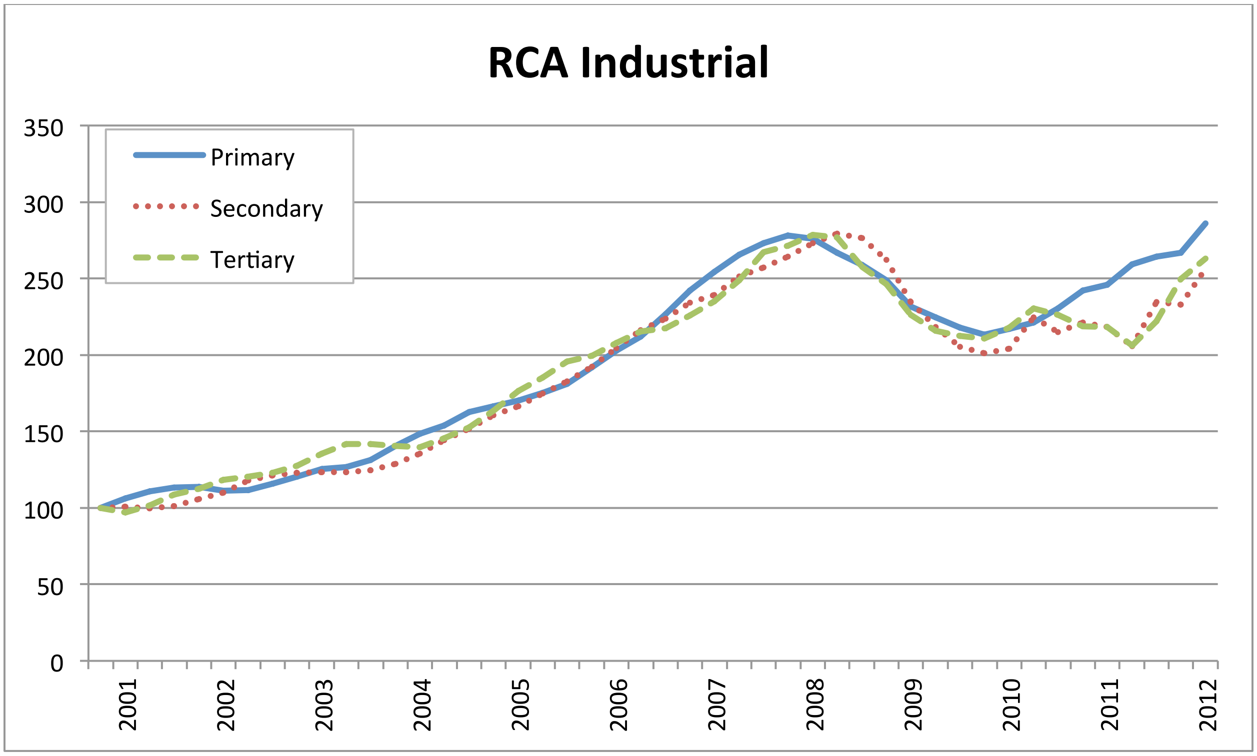


Figure 4.8

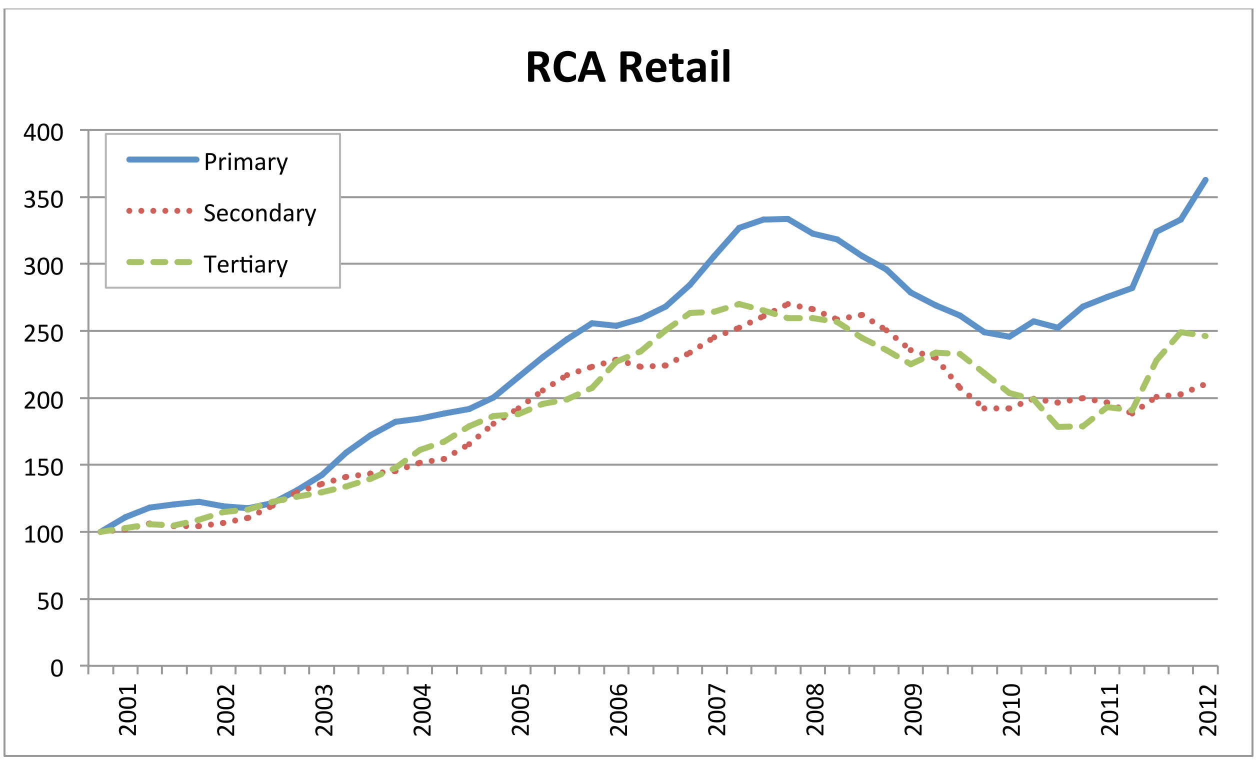


Figure 4.9

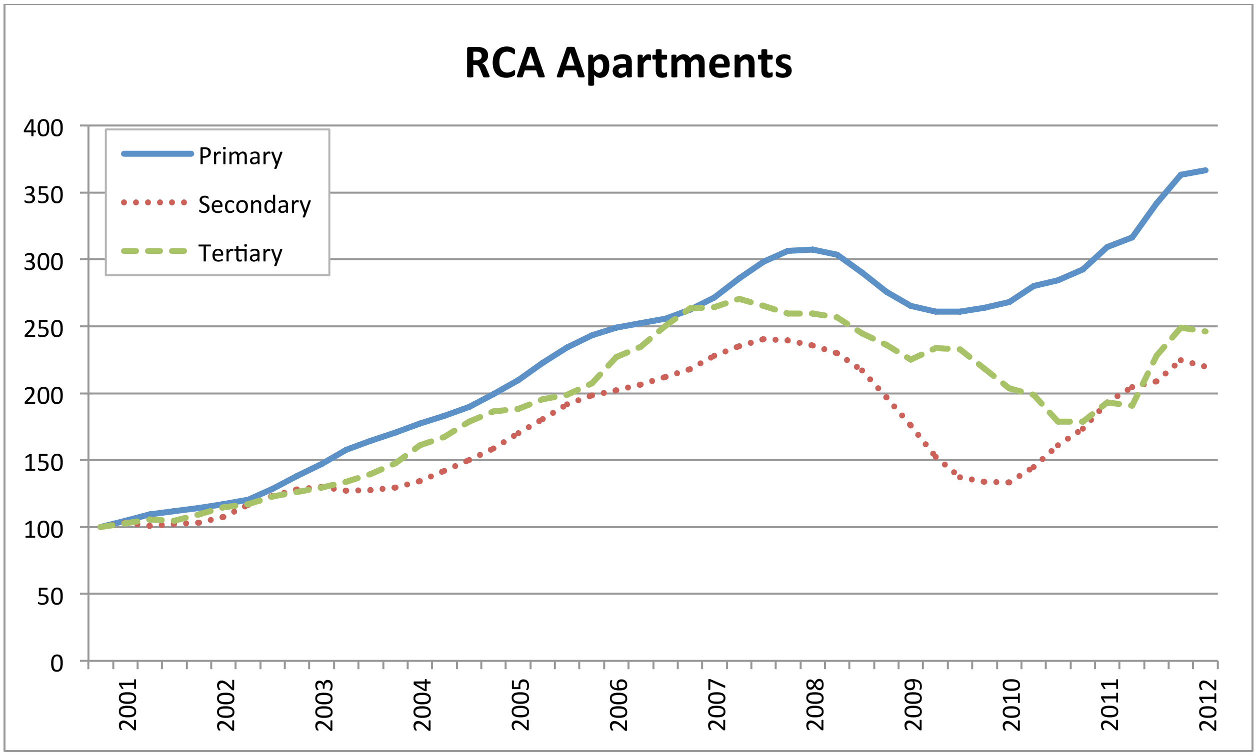


Figure 4.10

RCA Size Portfolios

A set of size-based portfolios (Big, Medium and Small) were created as well. Size has been shown to be an important determinant of return performance. (Esrig, Hudson and Cerreta, 2011) Cutoff points were chosen to create approximately equal portfolios and represent common market place definitions of asset size.

RCA Size Portfolio Cutoff Points

	Office CBD	Office Sub	Industrial	Retail	Apartment
High Cut	$45,000,000	$15,000,000	$12,000,0000	$12,000,000	$14,000,000
Low Cut	$15,000,000	$7,000,000	$5,000,000	$6,000,000	$9,000,000

Table 4.7

The cutoff points were based on the prior sale (original purchase) value in 2010 constant purchasing power dollars. The prior sale dates start in 1988, and the inflation indexing maintains consistent cutoff values for generating the indices. (This is also how the CPPI indices maintain a $2.5mm minimum initial property value requirement as well.) Small Apartments make up a large share of the dataset with 3,648 transactions. CBD Office Medium had the smallest share with just 421 transactions.

RCA Size Portfolio Repeat Sales

	Office CBD	Office Suburban	Industrial	Retail	Apartment	Total
Big	588	1,705	815	1,060	1,862	**6,030**
Medium	421	1,270	1,591	1,074	2,690	**7,046**
Small	583	1,854	1,976	1,648	3,648	**9,709**
Total	**1,592**	**4,829**	**4,382**	**3,782**	**8,200**	**22,785**[11]

Table 4.7

RCA Size Portfolios

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
CBD Office Big	0.027	0.024	0.236	-0.208	0.075	0.240	-0.169	0.779
Medium	0.030	0.025	0.337	-0.257	0.098	0.322	-0.086	0.723
Small	0.019	0.018	0.107	-0.083	0.051	0.167	-0.027	0.596
Suburban Office Big	0.017	0.016	0.120	-0.099	0.044	0.154	0.414	0.792
Medium	0.013	0.011	0.161	-0.152	0.060	0.179	-0.037	0.627
Small	0.018	0.017	0.095	-0.062	0.038	0.122	0.381	0.577
Industrial Big	0.018	0.016	0.126	-0.138	0.057	0.195	-0.274	0.623
Medium	0.022	0.021	0.080	-0.114	0.041	0.114	0.285	0.789
Small	0.027	0.027	0.132	-0.040	0.039	0.127	0.196	0.590
Retail Big	0.022	0.021	0.142	-0.068	0.049	0.143	0.531	0.417
Medium	0.020	0.019	0.102	-0.118	0.048	0.154	0.512	0.721
Small	0.025	0.024	0.121	-0.060	0.035	0.109	0.396	0.406
Apartment Big	0.025	0.024	0.112	-0.151	0.055	0.170	0.116	0.840
Medium	0.020	0.019	0.131	-0.095	0.041	0.144	0.384	0.737
Small	0.029	0.028	0.115	-0.052	0.037	0.136	0.354	0.781
Average	0.022	0.021	0.141	-0.113	0.051	0.165	0.198	0.666
Standard Deviation	0.005	0.005	0.065	0.061	0.017	0.055	0.260	0.134
Max	0.030	0.028	0.337	-0.040	0.098	0.322	0.531	0.840
Min	0.013	0.011	0.080	-0.257	0.035	0.109	-0.274	0.406

Table 4.8

RCA Size Descriptive Statistics. The RCA Size Portfolios exhibit a similar range of mean returns as the Metro Tier portfolios. Small properties outperformed Big and Medium size properties in all categories except CBD Office, where the Small properties had the lowest return. Small Apartments had the highest total return (2.8%) and Suburban Office Medium had the lowest total return (1.1%). Small properties also have the lowest annual standard deviations in CBD Office, Suburban Office, Retail, and

[11] Sales through April 2012.

Apartments. Within the Industrial property segment, the Medium tier portfolio had the lowest annual standard deviation, and Industrial had the lowest standard deviations among the property types.

RCA Size Time Series Graphs. There are a few interesting things to note in Figures 4.11-4.15. First, Big CBD Office tends to lead the Medium and Small portfolios. Second, Small Retail performed remarkably well during the downturn and declined only slightly.

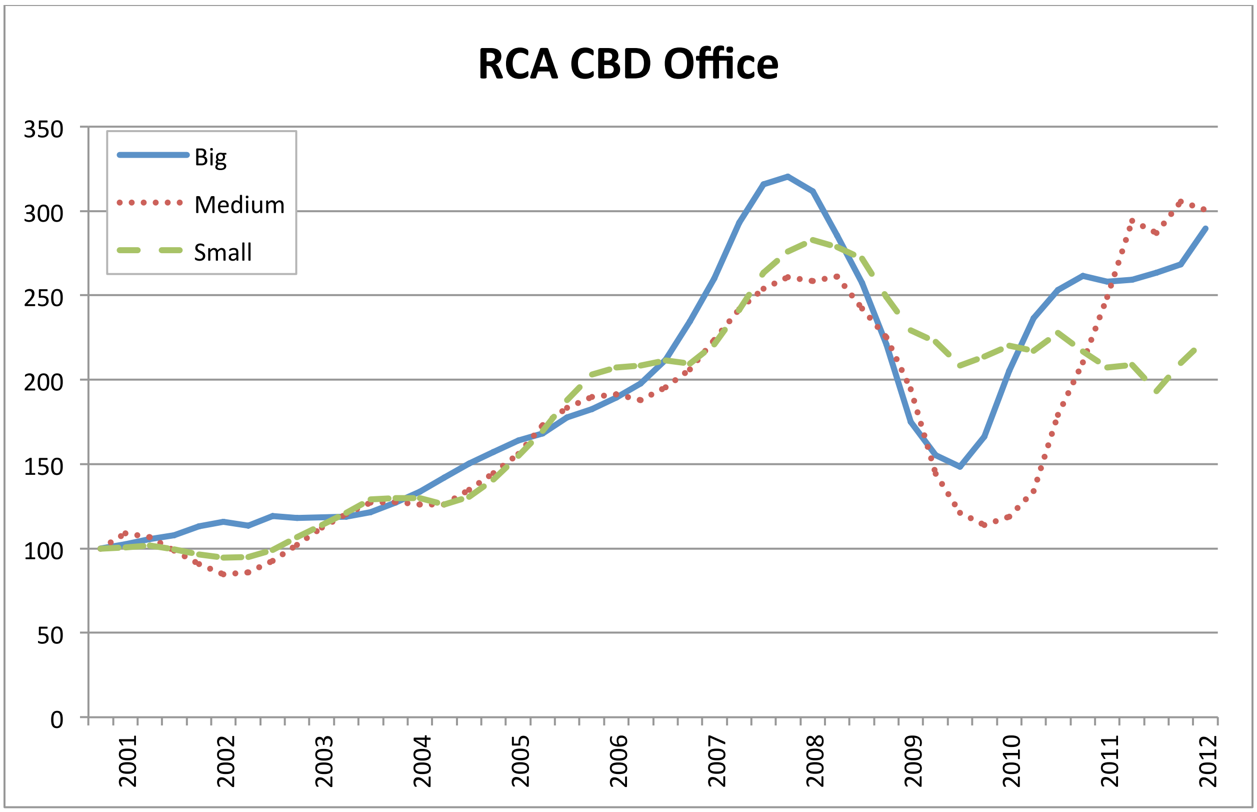


Figure 4.11

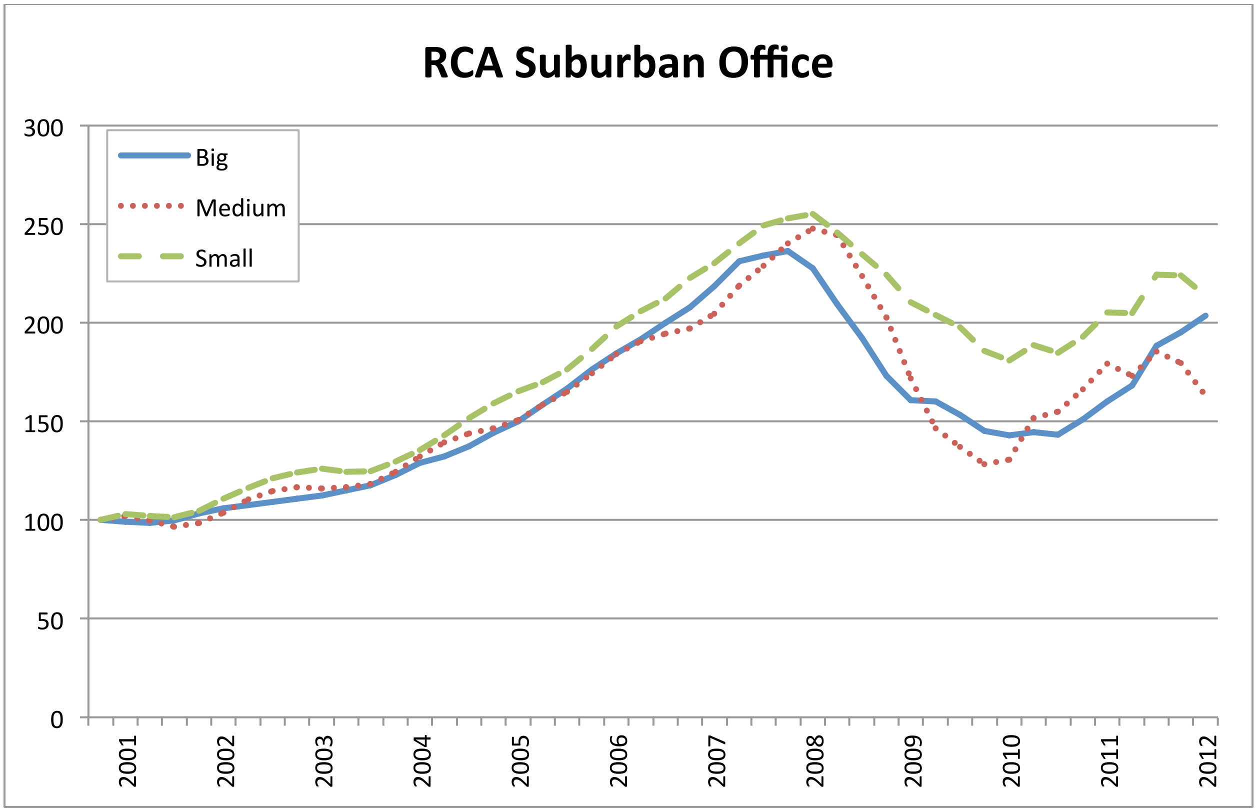


Figure 4.12

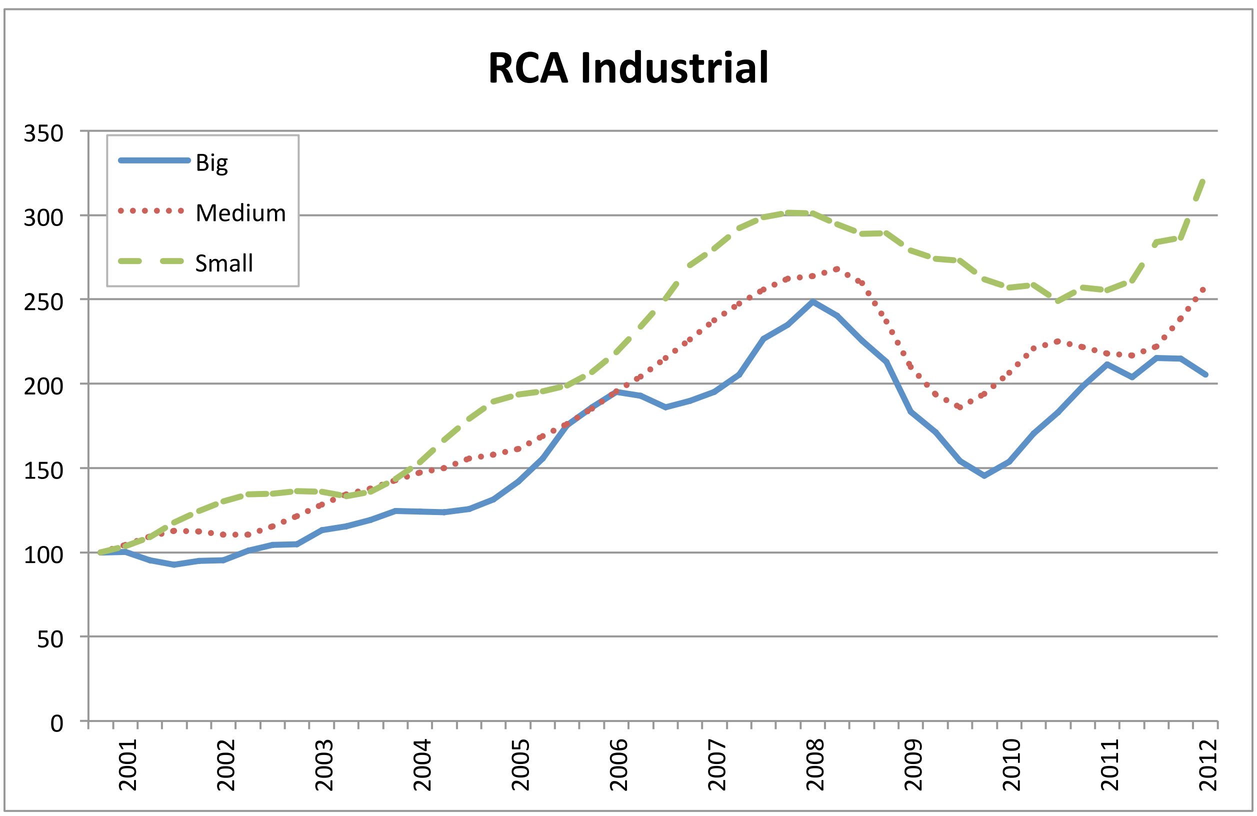


Figure 4.13

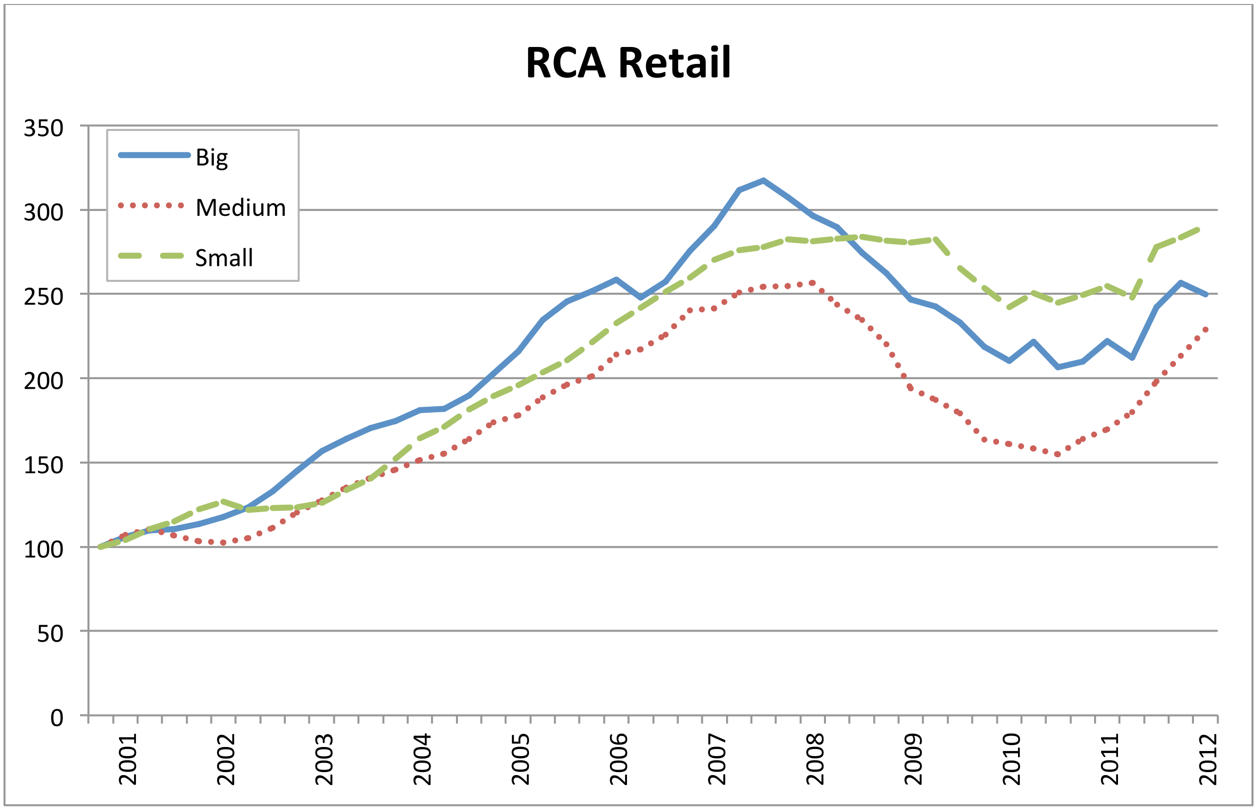


Figure 4.14

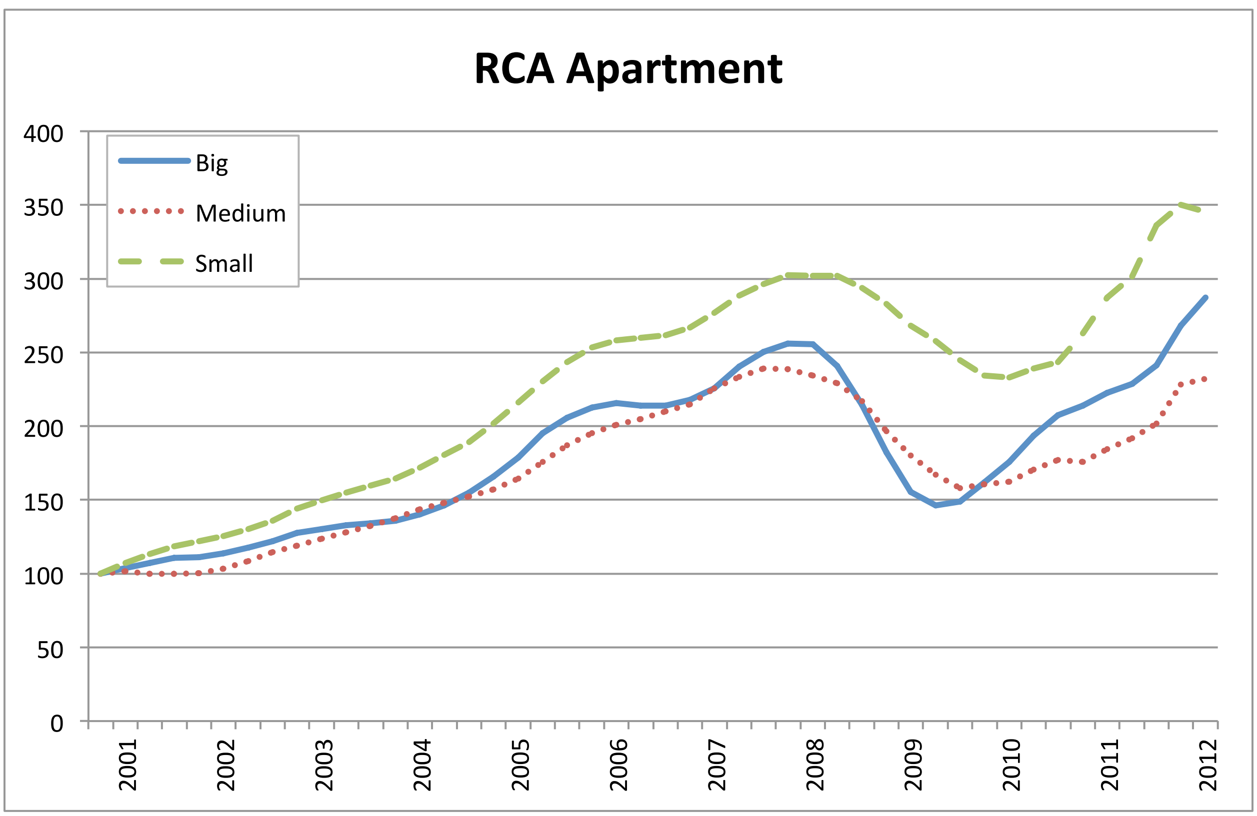


Figure 4.15

NCREIF Metro Tier Portfolios

The NCREIF Metro Indices were constructed with the same methodology described in the previous chapter. The only change was to account for splitting the Non-Major tier into Secondary and Tertiary indices as previously described for the RCA Metro tier portfolios.

NCREIF Metro Descriptive Statistics. The NCREIF Metro tier portfolios exhibited the same mean return (2.2%) and quarterly volatility (5.5%) as the RCA Market tier portfolios. Major tiers dominated the index, outperforming Secondary and Tertiary in all property types. This is consistent with the RCA portfolios and Pai and Geltner's 2007 study. CBD Office and Industrial had the largest range of returns within the property types. CBD Office and Retail Major had the highest total returns (2.8%) and Suburban Office Secondary had the lowest (1.6%). The results for quarterly volatility were mixed among the property types, Suburban Office and Apartments had the highest in the Major tier, Retail had the highest in the Secondary tier, and CBD Office and Industrial had the highest in Tertiary metros.

NCREIF Metro Tier Portfolios

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
CBD Office Major	0.028	0.027	0.085	-0.089	0.035	0.126	0.307	0.813
Secondary	0.020	0.018	0.109	-0.100	0.041	0.146	0.405	0.780
Tertiary	0.011	0.020	0.182	-0.082	0.045	0.153	0.386	0.633
Suburban Office Major	0.019	0.018	0.074	-0.093	0.035	0.124	0.363	0.821
Secondary	0.016	0.016	0.074	-0.066	0.030	0.113	0.503	0.848
Tertiary	0.018	0.017	0.130	-0.073	0.033	0.111	0.365	0.578
Industrial Major	0.025	0.024	0.100	-0.082	0.035	0.124	0.498	0.759
Secondary	0.019	0.018	0.072	-0.068	0.028	0.098	0.385	0.778
Tertiary	0.018	0.017	0.095	-0.152	0.040	0.130	0.451	0.453
Retail Major	0.028	0.028	0.100	-0.063	0.029	0.092	0.516	0.633
Secondary	0.027	0.026	0.183	-0.071	0.036	0.121	0.446	0.588
Tertiary	0.026	0.025	0.118	-0.067	0.031	0.113	0.640	0.667
Apartment Major	0.026	0.025	0.105	-0.086	0.033	0.115	0.248	0.749
Secondary	0.025	0.024	0.079	-0.065	0.030	0.112	0.301	0.843
Tertiary	0.024	0.023	0.086	-0.065	0.029	0.106	0.309	0.808
Average	0.022	0.022	0.106	-0.081	0.034	0.119	0.408	0.717
Standard Deviation	0.005	0.004	0.035	0.023	0.005	0.016	0.103	0.118
Max	0.028	0.028	0.183	-0.063	0.045	0.153	0.640	0.848
Min	0.011	0.016	0.072	-0.152	0.028	0.092	0.248	0.453

Table 4.10

NCREIF Metro Times Series Graphs. CBD Office Major consistently outperformed the Secondary and Tertiary indices while exhibiting lower volatility. CBD Office indices appear to be more correlated than the RCA indices, as do all the NCREIF Metro tier indices with the exception of the Industrial portfolios. The Industrial Tertiary index peaked first and led the Major and Secondary Metro tiers into decline.

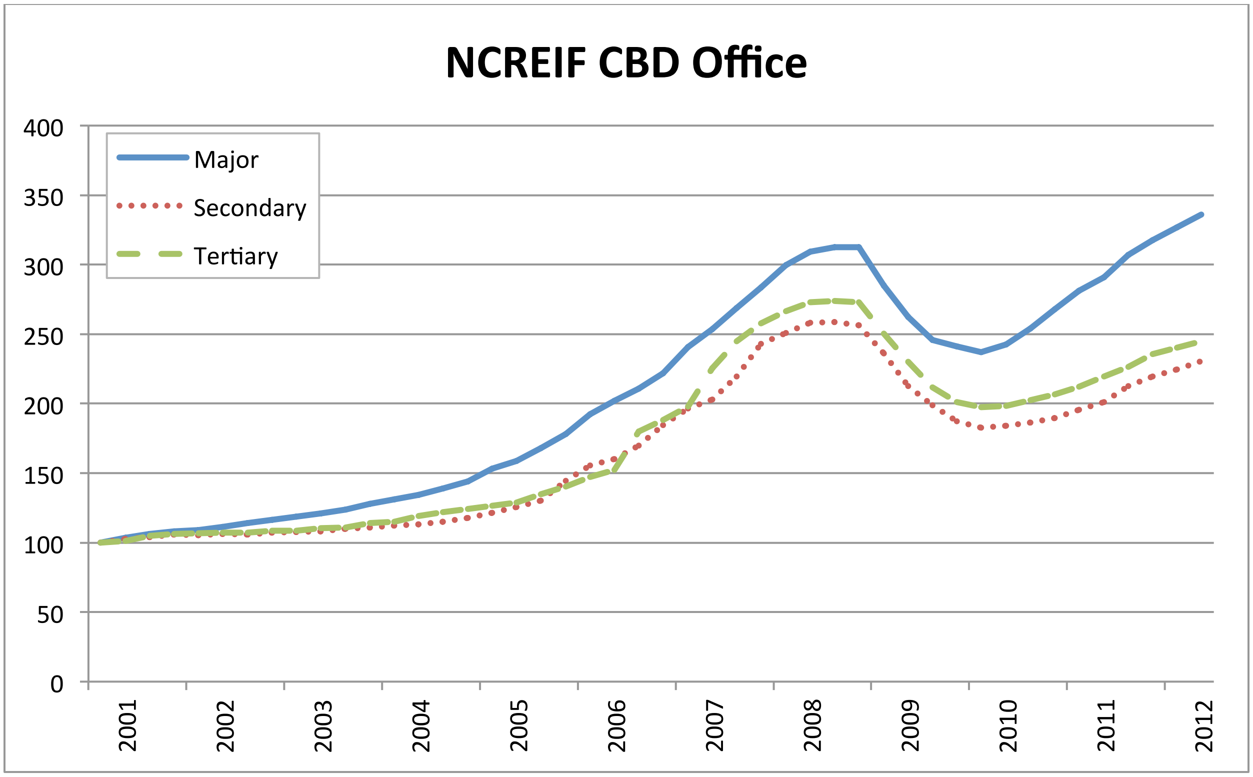


Figure 4.16

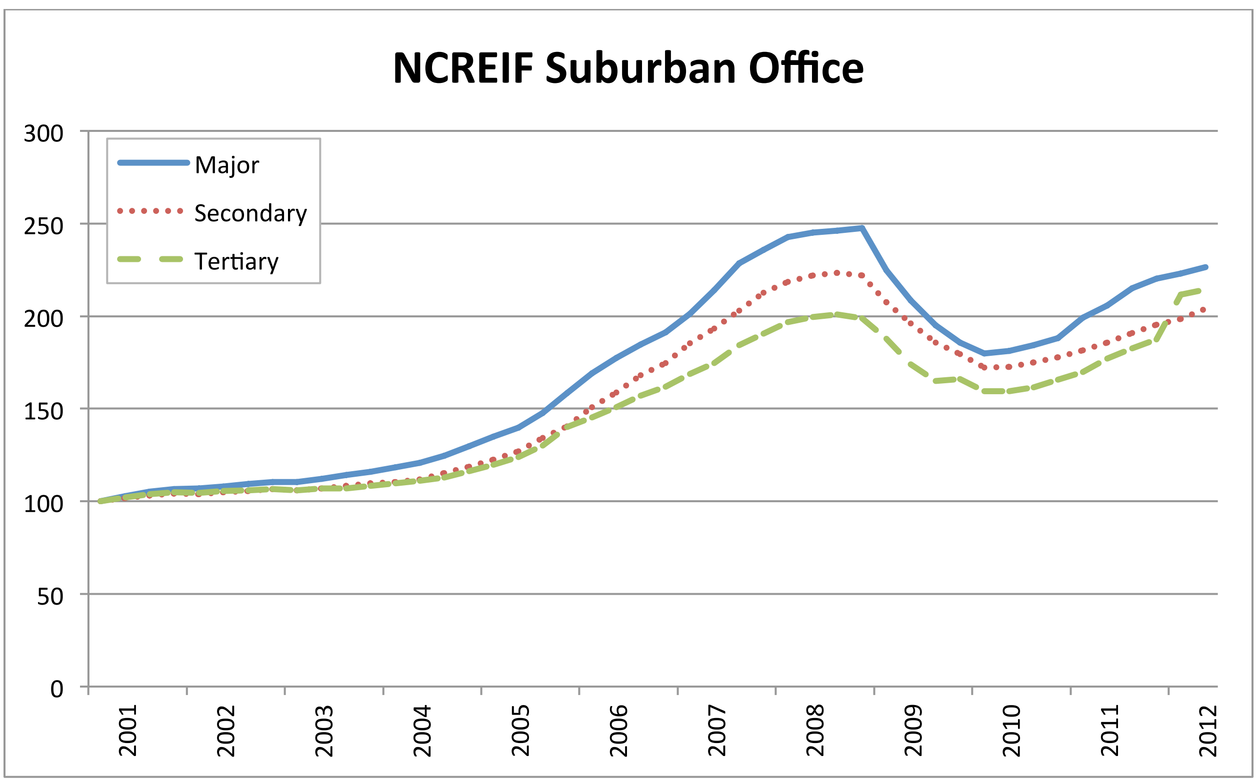


Figure 4.17

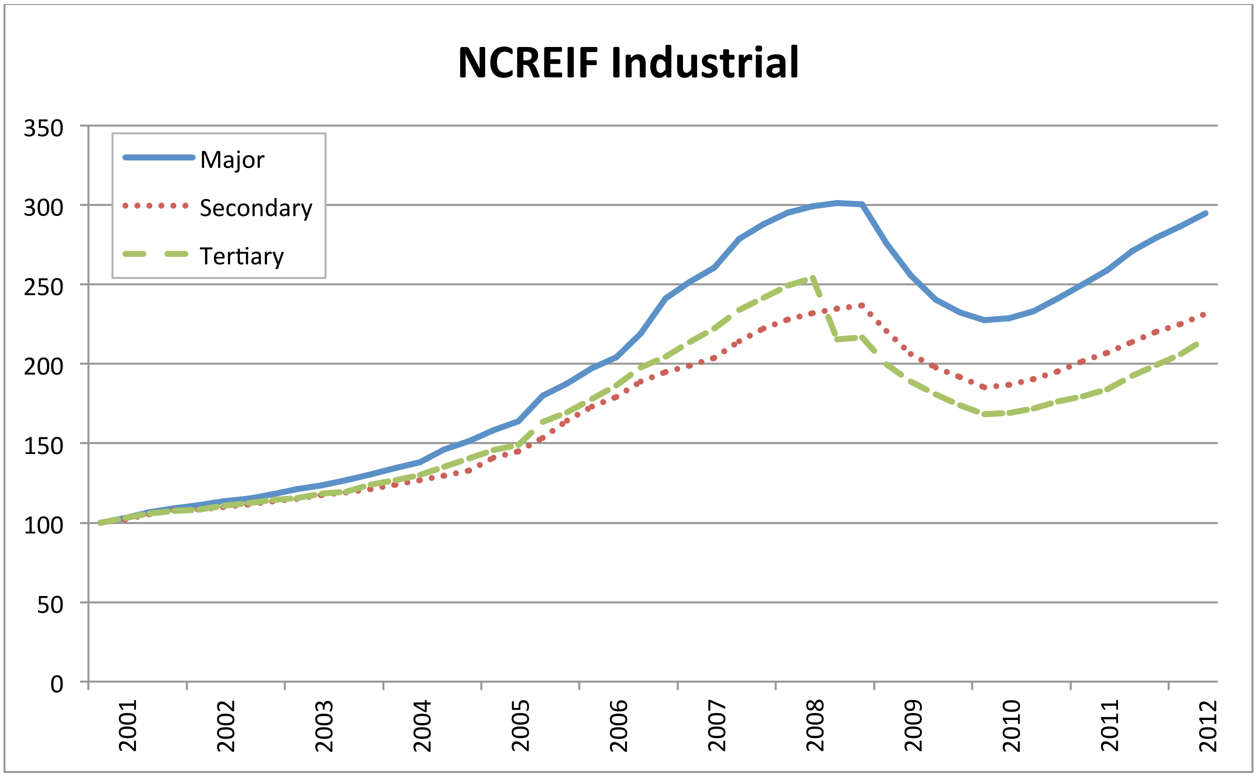


Figure 4.18

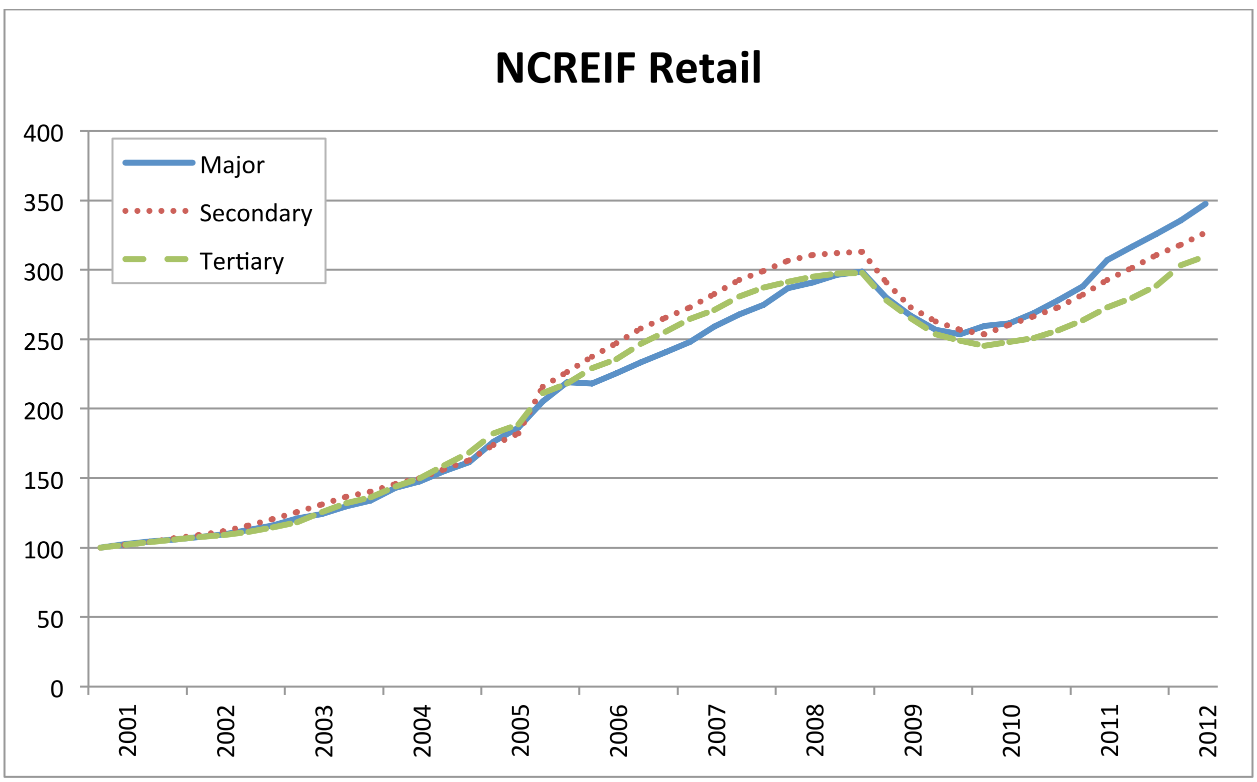


Figure 4.19

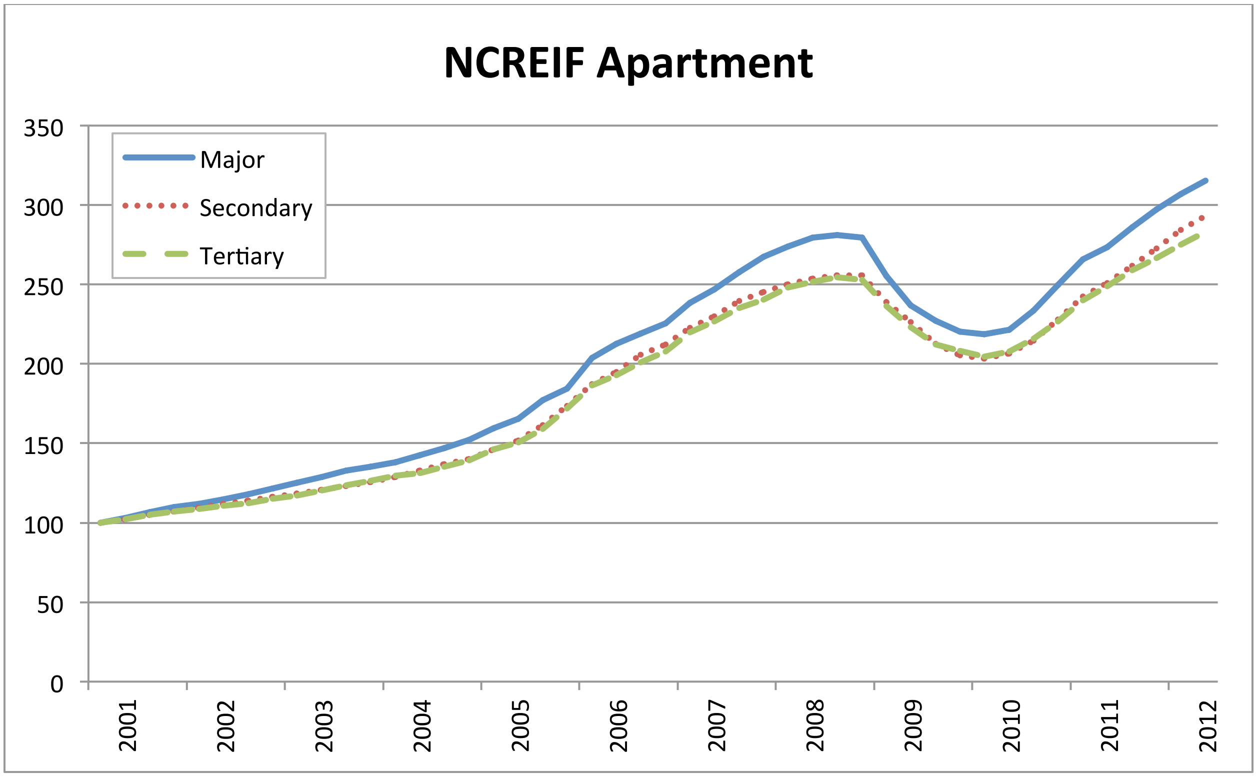


Figure 4.20

NCREIF Size Portfolios

The NCREIF-based size portfolios were constructed differently than the RCA-based indices for several reasons. NCREIF's capital returns are based on appraised values reported by member institutions, and RCA's capital returns are based on repeat sale transactions. Hence, NCREIF collects times series information on values for each property, whereas RCA collects values at only two points in time (purchase and sale) on each property in the database. Also, the properties in the NCREIF database are larger on average than the RCA dataset. To deal with the latter, the NCREIF cutoff values were increased for each property type to create approximately equal sized portfolios. To deal with the former, the RCA Size portfolios were sorted on the inflation adjusted prior sales value in each repeat sale transaction, whereas the NCREIF Size Tier portfolios were based on all the properties in the database whose reported value in a given period falls within the cutoff points outlined in Table 4.11.[12]

[12] This is a change from Pai and Geltner where the authors rebalanced the portfolios each year based on percentage cutoff points centered on the mean value.

NCREIF Size Portfolio Cutoff Points

	Office CBD	Office Sub	Industrial	Retail	Apartment
High Cut	$110,000,000	$35,000,000	$18,000,000	$35,000,000	$50,000,000
Low Cut	$40,000,000	$15,000,000	$7,000,000	$16,000,000	$19,000,000

Table 4.11

Descriptive Statistics. In the NCREIF Size portfolios, the Small portfolios recorded a higher mean total return than the Big and Medium portfolios in all property types except for Industrial, where the Big properties had the highest total return. This set of indices exhibited the largest range of returns with Small Apartments reporting a total return high of 3.2% and Medium Suburban Office reporting the lowest return of 1.3%. Medium sized properties had the lowest return and annual standard deviation across most portfolios. The CBD Office Small index had the highest (22.1%) annual standard deviation, and Retail Medium had the lowest annual standard deviation (9.2%). This was the opposite result to Esrig, Hudson and Cerreta's 2011 study where "trophy" or large Office, Retail and Multifamily assets outperformed the rest of the market from 1987-1999, although the NCREIF Size definition employed in this study is not a direct comparison to the "trophy" category.

NCREIF Size Tier Portfolios

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Ann Vol	Ann AC1	Qrtly AC1
CBD Office Big	0.024	0.023	0.073	-0.078	0.033	0.120	0.243	0.803
Medium	0.019	0.018	0.058	-0.097	0.032	0.118	0.296	0.823
Small	0.030	0.028	0.205	-0.114	0.059	0.221	0.451	0.666
Suburban Office Big	0.018	0.017	0.060	-0.068	0.028	0.108	0.377	0.875
Medium	0.014	0.013	0.045	-0.071	0.027	0.100	0.405	0.863
Small	0.023	0.022	0.123	-0.089	0.044	0.167	0.447	0.690
Industrial Big	0.023	0.022	0.071	-0.078	0.028	0.104	0.399	0.783
Medium	0.018	0.018	0.055	-0.078	0.026	0.096	0.425	0.795
Small	0.020	0.018	0.113	-0.208	0.052	0.175	0.484	0.444
Retail Big	0.025	0.024	0.069	-0.068	0.026	0.101	0.516	0.826
Medium	0.023	0.022	0.063	-0.070	0.026	0.093	0.491	0.794
Small	0.032	0.031	0.287	-0.061	0.049	0.142	0.634	0.331
Apartment Big	0.027	0.026	0.099	-0.074	0.032	0.122	0.228	0.792
Medium	0.021	0.020	0.065	-0.068	0.026	0.098	0.201	0.836
Small	0.034	0.032	0.197	-0.069	0.049	0.197	0.383	0.684
Average	0.023	0.022	0.106	-0.086	0.036	0.131	0.399	0.734
Standard Deviation	0.006	0.005	0.070	0.036	0.011	0.041	0.118	0.155
Max	0.034	0.032	0.287	-0.061	0.059	0.221	0.634	0.875
Min	0.014	0.013	0.045	-0.208	0.026	0.093	0.201	0.331

Table 4.12

Time Series Graphs. Small return outperformance is the most noticeable difference in the NRCEIF and RCA datasets and times series graphs. Interestingly, most of the Small property outperformance came in the period 2005-2008. Condo conversions are one explanation for Small outperformance in the RCA Size portfolios. However, it is unclear what caused the spike in the other property types. Also, the Small property outperformance is much clearer and persistent across property types in the NCREIF data, with the exception of the Industrial indices, where the Small index dropped substantially in 2008 and has lagged Big properties in the recovery. This behavior is not apparent in the RCA dataset, which has a similar low cutoff point ($5mm vs. $7mm).

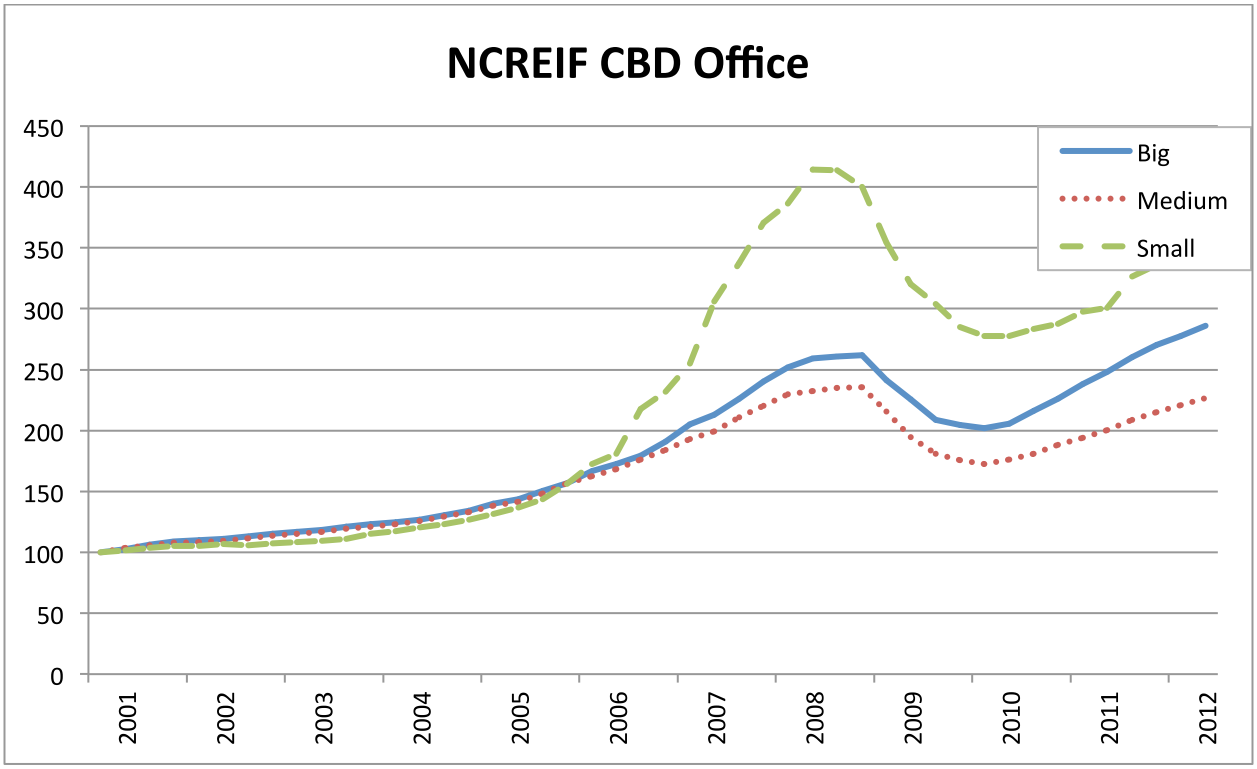


Figure 4.21

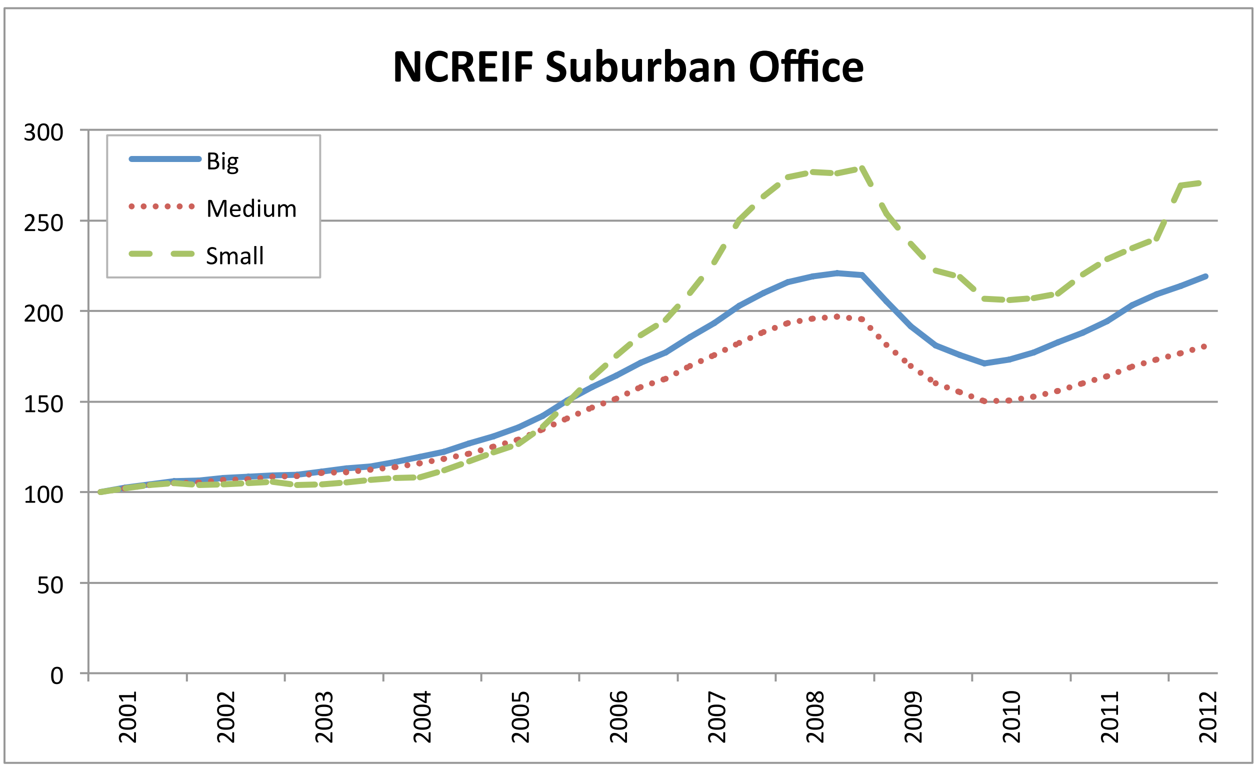


Figure 4.22

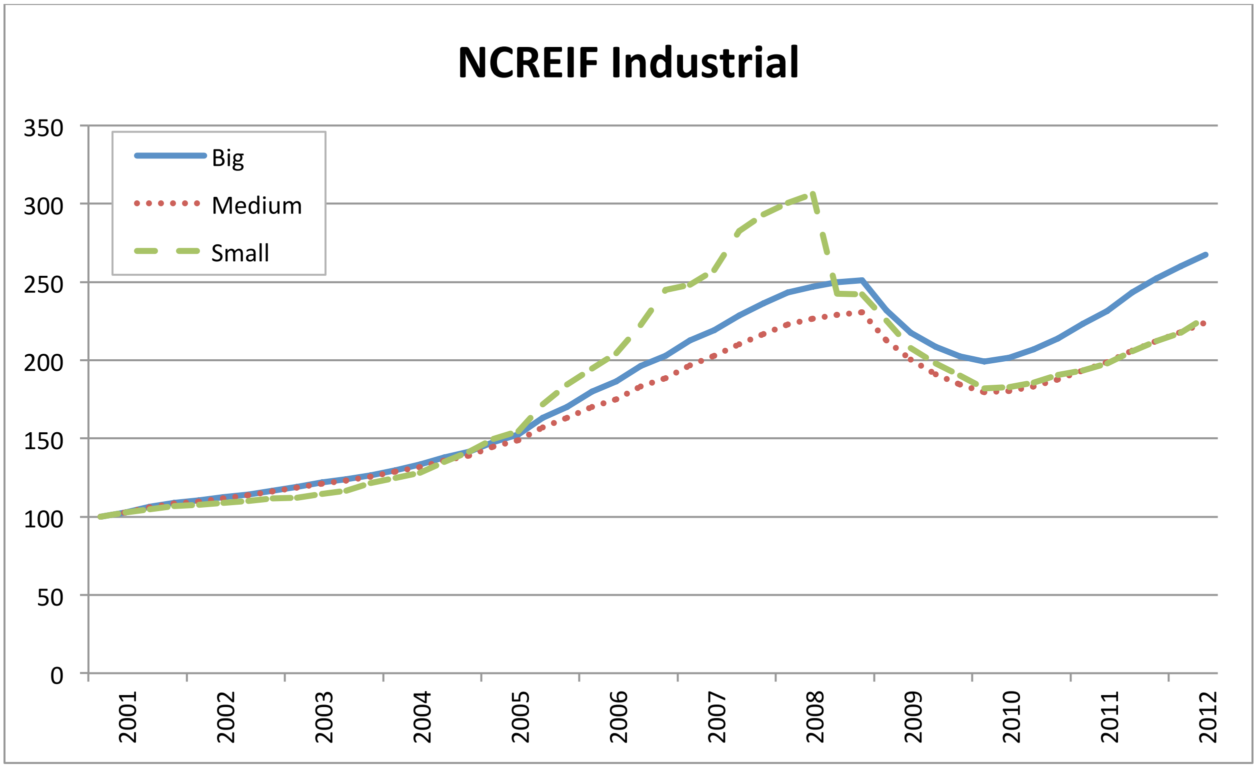


Figure 4.23

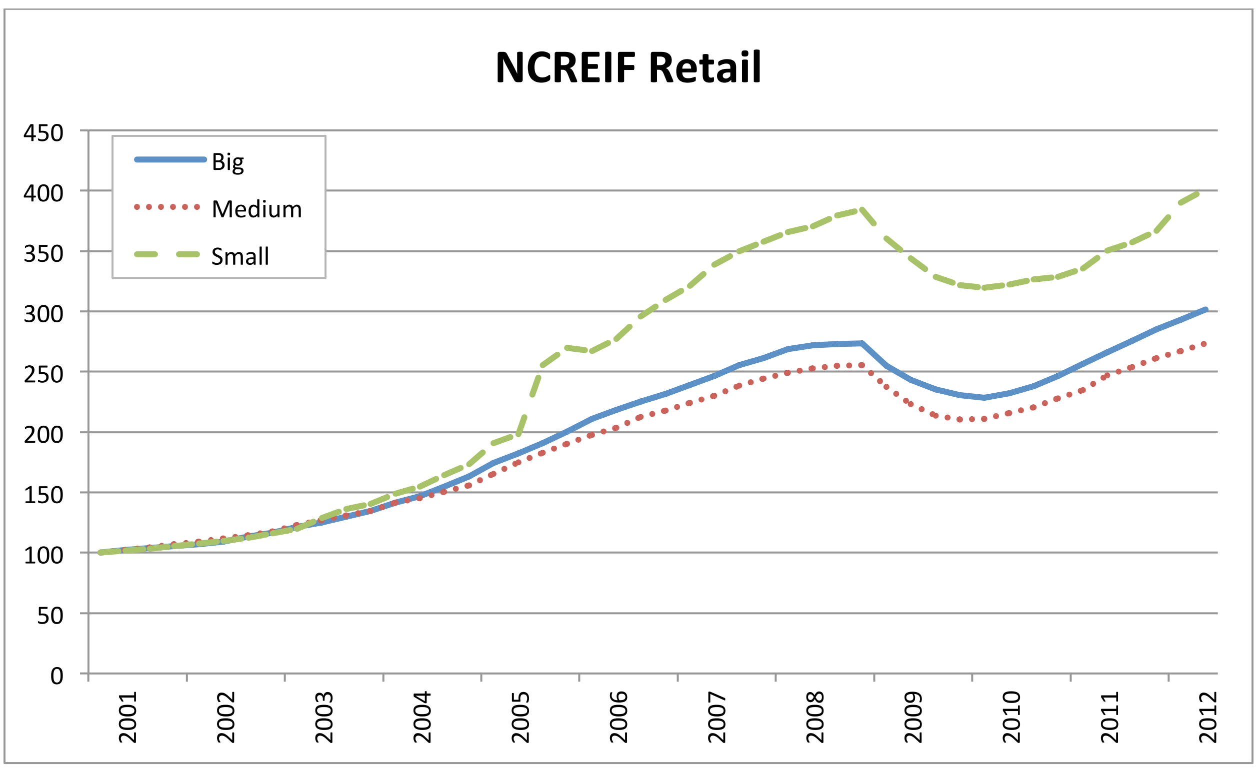
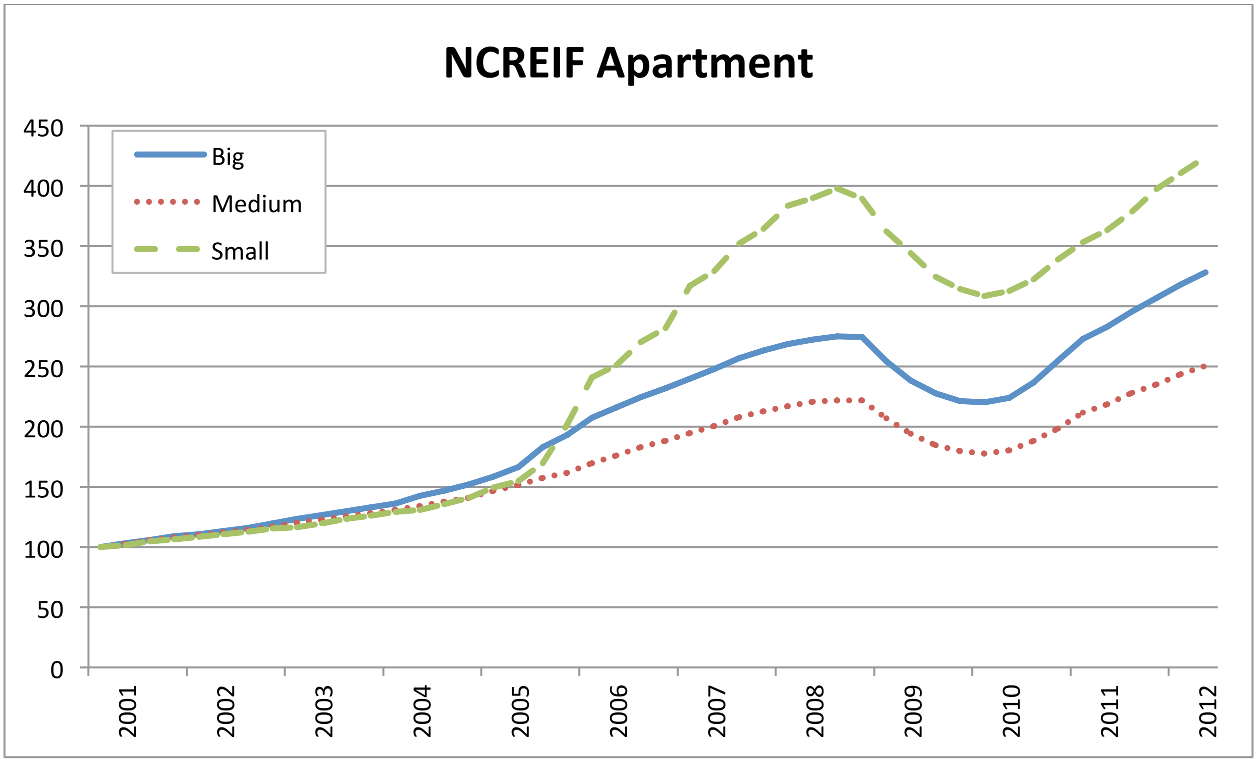


Figure 4.24



NCREIF Apartment
450
400
350
300
250
200
150
100
50
0
Big
Medium
Small
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

Figure 4.25

Chapter 5: Asset Pricing Models

Four asset pricing models were tested for the Size and Metro Tier portfolios in the RCA and NCREIF datasets. All the models use the standard two-stage regression. First, time series regressions were run to estimate betas for each of the portfolios, and second cross-sectional regressions were run to test whether the risk factors explained the cross-section of mean returns.

The CAPM (or Index) Model: The most basic model and the classic asset pricing model. First, the risk premia[13] from each portfolio were regressed onto the market index (either the CPPI National or NCREIF NPI) to estimate the betas using a time-series regression. Following the lead of Pai and Geltner, no correction was made for appraisal-smoothing issues in the NRCEIF database because the appraisal-based values on the both sides of the regression equation cancel out the smoothing. It should also be noted that while the NCREIF NPI Index (or CPPI National) is not the equivalent of the market portfolio described in the classical CAPM theory, as described by Pai and Geltner [2007], "the beta with respect to NCREIF can serve well as a measure of the relative market risk under the assumption that the real estate portfolios' true market-portfolio-based betas equal their betas with respect to NCREIF times the beta of the aggregate NCREIF Index with respect to the true market portfolio. This would seem like a plausible assumption for purposes of modeling the relative market risk ***within*** the institutional real estate asset class." The first pass regression equation was:

$$r_{it} - r_{ft} = a_i + b_i(r_{Mt} - r_{ft}) + e_{it}$$

where:

r_{ft} = Return on U.S. Treasury Bills
r_{it} = Return per quarter on the property portfolio over the sample period
r_M = Return per quarter on the market index over the sample period
b_i = Sample estimate of the beta coefficient of the portfolio

The second pass regression is the asset pricing model test. The average risk premia per quarter from 2001-2012 for the 15 portfolios were regressed onto the betas (or slope coefficients from the regression equation) calculated in the first stage. A positive result for the model would be a high R^2, statistically insignificant intercept (γ_0) of zero, a positive and statistically significant loading (γ_1) for beta. The second pass regression equation was:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_{\mathrm{i}}$$

[13] Total return on the portfolio minus the return on 3-month US Treasury Bills.

Where:

$\overline{r_i - r_f}$ = Sample average of the excess return of the portfolio

CAPM with Property Type Interactive Effects. This model is very similar to the CAPM model previously described, except that in the second pass, the coefficients for beta are combined with property type dummy variables to create interactive effects. While adding elements to the right side of the equation dilutes the power of the test, the property type variables add an additional and important risk factor for each portfolio. A positive result would be a high R^2, statistically insignificant intercept of zero, and a statistically significant loading (or coefficient) for as many of the factors as possible. The second pass regression equation was:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_{\mathrm{CBD}} b_{\mathrm{i}} D_{CBD} + \gamma_{Sub} b_{\mathrm{i}} D_{Sub} + \gamma_{Ind} b_{\mathrm{i}} D_{Ind} + \gamma_{\mathrm{Ret}} b_{\mathrm{i}} D_{Ret} + \gamma_{\mathrm{Apt}} b_{\mathrm{i}} D_{Apt} + e_i$$

Where:

D_{CBD} = 1 if the portfolio represents CBD Office properties, 0 otherwise
D_{Sub} = 1 if the portfolio represents Suburban Office properties, 0 otherwise
D_{Ind} = 1 if the portfolio represents Industrial properties, 0 otherwise
D_{Ret} = 1 if the portfolio represents Retail properties, 0 otherwise
D_{Apt} = 1 if the portfolio represents Apartments properties, 0 otherwise

Fama-French Style Multifactor Model. This model is the Fama-French style model proposed by Pai and Geltner. This adds two additional risk factors to the CAPM model, one to account for the difference between the return on Small and Big properties, and the other to account for the difference between the return on properties in Major and Tertiary metro tiers. Again, a positive result would be a high R^2, statistically insignificant intercept of zero, and a statistically significant loading for as many factors as possible. The first pass regression equation was:

$$r_{it} - r_{ft} = a_i + b_i(r_{Mt} - r_{ft}) + s_i SMB_t + m_i MMT_t + e_{it}$$

where:

SMB_t = Return on a portfolio of Small properties minus the return on a portfolio of Big properties
MMT_t = Return on a portfolio of properties in Major metros minus a return on a portfolio properties in Tertiary metros
s_i = Sample estimate of the SMB factor coefficient
m_i = Sample estimate of the MMT factor coefficient

The second pass regression equation was:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_{\mathrm{i}} + \gamma_2 s_{\mathrm{i}} + \gamma_3 m_{\mathrm{i}} + e_i$$

Multifactor Fama-French Style with Property Type Dummy Variables. The last model adds an additional risk factor, property type, to the Fama-French style model. A positive result is the same as previously described. This model proved to be the most effective in explaining the cross-section of long-run average total return performance. The first pass regression equation is the same as the last model and the second pass regression equation is:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_{\mathrm{i}} + \gamma_2 s_{\mathrm{i}} + \gamma_3 m_{\mathrm{i}} + wSub_i + xInd_i + yRet_i + zApt_i + e_i$$

Where:

Sub_i = 1 if the portfolio represents Office Suburban properties, 0 otherwise
Ind_i = 1 if the portfolio represents Industrial properties, 0 otherwise
Ret_i = 1 if the portfolio represents Retail properties, 0 otherwise
Apt_i = 1 if the portfolio represents Apartments properties, 0 otherwise
(CBD Office is the suppressed variable)

Chapter 6: Results

The time series, or first pass, regression results are included in Appendix C. The cross-sectional, or second pass, regression results for each of the four index sets are included in the tables and figures that follow. A scatter plot of the return-risk relationship accompanies the regression results for each set. The average risk premium per quarter is on the vertical axis and the beta with respect to the market index, measured from the first pass regression, is on the horizontal axis. The scatter plots visualize the power of the risk model. In the classical CAPM theory, assets with a higher beta should receive a higher risk premium, and the portfolios should center on an upward sloping security market line that begins from the intersection point (0.0 beta, 0.0% return) of the two axes.

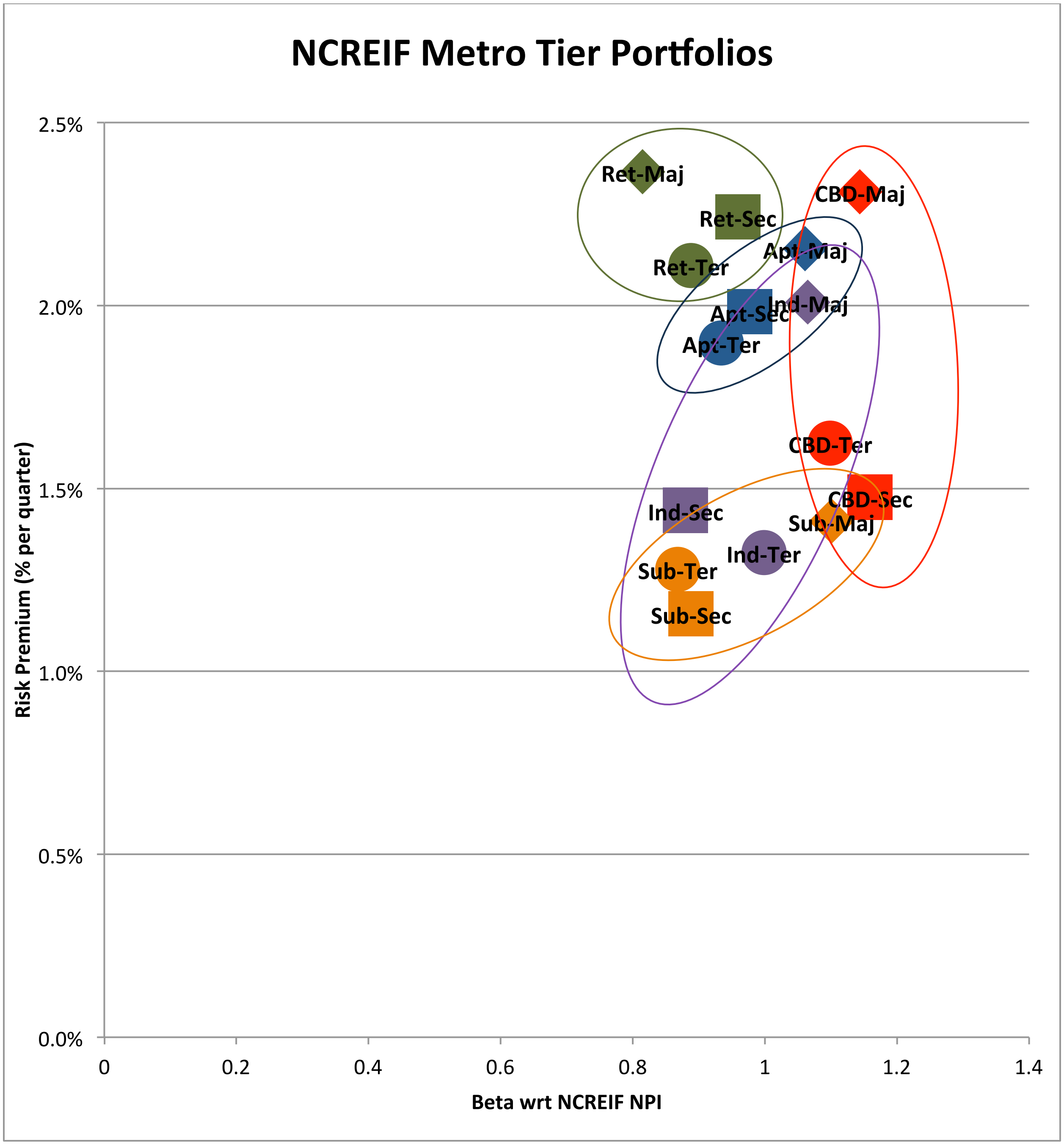
Following the scatter plots for each set of portfolios is a table reporting the results of the four models tested. Panel A reports the CAPM results, Panel B reports the CAPM with Property Type Interactive Effects results, Panel C reports the Multifactor Fama-French results, and Panel D reports the Multifactor Fama-French with Property Type Dummy Variables results.

NCREIF Metro Tier Portfolios

Figure 6.1 shows the return-risk relationship. Circles are drawn around each of the five property types, which appear to cluster in this dataset. (The NCREIF Metro Tier portfolios exhbited the clearest grouping of any of the index sets.) As can be seen, the NCREIF Metro Tier portfolios also had a fairly tight beta range.

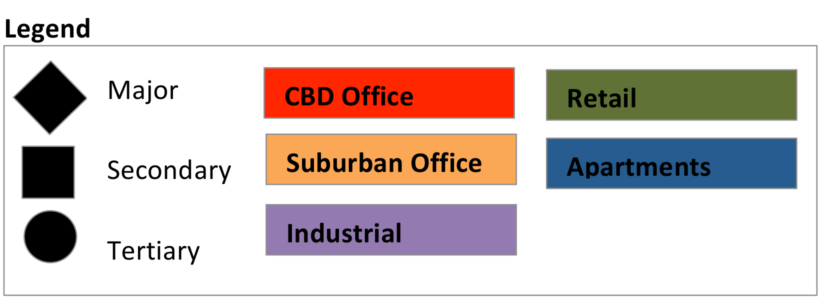
Single Factor CAPM Results. Panel A reports the results of the CAPM model. The results were positive as there was an insignificant intercept near zero and a significant, positive beta loading. However, the adjusted R^2 was fairly low at .22. Adding property type interactive effects significantly improved the model raising the adjusted R^2 to .55 as reported in Panel B. This model also exibited an insignificant intercept near zero, however none of the dummy variables were statistically significant. The Apartment dummy variable was the most significant and also had the highest risk premium.

Multifactor Model Results. Panel C reports the results of the Fama-French style model, which were mixed. The intercept was slightly higher than zero (.016) and also more significant (t-stat of 1.72) than the CAPM model. Neither the Size nor Metro Tier factor was statistically significant. Again, adding property type dummy variables improved the power of the model raising the adjusted R^2 from .21 to .74. The Multifactor Model Fama-French with Property Type Dummy Variables (Panel D) was the best model. The intercept was near zero and statistically insignificant and the beta loading was positive and weakly significant.   The Size factor is negative and weakly significant, indicating that larger properties would command a risk premium. The Metro Tier factor was positive and significant, suggesting that properties in Major Tiers command a risk premium. Only the Apartment property type dummy variable was significant, and it had the highest risk premium (0.6%).   The Suburban Office dummy variable was negative and weakly significant, suggesting that CBD Office commands a higher risk premium (since it was the suppressed variable).



NCREIF Metro Tier Portfolios
Risk Premium (% per quarter)
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Beta wrt NCREIF NPI
Ret-Maj
Ret-Sec
Ret-Ter
CBD-Maj
Apt-Maj
Ind-Maj
Apt-Sec
Apt-Ter
CBD-Ter
CBD-Sec
Sub-Maj
Ind-Sec
Ind-Ter
Sub-Ter
Sub-Sec

Figure 6.1



Legend
Major
Secondary
Tertiary
CBD Office
Suburban Office
Industrial
Retail
Apartments

NCREIF Metro Tiers – Cross-Sectional Regression Results						
	Coefficients	**Std. Error**	**t-stat**	**P-value**	**Lower 95%**	**Upper 95%**
PANEL A						
Single Factor CAPM (df=14)						
Intercept	0.002	0.008	0.258	0.800	-0.014	0.018
Beta	0.016	0.007	2.215	0.045	0.000	0.033
R^2	0.274					
Adj R^2	0.218					
Std. Error	0.005					
PANEL B						
Single Factor with Property Type Interactive Effects (df=10)						
Intercept	0.005	0.010	0.520	0.615	-0.017	0.028
Dummy CBD	0.011	0.009	1.266	0.237	-0.009	0.032
Dummy Suburban	0.008	0.011	0.760	0.466	-0.016	0.032
Dummy Industrial	0.011	0.010	1.071	0.312	-0.012	0.034
Dummy Retail	0.015	0.010	1.476	0.174	-0.008	0.038
Dummy Apartment	0.019	0.011	1.691	0.125	-0.006	0.045
R^2	0.710					
Adj R^2	0.548					
Std. Error	0.003					
PANEL C						
Multifactor Fama French (df=12)						
Intercept	0.016	0.009	1.721	0.113	-0.004	0.036
Beta NCREIF NPI	0.004	0.010	0.451	0.661	-0.017	0.026
Beta Metro	0.004	0.002	2.336	0.039	0.000	0.007
Beta Size	-0.006	0.004	-1.515	0.158	-0.015	0.003
R^2	0.381					
Adj R^2	0.212					
Std. Error	0.004					
PANEL D						
Multifactor Fama French with Property Type Dummy Variables (df=9)						
Intercept	0.005	0.010	0.557	0.595	-0.018	0.029
Beta NCREIF NPI	0.015	0.009	1.703	0.132	-0.006	0.037
Beta Metro	0.003	0.001	2.862	0.024	0.000	0.005
Beta Size	-0.005	0.003	-1.624	0.148	-0.013	0.003
Dummy Suburban	-0.004	0.002	-1.697	0.133	-0.009	0.002
Dummy Industrial	-0.001	0.002	-0.341	0.743	-0.006	0.004
Dummy Retail	0.000	0.003	-0.174	0.867	-0.006	0.006
Dummy Apartment	0.006	0.003	2.063	0.078	-0.001	0.013
R^2	0.872					
Adj R^2	0.743					
Std. Error	0.002					

Table 6.1

NCREIF Size Portfolios

The return-risk scatter plot (Figure 6.2) was less clear for the NCREIF Size portfolios and had slightly more dispersion on the horizontal axis (beta). Circles are drawn around the Big, Medium and Small portfolio sets. The portfolios tended to cluster by Size in this model as opposed to property type in the Metro Tier portfolios. However, there was some evidence of property type influence as the property types loosely align from left-to-right by increasing beta in the following order: Retail, Apartment, Industrial, Suburban Office and CBD Office. The Small properties have higher risk premia and are clustered in the upper-right region of the chart. The Big properties were in the middle range and the Medium properties were in the lower-left region of the chart.

Single Factor CAPM Results. The Single Factor model (Panel A) worked well again with an insignificant intercept near zero, and a positive and significant beta loading. However the model had a low adjusted R^2. Adding property type interactive effects significantly improved the model, increasing the adjusted R^2 to .76, while maintaining the insignificant intercept near zero. However, all of the property type dummy variables were insignificant. The Apartment dummy variable was the most significant (t-stat of 1.691) and (again) had the highest risk premium.

Mulitfactor Model Results. The Multifactor Fama-French results reported in Panel C were positive again with an insignificant intercept near zero and a positive but insignificant beta. However, unlike the Metro Tier portfoios, both Fama-French style factors, Size and Metro Tier, were significant. The Size factor loading was positive this time, reversing the result from Metro Tier results. The positive loading in the Size analysis was a stronger result for two reasons: first, because the portfolios were sorted by size and regressed directly with a size factor on the horizontal axis, and second, because the t-stat was higher. The adjusted R^2 was vastly improved again in the Multifactor model by adding property type dummy variables (Panel D) with an increase from .54 to .85. Also, the Multifactor Fama-French with Property Type Dummy Variables was the best overall model in the study in terms of explaining the cross-section of long-run total return performance. While it had a negative intercept (-.02) that was insignificant, the model exhibited signficant Beta, Size and Metro Tier factor loadings, and significant dummy variables for Apartment and Retail property types. The Apartment dummy also had the highest risk premium (1.1%) in this model.

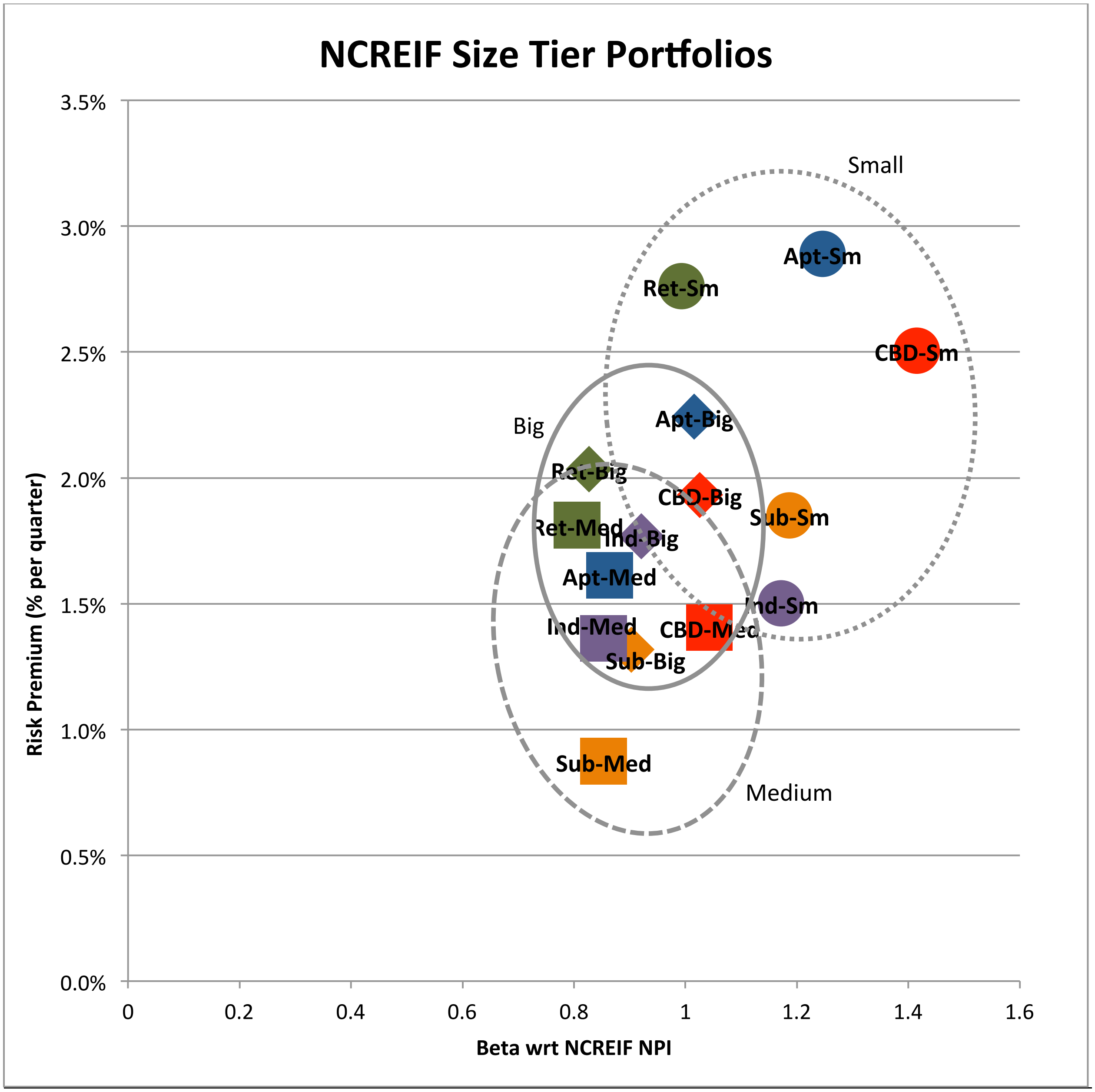
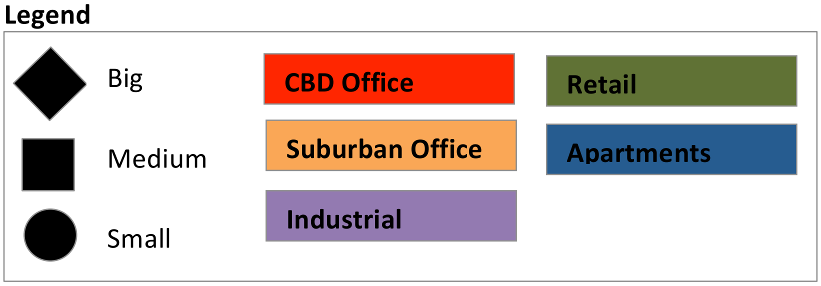


Figure 6.2

Legend



NCREIF Size Portfolios – Cross-Sectional Regression Results

	Coefficients	Std. Error	t-stat	P-value	Lower 95%	Upper 95%
PANEL A						
Single Factor CAPM (df=14)						
Intercept	0.002	0.008	0.258	0.800	-0.014	0.018
Beta	0.016	0.007	2.215	0.045	0.000	0.033
R^2	0.274					
Adj R^2	0.218					
Std. Error	0.005					
PANEL B						
Single Factor CAPM with Interactive Property Type Effects (df=10)						
Intercept	-0.006	0.005	-1.117	0.293	-0.017	0.006
Dummy CBD	0.022	0.004	4.834	0.001	0.012	0.032
Dummy Suburban	0.020	0.005	3.701	0.005	0.008	0.032
Dummy Industrial	0.021	0.005	3.965	0.003	0.009	0.033
Dummy Retail	0.027	0.005	5.433	0.000	0.016	0.038
Dummy Apartment	0.032	0.006	5.276	0.001	0.018	0.045
R Squared	0.848					
Adj R Squared	0.764					
Std. Error	0.003					
PANEL C						
Multifactor Fama French (df=12)						
Intercept	0.004	0.010	0.447	0.664	-0.017	0.026
Beta NCREIF NPI	0.014	0.011	1.282	0.226	-0.010	0.037
Beta Metro	0.007	0.002	2.850	0.016	0.001	0.012
Beta Size	0.004	0.002	2.429	0.033	0.000	0.008
R^2	0.635					
Adj R^2	0.536					
Std. Error	0.004					
PANEL D						
Multifactor Fama French with Property Type Dummy Variables (df=9)						
Intercept	-0.020	0.014	-1.415	0.200	-0.054	0.014
Beta NCREIF NPI	0.036	0.014	2.593	0.036	0.003	0.068
Beta Metro	0.007	0.002	3.080	0.018	0.002	0.013
Beta Size	0.005	0.001	4.602	0.002	0.002	0.007
Dummy Suburban	0.001	0.003	0.279	0.788	-0.006	0.008
Dummy Industrial	0.004	0.003	1.365	0.214	-0.003	0.011
Dummy Retail	0.005	0.002	2.690	0.031	0.001	0.010
Dummy Apartment	0.011	0.003	3.023	0.019	0.002	0.019
R^2	0.927					
Adj R^2	0.853					
Std. Error	0.002					

Table 6.2

RCA Metro Tier Portfolios

Figure 6.3 shows a widely dispersed and "shotgun" pattern of results for the return-risk relationship in the RCA Metro Tier portfolios. The only notable clustering occurs in the Industrial and Suburban Office property types. The Major metros tend to be higher on the vertical (risk premium) axis, except for the Industrial Major portfolio.

Single Factor CAPM Results. The results for the RCA Metro Tier portfolios were not very good. The intercept was positive and strongly significant. Thus indicating that the risk factor (beta) did not explain the cross-section of returns and that there was a large constant risk premium across the portfolios unexplained by the model. The beta was zero and insignificant. Unlike the NCREIF models, adding property type interactive effects failed to improve the model as the intercept was still positive (.018) and significant (t-stat of 4.45).

Multifactor Model Results. The results for the multifactor models were poor as well (Panels C and D). Both had very high and strongly significant intercepts, insignificant beta loadings and Fama-French style factors. However, there was some weak evidence of the Metro tier factor outperformance shown in Figure 6.3. Adding the property type dummy variables did not improve the model and none of the dummy vairables were close to significance.

RCA Size Portfolios

Figure 6.4 has no clear result and is another "shotgun" pattern.

Single Factor CAPM Results. The simple RCA Size CAPM result was disappointing as well (Panel A, Table 6.3) with a positive and significant intercept and an insignificant beta. Adding property type interactive effects did not improve the result as reported in Panel B. The adjusted R^2 is higher at .47, but the intercept was still strongly significant (t-stat 6.42) and positive (.02).

Multifactor Fama-French Model Results. The multifactor results were poor as well (Table 6.4). Both models had a significant and positive intercept. All the factors were insignificant, and both had a low adjusted R^2.

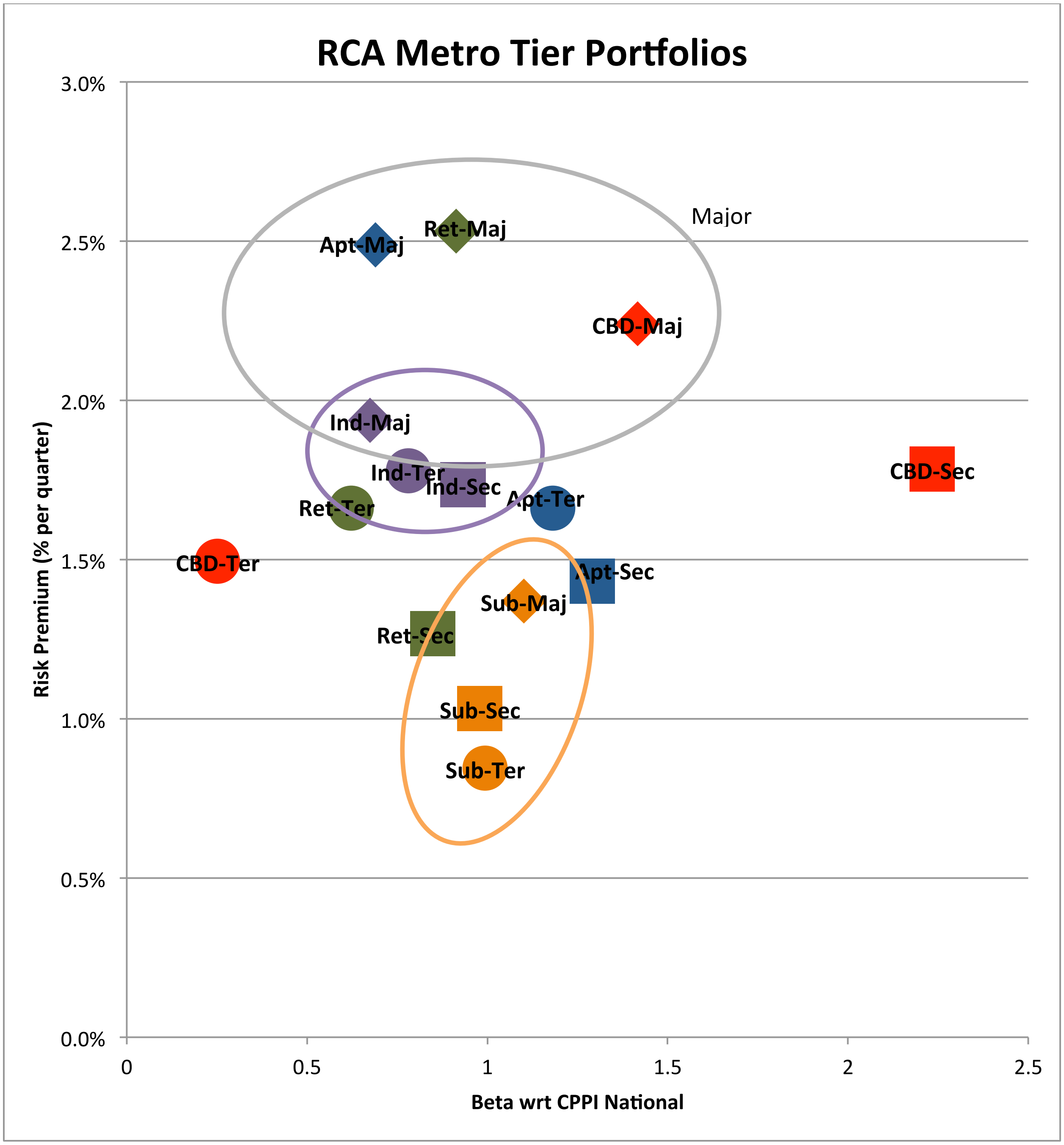
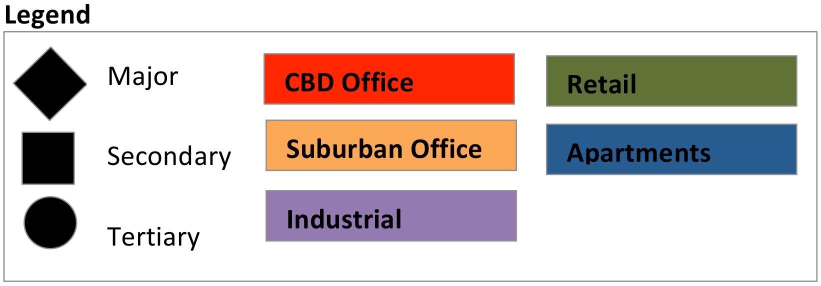


Figure 6.3

Legend



RCA Metro Tier – Cross-Sectional Regression Results

Variables	Coefficients	Std. Error	t-stat	P-value	Lower 95%	Upper 95%
PANEL A						
Single Factor CAPM (df=14)						
Intercept	0.017	0.003	5.144	0.000	0.010	0.024
Beta	0.000	0.003	0.058	0.955	-0.006	0.007
R^2	0.000					
Adj R^2	-0.077					
Std. Error	0.005					
PANEL B						
Single Factor CAPM with Interactive Property Type Effects (df=10)						
Intercept	0.019	0.004	4.312	0.002	0.009	0.028
Dummy CBD	0.000	0.003	0.147	0.886	-0.006	0.007
Dummy Suburban	-0.007	0.005	-1.504	0.167	-0.019	0.004
Dummy Industrial	-0.001	0.006	-0.091	0.930	-0.015	0.014
Dummy Retail	0.000	0.006	0.003	0.997	-0.014	0.014
Dummy Apartment	-0.001	0.005	-0.205	0.842	-0.011	0.009
R^2	0.415					
Adj R^2	0.089					
Std. Error	0.005					
PANEL C						
Multifactor Fama-French (df=12)						
Intercept	0.031	0.008	3.689	0.004	0.013	0.050
Beta RCA National	-0.014	0.008	-1.694	0.118	-0.031	0.004
Beta Metro	0.003	0.002	1.711	0.115	-0.001	0.007
Beta Size	0.004	0.003	1.171	0.266	-0.003	0.011
R^2	0.234					
Adj R^2	0.026					
Std. Error	0.005					
PANEL D						
Multifactor Fama-French with Property Type Dummy Variables (df=9)						
Intercept	0.031	0.011	2.964	0.021	0.006	0.056
Beta NCREIF NPI	-0.011	0.008	-1.374	0.212	-0.031	0.008
Beta Metro	0.003	0.002	1.509	0.175	-0.002	0.007
Beta Size	0.004	0.006	0.786	0.457	-0.009	0.018
Dummy Suburban	-0.008	0.006	-1.290	0.238	-0.022	0.007
Dummy Industrial	-0.002	0.007	-0.371	0.721	-0.018	0.013
Dummy Retail	-0.002	0.009	-0.178	0.863	-0.023	0.020
Dummy Apartment	-0.001	0.005	-0.114	0.912	-0.012	0.011
R^2	0.564					
Adj R^2	0.128					
Std. Error	0.005					

Table 6.3

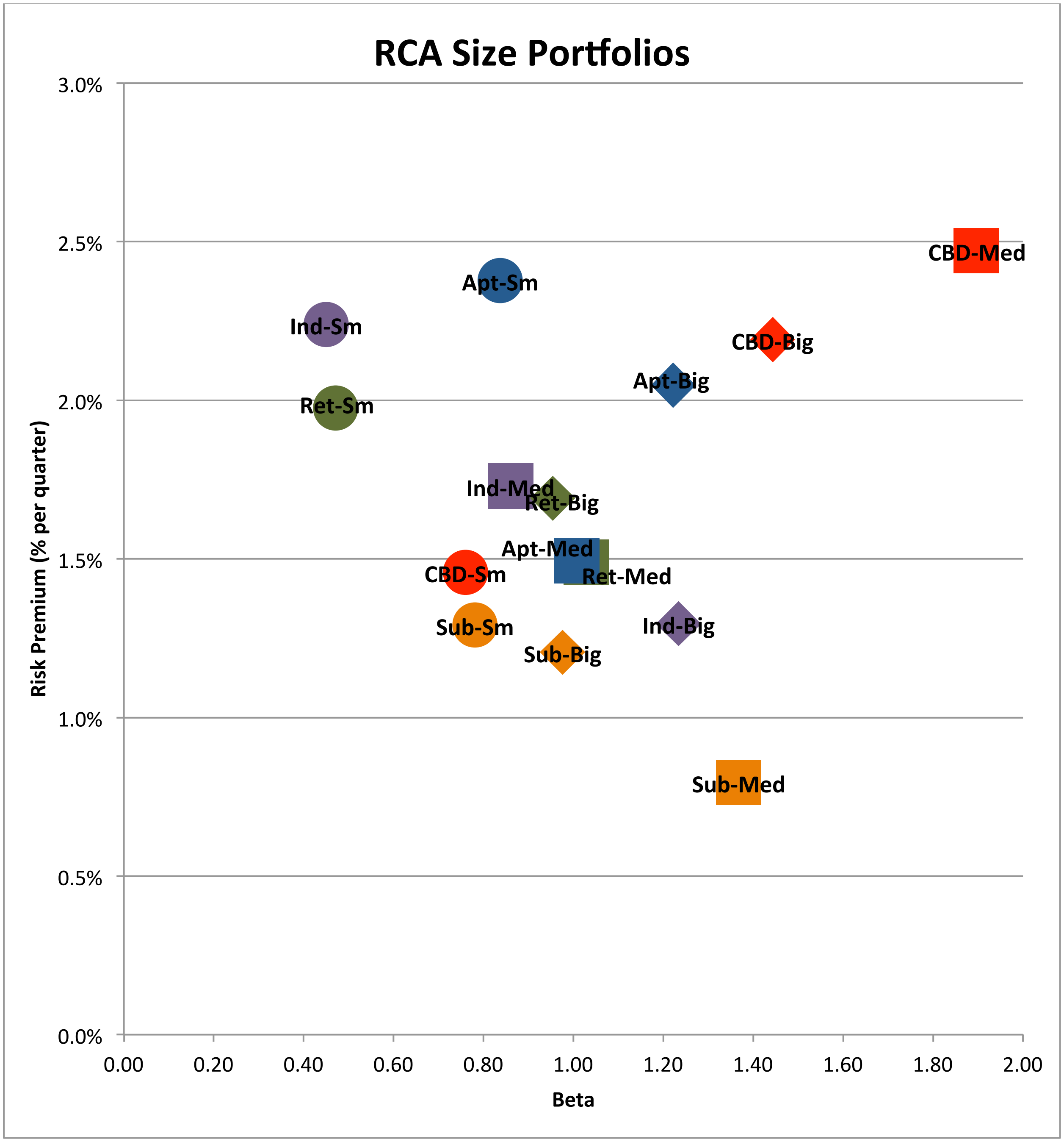
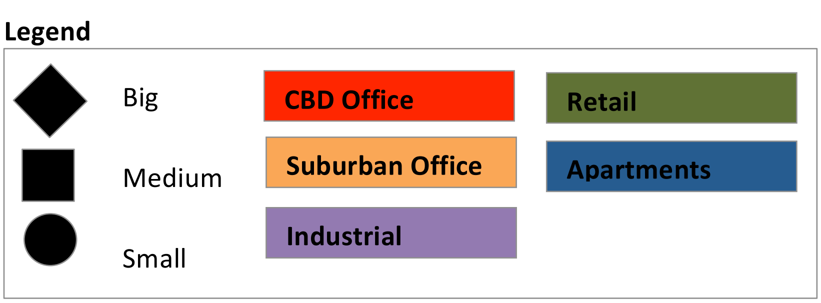

RCA Size Portfolios
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
Risk Premium (% per quarter)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Beta
CBD-Med
Apt-Sm
Ind-Sm
CBD-Big
Apt-Big
Ret-Sm
Ind-Med
Ret-Big
Apt-Med
CBD-Sm
Ret-Med
Sub-Sm
Ind-Big
Sub-Big
Sub-Med

Figure 6.4


Legend
Big
Medium
Small
CBD Office
Suburban Office
Industrial
Retail
Apartments

RCA Size – Cross-Sectional Regression Results

Variables	Coefficients	Std. Error	t-stat	P-value	Lower 95%	Upper 95%
PANEL A						
Single Factor CAPM (df=14)						
Intercept	0.016	0.004	4.217	0.001	0.008	0.025
Beta	0.001	0.004	0.213	0.835	-0.007	0.009
R^2	0.003					
Adj R^2	-0.073					
Std. Error	0.005					
PANEL B						
Single Factor CAPM with Property Type Interactive Effects (df=10)						
Intercept	0.020	0.003	6.242	0.000	0.013	0.028
Dummy CBD	0.001	0.003	0.358	0.729	-0.005	0.007
Dummy Suburban	-0.009	0.004	-2.565	0.030	-0.017	-0.001
Dummy Industrial	-0.009	0.004	-2.565	0.030	-0.017	-0.001
Dummy Retail	-0.004	0.004	-1.107	0.297	-0.014	0.005
Dummy Apartment	-0.004	0.004	-0.981	0.352	-0.014	0.006
R^2	0.661					
Adj R^2	0.473					
Std. Error	0.004					
PANEL C						
Multifactor Fama-French (df=12)						
Intercept	0.029	0.008	3.534	0.005	0.011	0.046
Beta RCA National	-0.011	0.008	-1.426	0.182	-0.029	0.006
Beta Metro	0.004	0.002	1.486	0.165	-0.002	0.009
Beta Size	0.002	0.002	0.896	0.389	-0.003	0.007
R^2	0.224					
Adj R^2	0.012					
Std. Error	0.005					
PANEL D						
Multifactor Fama-French with Property Type Dummy Variables (df=9)						
Intercept	0.028	0.009	2.950	0.021	0.006	0.050
Beta RCA National	-0.009	0.011	-0.785	0.458	-0.035	0.018
Beta Metro	0.003	0.003	1.162	0.283	-0.003	0.010
Beta Size	0.002	0.002	1.070	0.320	-0.003	0.007
Dummy Suburban	-0.007	0.006	-1.304	0.233	-0.020	0.006
Dummy Industrial	-0.003	0.004	-0.662	0.529	-0.013	0.007
Dummy Retail	-0.001	0.007	-0.097	0.926	-0.017	0.016
Dummy Apartment	0.001	0.005	0.293	0.778	-0.010	0.012
R^2	0.606					
Adj R^2	0.211					
Std. Error	0.004					

Table 6.4

Chapter 7: FTSE NAREIT PureProperty

The FTSE NAREIT PureProperty Index Series measures total return performance of commercial properties held by U.S. REITs. The methodology for the indices was developed by Horrigan, Case, Geltner, and Pollakowski in a 2009 paper titled "REIT-Based Property Return Indices: *A New Way to Track and Trade Commercial Real Estate."* The indices measure underlying property returns on a daily basis using changes in the stock market valuations of the REIT constituents. More specifically, the methodology uses REIT return data, property holdings data and REIT financial information to deleverage and filter REIT returns by region and property type. All fifteen sub-indices from the four geographical regions and four property types were utilized in this study.

East	**Midwest**	**South**	**West**
Apartments, Industrial, Office and Retail	Apartments, Industrial, Office and Retail	Apartments, Office and Retail	Apartment, Office and Retail
		Southwest Industrial (combined)	

Data and Portfolios

PureProperty Descriptive Statistics. The East Retail index had highest mean total return (2.8%) and Midwest Office had the lowest (0.0%). The PureProperty Indices had the greatest range of quarterly returns of all the datasets, mostly because of very low returns for Midwest Office (although East and Midwest Industrial were low as well). Overall, the East and West regions exhibited the highest absolute growth. Midwest Apartments had the lowest annual volatility with just 6.9%. Midwest Industrial had the highest volatility at 26.2%. The PurePropety indices also had very low quarterly autocorrelation, reflecting the stock market's ability to efficiently incorporate information into prices.

PureProperty Descriptive Statistics

	Arth Mean	Geo Mean	Max	Min	Qrtly Vol	Annual Vol	Annual AC1	Qrtly AC1
East Apartment	0.026	0.024	0.142	-0.161	0.060	0.131	-0.106	0.092
East Industrial	0.006	0.004	0.123	-0.126	0.057	0.118	0.328	-0.013
East Office	0.025	0.023	0.224	-0.200	0.073	0.155	-0.040	0.132
East Retail	0.029	0.028	0.134	-0.155	0.063	0.133	0.066	-0.092
MW Apartment	0.016	0.015	0.135	-0.065	0.043	0.069	-0.421	-0.238
MW Industrial	0.015	0.007	0.238	-0.551	0.121	0.262	0.258	0.135
MW Office	0.000	-0.001	0.068	-0.112	0.047	0.099	-0.080	0.136
Mid Retail	0.021	0.020	0.148	-0.195	0.064	0.121	0.297	0.079
South Apartment	0.021	0.019	0.144	-0.157	0.059	0.134	0.214	0.184
South Office	0.005	0.004	0.126	-0.166	0.063	0.090	-0.088	-0.172
South Retail	0.024	0.023	0.138	-0.129	0.062	0.109	0.115	-0.203
SW Industrial	0.023	0.022	0.169	-0.196	0.081	0.155	0.269	0.150
West Apartment	0.028	0.025	0.168	-0.231	0.078	0.155	0.075	-0.059
West Office	0.019	0.019	0.116	-0.143	0.050	0.102	-0.001	0.190
West Retail	0.026	0.021	0.214	-0.421	0.109	0.216	0.255	0.175
Average	0.019	0.017	0.152	-0.200	0.069	0.137	0.076	0.033
Standard Deviation	0.009	0.009	0.045	0.125	0.021	0.049	0.204	0.150
Max	0.029	0.028	0.238	-0.065	0.121	0.262	0.328	0.190
Min	0.000	-0.001	0.068	-0.551	0.043	0.069	-0.421	-0.238

Table 7.1

PureProperty *Time Series Graphs.* As noted above, the East and West regions exhibited strong outperformance in several of the property types, notably Office and Apartments. East Retail also outperformed the other geographic regions in the retail property type as seen in Figure 7.3. There are two striking declines during the late 2000s in the Midwest Industrial and West Retail indices. Perhaps these declines reflect the dramatic stock price decline of industrial heavyweight ProLogis and the fall of retail giant General Growth Properties during this time. Overall, the Apartment indices look the most stable and the East and West Apartment returns tracked very closely over the 2000-2012 cycle.

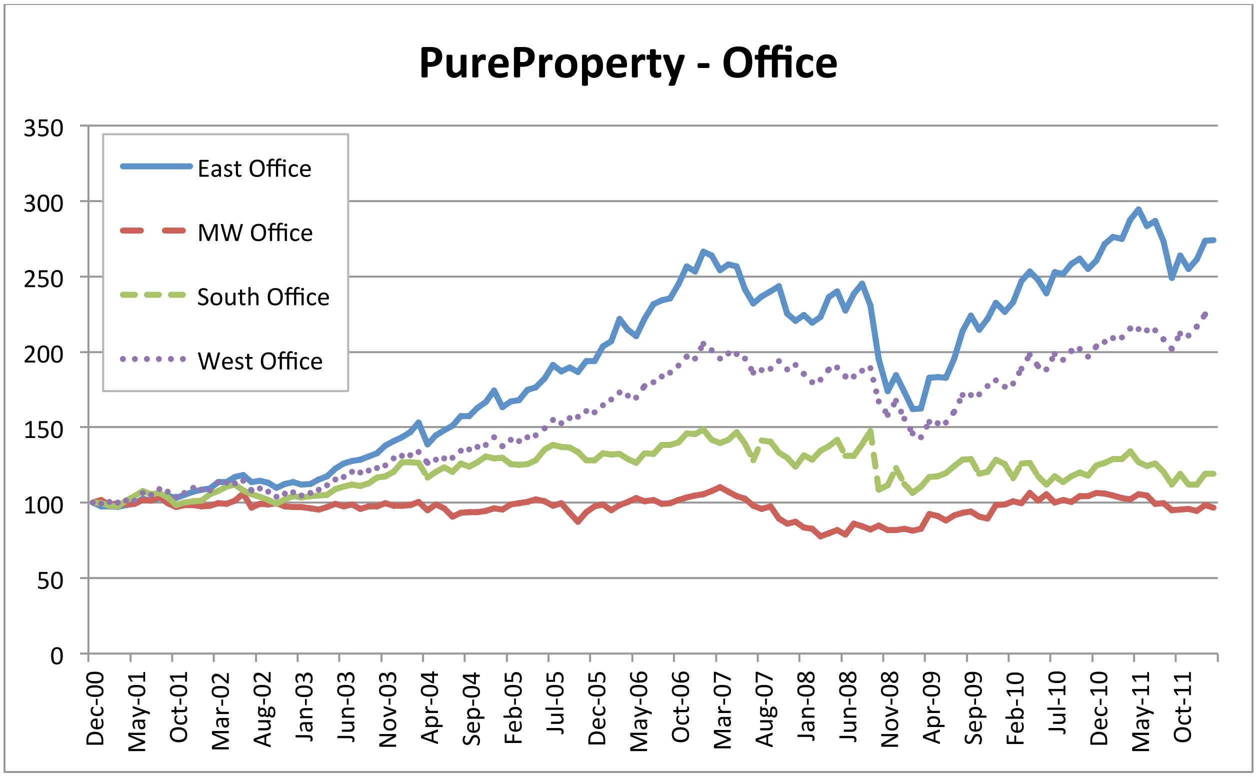


Figure 7.1

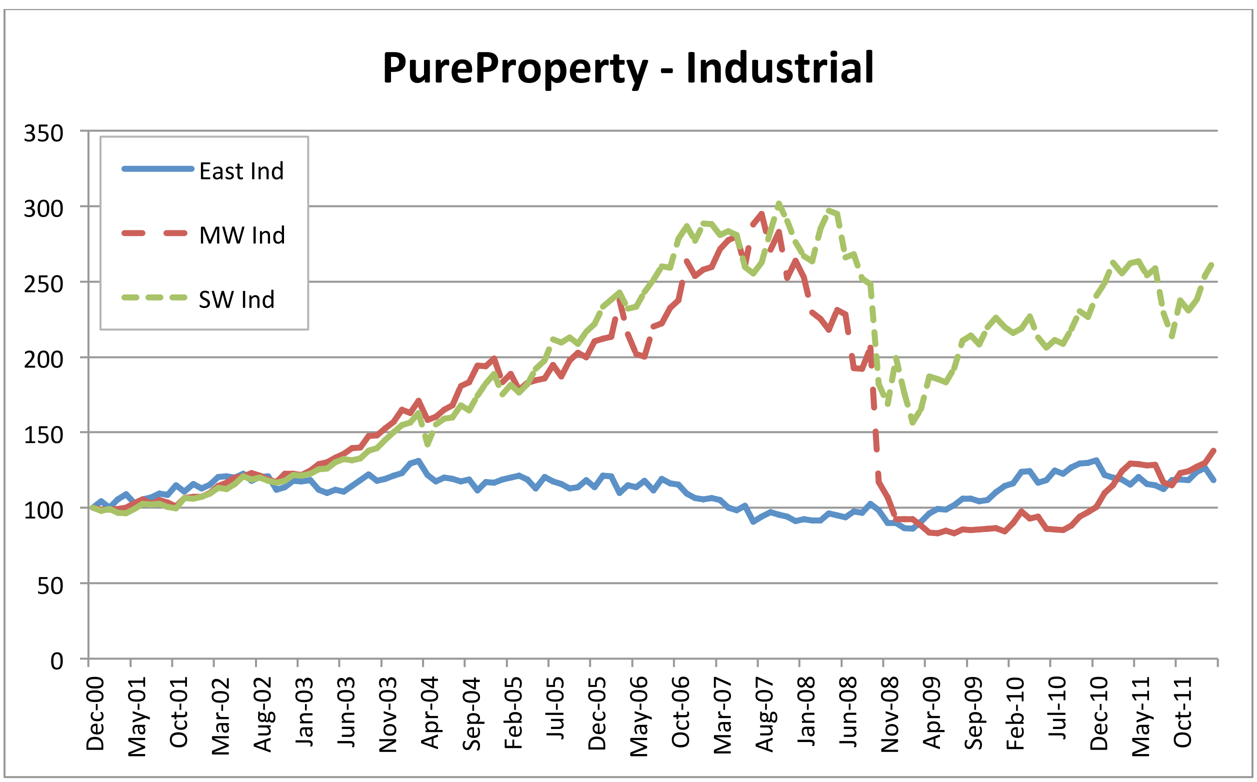


Figure 7.2

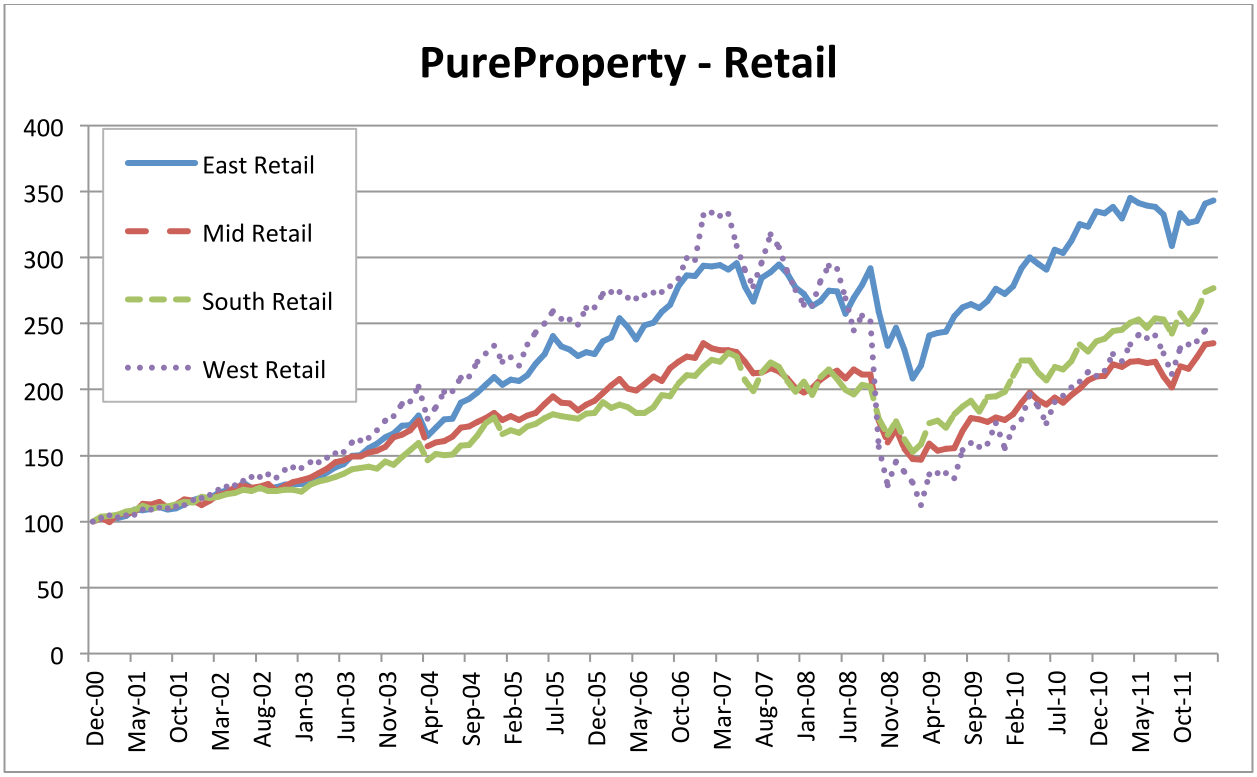


Figure 7.3

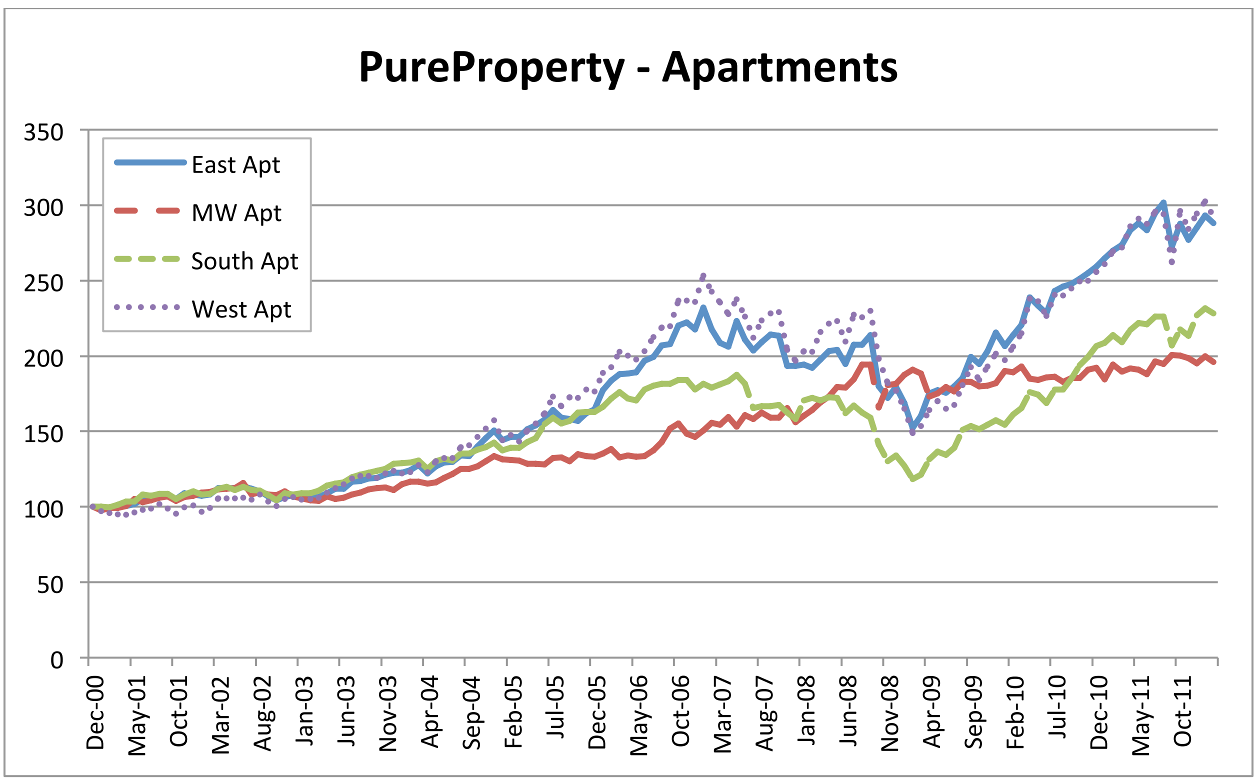


Figure 7.4

Asset Pricing Models and Results

The asset pricing model tested in this chapter are similar to those tested in the previous chapter with a few changes and one new model. All of the models used monthly as opposed to quarterly data in the previous chapter. The S&P 500 Index was chosen as the market index for all of the models as the PureProperty returns are based on stock market returns. The remaining changes to the models are described with the results below.

Single Factor CAPM. The PureProperty Single Factor CAPM was the same as previously described, although an additional model was run with regional interactive effects. A visual representation of the expected return-risk relationship is shown in Figure 7.5. The property types and regions are mixed, but an upward sloping return-risk relationship is clear. The Single Factor CAPM results are reported in Table 7.2. The three CAPM results were positive with insignifcant intercepts near zero. The simple model (Panel A) had a postive and signifcant beta. The property type model (Panel B) had significant dummy variables for all property types except for Office, which was weakly significant. The Retail and Apartment dummy variables had the highest risk premia. All the regional dummy variables (Panel C) were significant and the South region had a very strong risk premium (.87). (The Industrial Southwest portfolio was emitted from this model for statistical purposes.)

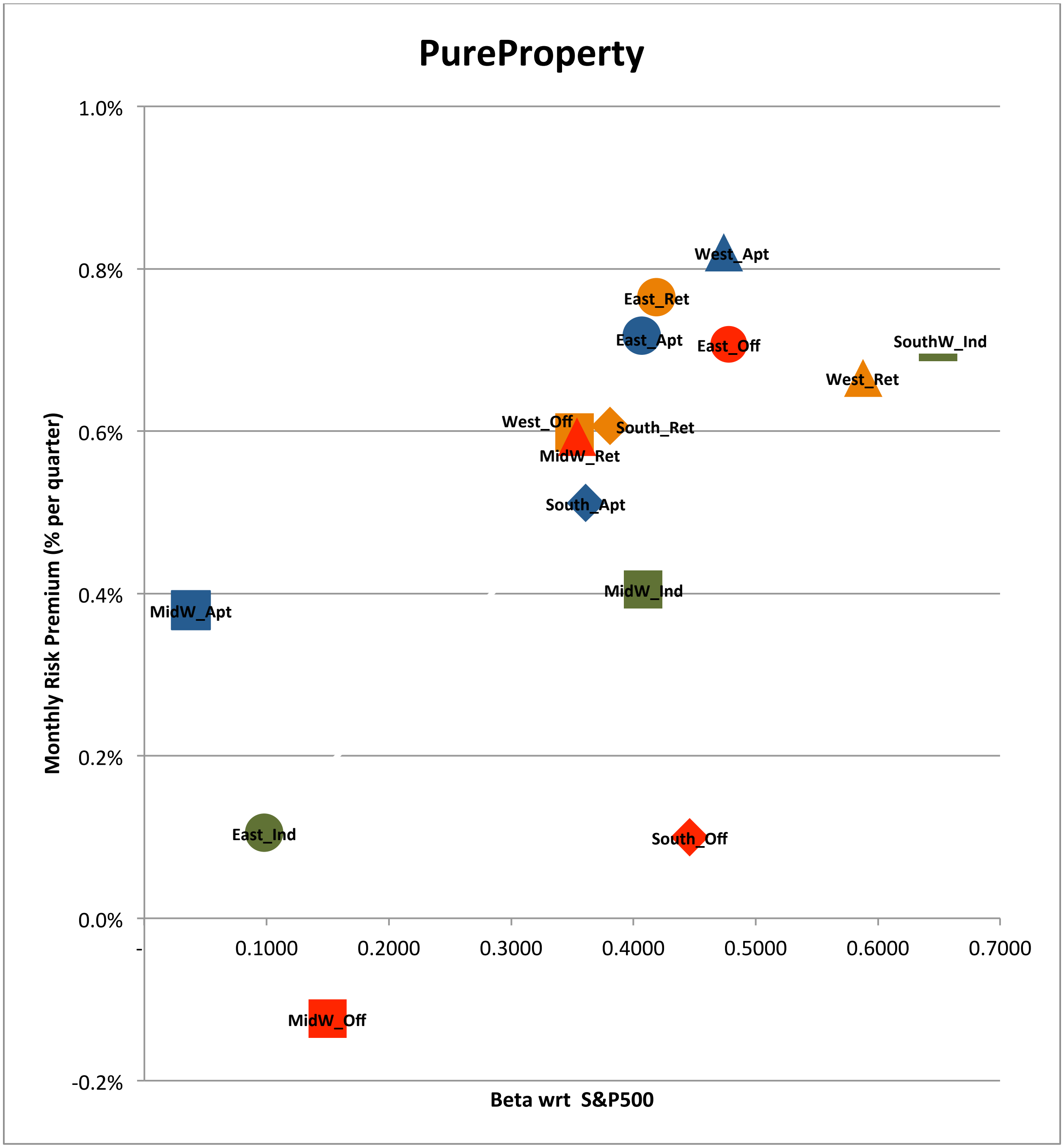
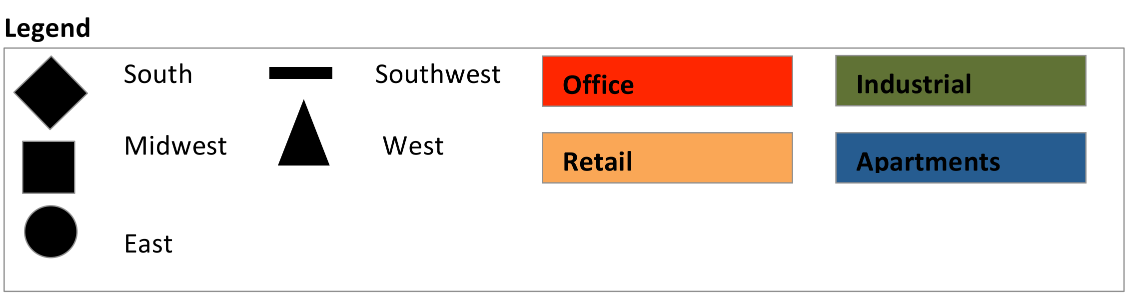

PureProperty
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
-0.2%
Monthly Risk Premium (% per quarter)
West_Apt
East_Ret
East_Apt
East_Off
SouthW_Ind
West_Ret
West_Off
South_Ret
MidW_Ret
South_Apt
MidW_Apt
MidW_Ind
East_Ind
South_Off
MidW_Off
-
0.1000
0.2000
0.3000
0.4000
0.5000
0.6000
0.7000
Beta wrt S&P500

Figure 7.5


Legend
South
Southwest
Office
Industrial
Midwest
West
Retail
Apartments
East

PureProperty – Single Factor Cross-Sectional Regression Results

Variables	Coefficients	Std. Error	t-stat	P-value	Lower 95%	Upper 95%
Panel A						
			Single Factor CAPM (df=14)			
Intercept	0.001	0.002	0.652	0.526	-0.002	0.004
Beta	0.010	0.004	2.853	0.014	0.002	0.018
R^2	0.385					
Adj R^2	0.338					
Std. Error	0.002					
PANEL B						
			Single Factor CAPM with Property Type Interactive Effects (df=10)			
Intercept	0.001	0.001	0.658	0.525	-0.002	0.004
Dummy Office	0.008	0.005	1.671	0.126	-0.003	0.018
Dummy Industrial	0.009	0.004	2.188	0.053	0.000	0.017
Dummy Retail	0.013	0.004	3.137	0.011	0.004	0.021
Dummy Apartment	0.015	0.005	3.146	0.010	0.004	0.025
R^2	0.571					
Adj R^2	0.399					
Std. Error	0.002					
PANEL C						
			Single Factor CAPM with Regional Interactive Effects (df=10)			
Intercept	0.001	0.001	0.581	0.576	-0.002	0.003
Dummy East	0.015	0.004	4.043	0.003	0.007	0.023
Dummy West	0.013	0.003	3.986	0.003	0.006	0.020
Dummy Midwest	0.010	0.005	2.046	0.071	-0.001	0.021
Dummy South	0.872	0.319	2.735	0.023	0.151	1.593
R^2	0.708					
Adj R^2	0.578					
Std. Error	0.002					

Table 7.2

Multifactor Fama-French Models. The PureProperty Fama-French models were different than the NCREIF and RCA-based models. Size and Tier Factors could not be created from the dataset. Instead, the classic Fama-French factors "Small minus Big" (SMB) for market capitalization and "High minus Low" (HML) for book value-to-market value ratio were used because the PureProperty returns are based on stock price movements. Monthly returns for the Fama-French factors were downloaded from Wharton Research Data Services website. After replacing the factors, the same two pass regression procedure was used. The basic model (Panel A, Table 7.3) resulted in an insignificant intercept near zero and a positive and significant beta. However, the Fama-French factors were not significant and the model had a relatively low adjusted R^2 (.26). Including property type dummy variables (Panel B) improved the adjusted R^2 modestly (.46). However, the Fama-French factors were insignificant again.

The dummy variables for Retail and Apartment were weakly significant but Industrial was insignificant. (Office was the suppresed vairable.)

Multifactor with Macroeconomic Variables. A multifactor model in the spirit of Ling and Naranjo [1997 and 1998] and Peng [2010] was tested as well. Factors in the model included the market index (S&P 500) along with several macroeconomic variables including the U.S. Treasury Bills, the credit spread (difference between AAA-rated and BAA-rated corporate bonds), the term spread (difference between 10-Year and 1-Year U.S. Government Bonds), and inflation (CPI for All Urban Customers, Seasonally Adjusted). Time series return statistics were download from the Wharton Reasearch Data Services website and the U.S. Department of Labor website. The first pass regression equation was:

$$r_{it} - r_{ft} = a_i + b_i(r_{Mt} - r_{ft}) + c_i tbill_t + d_i term_t + e_i credit_t + f_i cpi + e_{it}$$

where:

$tbill_t$ = return on U.S. Treasury Bills
$term_t$ = return on 10-Year U.S. Bonds and 1-Yr U.S. Bonds
$credit_t$ = return on BAA-rated corporate bonds less AAA-rated corporate bonds
cpi_t = Inflation measured by CPI Index for all Urban Costumers, Seasonally Adjusted

The second pass regression equation was:

$$\overline{r_i - r_f} = \gamma_0 + \gamma_1 b_{\mathrm{i}} + \gamma_2 c_{\mathrm{i}} + \gamma_3 d_{\mathrm{i}} + \gamma_4 e_{\mathrm{i}} + \gamma_5 \mathrm{f} + e_i$$

The Multifactor model with macroeconomic variables had marginal results (Panel C, Table 7.3). The intercept was insignificant and near zero, but none of the factors were statistically significant. And, the adjusted R^2 was low (.52). The beta was marginally significant (t-stat of 1.98) and positive. Interestingly the signs on credit spread and inflation were negative, although the coefficients were small (.002 and .001). Negative factor loadings suggest that investors are willing to pay more (accept lower returns) for properties with more exposure to these risk factors.

PureProperty – Multifactor Cross-Sectional Regression Results

Variables	Coefficients	Std. Error	t-stat	P-value	Lower 95%	Upper 95%
Panel A						
Multifactor Fama French (df=12)						
Intercept	0.002	0.002	0.787	0.448	-0.003	0.006
Beta	0.012	0.005	2.239	0.047	0.000	0.024
SMB	-0.004	0.015	-0.241	0.814	-0.038	0.030
HML	0.000	0.012	0.035	0.973	-0.025	0.026
R^2	0.416					
Adj R^2	0.256					
Std. Error	0.002					
Panel B						
Multifactor Fama French with Property Type Dummy Variables (df=9)						
Intercept	0.000	0.002	0.077	0.941	-0.005	0.005
Beta	0.011	0.005	2.431	0.041	0.001	0.022
SMB	-0.011	0.017	-0.693	0.508	-0.050	0.027
HML	0.006	0.011	0.550	0.597	-0.020	0.032
Dummy Industrial	0.000	0.002	0.070	0.946	-0.004	0.004
Dummy Retail	0.003	0.002	1.892	0.095	-0.001	0.007
Dummy Apartment	0.003	0.002	1.891	0.095	-0.001	0.006
R^2	0.691					
Adj R^2	0.460					
Std. Error	0.002					
Panel C						
Multifactor with Macro Economic Variables (df=10)						
Intercept	0.001	0.001	0.593	0.567	-0.002	0.004
Beta	0.011	0.005	1.982	0.079	-0.002	0.023
Treasury Bill	0.000	0.001	-0.363	0.725	-0.001	0.001
Term Spread	0.002	0.005	0.468	0.651	-0.008	0.013
Credit Spread	-0.002	0.001	-1.878	0.093	-0.004	0.000
Inflation	-0.001	0.001	-1.274	0.235	-0.002	0.001
R^2	0.692					
Adj R^2	0.520					
Std. Error	0.002					

Table 7.3

Chapter 8: Summary and Conclusions

This thesis tested whether equilibrium asset pricing models can explain the cross-section of long-run total returns within commercial real estate using several unique data sources. A total return index was created by constructing multi-dimensional portfolios using the Moody's/RCA CPPI Index methodology to calculate a capital return component and a "synthetic" income return component constructed with RCA-based capitalization rate data with adjustments for capital expenditures. The RCA-based indices were also compared directly with similar portfolios created from the NCREIF database. Finally, both of these private property market-based index sets were contrasted with stock market-based indices using the recently launched FTSE NAREIT PureProperty Index series.

Test Results

The results of the asset pricing model tests are summarized in Table 8.1 along with a comparison of the Pai and Geltner [2007] results. Overall, the more institutionally focused stock market-based PureProperty and appraisal-based NCREIF models worked quite well. However, the broad transactions-based RCA models performed poorly. Interestingly, several of the results from the NCREIF and PureProperty models were the opposite of the Pai and Geltner [2007] results while others were confirmed. These differences are highlighted in Table 8.1 and discussed in greater detail below.

The PureProperty results were largely in sync with classical asset pricing model theory. The single factor models worked better than the Fama-French style models, the opposite of the Pai Geltner results. The PureProperty single factor results found a significant and positive relationship with beta and an insignificant intercept near zero. When property type or geographic dummy variables were included, the adjusted R^2 increased significantly - meaning the risk factors explained a large portion of the cross-sectional differences in returns of the various portfolios. In the property type model, apartments commanded a risk premium relative to other property types. The classic Fama-French factors, "High minus Low" and "Small minus Big" were not statistically significant in the multifactor models, which had less explanatory power than the single factor models.

Results for the private property market returns were more ambiguous. The broad market transaction-based returns do not show any clear relationship between risk and return. However, the institutional appraisal-based return models worked pretty well, confirming the Pai and Geltner findings with some differences.

The NCREIF-based models confirmed that private property returns show a clear relationship with beta in a classical way, that is a higher beta, or covariance with the market index, results in investors expecting (receiving) a higher return. This was the opposite conclusion of the Pai and Geltner study, which found no or a negative return relationship with beta. The NCREIF-based models found that when property specific variables such as location, size, and, in particular, property type were included, the asset pricing models explained a large majority of the cross-section of long-run average returns, consistent with Pai and Geltner. Additionally, the models showed that small properties had a positive risk premium, the opposite result of Pai and Geltner for the size factor, and confirmed a positive risk premium for major metropolitan MSAs. Apartment properties also had a positive risk premium in the single factor and multifactor models.

Why didn't the RCA indices work as well as the NCREIF indices? A few thoughts come to mind. First, perhaps the time period in the analysis was too short, or the betas were measured with too much error or are not stable across time. Second, NCREIF and Pure Property may have "better behaved" data. NCREIF is narrow, homogenous and appraisal-based, and PureProperty has the efficiency of stock market pricing. However, RCA is broad and has a less "controlled" return measurement environment and perhaps this data "behaved" differently. Finally, perhaps participants in the broader commercial real estate markets don't invest with a systematic view of the risk and return relationship, at least in the world of the CAPM. The implications of such an occurrence are discussed in the final section of this chapter.

Asset Pricing Model Results

	Size Portfolios		Metro Tier Portfolios		Geographic Region
	Jones	Pai & Geltner	Jones	Pai & Geltner	Jones
NCREIF	• Good model (aR^2= .85) • **Beta +RP, significant** • Metro RP+, significant • **Size +RP, significant** • Apartment +RP, significant	• Very good model (aR^2= .94) • Beta -RP, not significant • Size -RP, significant • Apartment +RP, significant • CBD -RP, significant	• Good model (aR^2=.74) • **Beta +RP, significant** • Metro +RP, significant • Size -RP , insignificant • Apartment +RP, significant • **Suburban -RP, insignificant**	• Very good model (aR^2=.91) • Metro +RP, significant • Size -RP, significant	N/A
RCA	• Not good model	N/A	• Not good model • Major Metro +RP, insignificant	N/A	N/A
PureProperty	N/A	N/A		N/A	• Good model (aR^2= .58) • Beta +RP, significant • FF – only Beta significant • Apartment +RP, significant • East +RP, significant • West +RP, significant

Table 8.1

Legend

Bold = Opposite Result of Pai and Geltner [2007]
RP = Risk premium or factor loading
+/- = Sign on factor loading
Metro = MMT Factor (Major minus Tertiary) from Multifactor Fama-French models
Size = SMB Factor (Small minus Big) from Multifactor Fama-French models
Significant = Result was statistically significant (p-value less than .05)

Equilibrium Risk Premia

Figures 8.1-8.3 display the annual risk premia projected from the models using the historically estimated betas from the study. The Multifactor Fama-French with Property Type Dummy Variables model and Single Factor CAPM are shown for NCREIF, and the Single Factor CAPM model is shown for PureProperty.

NCREIF. Table 8.2 reports the inputs used to project the risk premia. The first and second columns report the average returns for the NCREIF NPI, MMT and SMB factors during the study period (2001-2012) and the risk premia estimated in the regression models for the property type dummy variables.[14] The third column reports the projected returns and risk premia for each variable. These represent what one might expect in equilibrium, as opposed to the ex post returns in the first and second columns. The projected inputs can be inserted into the regression equation to calculate a risk premium for a particular property type or portfolio (e.g., CBD Office Major).[15]

Inputs

	Historical (Size)	Historical (Market)	Projected*
NCREIF NPI Excess Return	4.20%	4.20%	4.00%
MMT Factor	1.34%	1.34%	1.00%
SMB Factor	1.48%	1.48%	1.25%
Dummy Suburban	0.32%	-1.55%	0.00%
Dummy Industrial	1.66%	-0.29%	0.00%
Dummy Retail	2.04%	-0.18%	1.00%
Dummy Apartment	4.23%	2.36%	1.50%

Table 8.2

Figure 8.1 reports the risk premia for the NCREIF Size portfolios. The average risk premium for the Multifactor model (4.68%) is slightly higher than the CAPM model (4.03%) and there is more variation in the Multifactor model. The smaller properties tend to have the higher risk premia, and apartments have higher risk premia than the other property types.

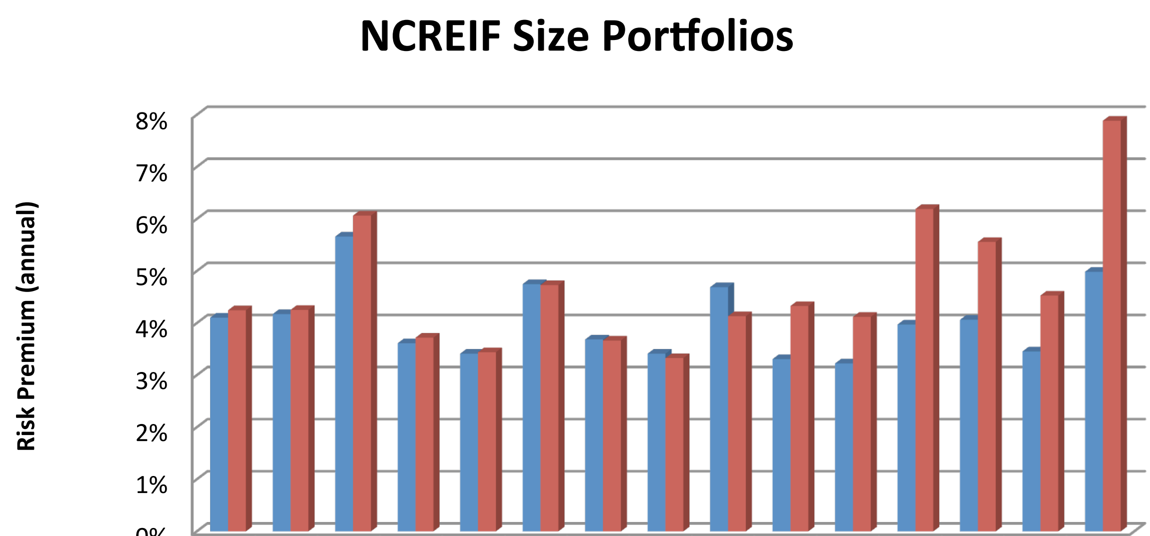
[14] These are in addition to CBD Office, which as the suppressed variable has a risk premium of 0%.

[15] Example calculation for CBD Office Big using the Multifactor Fama-French with Property Type Dummy Variables model (from Chapter 5). The coefficients (b, m and s) come from the time series regression (see Appendix), and the factor risk premia for NPI, MMT and SMB are from Table 8.2.

$$RP = b * NPI + m * MMT + s * SMB + dummy\ variable$$

$$4.25\% = 1.007\ (4.0\%) + 1.71(1\%) + .0377(1.25\%) + 0$$

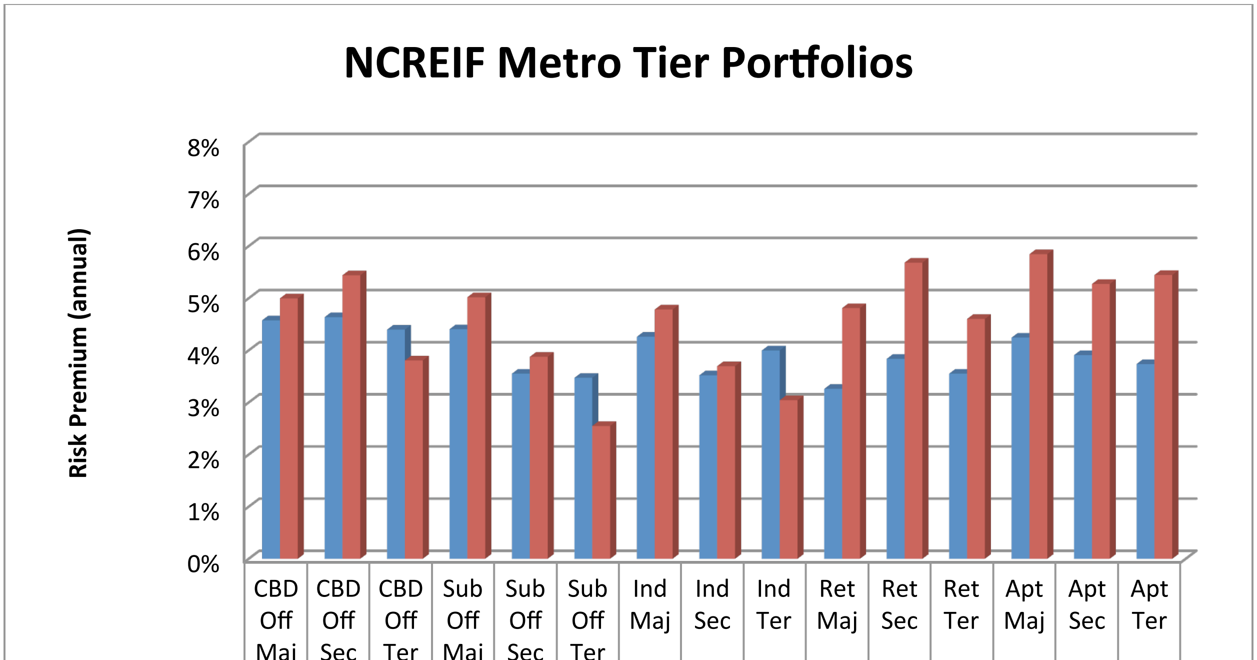
Figure 8.2 reports the risk premia for the Metro Tier portfolios. The Metro Tier portfolios have similar averages but slightly less variation than the Size portfolios. Suburban Office and Industrial properties have lower risk premia than the other three property types.



	CBD Off Big	CBD Off Med	CBD Off Sm	Sub Off Big	Sub Off Med	Sub Off Sm	Ind Big	Ind Med	Ind Sm	Ret Big	Ret Med	Ret Sm	Apt Big	Apt Med	Apt Sm
CAPM	4.10	4.17	5.66	3.61	3.41	4.75	3.68	3.41	4.69	3.31	3.22	3.97	4.06	3.46	4.98
MF-FF+DV*	4.25	4.25	6.06	3.72	3.44	4.73	3.67	3.33	4.13	4.33	4.12	6.19	5.56	4.53	7.89

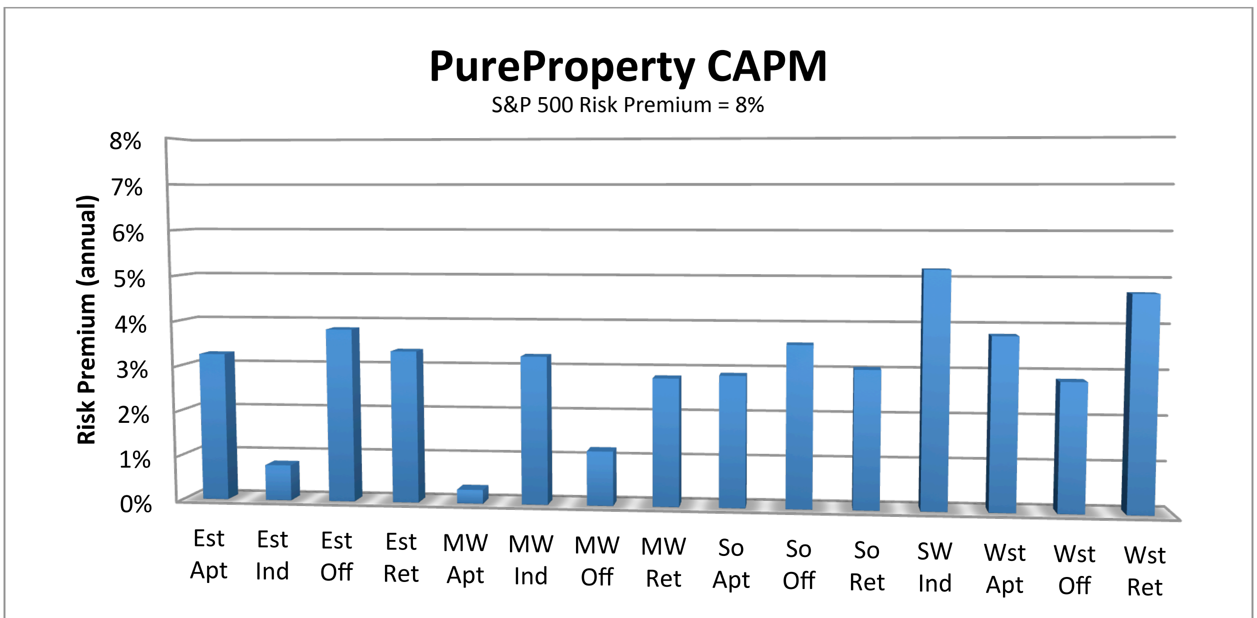
Figure 8.1

Pure Property. Figure 8.3 reports the risk premia using the PureProperty CAPM model. In this model, the beta of a portfolio with respect to the S&P 500 is multiplied by the excess return of the S&P 500 to calculate the portfolio's risk premium. The excess return of the S&P 500 is assumed to be 8%, near the long-run historical average (Bodie, Kane and Marcus, 2011). The average PureProperty-based risk premium (3%) is lower than the NCREIF-based models. The overall variation is similar but a few (Midwest Apartments, East Industrial and Midwest Office) of the property types have very low predicted risk premia. This is a simple result of these property types having a very low beta during the study period.



	CBD Off Maj	CBD Off Sec	CBD Off Ter	Sub Off Maj	Sub Off Sec	Sub Off Ter	Ind Maj	Ind Sec	Ind Ter	Ret Maj	Ret Sec	Ret Ter	Apt Maj	Apt Sec	Apt Ter
CAPM	4.58	4.64	4.40	4.40	3.55	3.47	4.26	3.52	4.00	3.26	3.84	3.55	4.24	3.91	3.74
MF-FF+DV*	5.00	5.44	3.80	5.02	3.88	2.55	4.78	3.70	3.04	4.81	5.68	4.60	5.85	5.27	5.44

Figure 8.2



	Est Apt	Est Ind	Est Off	Est Ret	MW Apt	MW Ind	MW Off	MW Ret	So Apt	So Off	So Ret	SW Ind	Wst Apt	Wst Off	Wst Ret
CAPM	3.256	0.784	3.824	3.352	0.304	3.264	1.200	2.816	2.888	3.568	3.048	5.192	3.792	2.832	4.704

Figure 8.3

Conclusions

This study found a clear dispersion of ex post returns by property type, metro location and size during the period from 2001 to 2012. A central question remains… *Is the dispersion systematic, reflecting difference in risk?* Or is it the result of a particular historical outcome (i.e. idiosyncratic) of the particular study period. (Or maybe a little of both?) The final section of this chapter will try to use the findings to address this question. Figure 8.4 is a flow chart of the discussion that follows.

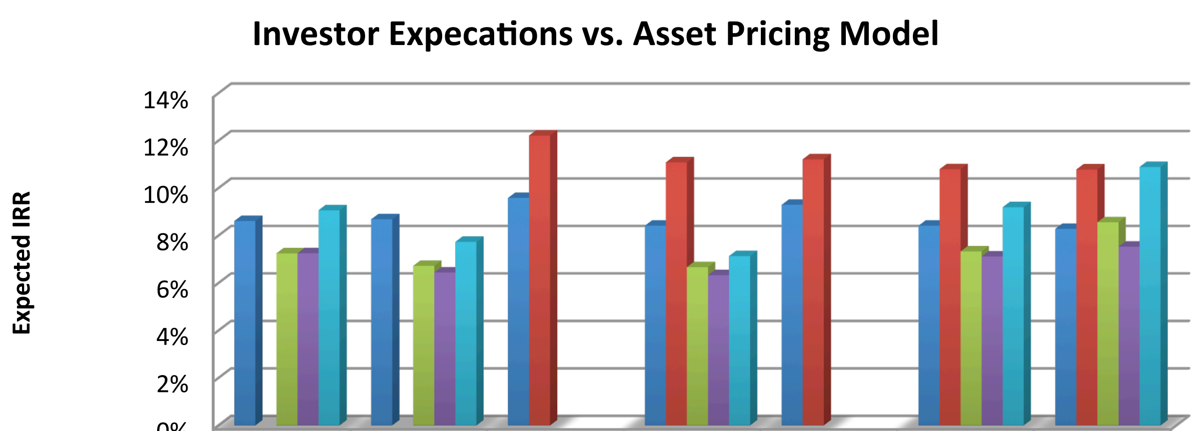
One the one hand, if the dispersion in returns is *systematic,* reflecting differences in risk, then asset pricing models should be able to identify and quantify the risk factors and explain the cross-section of returns. Persistent success of the models would provide evidence that markets are correctly pricing the relative risk of properties ex ante. However, even if the models don't "work," the market might still be pricing the relative risk of investments, but either the models are misspecified (i.e., wrong risk factors) or the data is bad (i.e., not enough history) and the results of the models don't reflect the "true" market.

On the other hand, if the dispersion in returns reflects the *idiosyncratic* nature of the particular historical outcome, then the lack of an ex post systematic pricing of risk (i.e. a failed model) might be explained in of two ways. First, perhaps the market is irrational (yikes!) at least from an expected risk-return relationship viewpoint. Or second, perhaps investors either can't distinguish the relative risk of properties (e.g., by type, location or size) or lack confidence in their ability to distinguish risk, and don't do so in practice. If so, then they won't require substantially different expected returns when making investments and the ex post results will reflect the idiosyncratic nature of the particular historical outcome. For example, apartment properties achieved a higher return than suburban office properties from 2001 to 2012. Perhaps apartment properties achieved a higher return because of what happened in the macroeconomic environment, not because they had more "risk", and investors demanded (ex ante) a higher risk premium. This would be a particularly satisfying explanation if investors expected the returns to be similar (or rather the same IRR) in 2001. (There is no apparent expected return premium for apartments in Figure 8.5, nor, for example, was there in the 2005 survey.) And finally, perhaps investors are, in fact, using different expected returns, but the differences reflect their current *preferences* and not actual *differences* in risk (Geltner and Miller, 2007).


Dispersion of ex post returns
Reflects differences in risk → asset pricing models should explain cross-section of returns
Reflects ex post idiosyncratic performance → Asset pricing models don't explain cross-section of returns
Models explain cross-section of returns→ Markets price relative risk ex ante
Models fail to explain cross-section of returns
Market is rational but investors can't price RELATIVE risk properly ex ante
Market is irrational → no systematic relationship between risk and return
Models are good; Results are bad → Poor or not enough data
Models are poor; Results are bad → Wrong or poorly estimated risk factors

Figure 8.4

Surveys are a useful tool for examining investors' expected returns. The PwC Real Estate Investor Survey results tend to show similar expected returns among property types but also reports differences for particular markets within a property type. In the 2012 1st quarter survey (Figure 8.5), the average expected return (IRR) for CBD Office properties was 8.61%, similar to the other property types. However, the expected returns for Manhattan and D.C. CBD Office properties (not shown) were around 7.5% and Phoenix and South Florida CBD office properties were at or above 10%. Do investors in Manhattan and DC office buildings believe they have that much less risk? Or are they willing to accept a lower return because they want to own an office building in Manhattan?



	CBD Off	Suburb. Off	Flx/R&D	Wrhse	Mall	Strip Center	Apts
PwC Inst*	8.61%	8.68%	9.58%	8.41%	9.29%	8.41%	8.28%
PwC N-Inst*			12.21%	11.08%	11.21%	10.79%	10.78%
Big**	7.25%	6.72%		6.67%		7.33%	8.56%
Medium**	7.25%	6.44%		6.33%		7.12%	7.53%
Small**	9.06%	7.73%		7.13%		9.19%	10.89%

*PwC Real Estate Investor Survey Q12012
** MF-FF+DV + 3% Risk Free Rate

*Blue = Institutional properties
*Red = Non-Institutional properties

Figure 8.5

Figure 8.5 also includes expected returns from the risk premia described earlier in this chapter. (A 3% risk-free rate was assumed to calculate the expected return for each property type.[16]) This figure shows how asset pricing models can be used to consider tactical investment policies. If properties in an asset class can be purchased with an expected return that is above the model's required return, then one would be inclined to invest in that asset class since it would offer a return above equilibrium. It is

[16] An expected return, or discount rate, is equal to a risk free rate plus a risk premium. E[r] = rf + RP

also interesting that the Size factor appears to be a good proxy for the institutional and non-institutional spread in the survey.

What does this all mean for investors? Asset pricing models appear to work well for real estate as one asset class among alternatives such as stocks and bonds, as evidenced by Li and Price [2005] and the brief update to their study included in Appendix A. However, the results *within* real estate are less clear and there is uncertainty as to whether there is a systematic relationship between risk and return. The RCA-based models failed to find a systematic relationship. Based on the expectations of investors in the PwC survey, the most likely explanation is that (some?) investors don't use different expected returns (or risk adjustments in the discount rate), and the ex post results or returns achieved ("shotgun" images in Figure 6.3 and 6.4) reflect idiosyncratic performance during the 2001-2012 study period. However, the NCREIF and PureProperty results seem to suggest that at least part of the commercial real estate market (the more institutional part) has a systematic relationship between risk and return. This has important implications for investment and risk management policies and deserves the attention of sophisticated investors. Given the short history of data, asset pricing models might be best suited as a risk management tool, used to raise a caution flag for particular investments where the expected returns are too low relative to equilibrium asset pricing models.

Limitations and Scope for Further Research

This study was limited by the short time span of the two new data sources, the FTSE NAREIT PureProperty Index Series and the Moody's/RCA CPPI Indices which began in 2000 and 2001 respectively.

Further research is warranted in several areas. More explicit or detailed work can be justified to construct portfolios, both for greater accuracy, and also for additional dimensions for the metro tiers, property type, and size factors. In this thesis, a major goal was to compare the new CPPI indices with the NCREIF database and so the portfolio construction largely mirrored the CPPI methodology. A separation of the industrial property type in flex/R&D and warehouse seems warranted, as well as garden-style and urban apartments. Also, it seems plausible that the major, secondary and tertiary metro markets should vary for each property type. A major metro classification is likely different for warehouse and CBD office properties.

Many of the most recent academic articles have looked at the dispersion of individual property level returns. Investors cannot purchase an index of apartment properties in major markets, and so it is difficult to diversify away the idiosyncratic risk element. A study that focused on the residuals from index (portfolio or market wide) could test for systematic reasons or factors why certain properties over (under) performed the index. The results could have important implications for tactical investment strategy and risk management.

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Appendix A: National Wealth Portfolio CAPM

Introduction. This thesis tested whether equilibrium asset pricing models can be used to explain the cross-section of long-run average total return performance in institutional commercial real estate. Previous work done by Li and Price [2005] showed that a National Wealth Portfolio (NWP) CAPM worked at a broad-brush level with real estate as one asset class compared to other investments available to institutional investors. This section updates their work with recent return data.

Quarterly total return data from 1979 through 2011 was compiled for stocks, bonds and real estate. Quarterly returns for the large stocks, small stocks, U.S. long-term government bonds, and U.S. intermediate-term government bonds were downloaded from the Ibboston Associates database. Returns for the Giliberto-Levy Commercial Mortgage Performance Index (GLCMPI) were provided by Investment Property Databank (IPD). Returns for the NAREIT All REIT Total Return Index were downloaded from NAREIT's website, and the NCREIF NPI returns were downloaded from NCREIF's website.

Methodology. The methodology to test the NWP-based CAPM relies heavily upon the work of Li and Price [2005]. In this version of the CAPM, a portfolio is constructed to represent the market index, rather than using the S&P 500 as is typically done in academic studies and practice. The NWP for this study was constructed by combining the returns of stocks, bonds and real estate in the following proportion:

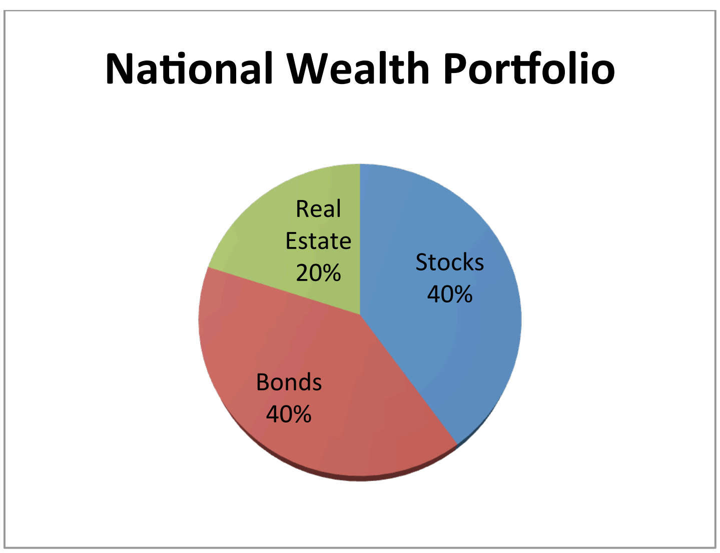


Figure 1

The asset level components (e.g. Stocks) were constructed in the following proportion:

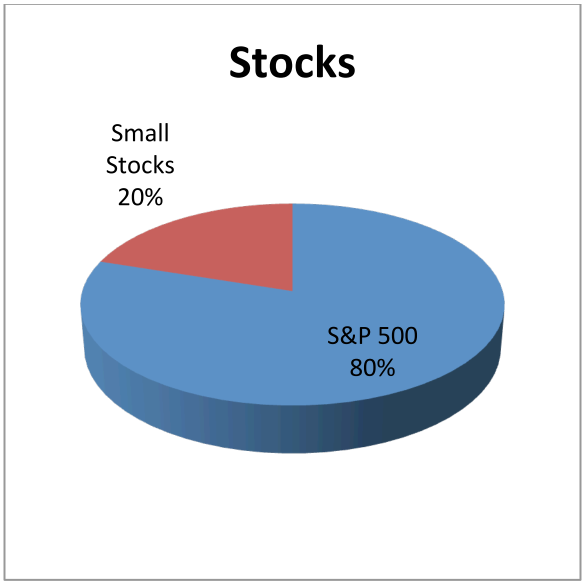


Figure 2

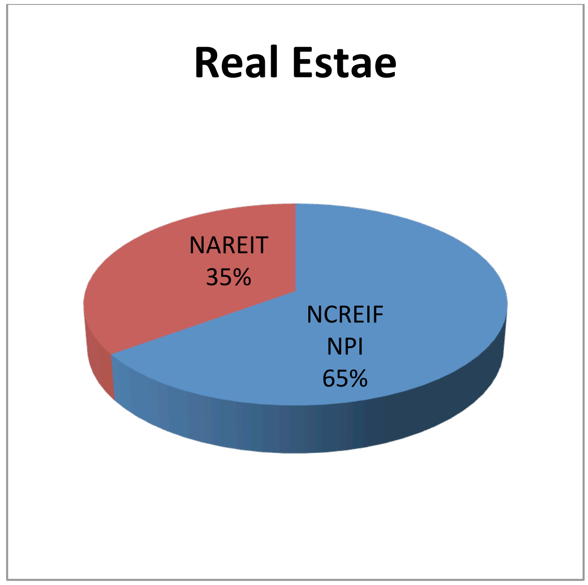


Figure 3

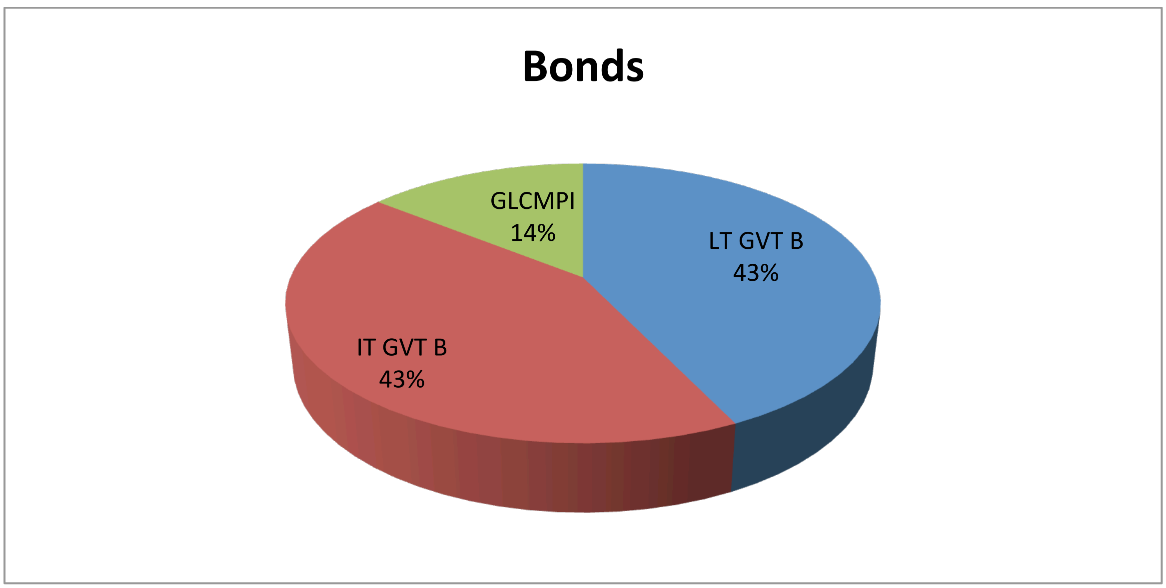


Figure 4

Prior to calculating the return of the NWP composite, the NCREIF returns were corrected for appraisal biases by using the methodology of Li and Price [2005] to unsmooth, or "pre-whiten," the NCREIF data. Specifically, the stale appraisal effect found in the NPI Index was removed by applying a zero autocorrelation-based procedure to these appraisal-based returns. The technique begins with a first and fourth-order autoregressive model of the indices:

$$r_t * = a_0 \; + \; a_0 r_{t-1} * \; + \; a_4 r_{t-4} * \; + e_t$$

Where:

- r_t* = the return in quarter t
- a_1 = factor reflecting autocorrelation estimated in the auto regression model
- a_4 = factor reflecting autocorrelation (including seasonality: the fourth-order lag) estimated in the auto regression model

Next, the residuals from the regression equation were used to estimate the unbiased return (r_t) each quarter:

$$(1/W) \; = \; \lambda / \, бe$$

$$r_t = \; (1/\text{w}) \; \text{e}_t \; + \; \bar{r}$$

- w = a weight chosen to give the unsmoothed returns the desired volatility
- λ = an a-priori volatility assumption set at 5% for quarterly returns
- бe = the standard deviation of regression residual
- e_t = the regression residual for period t
- $\bar{r}$ = the quarterly average return of the NPI Index

With the corrected NCREIF returns, the NWP composite could be calculated simply by multiplying the periodic return of each component by its weighting shown in the pie charts above and summing the components.

Regression. The National Wealth Portfolio CAPM involved running a similar two pass regression technique used extensively in this study with a few small changes. In the first pass, the beta estimate with respect to the NWP composite return for all of the asset classes (except NCREIF NPI) was measured with the following time series regression:

$$r_{i,t} - r_{f,t} \; = \; \alpha_{i,t} \; + \; \beta_{i,t} \, (\, r_{M,t} - r_{f,t} \,) \; + \; e_i$$

The NCREIF NPI beta was estimated by making a seasonal adjustment. Specifically, the market portfolio was lagged three quarters (t-1, t-2 and t-3) and the beta coefficients for each period were combined to simulate the true beta of the NCREIF NPI.

$$r_{i,t} - r_{f,t} = \alpha_{i,t} \; + \; \beta_{0,i} \, (r_{m,t} - r_{f,t}) \; + \; \beta_{1,i} \, (r_{m,t-1} - r_{f,t-1}) \; + \beta_{2,i} \, (r_{m,\text{t}-2} - r_{f,t-2})$$
$$+ \; \beta_{3,i} \, (r_{m,t-3} - r_{f,t-3}) \; + \; \varepsilon_{i,t}$$

$$\beta_i \; = \; \beta_{\text{i},1} + \beta_{\text{i},2} + \beta_{\text{i},3}$$

With all the betas estimated a cross-sectional regression was run to test the accuracy of the model. The regression equation was:

$$\overline{(r_i - r_f)} = \gamma_0 + \gamma_1 \beta_1 + e_i$$

Results. The scatter plot (Figure 4) visualizes the risk-return relationship of the various asset classes in the period from January 1979 to December 2011. The quarterly risk premium is on the vertical axis and the beta with respect to the NWP is on the horizontal axis. The plot shows a clear positive linear relationship between risk and return. However, the security market line does not intersect the two axes at zero as theory would suggest. This is a slightly different result that than found by Li and Price [2005], where the intercept was close to zero (.17%). The results are likely distorted by the recent performance of the long-term U.S. Government Bonds "pulling" up the security market line. The long term bond risk premium is much higher than justified by the beta. The behavior is likely a result of the Federal Reserve policy actions and other market participants as a reaction to the global financial crisis and recession. As of this writing, the yields on US 30-year bonds are below 3% and near all time-historical lows.

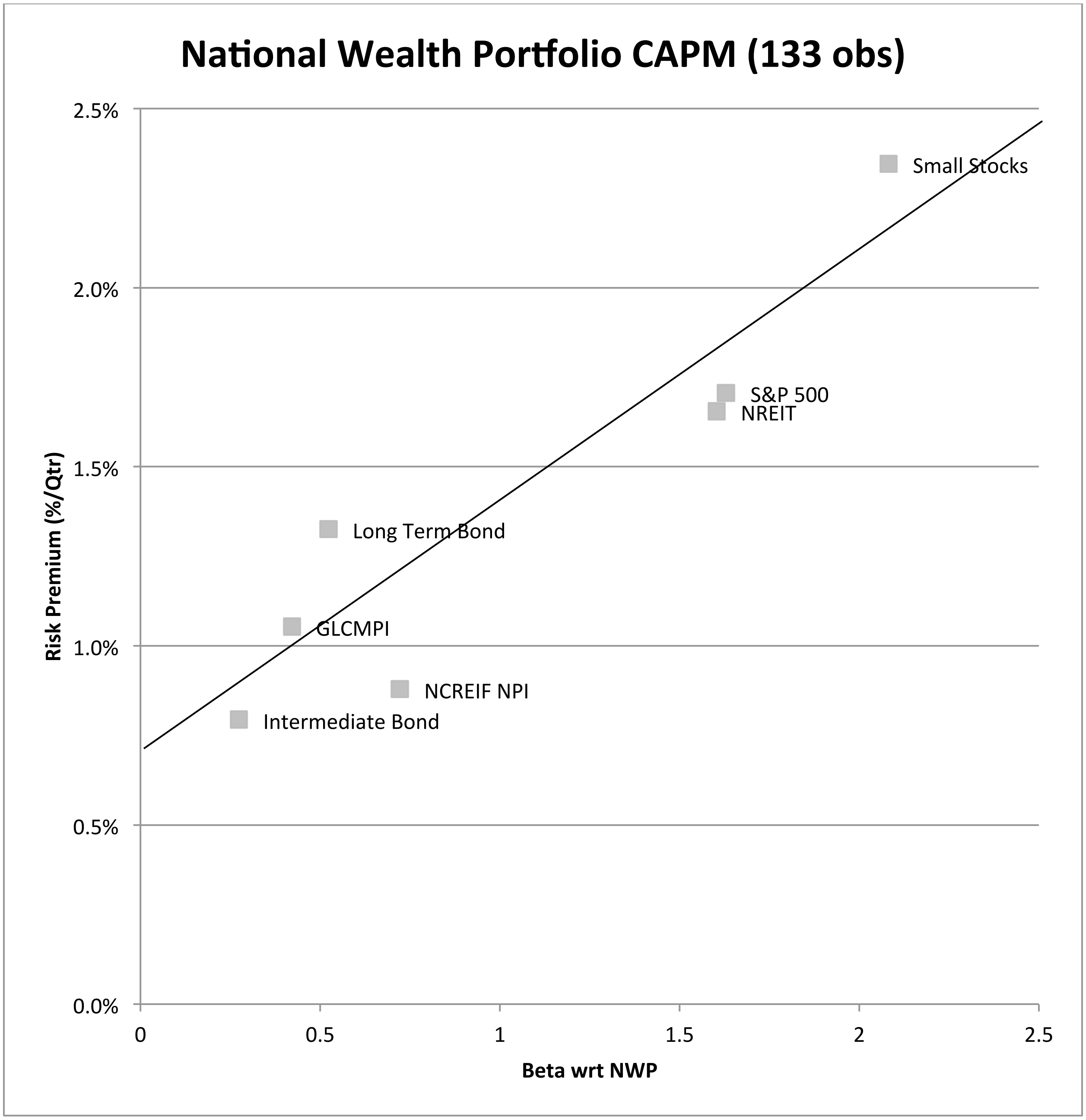


Figure 4

Tables 2 and 3 show the results of the time series regressions. Table 1 shows the mixed results of the cross-sectional regression. The intercept was positive and statistically significant, a poor result. However, the beta was positive and statistically significant and the model had a good adjusted R^2 (.82). The results suggest that some additional factors (other than beta with NWP) were needed to fully explain the cross-section of asset class returns in the period.

Cross-Sectional Regression Results

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	0.00659	0.001602	4.113089	0.009236	0.002471
Beta	0.007097	0.001301	5.453517	0.002818	0.003752
R^2	0.856077				
Adjusted R^2	0.827293				
Standard Error	0.002287				

Table 1

Time Series Regression Results

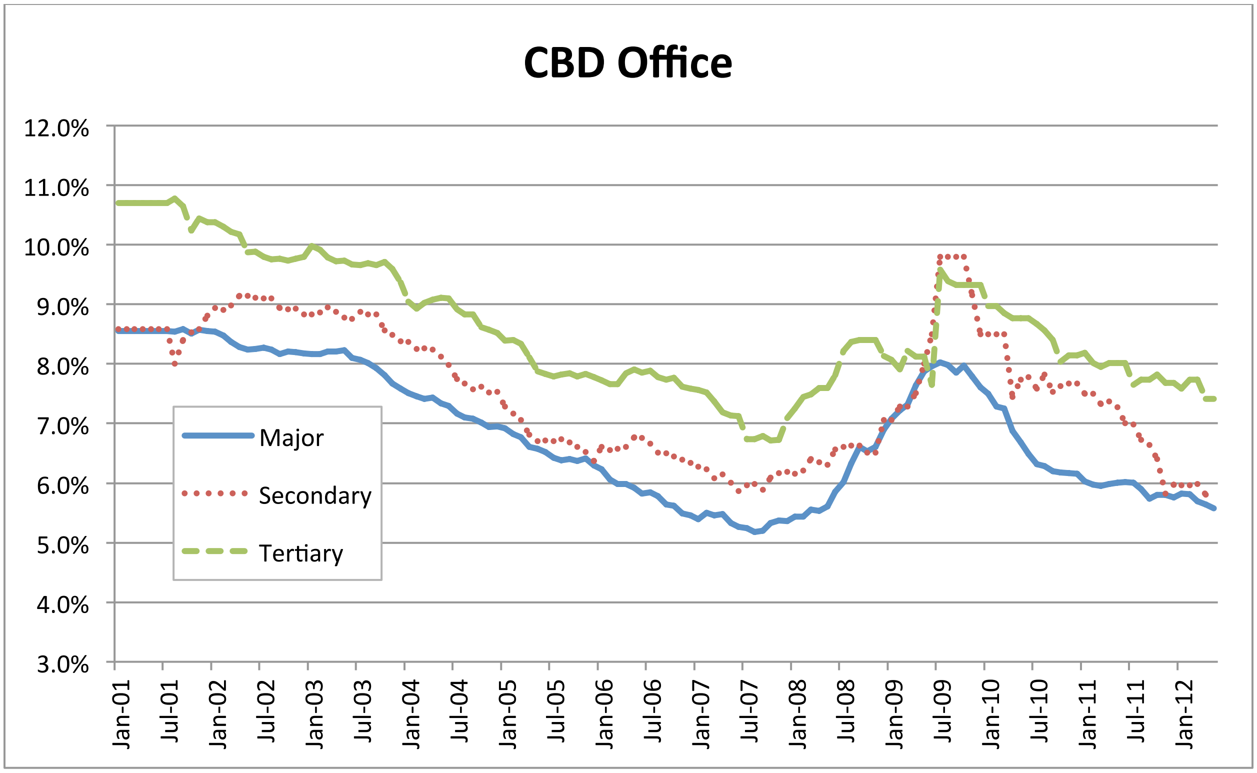
	sp500	smallstk	ltgbnd	itgbnd	glcmpi	nreit
nwp	1.63	2.082	0.523	0.274	0.421	1.603
	(21.11)**	(14.98)**	(4.36)**	(4.43)**	(7.79)**	(13.74)**
_cons	-0.006	-0.005	0.006	0.004	0.005	-0.006
	-1.53	-0.83	-1.07	-1.42	-1.85	-1.04
R^2	0.78	0.64	0.13	0.13	0.32	0.6
N	129	129	129	129	129	129

Table 2

	ncreifnpi
t	0.296
	(3.13)**
t-1	0.107
	-1.12
t-2	0.246
	(2.59)*
t-3	0.073
	-0.77
_cons	-0.001
	-0.24
R^2	0.14
N	129

Table 3

Appendix B: Cap Rates Charts


CBD Office
12.0%
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Major
Secondary
Tertiary
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
Jan-08
Jul-08
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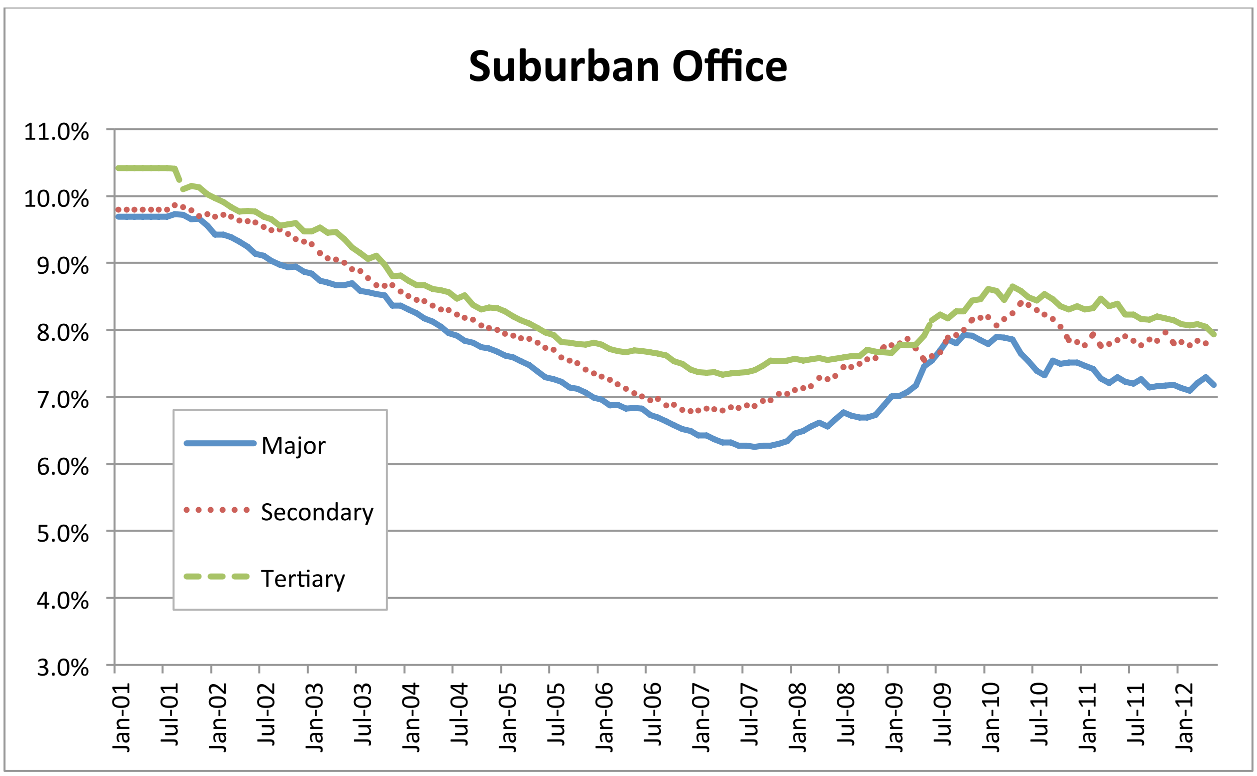
Jul-10
Jan-11
Jul-11
Jan-12


Suburban Office
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Major
Secondary
Tertiary
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
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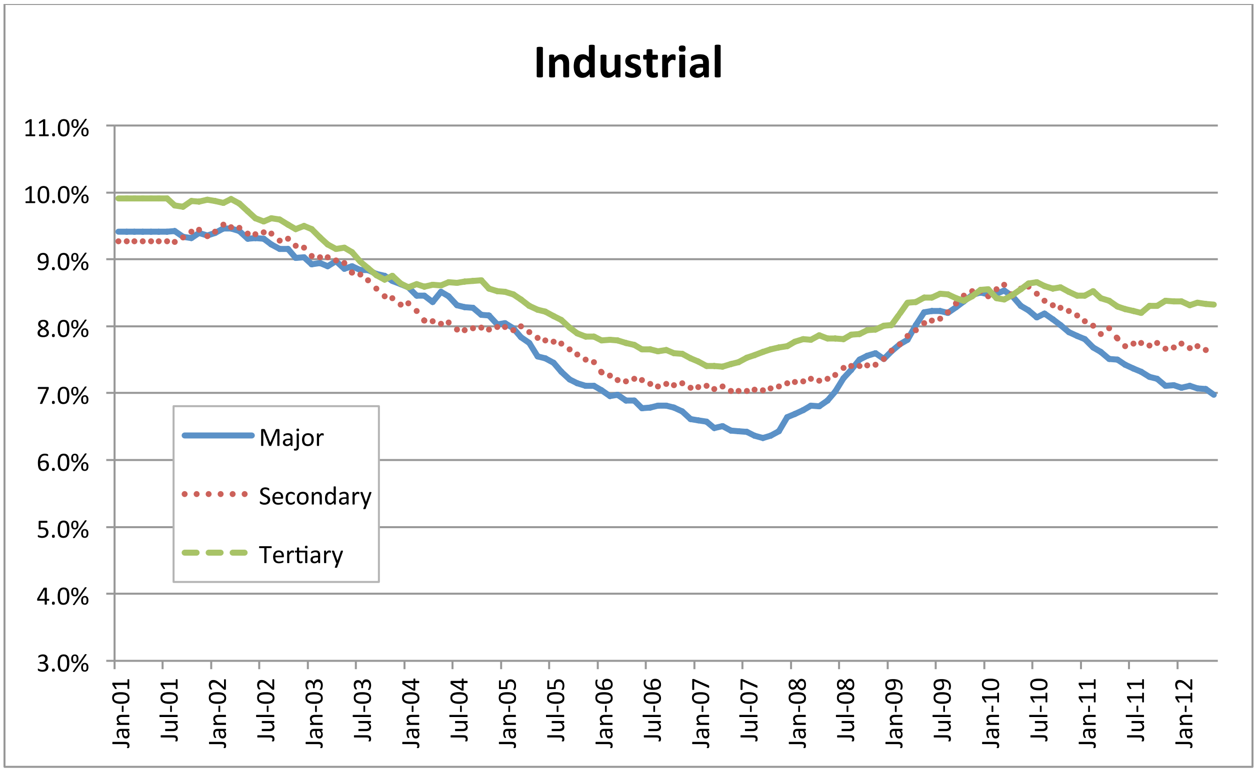
Jan-11
Jul-11
Jan-12


Industrial
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Major
Secondary
Tertiary
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
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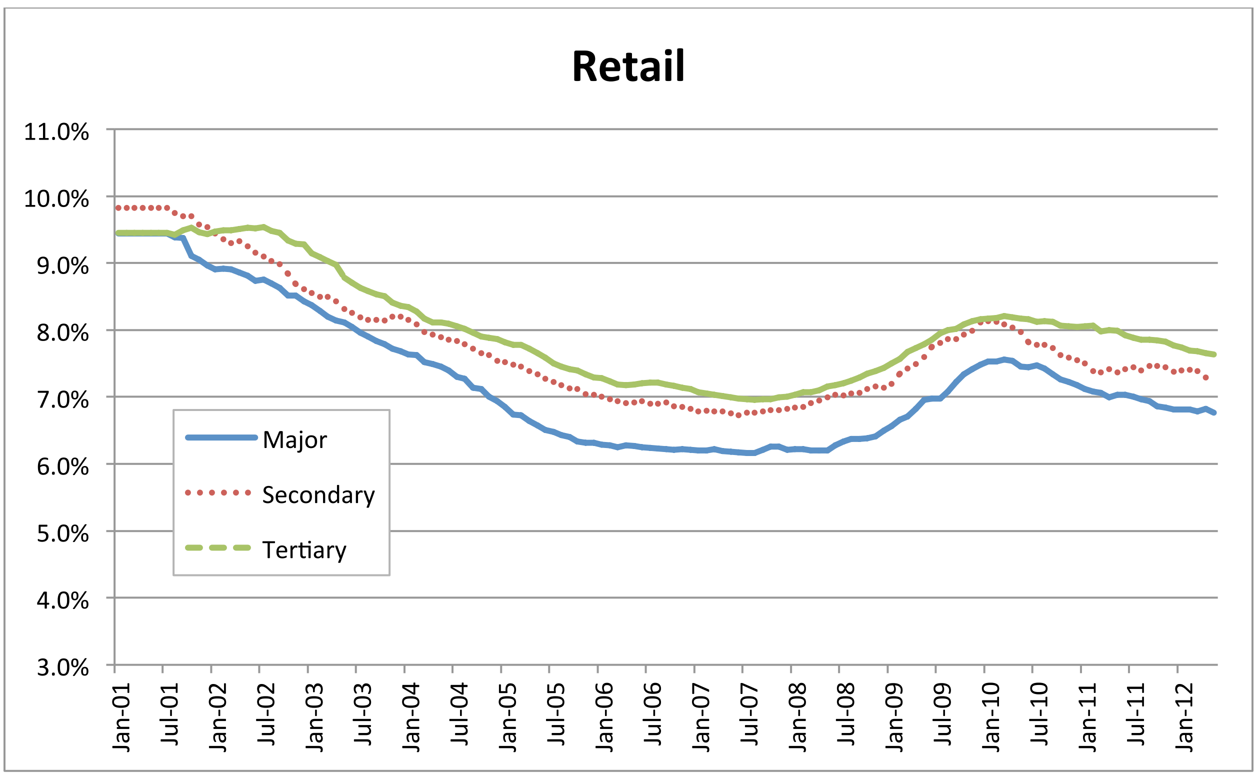
Jan-11
Jul-11
Jan-12


Retail
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Major
Secondary
Tertiary
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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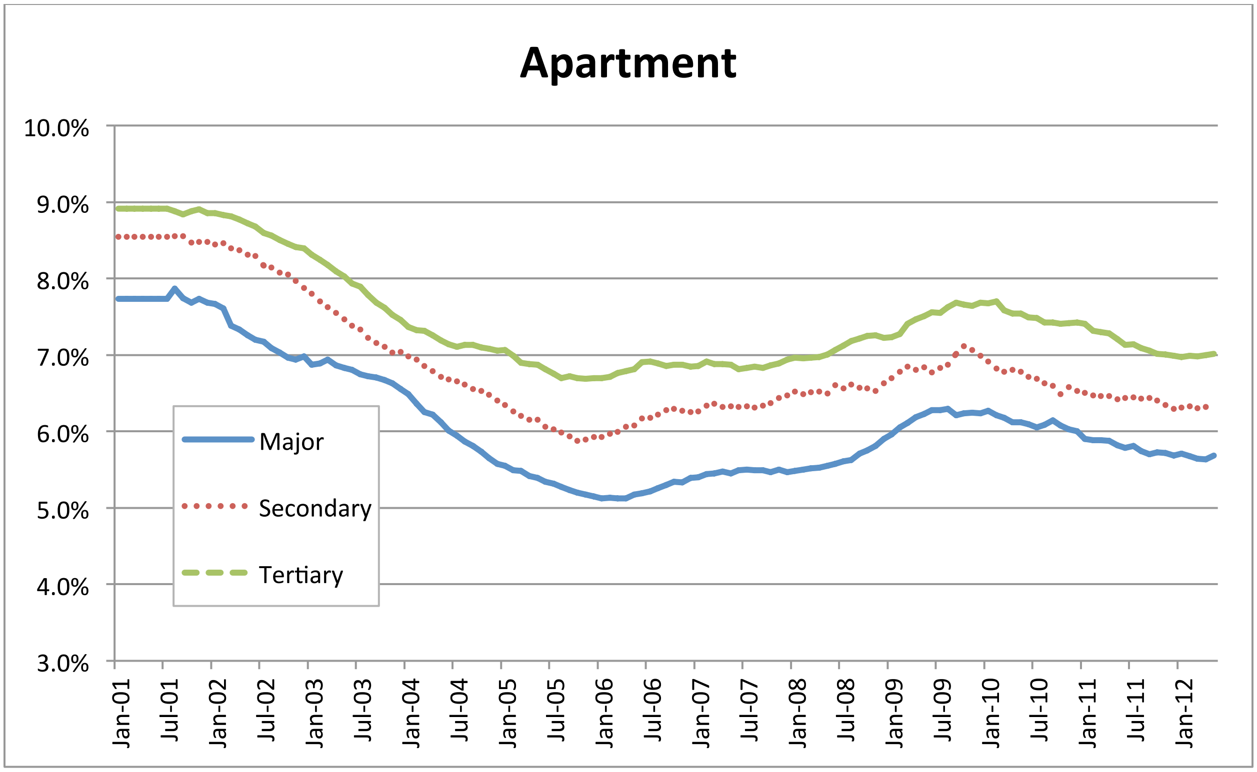
Jul-11
Jan-12


Apartment
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Major
Secondary
Tertiary
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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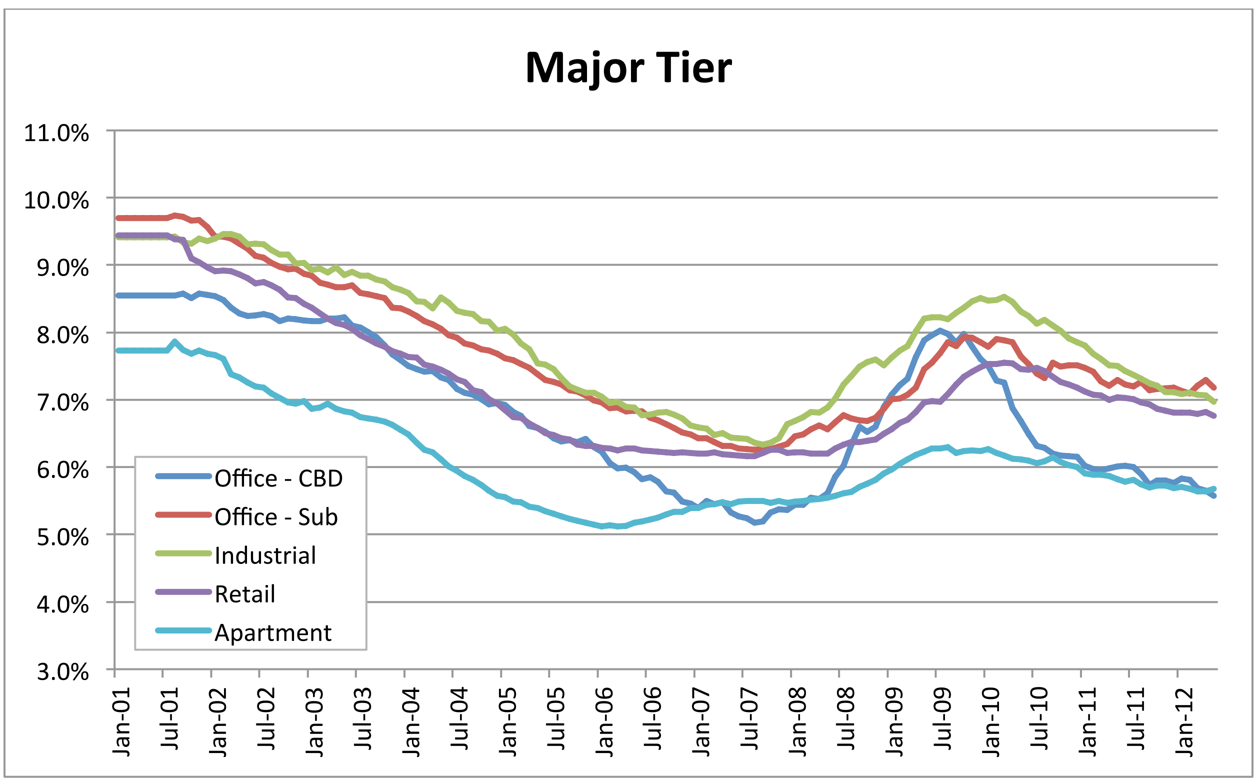
Jan-12


Major Tier
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Office - CBD
Office - Sub
Industrial
Retail
Apartment
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
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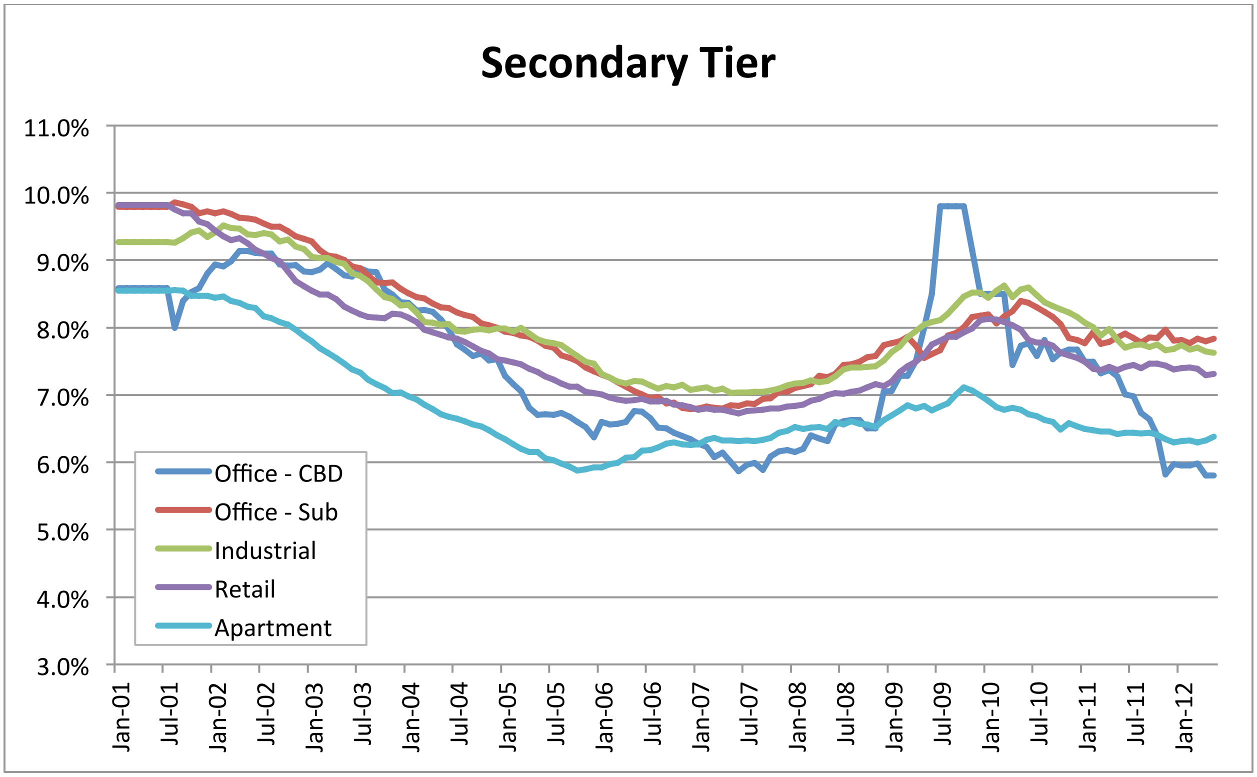
Jan-11
Jul-11
Jan-12


Secondary Tier
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Office - CBD
Office - Sub
Industrial
Retail
Apartment
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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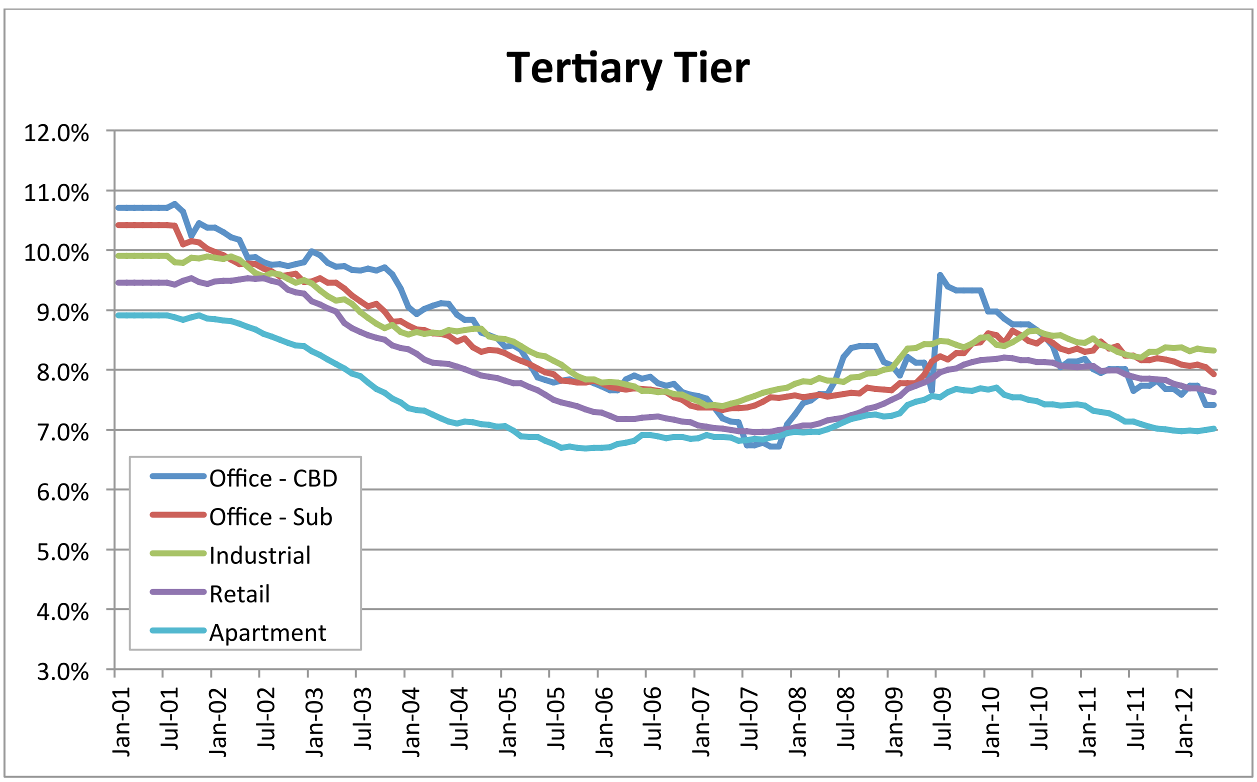
Jul-11
Jan-12


Tertiary Tier
12.0%
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
Office - CBD
Office - Sub
Industrial
Retail
Apartment
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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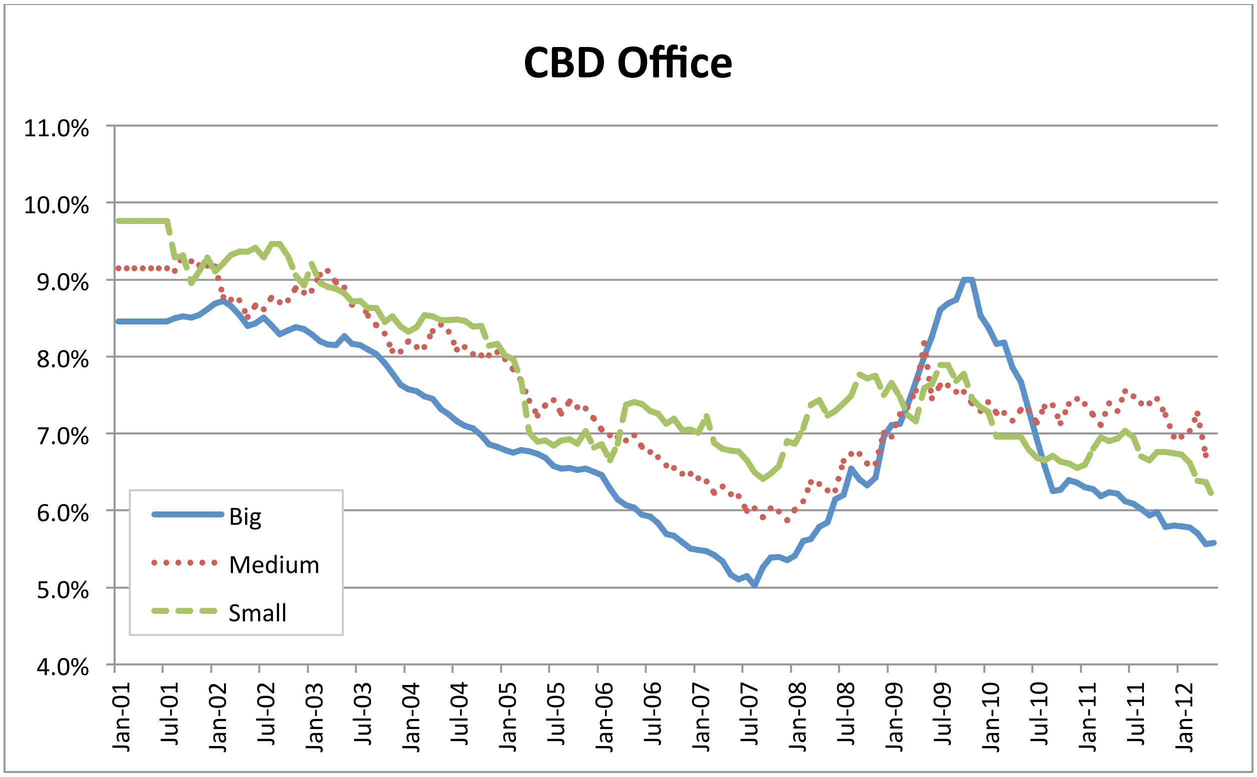
Jan-11
Jul-11
Jan-12


CBD Office
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big
Medium
Small
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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Jan-07
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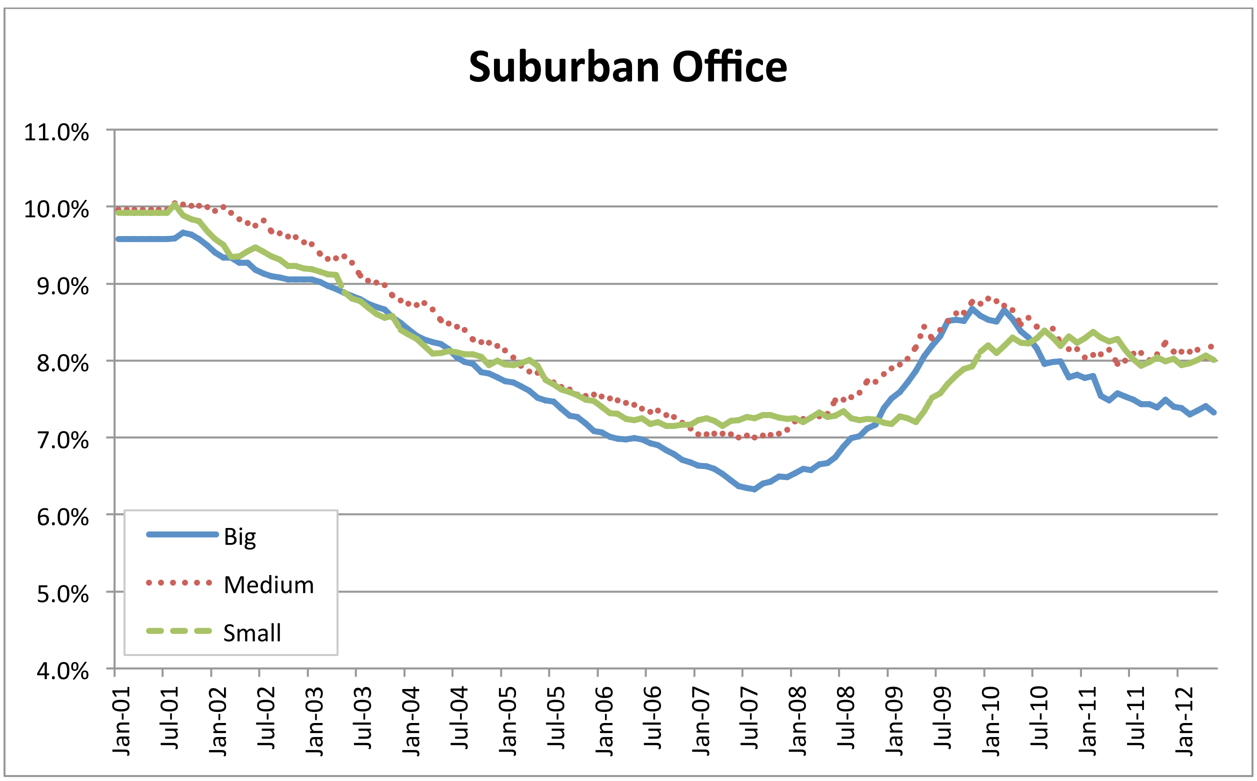
Jan-11
Jul-11
Jan-12


Suburban Office
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big
Medium
Small
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
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Jul-05
Jan-06
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Jan-11
Jul-11
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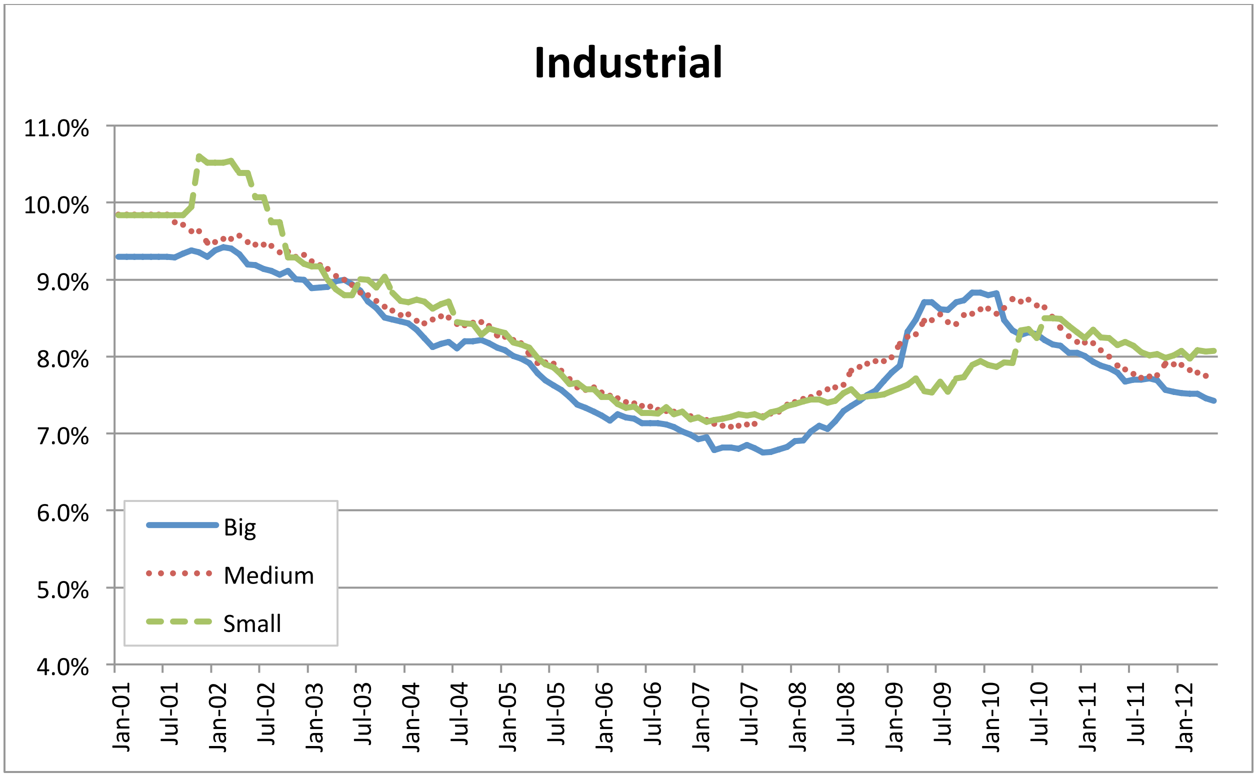
Industrial
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big
Medium
Small
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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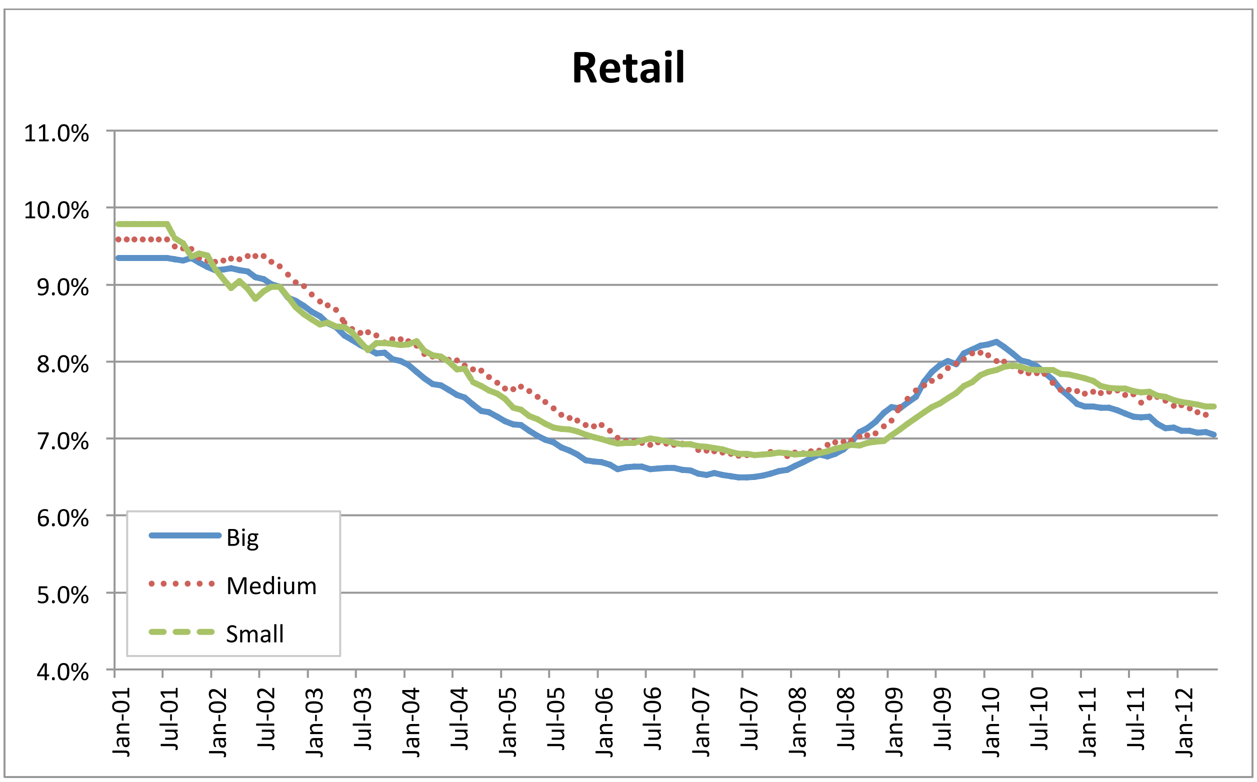
Retail
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big
Medium
Small
Jan-01
Jul-01
Jan-02
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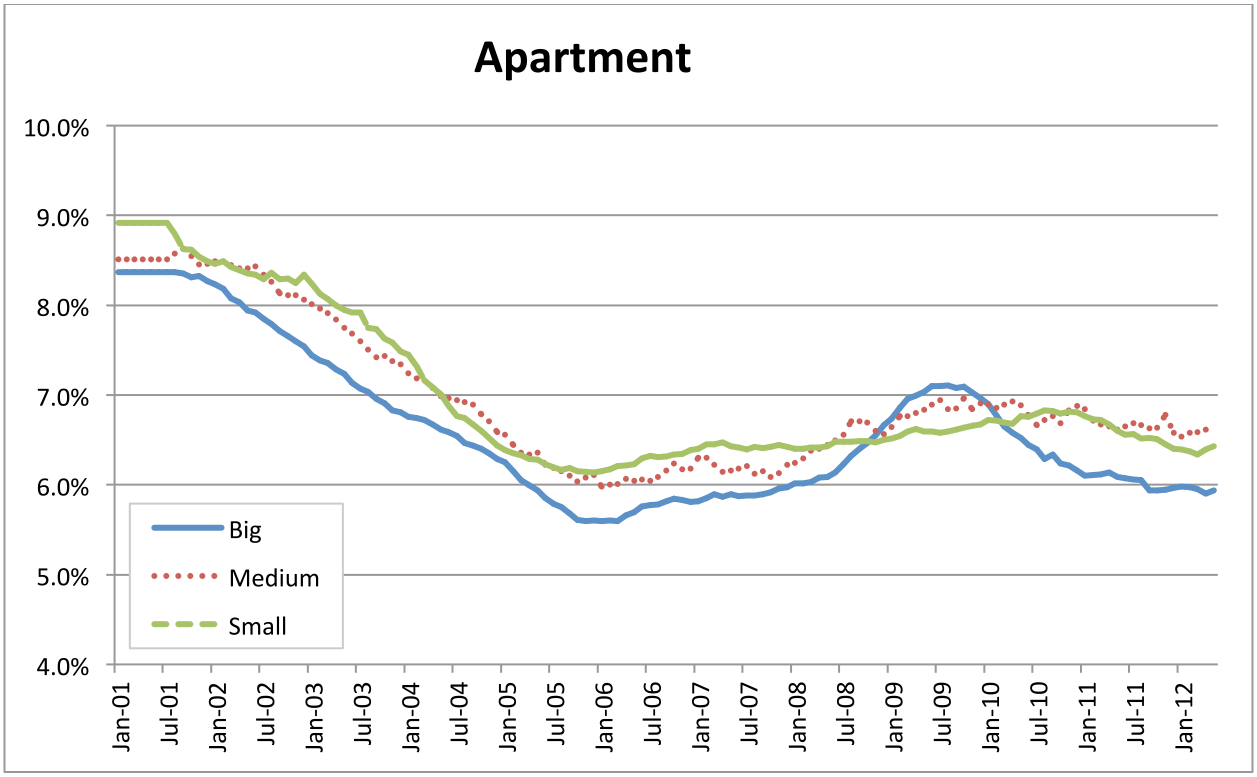
Apartment
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big
Medium
Small
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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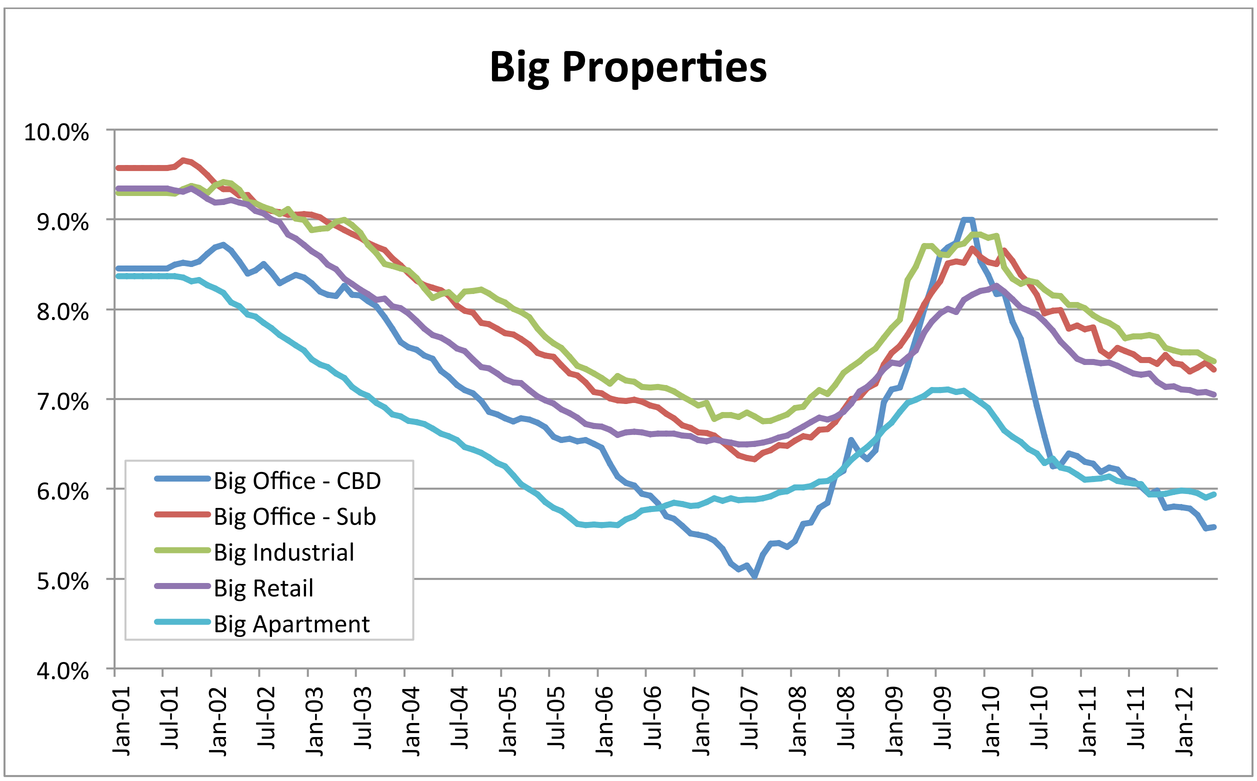
Jan-11
Jul-11
Jan-12


Big Properties
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Big Office - CBD
Big Office - Sub
Big Industrial
Big Retail
Big Apartment
Jan-01
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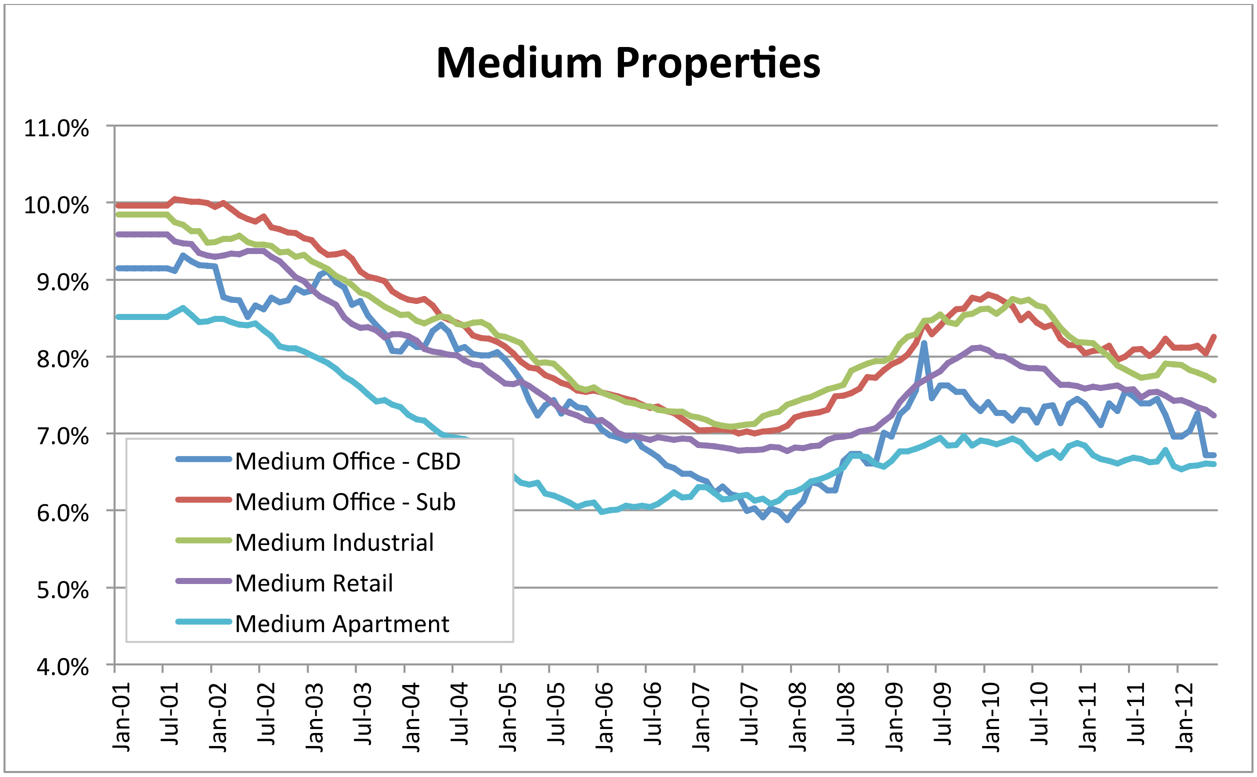
Jul-11
Jan-12


Medium Properties
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Medium Office - CBD
Medium Office - Sub
Medium Industrial
Medium Retail
Medium Apartment
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
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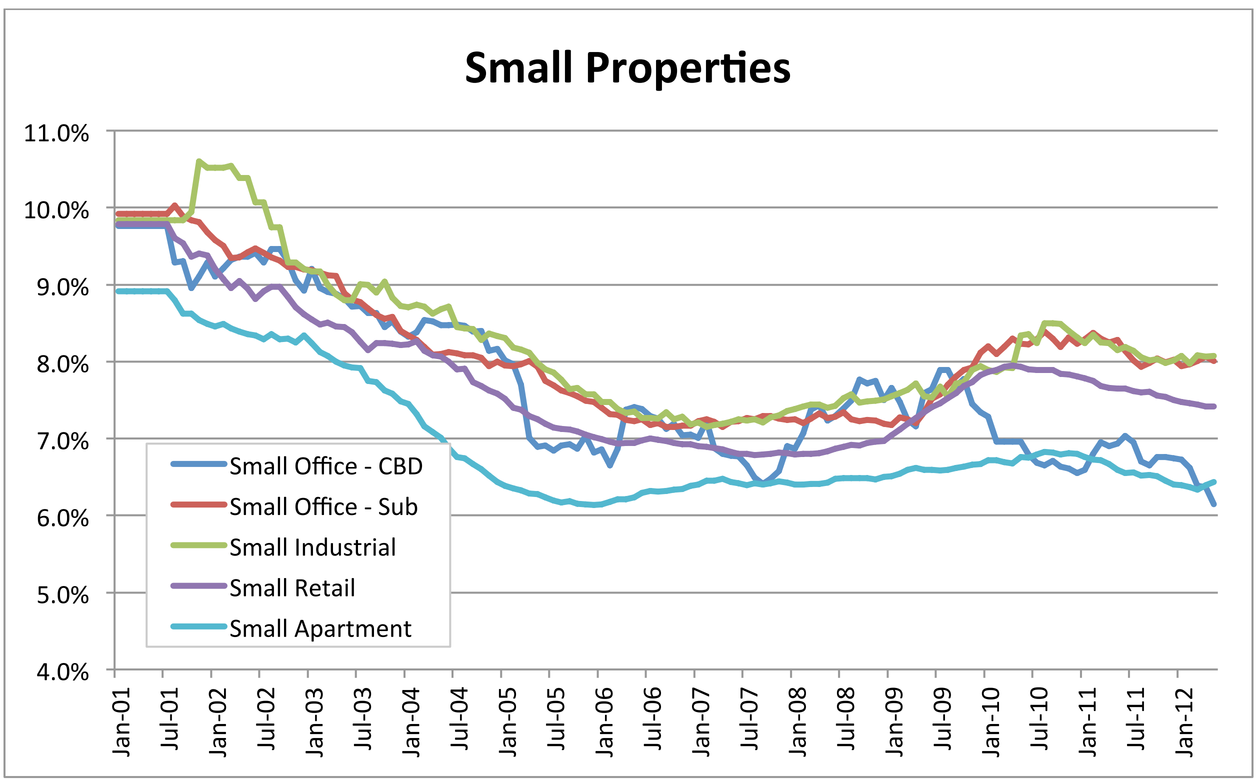
Jan-11
Jul-11
Jan-12


Small Properties
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
Small Office - CBD
Small Office - Sub
Small Industrial
Small Retail
Small Apartment
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
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Jul-04
Jan-05
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Jan-12

Appendix C: Time Series Regression Results

NCREIF Market Tier Portfolio – Single Factor Time Series Results

	NPI		R^2	N
officecbdmaj	1.144	(25.06)**	0.94	45
officecbdsec	1.159	(10.27)**	0.71	45
officecbdtert	1.099	(7.01)**	0.53	45
officesubmaj	1.101	(20.05)**	0.9	45
officesubsec	0.888	(14.34)**	0.83	45
officesubtert	0.868	(8.19)**	0.61	45
industrialmaj	1.065	(14.18)**	0.82	45
industrialsec	0.88	(19.02)**	0.89	45
industrialtert	0.999	(7.09)**	0.54	45
apartmentmaj	1.061	(18.87)**	0.89	45
apartmentsec	0.977	(19.54)**	0.9	45
apartmenttert	0.934	(19.33)**	0.9	45
retailmaj	0.815	(8.55)**	0.63	45
retailsec	0.959	(8.18)**	0.61	45
retailtert	0.888	(9.52)**	0.68	45

NCREIF Market Tier Portfolios – Multifactor Time Series Results

	NPI		MMT		SMB		R^2	N
officecbdmaj	1.06	(20.09)**	0.445	(2.35)*	0.25	(2.60)*	0.95	45
officecbdsec	0.942	(7.57)**	0.698	-1.57	0.779	(3.44)**	0.78	45
officecbdtert	1.037	(6.58)**	-1.112	-1.97	0.615	(2.14)*	0.7	45
officesubmaj	0.953	(17.51)**	0.588	(3.01)**	0.495	(4.99)**	0.94	45
officesubsec	0.763	(13.02)**	0.18	-0.86	0.515	(4.82)**	0.9	45
officesubtert	0.944	(8.55)**	-1.275	(3.22)**	0.038	-0.19	0.73	45
industrialmaj	0.92	(11.19)**	0.448	-1.52	0.524	(3.50)**	0.87	45
industrialsec	0.816	(15.53)**	0.111	-0.59	0.257	(2.68)*	0.91	45
industrialtert	1.018	(7.44)**	-1.475	(3.01)**	0.356	-1.43	0.73	45
apartmentmaj	1.068	(15.58)**	0.179	-0.73	-0.084	-0.67	0.9	45
apartmentsec	0.986	(15.96)**	-0.188	-0.85	0.013	-0.11	0.9	45
apartmenttert	0.888	(14.93)**	0.209	-0.98	0.147	-1.36	0.9	45
retailmaj	0.725	(6.21)**	0.635	-1.52	0.22	-1.04	0.65	45
retailsec	0.757	(5.59)**	0.802	-1.65	0.682	(2.76)**	0.67	45
retailtert	0.836	(7.37)**	-0.054	-0.13	0.249	-1.21	0.7	45

NCREIF Size Portfolios – Single Factor Time Series Results

	NPI		R^2	N
cbdb	1.026	(18.94)**	0.89	45
cbdm	1.043	(23.66)**	0.93	45
cbds	1.415	(6.59)**	0.5	45
subb	0.903	(26.33)**	0.94	45
subm	0.853	(30.96)**	0.96	45
subs	1.187	(8.84)**	0.64	45
industrialb	0.921	(33.78)**	0.96	45
industrialm	0.853	(29.66)**	0.95	45
industirals	1.172	(5.75)**	0.43	45
apartmentb	1.016	(16.39)**	0.86	45
apartmentm	0.864	(22.04)**	0.92	45
apartments	1.246	(7.42)**	0.56	45
retailb	0.827	(15.15)**	0.84	45
retailm	0.806	(14.45)**	0.83	45
retails	0.993	(4.65)**	0.33	45

NCREIF Size Portfolio – Multifactor Time Series Results

	NPI		MMT		SMB		R^2	N
cbdb	1.007	(14.86)**	0.171	-0.7	0.037	-0.3	0.89	45
cbdm	1.026	(18.56)**	0.079	-0.4	0.056	-0.56	0.93	45
cbds	1.093	(5.37)**	-0.217	-0.3	1.527	(4.12)**	0.72	45
subb	0.859	(22.09)**	0.053	-0.38	0.184	(2.59)*	0.95	45
subm	0.823	(27.72)**	-0.037	-0.35	0.148	(2.74)**	0.97	45
subs	1.021	(8.47)**	-0.473	-1.09	0.895	(4.08)**	0.82	45
industrialb	0.914	(27.45)**	-0.057	-0.48	0.053	-0.88	0.97	45
industrialm	0.855	(24.53)**	-0.129	-1.03	0.029	-0.46	0.96	45
industirals	1.035	(5.29)**	-1.258	-1.79	0.999	(2.80)**	0.67	45
apartmentb	1.034	(13.39)**	0.033	-0.12	-0.089	-0.63	0.86	45
apartmentm	0.973	(26.47)**	-0.391	(2.96)**	-0.379	(5.66)**	0.95	45
apartments	0.869	(4.97)**	1.226	-1.95	1.347	(4.23)**	0.7	45
retailb	0.841	(12.47)**	0.073	-0.3	-0.088	-0.72	0.85	45
retailm	0.848	(12.49)**	-0.055	-0.22	-0.175	-1.42	0.84	45
retails	0.637	(2.65)*	0.989	-1.15	1.323	(3.02)**	0.47	45

RCA Metro Tier Portfolios – Single Factor Time Series Results

	Nat'l		R^2	N
officecbdmaj	1.416	(8.36)**	0.62	45
officecbdsec	2.233	(6.16)**	0.47	45
officecbdtert	0.252	-0.64	0.01	45
officesubmaj	1.101	(7.17)**	0.54	45
officesubsec	0.979	(10.07)**	0.7	45
officesubtert	0.994	(8.31)**	0.62	45
industrialmaj	0.675	(7.23)**	0.55	45
industrialsec	0.933	(6.93)**	0.53	45
industrialtert	0.781	(5.66)**	0.43	45
retailmaj	0.913	(6.21)**	0.47	45
retailsec	0.848	(7.18)**	0.55	45
retailtert	0.623	(3.21)**	0.19	45
apartmentmaj	0.69	(10.01)**	0.7	45
apartmentsec	1.291	(10.51)**	0.72	45
apartmenttert	1.182	(11.05)**	0.74	45

RCA Metro Tier Portfolios – Multifactor Time Series Results

	Nat'l		MMT		SMB		R^2	N
cbdb	0.756	(5.03)**	0.978	(5.95)**	-1.192	(5.46)**	0.84	45
cbdm	1.458	(4.84)**	2.748	(8.35)**	-0.79	-1.8	0.8	45
cbds	0.373	-1.03	-2.625	(6.61)**	-0.713	-1.35	0.55	45
subb	1.292	(6.43)**	0.132	-0.6	0.503	-1.72	0.58	45
subm	1.111	(9.19)**	-0.383	(2.90)**	0.167	-0.95	0.75	45
subs	0.91	(5.86)**	-0.247	-1.46	-0.293	-1.3	0.65	45
industrialb	0.704	(5.90)**	0.268	(2.05)*	0.171	-0.98	0.61	45
industrialm	1.122	(6.34)**	-0.285	-1.48	0.339	-1.32	0.56	45
industirals	0.933	(7.15)**	-0.943	(6.61)**	0.002	-0.01	0.73	45
retailb	1.144	(5.92)**	-0.101	-0.48	0.51	-1.82	0.51	45
retailm	1.158	(8.08)**	-0.307	-1.96	0.619	(2.97)**	0.64	45
retails	1.311	(6.68)**	-0.954	(4.45)**	1.268	(4.45)**	0.56	45
apartmentb	0.729	(8.74)**	-0.301	(3.30)**	-0.022	-0.18	0.76	45
apartmentm	1.102	(7.29)**	0.501	(3.03)**	-0.258	-1.18	0.77	45
apartments	1.099	(8.05)**	-0.256	-1.72	-0.294	-1.48	0.77	45

RCA Size Portfolios – Single Factor Time Series Results

	Nat'l		R^2	N
cbdb	1.443	(6.22)**	0.47	45
cbdm	1.897	(6.09)**	0.46	45
cbds	0.76	(4.13)**	0.28	45
subb	0.976	(8.73)**	0.64	45
subm	1.367	(9.15)**	0.66	45
subs	0.781	(7.44)**	0.56	45
indb	1.234	(7.86)**	0.59	45
indm	0.86	(7.68)**	0.58	45
inds	0.45	(3.08)**	0.18	45
retb	0.954	(6.36)**	0.48	45
retm	1.028	(7.97)**	0.6	45
rets	0.471	(3.60)**	0.23	45
aptb	1.222	(8.18)**	0.61	45
aptm	1.008	(11.20)**	0.74	45
apts	0.837	(8.96)**	0.65	45

RCA Size Portfolios – Multifactor Time Series Results

	Nat'l		MMT		SMB		R^2	N
cbdb	0.558	(2.52)*	0.032	-0.13	-2.086	(6.45)**	0.74	45
cbdm	1.14	(4.02)**	2.171	(6.97)**	-0.998	(2.42)*	0.76	45
cbds	0.738	(3.02)**	-0.338	-1.26	-0.176	-0.49	0.32	45
subb	1.177	(8.57)**	-0.423	(2.80)**	0.322	-1.61	0.71	45
subm	1.14	(5.93)**	0.405	-1.92	-0.389	-1.39	0.7	45
subs	0.992	(7.44)**	-0.222	-1.51	0.421	(2.17)*	0.62	45
indb	0.861	(4.42)**	0.275	-1.29	-0.785	(2.77)**	0.66	45
indm	0.72	(4.89)**	-0.057	-0.35	-0.353	-1.65	0.61	45
inds	0.897	(5.34)**	-0.357	-1.94	0.93	(3.80)**	0.42	45
retb	1.257	(7.09)**	-0.661	(3.40)**	0.478	-1.85	0.61	45
retm	1.351	(8.52)**	-0.202	-1.16	0.691	(2.99)**	0.67	45
rets	0.971	(7.27)**	-0.284	-1.94	1.082	(5.56)**	0.57	45
aptb	0.777	(5.72)**	-0.416	(2.79)**	-1.209	(6.11)**	0.83	45
aptm	0.967	(8.33)**	-0.223	-1.75	-0.18	-1.06	0.77	45
apts	1.032	(8.82)**	0.008	-0.06	0.464	(2.73)**	0.71	45

PureProperty Portfolios – Single Factor Time Series Results

	SP&500		R^2	N
erap	0.407	(7.52)**	0.28	144
erip	0.098	-1.42	0.01	144
erop	0.478	(8.49)**	0.34	144
errp	0.419	(8.61)**	0.34	144
mrap	0.038	-0.75	0	144
mrip	0.408	(4.12)**	0.11	144
mrop	0.15	(2.72)**	0.05	144
mrrp	0.352	(6.60)**	0.23	144
srap	0.361	(7.61)**	0.29	144
srop	0.446	(6.58)**	0.23	144
srrp	0.381	(7.42)**	0.28	144
swirp	0.649	(8.98)**	0.36	144
wrap	0.474	(7.19)**	0.27	144
wrop	0.354	(8.39)**	0.33	144
wrrrp	0.588	(6.24)**	0.22	144

PureProperty – Multifactor FF Time Series Results

	S&P500		SMB		HML		R^2	N
erap	0.382	(7.86)**	0.273	(4.22)**	0.399	(5.95)**	0.44	144
erip	0.075	-1.15	0.259	(2.98)**	0.405	(4.51)**	0.15	144
erop	0.45	(9.32)**	0.307	(4.77)**	0.48	(7.20)**	0.53	144
errp	0.389	(9.33)**	0.316	(5.69)**	0.393	(6.83)**	0.54	144
mrap	0.034	-0.65	0.048	-0.7	0.059	-0.82	0.01	144
mrip	0.393	(3.93)**	0.157	-1.18	0.198	-1.43	0.12	144
mrop	0.129	(2.40)*	0.218	(3.06)**	0.24	(3.24)**	0.14	144
mrrp	0.325	(6.94)**	0.289	(4.63)**	0.419	(6.48)**	0.43	144
srap	0.34	(8.01)**	0.239	(4.22)**	0.358	(6.12)**	0.45	144
srop	0.419	(6.75)**	0.296	(3.58)**	0.469	(5.47)**	0.38	144
srrp	0.361	(7.52)**	0.214	(3.34)**	0.319	(4.82)**	0.39	144
swirp	0.627	(9.24)**	0.255	(2.82)**	0.452	(4.82)**	0.46	144
wrap	0.45	(7.47)**	0.275	(3.41)**	0.471	(5.66)**	0.41	144
wrop	0.33	(9.09)**	0.255	(5.26)**	0.345	(6.88)**	0.52	144
wrrrp	0.543	(6.09)**	0.448	(3.77)**	0.487	(3.96)**	0.32	144

PureProperty Portfolios – Multifactor Macro Time Series Results

	sp500		tbill		term		credit		cpi		R^2	N
fnperap	0.408	(7.25)**	5.351	-1.2	0.849	-1.5	-0.363	-0.62	0.152	-0.19	0.3	144
fnperip	0.11	-1.52	2.86	-0.5	0.508	-0.7	0.492	-0.65	-0.441	-0.44	0.03	144
fnperop	0.468	(8.18)**	10.556	(2.32)*	1.49	(2.59)*	0.134	-0.22	1.209	-1.51	0.38	144
fnperrp	0.429	(8.58)**	8.31	(2.09)*	1.234	(2.45)*	-0.171	-0.33	-0.157	-0.22	0.38	144
fnpmrap	0.029	-0.54	0.33	-0.08	0.058	-0.11	0.174	-0.31	0.7	-0.94	0.01	144
fnpmrip	0.333	(3.45)**	9.322	-1.21	1.503	-1.54	-1.926	-1.91	4.542	(3.35)**	0.23	144
fnpmrop	0.165	(2.85)**	2.732	-0.59	0.409	-0.7	0.722	-1.2	-0.493	-0.61	0.07	144
fnpmrrp	0.341	(6.35)**	9.806	(2.30)*	1.43	(2.64)**	-0.386	-0.69	1.127	-1.5	0.3	144
fnpsrap	0.34	(6.91)**	-0.906	-0.23	0.212	-0.43	-0.552	-1.07	0.986	-1.43	0.32	144
fnpsrop	0.438	(6.39)**	14.105	(2.59)*	1.67	(2.42)*	1.377	-1.92	1.744	-1.82	0.29	144
fnpsrrp	0.386	(7.24)**	6.517	-1.54	0.999	-1.86	-0.007	-0.01	0.017	-0.02	0.3	144
fnpswrip	0.638	(8.65)**	13.642	(2.33)*	1.746	(2.35)*	0.568	-0.74	1.617	-1.56	0.4	144
fnpwrap	0.474	(6.96)**	2.332	-0.43	0.564	-0.82	-1.282	-1.8	-0.232	-0.24	0.29	144
fnpwrop	0.355	(8.26)**	7.087	(2.08)*	0.911	(2.11)*	-0.351	-0.78	0.388	-0.65	0.37	144
fnpwrrp	0.531	(5.66)**	13.849	-1.86	2.288	(2.42)*	-0.15	-0.15	3.989	(3.04)**	0.3	144