What determined the Great Cap Rate Compression of 2000-2007, and the dramatic reversal during the 2008-2009 Financial Crisis?

by

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Abstract

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In this paper we revisit the many studies that have attempted to explain the determinants of commercial real estate capitalization rates. We introduce two new innovations. First we are able to incorporate two macroeconomic factors that greatly impact cap rates besides treasury rates and local market fundamentals – the variables most commonly used in such research. These are the general corporate risk premium operating in the economy, and the amount of debt relative to GDP in the general economy (liquidity). The addition of these factors greatly adds to the ability of previous models to explain the secular fall of cap rates in the last decade and their recent rise – in terms of traditional measures of within-sample fit.

Our second innovation is methodological; our analysis uses a large and robust quarterly panel data set of 30 US metropolitan areas from 1980q1 through 2009q3. With this data we compare 3 models: a "base model and then one that selectively adds each of our macro-economic variables. We test the ability of each of these models to fit the 2002-2009 period using "back test" dynamic forecasts. Our conclusion is that much of the secular decline in cap rates from 2000 through 2007 and their subsequent rise seem attributable to the macro-economic factors and less to movements in market fundamentals.

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I. Introduction

In this paper we revisit many studies that have attempted to explain the determinants of real estate capitalization rates.[1] We introduce several new innovations. First we are able to show that macroeconomic factors greatly impact cap rates besides risk-free government treasury rates. These are the general corporate risk premium operating in the economy, and the amount of debt (liquidity) issued in the economy. The addition of these factors greatly adds to the ability of previous models to explain the rise of cap rates in the early 1990s, the secular fall of cap rates in the last decade, and the recent rise during the "financial crisis".

Methodologically, our analysis uses a large and robust quarterly panel data set of 30 US metropolitan areas from 1980q1 through 2009q3. We compare models not only using traditional measures of within sample "fit", but also examine how the models behave in in-sample "back test" forecasts. Our paper is organized as follows. In the next section, we review the literature on cap rates. Next, we detail our panel data base and outline the basic econometric model that is used, and then present our results from this basic model as well as results from extended models, which introduce additional macroeconomic variables. We then compare the ability of the three models to explain changes in cap rates over the last 3 decades, using traditional measures of "fit", and examine their relative performance using within-sample back test forecasts. The discussion and interpretation of our findings is offered in conclusion.

II. Background and Literature

The starting point of our paper is a long literature on the determinants of real estate capitalization rates. A number of studies have modeled cap rates as an adjustment around equilibrium values, which are in turn determined by real estate fundamentals such as rent levels and rental growth, as well as risk-free interest rates (see Sivitanides, Southard, Torto, and Wheaton [2001], Hendershott and MacGregor [2005a,b]; Chen et al [2004]; Chichernea et al. [2008] Sivitanidou and Sivitanides [1999], Shilling and Sing [2007]). Only one of these studies also includes any kind of metric representing a risk premium(see Archer and Ling [1997]). Our paper draws on this literature to specify what we term as our "Null" hypothesis - a standard, literature-based model with risk free rates and real estate fundamentals in determining capitalization rates. We specifically draw on Sivitanides, Southard, Torto, and Wheaton [2001] for this task. A related line of inquiry asks about the "efficiency" of real estate pricing – in particular whether cap rates have the expected predictive power in explaining subsequent real estate returns (Hendershott and MacGregor [2005a,b], Ghysels, Plazzi, and Valkanov [2007]).

To this literature we more carefully add an impact of economy-wide risk premiums – assessing the impact of risk across property types. We also introduce the idea that the macro-economic capital flows – in particular the availability of debt - may impact capital pricing. In the literature, there are theoretical models of asset pricing in which capital flows play an obvious role (for example Geltner et al [2007], Wheaton [1999]). Empirically, some recent work on real estate returns has begun to include the dynamics of commercial real estate capital flows (Ling and Naranjo [2003, 2006] as well as Fisher et al. [2007]). Concern over the obvious simultaneity between flows and returns has been raised over this line of research. Ling and Naranjo [2003, 2006] find that capital flows into public (securitized) markets do not predict subsequent returns, while returns do impact subsequent capital flows. Other studies, however, find evidence that lagged institutional capital flows do have an effect on current returns at the aggregate level (Fisher et al. [2007]). In this study we avoid the simultaneity issue by using aggregate US capital flows rather than those directed at real estate. Furthermore, we do not consider equity, but only the availability and issuance of overall debt in the economy.

In this regard we draw on a long macro-economic literature concerning the role of debt availability in generating asset demand and asset "bubbles" (Kiyotaki and Moore [1997], Miller and Stiglitz [2008]). In recent years, these ideas have spawned a literature on what is termed "global imbalances" (see Caballero et al [2008]). This thesis postulates that due to the heterogeneity in countries' ability to produce financial assets for domestic savers, large capital flows from developing countries to developed ones have tremendously increased debt availability and have bid up asset prices, including those of real estate. In this paper we specifically examine whether trends in the growth of overall debt in the US economy can help in explaining movements in real estate cap rates over the last decade.

Our paper is most closely related to the recent work by Clayton, Ling, Naranjo [CLN, 2009]. Our extensions of their paper are four. First, rather than use a 2-step error-correction specification to model cap rates we rely on the suggestion of Gallin [2006] and use a single-step adjustment model. Secondly, instead of relying on a short national time series, we gain immense degrees of freedom by working with a panel data base combining the time series of 30 US markets. Finally, we specifically examine the role of economy-wide debt availability. Particularly in the last decade, the widespread availability of debt and then the sudden contraction of this source of capital is often felt to be an important factor explaining the drop in cap rates from 2000-2006 and then their sudden recent rise.

III. Data and Historic Movements

Like most other studies of US capitalization rates, we utilize the appraisal-based values reported since the early 1980s by the National Council of Real Estate Fiduciaries (NCREIF). NCREIF cap rates have often been criticized for not being based on actual sales transactions, but in the US they are the sole source of data going back several decades. Our data on rental rates comes from CBRE Econometric Advisors (formerly Torto Wheaton Research), and utilizes their rent indices created by applying hedonic analysis to data on thousands of actual lease transactions in each market.

In Figure 1, we illustrate the two factors from our "Null" model that have previously been studied as influencing the NCREIF cap rate: the 10 year Treasury rate and the deflated (constant dollar) rent index for properties. We use the office market in New York as our example. Like many US markets, office cap rates in that city moved between 6 and 10% over the last 2 decades, then declined sharply to 4% from 2002 to 2006, only to jump back to 7.5% in the last year. Against this we depict the real 10 year treasury rate and the real level of office rents. Over this 25 year period, real interest rates steadily declined until the current financial crisis and visually there does seem to be some positive correlation with caps rates. Constant dollar rents vary almost 100% from index values of 0.7 to 1.3. When measured contemporaneously they seem on casual inspection to move inversely with cap rates – when rates are high rents are low. This affords some support for those studies arguing that markets inefficiently price current conditions and are not forward looking.

In Figure 2 we introduce the first of our two macro-economic factors and plot the NY office capitalization rate alongside a general debt risk premium (spread). Here we use the Moody's AAA yield versus the 10 year Treasury bond. On inspection, there seems to be a positive association, with the exception of 2001-2003 when close to record risk spreads are matched against a minor shift (if any) in cap rates.

Finally, in Figure 3 we compare the cap rate with our measure of the growth in the debt as a fraction of GDP. Since 1980 the ratio of debt to GDP has increased by a factor of 2.3 – which amounts to an average yearly increase of about 4.6%. It is important to note that the debt measured here is gross debt and not final debt by households. If a household borrows from a bank that then borrows that money from (say) a securitized public market – the debt is counted twice. Similarly, firm borrowing can have many redundancies. Hence much of the growth in debt reflects an increase in financial intermediation. The question we ask then is whether increases in financial intermediation make it "easier to borrow" and whether this in turn impacts asset prices. If we were measuring asset prices in dollars there would of course be high simultaneity between prices and borrowing. Loan demand surely increases with rises in asset prices. But here we are regressing growth in intermediation against cap rates to see if greater availability of debt and liquidity spur investors to "gamble" by paying more per dollar of current income.

Historically, our index of the annual growth in debt/GDP shows three periods where financial intermediation grew rapidly: the mid 1980s, 1999-2002 and then 2005-2007. Financial intermediation stalled and took a step backwards in the early 1990s. Interestingly, the ratio of debt to GDP has not declined much in the current financial crisis because GDP has declined at the same time as firms and households have been deleveraging. The correlation here with cap rates is not so apparent, but in our multivariate analysis we will find in to be very strong.

Using this data we estimate a separate model for each type of real estate (office, retail shopping centers, multifamily housing, and industrial). The macro-economic data is the same for each type of real estate – only the rent series and cap rates vary across property categories. For each model we use an unbalanced panel (they contain missing values for some observations) that spans the period from 1980 q1 to 2009 q3. Each panel has over 30 MSA markets and a statistical summary of the data set is found in the Appendix. As a result of missing values, the dataset for each property type contains from 1,920 to 3,175 usable observations, which generates high degrees of freedom. In terms of our estimation approach, all models in this paper are estimated using the fixed effects panel method (see Greene [2004]), with White's heteroskedasticity correction for standard errors (White [1980]).

The rationale behind this estimation strategy is compelling. The fixed effects panel technique allows us to use both time-series as well as cross-sectional (between MSA) variation, which increases the efficiency of the OLS estimators (see Greene [2004]). This generates better estimates of model coefficients. Furthermore, it explicitly models for the time-invariant differences (hence the name fixed effects) in trends between the cross-sectional MSA units. This framework is consistent with theoretical expectations that market-specific unobserved characteristics will lead to permanent differences in capitalization rate trends across markets, and the fixed effects method allows us to estimate the effect of these unobservables and test for their statistical significance. Finally, the higher estimator efficiency increases the power of post-estimation tests, which allows for better inferences about results. Table 1 lists all variables used in this paper as well as their sources. The statistical summary for these variables is given in the Appendix.

Among the right-hand-side variables, the Real Rent Ratio is the only one that exhibits full cross-sectional as well as time series variation. The national macroeconomic variables are of course the same for each cross-sectional unit. As such, this setup prevents us from including time fixed effects in the models, since these would absorb the impact of the national macroeconomic variables.

IV. The "Null" Specification: Market fundamentals and Treasury Rates.

The first, most basic model intends to reflect the standard approach used in the literature to date (for reference see Sivitanides, Southard, Torto, and Wheaton [2001], from now on SSTW). This literature does not apply a 2-step error-correction process [see Gallen [2006]] and instead postulate that cap rates simply follow an adjustment process around equilibrium values. The equilibrium is estimated at the same time as the adjustment and is determined by two sets of influences: 1) the influences of a discount rate that reflects both the opportunity cost of capital and systematic market risk; (2) fundamental factors that shape investors' income growth expectations. This is in keeping with the literature, which usually uses rental fundamentals and some proxy for interest rate to explain cap rates.

As discussed above, the standard specification we use is given in (1). It is formulated so as to be comparable to more extended specifications used below.

$$Log(C_{j,t}) = a_0 + a_1 log(C_{j,t-1}) + a_2 log(C_{j,t-2}) + a_3 log(C_{j,t-3})+a_4 log(C_{j,t-4}) + a_5 log(RRR_{j,t}) + a_6 RTB_t + a_7 Q2_t + a_8 Q3_t + a_9 Q4_t + a_{10} D_j \quad (1)$$

In this panel specification *j* is Metropolitan Statistical Areas (MSA) and *t* is time. This is estimated separately for each property sector. The variables are as follows:

$C_{j,t}$ — Capitalization rate from NCREIF database calculated from Net Operating Income and asset values.

$RRR_{j,t}$ — This is real rent ratio calculated as a ratio of real rent data from CBRE EA rent database for a given MSA in a given quarter to the historical average of real rent for this MSA:

$$RRR_{j,t-s} = Real\ Rent_{j,t}/Mean(Real\ Rent_j) \quad (1.1)$$

where the mean is calculated over sample time period for each *j*.

RTB_t — Real T-Bond yield calculated as nominal yield minus inflation rate; this proxies risk-free rate and the opportunity cost of capital.

$Q2_t$, $Q3_t$, $Q4_t$, — Seasonal dummies to take out seasonality

D_j — Fixed market-level effects associated with each MSA

In terms of theoretical priors on the signs of coefficients, the risk free rate (*RTB)* is expected to have a positive effect on the cap rates. The effect of the real rent ratio *RRR*, on the other hand, is theoretically ambiguous and depends on whether investors are forward or backward-looking. The real rent ratio is a stationary series with a strong tendency to mean revert (SSTW,[2001]). In case of forward-looking expectations, high rent levels (as compared to historical means) will inform investors that the market is at the peak of the cycle, and a downward adjustment is in order, causing them to expect lower cash flows in the future. If investors possess this paradigm, *RRR* will have a positive effect on capitalization rates. Alternatively, if investors are backward-looking (as evidenced by SSTW [2001]), investors will project current rent growth into the future and will bid up asset values accordingly. This mindset implies a negative effect of the rent ratio on cap rates. These expectations are in line with the long existing literature as discussed in the previous section. Finally, the MSA-level fixed effects (dummy variables) D_j account for non-varying market-specific characteristics not explicitly included in the model.

Table 2 depicts estimation results for this basic model on our data set. The sum of the coefficients on lagged cap rates is around 0.8 indicating considerable momentum in the creation of appraisal cap rates. The real T-bond coefficient has the expected positive sign across property sectors and is statistically significant. The real rent ratio, the variable without an *a priori* sign expectation, has a statistically significant negative sign, which testifies to the backward-looking behavior of real estate investors, and is generally consistent with previous research.

The group test for the collective effect of MSA dummies yields insignificant statistics for all property types but retail, while individual tests show that some MSAs are significant, while others are not. This is in line with findings in SSTW [2001], indicating that only some markets exhibit statistically significant differences in average cap rate levels.

V. Extended Model Specification: Adding a Risk Premium.

In this specification, we attempt to improve on the existing literature by including one new variable: the degree of general risk aversion in the economy (and hence the associated premium demanded by investors for this risk). We measure this with a standardized corporate bond spread. Specifically, we extend (1) with the following specification:

$$Log(C_{j,t}) = a_0 + a_1 log(C_{j,t-1}) + a_2 log(C_{j,t-2}) + a_3 log(C_{j,t-3}) + a_4 log(C_{j,t-4}) + a_5 log(RRR_{j,t}) + a_6 RTB_t + a_7 SPREAD_t + a_8 Q2_t + a_9 Q3_t + a_{10} Q4_t + a_{11} D_j \quad (2)$$

The model setup is the same as in (1) with the addition of the *SPREAD variable*. Details are as follows:

$SPREAD_t$ Economy wide risk premium over the risk-free rate, calculated as the difference between Moody's AAA Corporate Bond Index and the 10-year T-Bond.

The expected coefficient signs for the variables carried over from (1) are the same as before. In terms of the new variables, *SPREAD* is expected to have a positive sign (with investors demanding compensation for higher risk in the form of lower asset values for the same NOI stream).

The extended model is again estimated using fixed effects with White's heteroskedasticity correction on the same unbalanced panel sample as the one used for standard model (1). Results of estimating the extended model (2) are given in Table 3. It is interesting that all coefficients have the expected signs and are significant across the four property types and that the addition of *SPREAD* has not changed the sign or significance of the original rental index and Treasury yield variables. This suggests this new factor is largely orthogonal to the original factors. In terms of point estimates, the sum of the coefficients on lagged cap rates is still around .8, but the coefficients on the rent ratio and real Treasury rate are *increased.* Finally, as was the case in the case of model (1), group tests on the collective significance of MSA fixed effects indicate group insignificance for all property types except multifamily.

A comparison of estimation results of equation (1) and (2) show an improvement in the performance of the extended specification (2) vis-à-vis the standard version (1), across all property types. The extended model results in higher adjusted R squared statistics, and goodness of fit tests (discussed below in Table 5) and confirms the value of the additional variable. More importantly, however, the orthogonality and statistical significance of the risk spread variable indicates its importance in determination of capitalization rates. Clearly it should be included in future research on capitalization rates. This finding is in line with theoretical expectations that risk premium demanded by investors have strong effects on real estate asset pricing, and omitting these factors in cap rate models has been a major deficiency in most of the literature so far.

VI. Extended Model Specification: Adding Debt Availability

Our final and complete specification examines the possible importance of the availability of debt – as measured by the quarterly growth in overall economy wide ratio: Debt/GDP. Traditional financial economics implies that capital structure should not matter in an efficient market. Specifically, in equilibrium asset pricing theory, the amount of debt applied to an asset should not impact its price, as risk increases commensurately. But as discussed above, recent economic thinking calls this into question. Macro-economic theory now regards debt availability as a frequent cause of financial crises, and micro-economic theory argues that debt provides purchase liquidity. Thus when debt is scarce, real estate transactions are more difficult, and prices may fall below their fundamental value. Easy debt encourages transactions and can increase asset prices above fundamental value – possibly into a "bubble". Hence, we add a variable, which proxies for debt availability as is described below.

$$Log(C_{j,t}) = a_0 + a_1 log(C_{j,t-1}) + a_2 log(C_{j,t-2}) + a_3 log(C_{j,t-3}) + a_4 log(C_{j,t-4}) + a_5 log(RRR_{j,t}) + a_6 RTB_t + a_7 SPREAD_t + a_8 DEBAVAIL_t + a_9 Q2_t + a_{10} Q3_t + a_{11} Q4_t + a_{12} D_j \quad (3)$$

$DEBT\_AVAIL_t$ Debt Availability as proxied by the annual growth rate in Total Debt $\text{Outstanding}_t/\text{GDP}_t$. Both series are nominal numbers from the Federal Reserve's Flow of Funds Database:

$DEBT\_AVAIL_t$ = Year- on- Year Change in (Total Debt $\text{Outstanding}_t/\text{GDP}_t$)

The coefficient sign for *DEBT_AVAIL* is expected to have a positive effect on asset values as (and a negative effect on cap rates), as *ceteris paribus* investors will bid up asset values when it becomes easier to trade them. The test of this effect and its magnitude is especially relevant in the current environment where the general lack of debt financing is postulated to have an important negative influence on real estate asset prices.

The extended model is again estimated using fixed effects with White's heteroskedasticity correction on the same unbalanced panel sample as the one used for standard model (2). Results of estimating the extended model (3) are given in Table 4. It is interesting that all coefficients once more have the expected signs and are significant across the four property types. It is furthermore of note that the addition of *DEBT_AVAIL* has not changed the sign or significance of the original rental index, the real Treasury yield, or the risk premium variables. In fact, in Table 4 the point estimates of the other two macro variables increases when the debt variable is included, suggesting again remarkable orthogonality. Finally, as was the case in the case of model (1), group tests on the collective significance of MSA fixed effects indicate group insignificance for all property types except multifamily.

VII. Comparison of Alternative Specifications: Goodness-of-Fit, Back-tests Forecasts

Table 5 offers abbreviated goodness-of-fit results for all three specifications used in this paper used (equations (1), (2), and (3)) as well as Wald specification tests for the three equations. Specifically, the specification tests are implemented as Wald tests for exclusion restrictions on the additional variables (Greene [2004]). That is, we start with the most comprehensive model (3) and first test the null hypothesis that the coefficient a_8 on the *DEBT_AVAIL* is equal to zero. Next, we test the joint exclusion restriction on the coefficients on all three variables that are not in specification (1)—*DEBT_AVAIL* and *spread* (i.e. this tests H_0: $a_8 = a_7 = 0$). In this sense, equations (1) and (2) are nested with the comprehensive model (3) and the specification search can be conducted by testing these exclusion restrictions (Greene [2004]).

As can be seen from Table 5, the progression of specifications from (1) to (2) and to (3) at each stage produces a statistically significant increase in explanatory power of the model. This is further confirmed by the goodness of fit statistics such as the adjusted R squared. This ranking testifies to the importance of such macro-economic financial factors in modeling capitalization rates.

While the goodness-of-fit tests utilized above are an important indicator of the relative model performance, they are not always conclusive. Specifically, when lagged dependent variables are used, dynamic models customarily generate high measures of fit (and this is true in our case). It is often hard to judge between the various model specifications when they all exhibit such high measures of fit.

A complimentary approach to judge the relative model performance is to construct a number of back-tests to ascertain the ability and effectiveness of each model to replicate the historical data. Such back-tests start at a point in the historical data and use the equation estimated on the full historical sample to dynamically forecast the dependent variable within a specified sample period. With this approach actual historical values for the model's exogenous right-hand-side variables are used, but any autoregressive terms (such as our lagged cap rates), use the *previous period's forecast*. This is what distinguishes a dynamic in-sample forecast from the more common predicted values of the model used in R^2 calculations. The result of this process allows the researcher to compare the in-sample forecast to actual historical observations and judge model performance. This method has an advantage over standard measures of fit in that it allows us to judge how well the different models can replicate historical data. The emphasis the back-tests we do here is on the ability of the various model specifications to replicate the strong decline in cap rates experienced across property types (often dubbed the cap rate compression) in the period from 2000-2009.

Figure 4 shows the back-test results for all 3 models used in this paper, with both performance statistics and the graphs of back-test forecasts. All back tests are performed against historical cap rates by using the model estimated on the entire sample to dynamically forecast capitalization rates from 2000q4 through the end of the sample in 2009q3 using historical data for the independent variables[2]. These dynamic forecasts are performed in a panel setting, which generates a cap rate forecast for each cross-sectional MSA unit. Next, these individual MSA forecasts are dynamically weighted by real estate stock in each market to produce a national weighted average forecast[3]. Finally, this weighted national forecast is used in conjunction with the historical weighted average cap rate (also dynamically weighted by stock[3]) to produce various forecast performance statistics reported for each model specification. These statistics, together with back-test plots, allow us to judge the relative success of the three models in explaining historical capitalization rates.

In the first graph of Figure 4, the actual weighted average cap rate for office properties rises by 100bps from 2000q1 to 2002q2 and then declines steadily by almost exactly 400bps to 2008q1. It then rises 200bps between then and 2009q2. With the "null" model there is no rise around the 9/11 recession, the total decline is less than 200bps. The recent rise is only 80bps. On the other hand, the full extended model (with both risk premium and debt variables) has a slight 30 bps rise, then a steady decline of 300 bps and very close to the actual 200bps recent increase. Examining the other plots shows that the null model does not do well at explaining the cap rate compression and sharp reversal over 2000-2009 - for all property types except possibly multi-family housing. On the other hand, the full extended version of the model shows a marked improvement in explaining historical cap rates. The addition of the risk and debt variables makes a significant reduction in forecast error (over 2000q4-2009q3) using the various tests below each plot in Figure 4.

VIII. Conclusion

We draw several conclusions from this research about the behavior of appraisal-based real estate prices during the last 30 years and in particular during the last 9 years. First, despite the fact that the rent fundamentals of the 30 markets studied here vary widely, local rent fundamentals are really just a small part of the explanation of cap rates. In fact, the test for collective significance of the cross-section fixed effects is not significant. We find it hard to imagine that relative rents are the only local variable that matters, and that there are no other systematic factors between markets.

Secondly, our three macro-economic variables (real Treasury rate, bond risk premium, and expansion of debt) matter enormously, despite the fact that they have no local variation and are simply a common factor across time for our 30 markets. Each of these factors individually is highly significant and collectively they drive the model. With commercial real estate the old adage that "all real estate is local" does not seem to be true – at least with this data.

Finally, our results really do suggest a strong empirical relationship between asset prices and growth of debt within the economy. To address causality, the variable that we use is the ratio of total debt outstanding to GDP, and within this data, commercial real estate debt represents less than 6% of total current public and private debt. It is hard to argue that changes in commercial real estate prices are driving the entire debt structure of the economy. Still the very significant role of this variable only hints at the complex relationships that must exist between real estate prices and the availability of debt. What determines the amount of debt that investors *want* to put on property? Does the supply of debt and underwriting vary with the current position of the market? To what extent is debt rationed as opposed to being priced and why? Given the empirical relationship here, we need to return and reexamine the core theory of capital structure in real estate finance.

Endnotes:

1. Real estate capitalization rates can be thought of as inverse Price/Earnings ratios.
2. Back-test forecasts start in 2002q4 for multifamily due to some issues with the averaged national series for multifamily around 2000.
3. The stock measure used in thousands of square feet in each market for the given property type. The weighting is dynamic in that for each time period *t*, that period's stock series is used across the cross section to produce the national cap rate value for this period *t*

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APPENDIX: Statistical Summary of Variables

Note: since the time period differs between property type (except for office and industrial), the moments for national variables and the number of included observations differ as a result.

Office

Variable	Obs	Mean	Std Error	Minimum	Maximum
Log(CAP)	2814	2.012677	0.234099	0.686123	2.762589
Log(Real Rent ratio)	5382	-0.033678	0.157157	-0.619435	0.855274
Real T-Bond	5510	3.555497	1.797885	0.264329	9.100207
Risk Spread	5662	1.022259	0.404341	0.013333	2.27333
Debt Flow	5662	0.220033	0.058572	0.093652	0.352057

Industrial

Variable	Obs	Mean	Std Error	Minimum	Maximum
Log(CAP)	3175	2.064373	0.193181	1.122329	2.892148
Log(Real Rent ratio)	5437	-0.02478	0.140474	-0.539366	0.555696
Real T-Bond	5510	3.555497	1.797885	0.264329	9.100207
Risk Spread	5662	1.022259	0.404341	0.013333	2.27333
Debt Flow	5662	0.220033	0.058572	0.093652	0.352057

Multifamily

Variable	Obs	Mean	Std Error	Minimum	Maximum
Log(CAP)	1920	1.921208	0.235038	0.712165	2.554744
Log(Real Rent ratio)	4099	0.003288	0.082049	-0.256498	0.319933
Real T-Bond	4930	3.555497	1.797904	0.264329	9.100207
Risk Spread	5066	1.022259	0.404345	0.013333	2.27333
Debt Flow	5066	0.220033	0.058573	0.093652	0.352057

Retail

Variable	Obs	Mean	Std Error	Minimum	Maximum
Log(CAP)	2011	1.980214	0.215791	0.337044	2.796623
Log(Real Rent ratio)	3798	-0.014735	0.142909	-0.749771	0.458475
Real T-Bond	3834	3.563226	1.809565	0.264329	9.100207
Risk Spread	3942	1.032945	0.399909	0.013333	2.27333
Debt Flow	3942	0.221487	0.058235	0.093652	0.352057

MSA's Used in the Panel

Office	Industrial	Multifamily	Retail
Atlanta	Atlanta	Atlanta	Atlanta
Austin	Austin	Austin	Austin
Baltimore	Baltimore	Baltimore	Baltimore
Boston	Boston	Boston	Boston

Charlotte	Charlotte	Charlotte	Chicago
Chicago	Chicago	Chicago	Columbus
Columbus	Cincinnati	Cincinnati	Dallas
Dallas	Columbus	Dallas	Denver
Denver	Dallas	Denver	Fort Lauderdale
Detroit	Denver	Fort Lauderdale	Houston
Edison	Edison	Fort Worth	Los Angeles
Fort Lauderdale	Fort Lauderdale	Houston	Miami
Houston	Fort Worth	Kansas City	Minneapolis
Kansas City	Houston	Las Vegas	New York
Los Angeles	Indianapolis	Los Angeles	Oakland
Miami	Kansas City	Memphis	Orange County
Minneapolis	Los Angeles	Miami	Orlando
New York	Memphis	Minneapolis	Philadelphia
Newark	Miami	Nashville	Phoenix
Oakland	Minneapolis	New York	Portland
Orange County	New York	Orange County	Sacramento
Orlando	Oakland	Orlando	San Diego
Philadelphia	Orange County	Philadelphia	San Francisco
Phoenix	Orlando	Phoenix	San Jose
Pittsburgh	Philadelphia	Portland	Seattle
Portland	Phoenix	Raleigh	Washington, DC
Raleigh	Portland	Riverside	West Palm Beach
Sacramento	Riverside	Salt Lake City	
San Antonio	Sacramento	San Diego	
San Diego	Salt Lake City	Seattle	
San Francisco	San Diego	St. Louis	
San Jose	San Francisco	Tampa	
Seattle	San Jose	Washington, DC	
St. Louis	Seattle	West Palm Beach	
Stamford	St. Louis		
Tampa	Tampa		
Washington, DC	Ventura		
West Palm Beach	Washington, DC		
38 Markets	**38 Markets**	**34 Markets**	**27 Markets**

Table 1
Main Variables Used in Specifications

Variable	Description	Source
$C_{j,t}$	**Capitalization rate** from NCREIF database calculated from Net Operating Income and NCREIF portfolio values.	National Council of Real Estate Investment Fiduciaries (NCREIF)
$RRR_{j,t}$	**Real rent ratio** calculated as a ratio of real rent index from Torto Wheaton rent database for a given MSA in a given quarter to the historical average of real rent for this MSA: $RRR_{j,t} = Real\ Rent_{j,t}/Mean(Real\ Rent_j)$ where the mean is calculated over sample time period for each *j*.	CBRE Torto Wheaton Research Rental Index. The index is hedonically derived and controls for quality
RTB_t	**Real T-Bond yield** calculated as nominal yield minus inflation rate.	Federal Reserve
$SPREAD_t$	**Risk premium** calculated as the spread between Moody's AAA Corporate Bond Index and the 10-year T-Bond yield.	Federal Reserve
$DEBT\_AVAIL_t$	**Debt Availability** proxied by the annual growth rate in $Total\ Debt\ Outstanding_t/GDP_t$. Both series are nominal numbers from the Federal Reserve's Flow of Funds Database: $DEBT\_AVAIL_t = Year\text{-}on\text{-}Year\ Change\ in\ (Total\ Debt\ Outstanding_t/GDP_t)$	Federal Reserve

Table 2
Multiple Regression Results
Simple Literature-based Specification with Rents and T-Bond

Independent Variable	Office	Industrial	Multifamily	Retail
Constant	0.323 (8.599)	0.327 (9.835)	0.209 (8.333)	0.326 (5.994)
Log(CAP)_{t-1}	0.484 (9.568)	0.442 (16.286)	0.574 (18.879)	0.365 (7.034)
Log(CAP)_{t-2}	0.170 (4.451)	0.196 (7.593)	0.116 (3.353)	0.196 (4.869)
Log(CAP)_{t-3}	0.064 (1.829)	0.058 (2.406)	0.122 (2.860)	0.143 (3.296)
Log(CAP)_{t-4}	0.102 (3.240)	0.132 (5.495)	0.064 (2.140)	0.124 (3.823)
$\text{Log(Real Rent Ratio)}_t$	-0.062 (-3.038)	-0.059 (-3.147)	-0.135 (-3.790)	-0.117 (-3.702)
Real T-Bond 10year	0.014 (6.267)	0.009 (5.754)	0.020 (10.411)	0.010 (4.181)
Q2	0.002 (0.261)	-0.036 (-0.905)	-0.012 (-2.189)	0.007 (-0.872)
Q3	-0.035 (-3.762)	-0.011 (-1.730)	-0.021 (-3.583)	-0.021 (-2.507)
Q4	-0.036 (-4.383)	-0.020 (-3.016)	-0.006 (-0.974)	0.020 (2.456)
R-square (adjusted)	0.604	0.579	0.853	0.608
Number of cross-sectional units (MSA markets)	38	38	34	27
Number of usable observations (excludes missing values)	2902	3227	2001	2092
Test of group significance of fixed effects	F(37,*)= 0. 90508 Significance Level: 0.63447242	F(37,*)= 0.59464 Significance Level 0.97598639	F(33,*)= 0.53119 Significance Level 0.98742796	F(26,*)= 1.13022 Significance Level 0.29383569

Notes: *The dependent variable is* Log(Cap)_t*. The* ***t-statistics*** *are in parentheses below coefficient values. Estimate of fixed effects omitted for brevity. All data is quarterly from 1980q1 through 2009q3*

Table 3
Multiple Regression Results
Extended Specification with the Risk Spread

Independent Variable	Office	Industrial	Multifamily	Retail
Constant	0.247 (7.203)	0.296 (9.024)	0.183 (7.252)	0.288 (5.611)
$Log(CAP)_{t-1}$	0.457 (9.500)	0.433 (15.907)	0.562 (18.523)	0.332 (6.524)
$Log(CAP)_{t-2}$	0.166 (4.669)	0.194 (7.594)	0.116 (3.304)	0.185 (4.760)
$Log(CAP)_{t-3}$	0.070 (2.069)	0.059 (2.456)	0.116 (2.885)	0.147 (3.461)
$Log(CAP)_{t-4}$	0.112 (3.624)	0.133 (5.542)	0.068 (2.232)	0.137 (4.233)
$Log(Real Rent Ratio)_t$	-0.106 (-4.960)	-0.067 (-3.621)	-0.168 (-4.722)	-0.138 (-4.451)
Real T-Bond 10year	0.022 (9.042)	0.012 (7.431)	0.022 (11.474)	0.017 (6.408)
Risk Spread	0.065 (9.491)	0.031 (6.215)	0.023 (5.412)	0.061 (9.426)
Q2	0.004 (0.546)	0.001 (0.144)	-0.011 (-2.022)	-0.005 (-0.590)
Q3	-0.033 (-3.601)	-0.010 (-1.657)	-0.021 (-3.530)	-0.021 (-2.486)
Q4	-0.039 (-4.851)	-0.022 (-3.250)	-0.007 (-1.171)	0.017 (2.044)
R-square (adjusted)	0.617	0.584	0.855	0.623
Number of cross-sectional units (MSA markets)	38	38	34	27
Number of usable observations (excludes missing values)	2902	3227	2001	2092
Test of group significance of fixed effects	F(37,*)= 1.02112 Significance Level: 0.43342794	F(37,*)= 0.62153 Significance Level 0.96524632	F(33,*)= 0.64296 Significance Level 0.94366394	F(26,*)= 1.32915 Significance Level 0.12154516

Notes: *The dependent variable is $Log(Cap)_t$. The* ***t-statistics*** *are in parentheses below coefficient values. Estimate of fixed effects omitted for brevity. All data is quarterly from 1980q1 through 2009q3*

Table 4
Multiple Regression Results
Full Specification with Risk Spreads and Debt Availability

Independent Variable	Office	Industrial	Multifamily	Retail
Constant	0.348 (9.419)	0.381 (10.448)	0.296 (10.403)	0.344 (6.866)
$Log(CAP)_{t-1}$	0.430 (9.272)	0.418 (15.429)	0.521 (17.338)	0.318 (6.222)
$Log(CAP)_{t-2}$	0.154 (4.507)	0.185 (7.243)	0.102 (3.064)	0.177 (4.507)
$Log(CAP)_{t-3}$	0.065 (1.958)	0.051 (2.158)	0.117 (3.109)	0.144 (3.312)
$Log(CAP)_{t-4}$	0.113 (3.728)	0.126 (5.265)	0.071 (2.433)	0.139 (4.306)
$Log(Real\ Rent\ Ratio)_t$	-0.070 (-3.420)	-0.045 (-2.451)	-0.140 (-4.092)	-0.089 (-2.967)
Real T-Bond 10year	0.023 (9.735)	0.014 (8.498)	0.021 (11.455)	0.018 (6.960)
Risk Spread	0.088 (11.933)	0.047 (8.729)	0.046 (9.887)	0.077 (11.286)
Debt Availability	-1.575 (-8.911)	-0.931 (-6.400)	-1.653 (-10.128)	-1.064 (-5.305)
Q2	0.005 (0.664)	0.001 (0.145)	-0.009 (-1.813)	-0.004 (-0.544)
Q3	-0.033 (-3.733)	-0.011 (-1.806)	-0.022 (-3.907)	-0.022 (-2.611)
Q4	-0.041 (-5.224)	-0.023 (-3.466)	-0.010 (-1.657)	0.015 (1.799)
R-square (adjusted)	0.629	0.590	0.863	0.630
Number of cross-sectional units (MSA markets)	38	38	34	27
Number of usable observations (excludes missing values)	2902	3227	2001	2092
Test of group significance of fixed effects	F(37,*)= 1.23936 Significance Level: 0.15070758	F(37,*)= 0.77803 Significance Level 0.83073289	F(33,*)= 0.98992 Significance Level 0.48357607	F(26,*)= 1.11011 Significance Level 0.31735430

Notes: *The dependent variable is* $Log(Cap)_t$*. The* ***t-statistics*** *are in parentheses below coefficient values. Estimate of fixed effects omitted for brevity. All data is quarterly from 1980q1 through 2009q3*

Table 5
Goodness-of-fit Statistics and Specification Tests

	Office	Industrial	Multifamily	Retail
Standard Rents and T-Bond Model				
Adjusted R^2	0.604	0.579	0.853	0.608
Sum of Squared Residuals	67.535	53.054	16.769	37.676
Log Likelihood	1338.729	2049.337	1944.970	1233.216
Akaike Information Criterion	-3.72811	-4.07887	-4.73890	-3.98244
Swartz Information Criterion	-3.63137	-3.99032	-4.61853	-3.88529
Extended with Risk Spread				
Adjusted R^2	0.617	0.584	0.855	0.623
Sum of Squared Residuals	65.223	52.449	16.536	36.225
Log Likelihood	1389.289	2067.856	1958.953	1274.282
Akaike Information Criterion	-3.76227	-4.08972	-4.75187	-4.02075
Swartz Information Criterion	-3.66347	-3.99930	-4.62870	-3.92089
Full Specification with Risk Spread and Debt Availability				
Adjusted R^2	0.629	0.590	0.863	0.630
Sum of Squared Residuals	63.117	51.588	15.699	35.543
Log Likelihood	1436.902	2094.547	2010.966	1294.170
Akaike Information Criterion	-3.79439	-4.10565	-4.80286	-4.03880
Swartz Information Criterion	-3.69353	-4.01334	-4.67689	-3.93625
Specification Tests				
H_0: coefficients on spread, debt_avail jointly = 0	Chi-Squared(2)= 156.242455 or F(2,*)= 78.12123 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(2)= 86.080019 or F(2,*)= 43.04001 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(2)= 136.943656 or F(2,*)= 68.47183 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(2)= 128.350891 or F(2,*)= 64.17545 with Significance Level 0.00000000 **Reject H_0**
H_0: coefficient on debt_avail = 0	Chi-Squared(1) = 79.404697 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(1)= 40.963133 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(1)= 102.575678 with Significance Level 0.00000000 **Reject H_0**	Chi-Squared(1)= 28.147323 with Significance Level 0.00000011 **Reject H_0**

Figure 1
NY Office Cap Rate and Model Variables

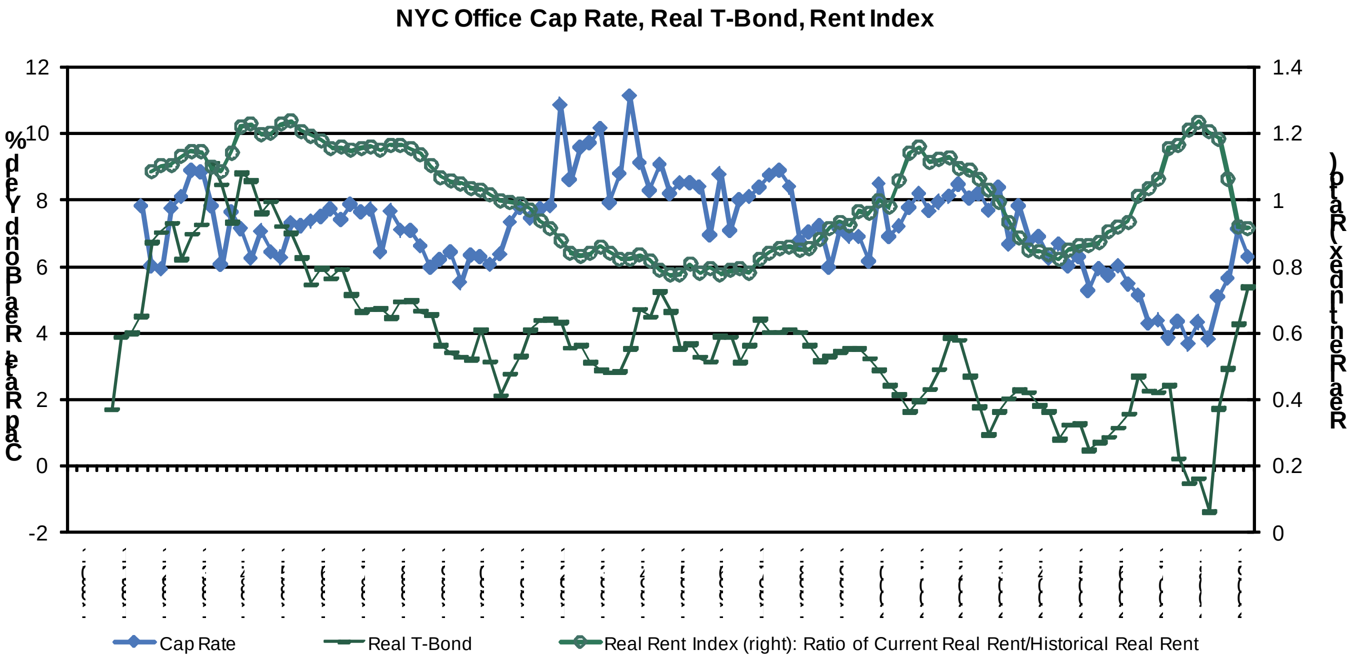


Figure 2
NY Office Cap Rate and Model Variables

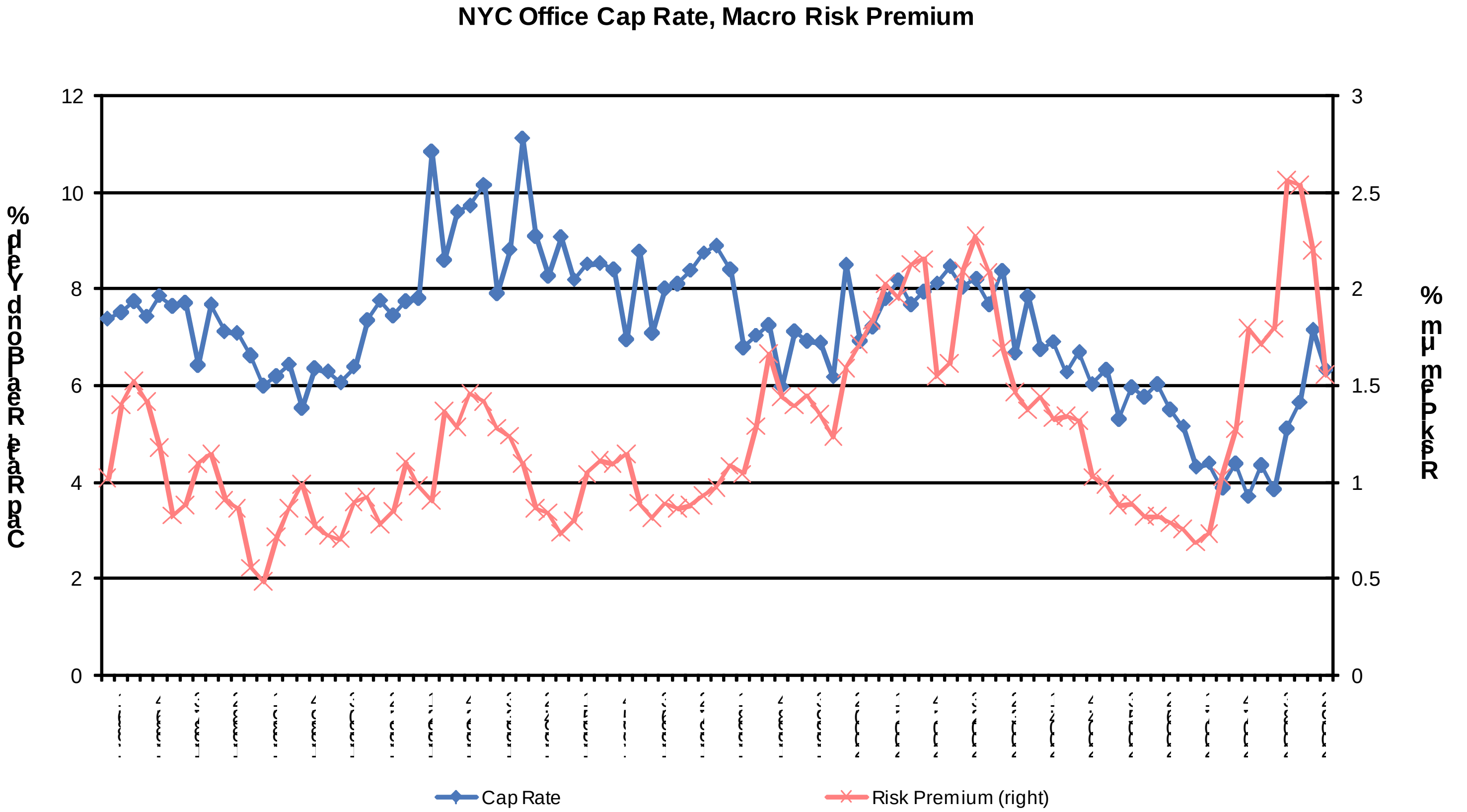


Figure 3
NY Office Cap Rate and Model Variables

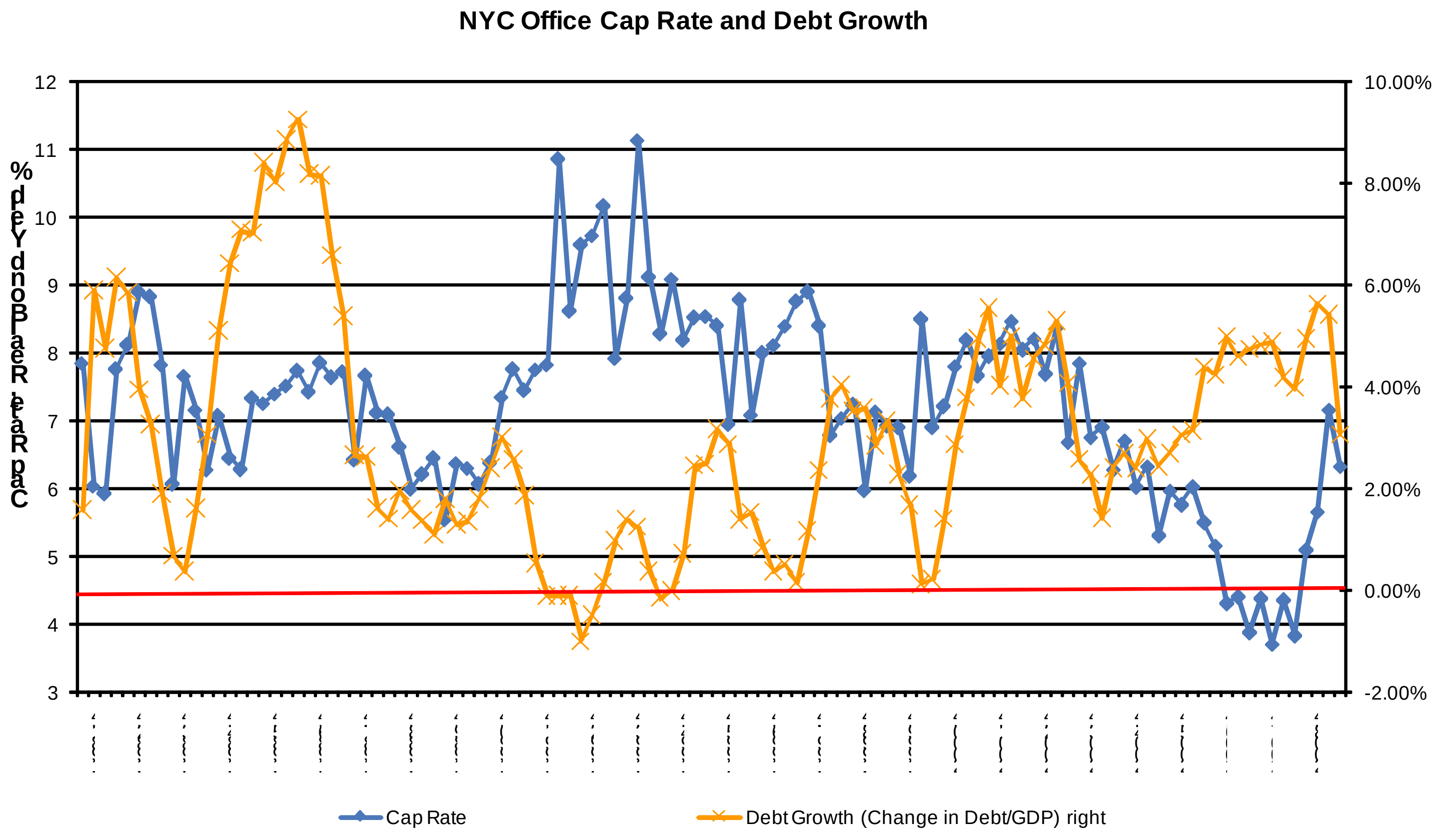
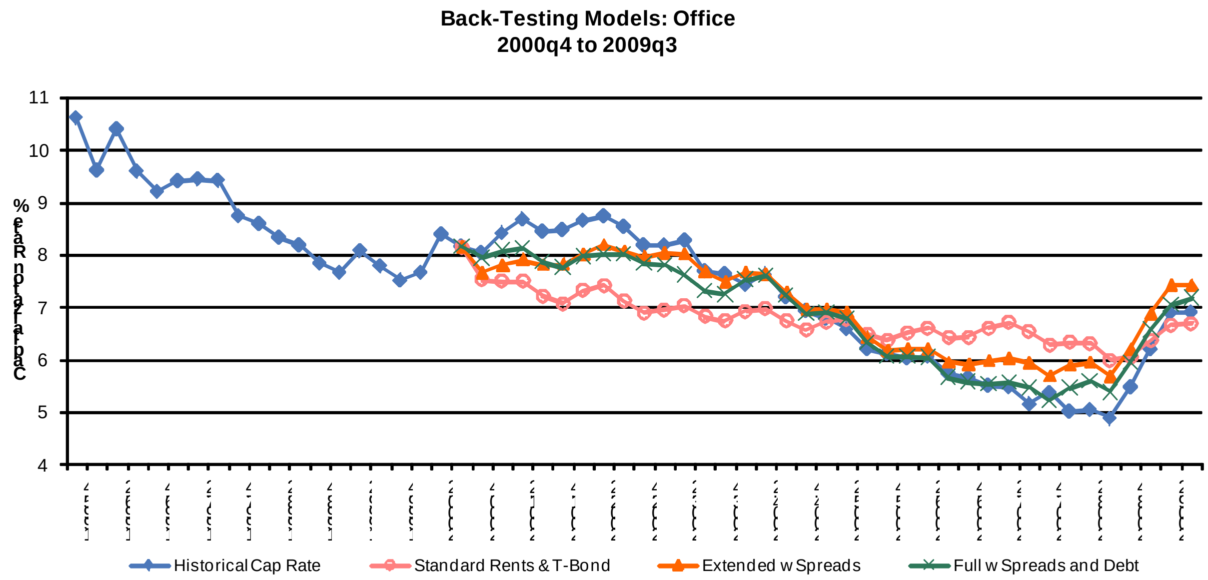


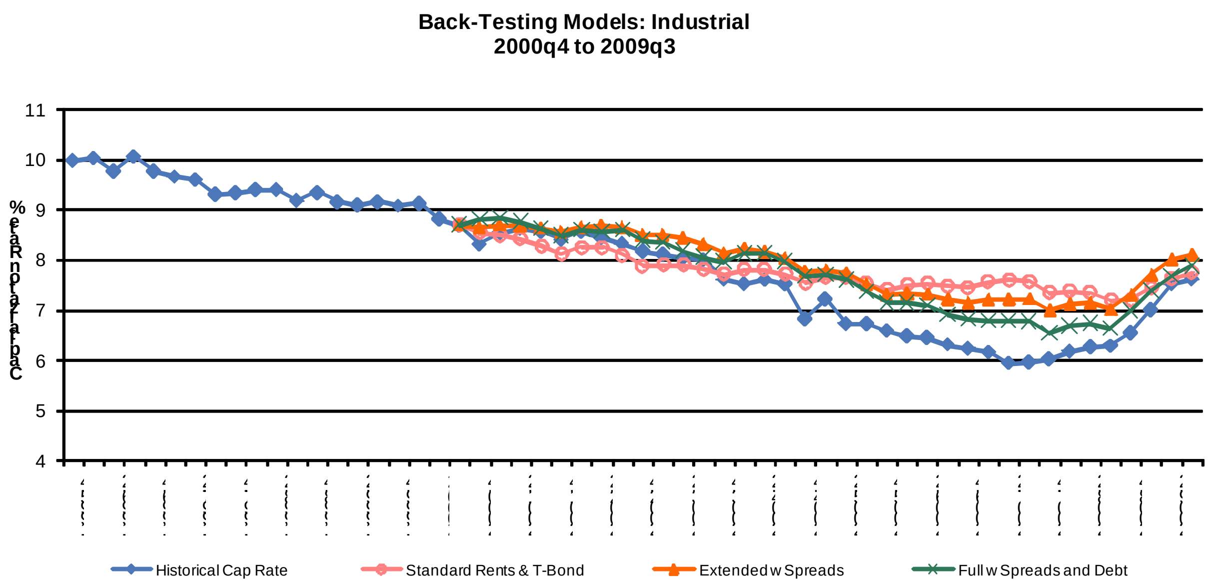
Figure 4
Back-Testing Model Specifications



Forecast Performance: Office

Model	Mean Error of Forecast	Mean Absolute Error of Forecast	RMS Error
Standard Rents and T-Bond	0.141923472	0.822825128	0.928674129
Extended: Risk Spreads	-0.097916628	0.405762272	0.48367437
Full: Risk Spread and Debt Growth	0.086932869	0.294923269	0.371128848

Based on 36 forecast steps from 2000q4 through 2009q3



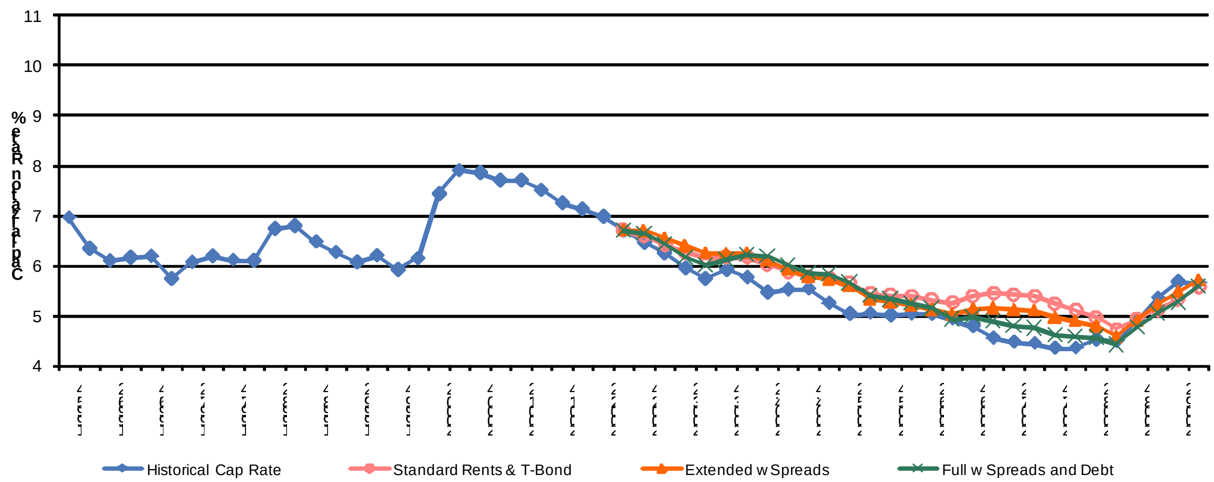
Forecast Performance: Industrial

Model	Mean Error of Forecast	Mean Absolute Error of Forecast	RMS Error
Standard Rents and T-Bond	-0.484320258	0.616390147	0.782933987
Extended: Risk Spreads	-0.621723828	0.621723828	0.705688893
Full: Risk Spread and Debt Growth	-0.429204775	0.429204775	0.492186386

Based on 36 forecast steps from 2000q4 through 2009q3

Figure 4
Back-Testing Model Specifications

Back-Testing Models: Multifamily
2002q4 to 2009q3

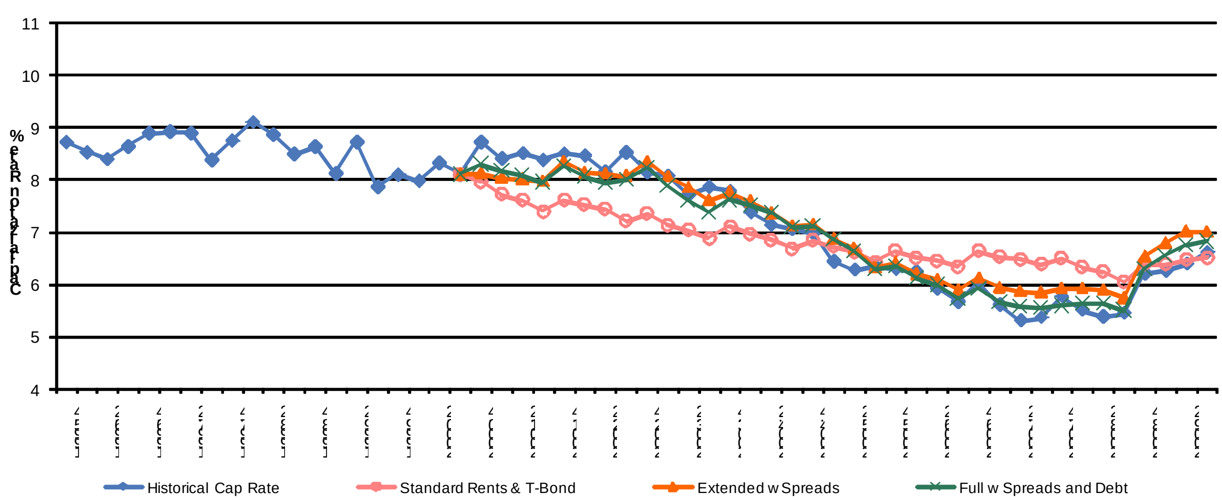


Forecast Performance: Multifamily

Model	Mean Error of Forecast	Mean Absolute Error of Forecast	RMS Error
Standard Rents and T-Bond	-0.390658921	0.438488021	0.508791942
Extended: Risk Spreads	-0.332357839	0.355807289	0.40854791
Full: Risk Spread and Debt Growth	-0.216759011	0.286913489	0.334277814

Based on 28 forecast steps from 2002q4 through 2009q3

Back-Testing Models: Retail
2000q4 to 2009q43



Forecast Performance: Retail

Model	Mean Error of Forecast	Mean Absolute Error of Forecast	RMS Error
Standard Rents and T-Bond	0.081445658	0.618472864	0.704565798
Extended: Risk Spreads	-0.104826436	0.289108592	0.33781894
Full: Risk Spread and Debt Growth	0.023577708	0.218515364	0.261723851

Based on 36 forecast steps from 2000q4 through 2009q3