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# LIVING WITH TERMINAL CAPITALIZATION RATES: A LOOK at REAL ESTATE VALUATIONMODEL PARAMETER SETTING

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# LIVING WITH TERMINAL CAPITALIZATION RATES: A LOOK at REAL ESTATE VALUATION MODEL PARAMETER SETTING

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### Abstract

This paper examines assumptions about future prices used in real estate applications of DCF models. We confirm both the widespread reliance on an *ad hoc* rule of increasing period-zero capitalization rates by 50 to 100 basis points to obtain terminal capitalization rates and the inability of the rule to project future real estate pricing. To understand how investors form expectations about future prices, we model the spread between the contemporaneously period-zero going-in and terminal capitalization rates and the spread between terminal rates assigned in period zero and going-in rates assigned in period N. Our regression results confirm statistical relationships between the terminal and next holding period going-in capitalization rate spread and the period-zero discount rate, although other economically significant variables are statistically insignificant. Linking terminal capitalization rates by assumption to going-in capitalization rates implies investors view future real estate pricing with myopic expectations. We discuss alternative specifications devoid of such linkage that align more with a rational expectations view of future real estate pricing.

Keywords: DCF Models, Real Estate Valuation, Capitalization Rates

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# LIVING WITH TERMINAL CAPITALIZATION RATES: A LOOK at REAL ESTATE VALUATION MODEL PARAMETER SETTING

"An often-heard complaint is that the projection of future selling price is an exercise in *crystal ball gazing*." Geltner, Miller, Clayton, and Eichholtz, *Commercial Real Estate: Analysis and Investments*, 2007, p.243.

## *I. Importance of Terminal Values in Discounted Cash Flow Valuations*

Real estate valuations and related financial analyses in the U.S. rely heavily on the Discounted Cash Flow Model (DCF) model. Since the introduction of DCF technology to real estate finance over four decades ago by Wendt and Wong (1965), a substantial literature has accumulated that extends the model including papers citing limitations for valuing firms (*e.g.*, Ross 1995), critiques of how analysts apply DCF models in real estate finance (*e.g.*, Martin 1988), and numerous modeling innovations (*e.g.*, Ang and Liu 2004). In DCF adaptations for valuing firms, a terminal date may be assumed beyond the planning period and one of several alternative terminal value specifications introduced. These terminal valuations either derive from liquidation value as a function of book value or from capitalization of incomes assumed to grow a constant rate beyond the terminal date.[1]

Real estate finance adaptations of DCF have a similar construction. These valuations generally include behavioral assumptions about investors' holding periods not exceeding expected asset lives such that investors expect substantial lump-sum cash flows at the terminal date either less than, equal to, or greater than initial investments.[2] Terminal cash flows derive either from the remaining productivity of capital improvements and the land or simply the value of the land.

The present value of property sale proceeds received at the terminal date contributes "well over one third of the total present value of the property" (Geltner, Miller, Clayton, and Eichholtz, 2007, p.244). Yet treatments of this topic in papers and texts are surprisingly thin and even fewer references appear in the literature to connect long-run asset price behavior with DCF parameterization. For example, the nearly 700 page treatise on real estate valuation - *The Appraisal of Real Estate* (Appraisal Institute 2008) - contains only two pages on the conceptualization of terminal values. Similarly, the texts often used in university real estate

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[1] See, for example, sections on terminal values in texts by Titman and Martin (2007) and Damodaran (2002).

[2] A survey of real estate investor decision-making practices by Farragher and Savage (2008) revealed that 89 percent of real estate investors forecast residual (disposition) returns. An earlier survey (Farragher and Kleiman, 1996) found that 60 percent of the investors made the same forecast.

finance and investment courses by Brueggeman and Fisher (2008) and Geltner, Miller, Clayton, and Eichholtz, (2007) devote limited numbers of pages to the topic of estimating terminal values despite its large contribution to present values relative to periodic cash flows for which far more detail is provided.

### *1.1 Terminal Capitalization Rate Methodology*

Alternative methods for estimating real estate terminal values including appreciation rate assumptions (Brueggeman and Fisher 2008, pp. 293-94) and forecasts of income growth over a subsequent holding period (Lusht 1987), the latter of which aligns with firm valuation methodology. Notwithstanding, capitalizing the net operating income (NOI) estimated for the first period after the terminal period N (*i.e.*, N+1) by an assumed capitalization rate dominates industry practice.

The period-zero capitalization rate, $R_0$, (*aka* 'going in' capitalization rate) refers to relationship between the current price of real estate and the forecast of NOI during the first holding period year.[3] Conceptually, this ratio of space and capital market financial performance measures indicates the pricing of commercial real estate at a point in time. By attaching an assumption about future pricing, $R_0$ serves as a useful starting point for estimating property sale price at the end of a holding period. The resultant period N capitalization rate assigned in period zero, $RT_0$, has several common names including the 'going-out,' 'exit,' 'resale,' 'residual,' 'reversion,' and 'terminal' capitalization rate.

The general assumption, $RT_0 = R_0$, comes from a belief that future space and asset markets conditions will be the same in period N as they exist in period zero. For some time, real estate industry analysts have relied on the specific assumption, $RT_0 > R_0$, which comes from fundamentally-based ideas about handicapping terminal values relative to period zero values.[4] Justifications for handicapping the future come from (1) the need to build in greater uncertainty associated with forecasting NOIs during a distant holding period relative to the initial holding period and; (2) the likelihood that because properties will be N-years older they will be less competitive against constructed property by the end of the forthcoming

[3] The $NOI_1$ proxies for long-run income production.

[4] If systemic income growth also is assumed, the estimated sale price in period N after capitalizing the projected $NOI_{N+1}$ by $RT_0$ may exceed the period zero price.

holding period.[5] Born and Pyhrr (1994) argue that specifications of $RT_0$ should explicitly recognize property cycles to avoid bias in DCF valuations that tend to be 'trend driven' from constant NOI growth rate assumptions. Their paper, however, neither conceptually extends this argument nor adds empirical support. *The Appraisal of Real Estate* (Appraisal Institute, 2008) reflects some thinking about property cycles and terminal values, but retains the discussion about the $RT_0 > R_0$ assumption and its' association with property aging and future holding period cash flow forecasting uncertainty.

Wang, Grissom, and Chan (1990) examine the rule-of-thumb in which $RT_0$ is estimated by adding between one-half and one percent to $R_0$. Their simulations reveal logical inconsistencies in typical sets of DCF assumptions that include the 'plus .50-1.00 percent.' No justifications were discovered for these types of *ad hoc* linkages between $R_0$ and $RT_0$. In the only empirical study of $RT_0$, Gunnelin, Hendershott, Hoesli, and Söderberg (2004) use data from a Swedish IPD account containing appraisal assumptions and estimates to explain variations in exogenous DCF inputs, including $RT_0$. Raw data extracted from appraisal reports indicate a positive spread between $R_0$ and $RT_0$ of 130 basis points. Their regressions establish strong connections between $RT_0$, the period zero discount rate, and property locations; but weak statistical links to long-run market performance measures, including vacancy and NOI growth.

Motivation for this paper comes from the recognition that real estate investors rely so religiously on value estimates derived from arbitrary rules-of-thumbs to forecast future property values. Perhaps terminal capitalization rate rules-of-thumbs effectively reflect future property values! If they do not lead to accurate predictions, investors place heavy bets with analysts who indiscriminately add basis points to going-in capitalization rates for capitalizing period N+1 NOIs to produce terminal values because of the relative importance of these numbers to market and investment valuations.

Our intent here is to stimulate thought about terminal value specifications in real estate DCF modeling specifically, and generally to consider the prospects for predicting future real estate values. We use a readily available data to test, both over time and across property types, whether or not terminal capitalization rules-of thumb contain useful information about

[5] See Wincott (1991) for a detailed explanation of how appraisers should account for property obsolescence and depreciation in the development of $RT_{0.}$

future real estate pricing. This is the first study to empirically verify a persistent use and reliability of the *ad hoc* ‘plus .50-1.00 percent’ rule. We find that the reliance on such naïve inputs for determining the single most important cash flow in real estate DCF valuations leads to large errors, especially in light of compelling historical evidence of long-run cyclical market patterns.

### *1.2 Expectations and Mean Reversion*

The cyclicality of commercial real estate markets is well established.[6] Consistent, long-run up and down patterns of rents, vacancies, construction, and prices during more than three decades demonstrate mean reversion in real estate markets. Gyourko (2009) estimates that a one percent increases in commercial property prices during a prior three-year period lead to .27 percent declines over the next three years. Modeling the *ex-ante* behaviors of economic agents, such as developers, has been productive for explaining cyclicality patterns and eventual over-building in commercial real estate markets.[7]

Our interest lies with investors’ expectations in the presence of mean reverting property valuations. Despite the predictive nature of reoccurring cycles, our results show that $RT_0$ fails to reflect forward pricing as indicated by investors behaving with rational expectations. Specifically, low $R_0$ and $RT_0$ connected by assumption means that investors expect persistent high prices from cyclical peaks forward when future condition should be eroding as argued by Henderschott (1996, 1999, 2000) for real rent cycles.[8] In the absence of rational expectations, myopically looking backward suggests that investors overvalue (undervalue) commercial real estate during cyclical peaks (troughs).

Several studies address the question of real estate investor rationality in the context of expectations about future values. Henderschott (2000) and Sivitanides *et. al.* (2001) find evidence in Australian and U.S. markets of real estate investors settling transactions with

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[6] An extensive literature exists on cyclicality in housing and commercial and real estate markets as reviewed up until 1999 by Pyhrr, Roulac, and Born (1999). Macroeconomic activity (Kan, Kai-Sun, and Leung, 2004 and Leung, 2007) and inherent delivery lag in conjunction with the behaviors of specific economic agents have been offered as explanations for real estate cycles (Clayton, 1996, 1997; Grenadier, 1995; Wheaton, 1987, 1999; and Wheaton, Torto, and Evans, 1997).

[7] A dominate theme in discussions regarding the question of why construction activity continues beyond the point when demand has evidenced a decline involves developers’ rationality in options exercise (Grenadier, 1995, 1996 and Wang, 2000).

[8] The same argument applies to cyclical troughs as peaks. The future path of rents is reflected in the growth term of $RT_0$ in the Gordon Growth Model.

capitalization rates that did not reflect foreseeable changes in real rents. During 2002 - 2003, the market capitalization rate fell while fundamentals deteriorated. Corcoran and Iwai (2003) argue that investors behaved rationally by anticipating a quick recovery, while Sivitanides *et. al.* (2003) explain the low market $R_0$ was a reflection of downward movement in the general level of interest rates. In a departure of from earlier findings, Henderschott and Macgregor (2005) use an error correction model with U.K capitalization rate and real rent proxies to produce evidence of rational expectations – the real rent proxies predict future rental growth and capitalization rates.

We analyze Real Estate Research Corporation (RERC) survey data to test hypotheses about investor expectations of future asset pricing as reflected in their $RT_0$ assignments. Although the RERC's $RT_0$ data do not come from transactions, Clayton, Ling, and Naranjo (2009) establish that $R_0$ estimates from RERC surveys align almost perfectly with capitalization rates derived from market experiences. We therefore assume then that the RERC $RT_0$ data represent unbiased estimates of investor future pricing expectations.

Because these data extend back to the early 1990s, comparisons may be drawn between $RT_0$ specified by survey respondents at the beginning of holding periods and the capitalization rate specified by survey respondents at the end of the current holding periods/beginning of the next holding periods, $R_N$. The terminal capitalization rate assigned in period zero ought to be a rational expectation of the going-in capitalization rate of investors acquiring assets for the next holding period. Strong statistical connections between the two series would indicate that investors possess the ability to anticipate future property pricing in defiance of myopic expectations. We present evidence to support the assertion that investors have not foreseen the $R_N$, and thus poorly forecast future property sale prices when valuing commercial real estate. This implies that DCF models guided by either rules-of-thumb or survey $RT_0$ may seriously under-estimate (over-estimate) terminal values during periods of falling (rising) capitalization rates.

Our regression results affirm statistical relationships between the $RT_0$ and $R_0$ spread and the period-zero discount rate, but little else. Discount rates also help explain variation in the $RT_0$ and $R_N$ spread although other economically significant variables are statistically insignificant.

## *2. A Simple Model Linking $R_0$ and $RT_0$*

In DCF applications in commercial real estate, valuation problems typically separate into two ownership periods – the period during the upcoming holding period of owners and the period immediately thereafter when subsequent owners receive cash flows. We use a forward contracting approach to understand the determinants of capitalization rate differences across the two periods. In our model, investors sell forward contracts with the delivery date N and delivery value $V_N$. The asset pays dividends $NOI_{t=1\ldots N}$, $NOI_t \neq NOI_{t=1\ldots N}$, and $NOI_t$ grows at a constant rate. We assume investors either sell then immediately buy assets back at the same price assuming no transaction costs or they elect not to sell assets into the market.

The forward price is defined as,

$$F_{(t=0,N)} = \frac{V_t}{B_{(t=0,N)}} \quad (1)$$

where B is zero-coupon bond yield serving as the discount rate.[9] Taking the log of both sides results in

$$\ln F_{(t=0,N)} = \ln V_t - \ln B_{(t=0,N)} \quad (2)$$

where B follows an adapted process.[10]

In a complete and efficient market, the delivery value is $F_{(t=0,N)} = V_N = \frac{NOI_{t=0,N}}{RT_{t=0}}$ and we obtain;

$$\ln F_{(t=0,N)} = \ln NOI_t - \ln RT_t = 0 - \ln B_{(t=0,N)} = \ln NOI_{t=0,N} - \ln RN_t \quad (3)$$

Rearranging Equation (3) gives;

$$\ln RN_t = \ln B_{(t=0,N)} + \ln RT_t + \ln NOI_{t=0,N} - \ln NOI_t \quad (4)$$

And therefore;

$$\ln RN_t - \ln RT_t = \ln B_{(t=0,N)} + \ln NOI_{t=0,N} - \ln NOI_t \quad (5)$$

The difference between terminal and going-in capitalization rates as shown in Equation (5) is explained by the discount rate, the constant NOI growth rate, and N.

[9] See Shreve (2004a), p.36.
[10] See Shreve (2004a), p.36, and Shreve (2004b), pp.240, 270.

### *3. Data and Method*

The data come from the RERC's quarterly *Real Estate Report*. Consistent survey data collection by RERC on U.S. real estate investment criteria began in 1989. Nearly the same information for nine property types became available in 1992 and then for large MSAs in 2000.[11] These data include initial and terminal capitalization rates, discount rates, an investor sentiment index, expected holding period, rental growth, and selected financial and real estate market measures.

Because rates of return and other information RERC publishes come from institutional investor surveys, these data have been somewhat underutilized for research purposes due to concerns about alignment of survey responses with market-based outcomes. Clayton, Ling, and Naranjo (2009) performed comparative analyses of RERC capitalization rate data against Real Capital Analytics and National Council of Real Estate Investment Fiduciaries capitalization rates that come from property transactions. Correlation and regression analyses with these three series indicate that all are nearly perfectly aligned, thus offering reasonable assurance that the RERC survey data reflect market behavior.

Our analysis of RERC data occurs in three steps. First, we compare $\mathrm{R}_0$ and $\mathrm{RT}_0$ reported during the same quarter by performing a series of mean difference tests directed by the following hypotheses: $(\mathrm{RT}_0 - \mathrm{R}_0) = 0$ and $\mathrm{RT}_0 - (\mathrm{R}_0 + x) = 0$, where $.50 \leq x \leq 1.00$. We run these tests to ascertain institutional real estate investor preferences for popular rules-of thumb in specifying $\mathrm{RT}_0$. Second, we performed tests that compare the terminal capitalization rate specified at the beginning of the holding period to the going-in capitalization rate reported at the end of the holding period given the following hypothesis: $(\mathrm{RT}_0 - \mathrm{R}_\mathrm{N}) = 0$. Results from these tests provide insights about how well investors in period zero anticipate future pricing by investors in period N. Finally, a series of regressions are run to explain variation between $\mathrm{R}_0$ and $\mathrm{RT}_0$ and $\mathrm{RT}_0$ and $\mathrm{R}_\mathrm{N}$ .The general forms of the estimating equations are,

$$(\mathrm{RT}_0 - \mathrm{R}_0) = f\,(\mathrm{i, g, N, D}) \tag{6}$$

And,

$$(\mathrm{RT}_0 - \mathrm{R}_\mathrm{N}) = f\,(\mathrm{i, g, N, D}) \tag{7}$$

[11] Ling (2005) provides a more complete discussion of how RERC collects survey data.

where i is the discount rate, g is the expected NOI growth rate, N is the expected holding period – each specified in period zero – and D represents dummy variable series for property types, MSAs, and time.

### *4. Results*

Exhibit 1 presents a line graph of RERC data for $(RT_0 - R_0)$ over the period 1989Q1 through 2009Q2. The .9812 correlation coefficient indicates a close relationship between $RT_0$ and $R_0$. The dotted line through the middle of the graph set at .5 represents the *ad hoc* rule. For all but three quarters $(RT_0 - R_0) > 0$. During most of the post 1990-1991 economic and real estate market recovery $(RT_0 - R_0) < .50$ percent, and then the spread tracks tightly around .50 percent after 1998. The mean difference equals .4539 percent with a small standard deviation of .0021 percent.

[EXHIBIT 1 HERE]

Computing differences between the terminal capitalization rates assigned at the beginning of holding periods and going-in capitalization at the end of holding periods, requires assumptions about investors' holding periods. The RERC data beginning in 1997Q2 include investors' survey responses to questions about expected holding periods at period zero. We use these expected holding periods to establish $R_N$ after 1997Q2. Before 1997Q2, we introduce the long-run average holding period from the RERC all property series of 8.2 years. For example, an expected holding period of 7.26 years in 2001Q2 means that the terminal period occurs during early 2008Q3. The $RT_0$ equal to 9.84 percent specified in 2001Q2 and the $R_N$ of 7.73 percent recorded in 2008Q3 yields a difference of 2.11 percent. Note that the analysis ends in 2001Q3 because holding periods beginning in that quarter extend beyond the ending date of the study period (*i.e.*, 2009Q2).

Differences between $RT_o$ and $R_N$ for holding periods beginning in 1989Q1 and ending through 2001Q3 graphically appear in Exhibit 2. From 1989 through 1995 relatively small gaps exist between the terminal capitalization rates specified at the beginning of holding periods and the eventual going-in capitalization rates reported at the start of the next holding period. This means that investors were fairly adept at anticipated future commercial real estate pricing during these years of declining and then slowly increasing property prices.

[EXHIBIT 2 HERE]

As the pace of the real estate market recovery quickened and property prices began to move upward more rapidly, period-zero investors demonstrated an increasing inability to anticipate how period-N investors would price income streams. By late 1997, positive differences between $RT_0$ and $R_N$ of two-to-three percent indicate that investors who used the terminal capitalization method in DCF models guided by investor surveys seriously underestimated future selling prices. Consequently, their DCF valuations exhibited a strong downward bias.[12] For all holding periods from 1989Q2 through 2001Q3 the mean difference between $RT_0$ and $R_N$ is 1.00 percent and the correlation coefficient equals -.30.

### *4.1 Local Market and Property Type Effects*

The extent to which variation in capitalization rate levels and spreads over risk-free rates mainly derive from national capital market conditions, relative to local market conditions, serves as the central theme in several research papers. Support for the argument that capitalization rates contain strong local market determinants comes from analyses of office market data by Sivitanidou and Sivitanides (1999) and Sivitanides *et. al.* (2001) and multi-family market data by Chichernea *et. al.* (2008) and Huang and Li (undated). These findings coincide with the traditional notion about the importance investors focusing on local real estate markets. These ideas motivate an extension of our examination of going-in and terminal capitalization rate relationships to the MSA level.

Investors also may possess the ability to anticipate price movements for certain property types better than for others. For example, office properties which constitute the largest share of the commercial real estate market in the U.S. and produce relatively stable cash flows because of long-term lease contracts may be more predictable than, say, hotels which represent approximately ten percent of the market and have the more volatile cash flows. Jud and Winkler (1995) and Sivitanides *et. al.* (2001) find statistical evidence that capitalization rates vary by property type. Clayton, Ling, and Naranjo (2009), however, find a fair amount of consistency across capitalization rates model parameters for all the nine RERC property types, except hotels. These conflicting results motivate extending our examination of going-in and terminal capitalization rate relationships to the property type level.

[12] This error may be exacerbated by the fact that exceptionally strong income growth occurred during these years.

Exhibit 3 displays descriptive statistics for $(RT_0 - R_0)$ and $(RT_0 - R_N)$ computed for the nine RERC property types and $RT_0 - R_0$ for eight major MSAs.[13] Panel A of the exhibit shows the averages and standard deviations for all properties and nine property types. The $(RT_0 - R_0)$ averages vary somewhat falling in a range of .33 percent to .78 percent except hotels for which the mean difference equals .11 percent. The standard deviation of .0093 also is noticeable higher for hotels relative to the .0021 average. With respect to $(RT_0 - R_N)$, hotels again stand out among property types. The average difference for all property types equals 1.08 percent and the range for property types except for hotels is .49 percent to 1.67 percent. The hotel mean of -.09 percent suggests that investors over this period anticipated future pricing of hotels more precisely than for other property types – a counterintuitive result.

[EXHIBIT 3 HERE]

Results in Panel B of Exhibit 3 for the eight MSAs do not support findings from previous real estate capitalization studies that investor behavior differs across local markets. The means of $(RT_0 - R_{0)}$ for individual MSAs show little variation either from each other or from the national average shown in Panel A of Exhibit 3.

### *4.2 Tests for Significant Mean Differences*

Differences of mean tests applied to the data confirm many of the observations from our graphical and descriptive data presentations, albeit with a few surprises. Results from a parametric and a non-parametric test appear in Exhibit 4. Because the three capitalization rate series we examine have some degree of interdependence, we rely on a dependent sample (*i.e.*, paired) means t-test and the Wilcoxon signed-rank z-test. These tests align with the hypotheses $RT_0 - (R_0 + x) = 0$ and $(RT_0 - R_N) = 0$. Panel A of Exhibit 4 shows that the means of $RT_0$ and $(R_0 + .50)$ are not statistically different at the five percent level for all properties. Yet for CBD office and hotel properties, statistically significant differences emerge from both tests. These results indicate that the 'plus .50-1.00 percent' rule holds for most, but not every property type.

Because the mean differences between $RT_0$ and $R_0$ appear slightly higher for the MSAs relative to the property types, we use x = .75 in these tests. Reliance on the 'plus .50-1.00

[13] Data are not available for a long enough time to compute $RT_0 - R_N$ for MSAs.

percent' rule can be generally confirmed from testing the MSA capitalization rate data, as shown in Panel B of Exhibit 4. Significant differences resulted in six MSAs and no significant differences are found in two MSAs (*i.e.*, Boston and LA).

[EXHIBIT 4 HERE]

Differences in the means of $RT_0$ and $R_N$ are found to be statistically different at the five percent level for all property types except for CBD office. These results generally support a myopic expectations view of real estate investor behavior.

***4.3 Regression Analysis and Results***

Our univaiate analyses of the RERC capitalization rate data provide insights regarding two issues investigated in this study – investor reliance on *ad hoc* rules for setting terminal capitalization rates in real estate DCF models and the ability of investors to anticipate future asset pricing. An in-depth look at investor-assigned capitalization rates begins with Equation (5) which indicates that variation in the $RT_0$ and $R_0$ spread are related variations in i, N, and g - all specified at period zero. As $(RT_0 - R_0)$ becomes more positive (negative), investors expect deterioration (improvement) in property pricing. Thus, we posit a direct relationship between $(RT_0 - R_0)$ and both i and N (see Collett, Lizieri, and Ward, 2003), but g to be negatively related to $(RT_0 - R_0)$ in line with the Gordon growth model.

The same period-zero investor expectations should explain differences between $RT_O$ and $R_N$. Our intuition about the direction of these relationships differs from the intuition regarding $(RT_0 - R_0)$ stated above. As i, N, and g become larger the absolute value of the spread between $RT_0$ and $R_N$ should widen because the difficulty of predicting asset prices increases. In the special case in which i = N = g = 0, investors' ability to predict future real estate prices become quite easy.

To judge the integrity of the RERC data, we generate regressions estimates from capitalization rate models recently presented in Chervachidze, Costello, and Wheaton (2009) building on research by Sivitanides, Southard, Torto, and Wheaton (2001) among others. The standard setup relies on the Gordon growth model whereby variation in capitalization rates levels derives from variation in risk-free rates, risk premiums, income growth, along with cross-sectional controls for local market and property type effects as well as time-series and seasonal effects. While our single-stage partial adjustment model construction is the same, the model we estimate departs from Chervachidze, Costello, and Wheaton (2009) in several ways. First, levels instead of natural log transformations are used for contemporaneous and lagged capitalization rates. The tests we conducted indicated no efficiency gains from making log transformation to these data. Second, the economy-wide risk premium variable takes the form of the Moody's Baa bond rate minus the 10-year Treasury rate (*i.e.*, SPREAD) as opposed to using the AAA bond rate. We considered both spreads and determined that the Moody's Baa bond rate minus the 10-year Treasury rate risk premium variable conceptually aligned better with the idea of economy–wide risk measurement, and in addition, our tests with this variable resulted in a better fit of the data. Third, yearly dummies are introduced in favor of quarterly dummies. In doing so, we hold constant trends while examining other drivers of capitalization rates. Also, we had difficulty developing arguments for capitalization rate seasonality. Our tests and the results reported by others indicate that quarterly seasonal effects are quite small. Fourth, the rental growth rate is used instead of real rent index variable to conform to the Gordon growth model.

Finally, debt availability and sentiment measures do not appear in the models. We ran a series of time-specific regression tests with debt availability and found that it operated well in periods when credit was severely constrained and generously available. At other times which dominated our study period, the importance of this variable substantially diminished. With respect to investor sentiment, we found as reported below that our measure of investor sentiment – the investment condition index from RERC surveys (ICOND) – is highly collinear with the rent growth measure (RGROW).

Our estimates come from TSCS fixed-effects regressions with property types instead of MSAs used by Chervachidze, Costello, and Wheaton (2009). Their objective of discriminating among local market and economy-wide explanations for variation in real estate capitalization rates required the use of MSA dummies. We preserve degrees of freedom while controlling for idiosyncratic cross-sectional effects by using property type dummies. Experiments run with levels and annual dummies produced nearly identical results to those when we estimated a TSCS fixed-effects model in logs and with quarterly dummies. With these departures, a high percentage of the variation in capitulation rates is explained with our model.

Descriptive statistics and correlations for data collected from RERC and other sources appear in Panel A and Panel B of Exhibit 5, respectively.[14] Statistics for capitalization rates, discount rates (DISRT), and other investment condition indicators align fairly closely across property types except for hotels which have higher rates and greater volatility among the investment condition measures. First-order correlation coefficients reveal the strongest relationships between SPREAD and capitalization rates. Also, RGROW and ICOND are highly correlated. This correlation causes some concern about using ICOND as a sentiment indicator if investors' base their ratings of future investment conditions largely on expected income growth.

[EXHIBIT 5 HERE]

Exhibit 6 shows parameters estimated for going-in and terminal capitalization rates models in the first two columns and estimates for the $(\mathrm{RT}_0 - \mathrm{R}_0)$ and $(\mathrm{RT}_0 - \mathrm{R}_\mathrm{N})$ models in columns three and four. Not surprisingly given to the strong co-linearity of $\mathrm{RT}_0$ and $\mathrm{R}_0$, the two sets of estimated coefficients are quite similar. All of the fundamental variables have the correct sign, are significant at the .01 level, and overall the model has a high degree of explanatory power. The quarterly speed of adjustment for capitalization rates of approximately 50 percent coincides with the findings of Chervachidze, Costello, and Wheaton (2009). Importantly, the results confirm the integrity of the RERC capitalization rate data as reflective of realized capital market participant behavior similar to the findings of Clayton, Ling, and Naranjo (2009).

The estimates for the $(\mathrm{RT}_0 - \mathrm{R}_0)$ and $(\mathrm{RT}_0 - \mathrm{R}_\mathrm{N})$ models proved disappointing, but not surprising. Among the three conceptual linkages of $\mathrm{RT}_0$ to $\mathrm{R}_0$ - discount rate, holding period, and income growth rate - only the coefficient on DISRT is significant at either the .05 or .01 levels, albeit incorrectly signed. The overall explanatory power of the model is low. Given the arbitrary nature of $\mathrm{RT}_0$ assignments by investors as demonstrated by our univariate analysis, these results are consistent with our priors about finding conceptually supported empirical connections between $\mathrm{RT}_0$ and $\mathrm{R}_0$ in survey data.

In the $(\mathrm{RT}_0 - \mathrm{R}_\mathrm{N})$ model, all of the coefficients are correctly signed, DISRT is highly significant, but the overall explanatory power of the model is low. We expected that investors' ability to predict future pricing metrics would deteriorate, and hence this spread

[14] Variable definitions appear in the notes accompanying each exhibit.

widens, with longer expected holding periods, larger expected income growth rates, and higher discount rates.

[EXHIBIT 6 HERE]

### *5. Terminal Capitalization Rates with Rational Expectations*

In rational expectations theory, forecast outcomes do not differ systematically from market equilibrium. These outcomes derive from formal models that anticipate future demand and supply conditions and any deviations from the modeled outcomes are assumed to be random. The ‘model’ may be less formal, but still must recognize future economic conditions and equilibriums. We argue in this paper with empirical support that traditional approaches to terminal capitalization rate selection in real estate DCF valuations suffer from reliance on myopic expectations. More than three decades of real estate market data provide evidence that future economic conditions can be anticipated except those caused by shocks. Hence, approaches to estimating future property sale prices based on rational expectations theory are possible and may dominate predictions of those based on myopic and adaptive expectations.

We propose four ways to estimate future capitalization rates and property sale prices based rational expectations and are not in current usage. These are listed as follows:

1. Assume a long-run average capitalization rate at the time that the terminal capitalization is assigned.
2. Rely on the term structure of Treasury rates plus a long-run average real estate risk premium.
3. Introduce a capitalization rate forecasting model – Published papers by Chervachidze, Costello, and Wheaton (2009) building on research by Sivitanides, Southard, Torto, and Wheaton (2001) among others report successes in estimating capitalization rate models that can be used to forecast.
4. Cycle dating procedures – See Drescher, Erler, and Krizanac (2010) for an application of these procedures in real estate pricing.

As an extension of our work in this paper, tests of some or all of these are planned.

## *6. Conclusion*

The DCF model likely will remain dominate well into the future for valuing commercial real estate in the U.S. Typically, model developers go to great lengths to fine tune periodic cash flows estimates while maintaining rather cavalier attitudes regarding the forecasting of terminal cash flows despite the fact that terminal cash flows may constitute over one half of present values. Future sale price forecasting remains in its infancy and may be there for some time. Nevertheless, historical evidence continues to accumulate that real estate markets follow reoccurring long-run cyclical patterns characterized by mean reverting economic and financial performance measures. In the face of these strong informational headwinds, DCF model developers and consumers persist in their reliance on *ad hoc* specifications to forecast the terminal capitalization rates used to obtain future real estate sale prices. These specifications align with a myopic expectations view of real estate pricing rather than adaptive and rational expectations theories.

Given this backdrop, we set out to accomplish several objectives. First, graphical and univariate statistical representations of RERC's going-in and terminal capitalization rate data confirm institutional investors' longstanding acceptance of forecasting terminal capitalization rates by adding approximately 50 bps. to going-in capitalization rates. Second, we show that institutional investors' reliance on such *ad hoc* terminal capitalization rate specifications result in poor forecasts of future real estate pricing. Throughout the early and mid 1990s, for example, informed investors tacked on 50 to 100 bps. to the prevailing capitalization rates as their best estimate of terminal capitalization rates evidence of persistent upward movement in property prices. Third, we link going-in and terminal capitalization rates to the period zero discount rate, expected holding period and expected income growth rate and estimate regressions based on these relationships. Unfortunately, the empirical evidence is not compelling. Only the discount rate has any informational content.

Finally, we propose some alternative approaches to the standard *ad hoc* terminal capitalization rate specification. These include using long-run average capitalization rates, extracting them from the yield curve, cycle dating, and econometric modeling of capitalization rates.

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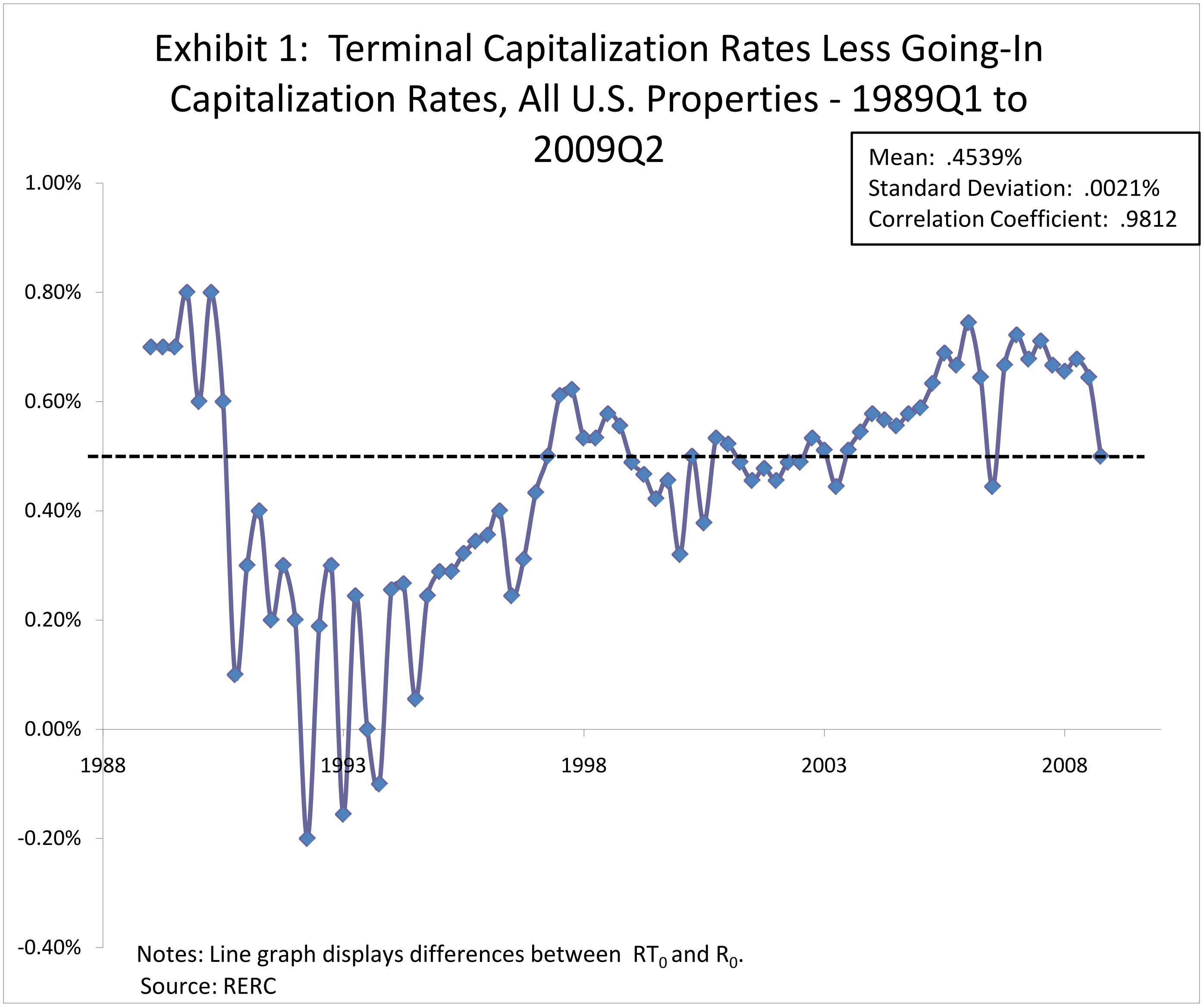
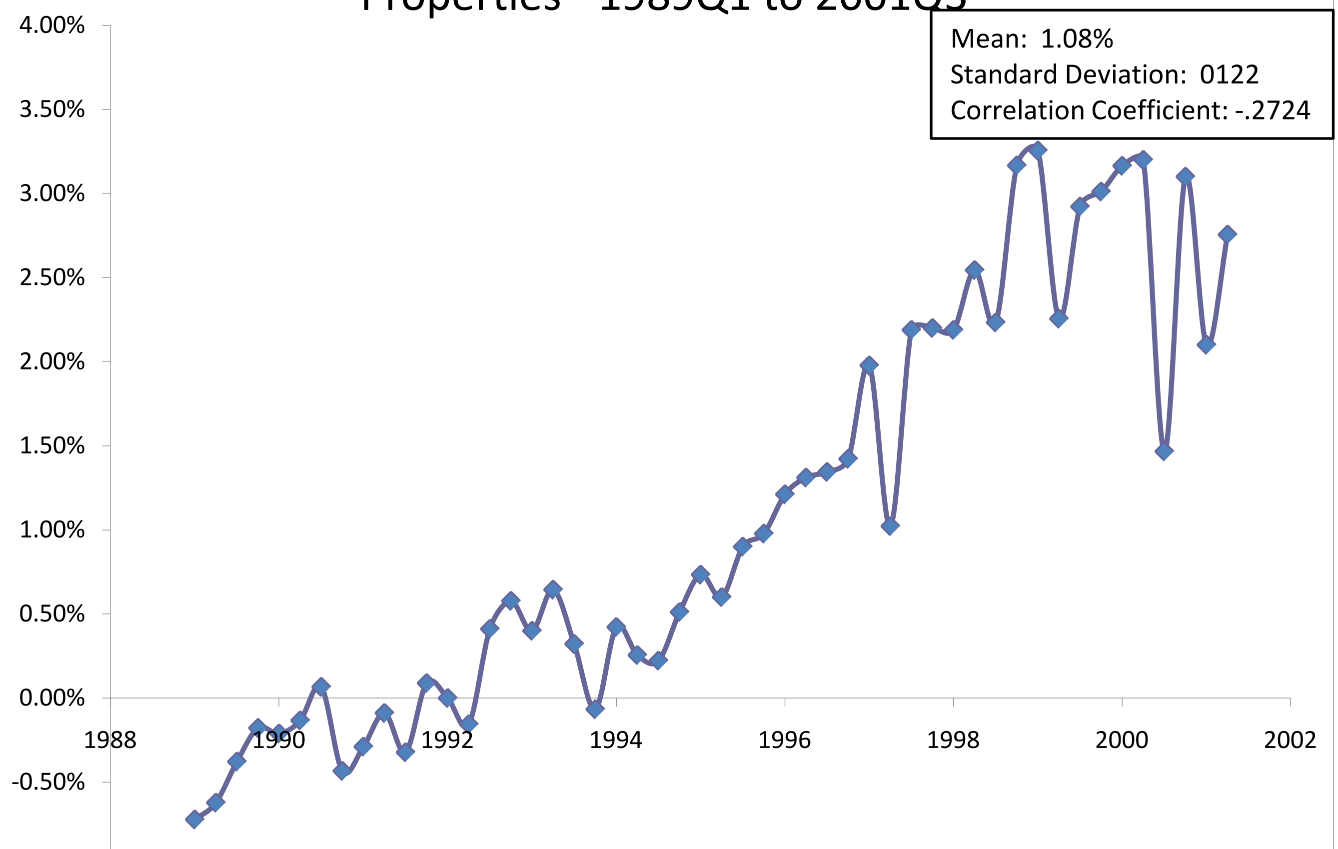


## Exhibit 2: Terminal Capitalization Rates Less End of Holding Period Going-In Capitalization Rates, All U.S. Properties - 1989Q1 to 2001Q3




Notes: Line graph displays difference between $RT_0$ and $R_N$.

Source: RERC

Exhibit 3: Terminal and Going-In Capitalization Rate Statistics, U.S. Property Types and MSAs

| Property Type/MSA | $(RT_0 – R_0)$ | | | $(RT_0 - R_N)$ | | |
|---|---|---|---|---|---|---|
| | Mean% | St. Dev.% | Correlation | Mean% | St. Dev.% | Correlation |
| ***Panel A: Property Types*** | | | | | | |
| All Properties | 0.0045 | 0.002101 | 0.981191 | 1.08% | 0.012163 | -0.2724427 |
| CBD Office | 0.0043 | 0.003184 | 0.956089 | 0.65% | 0.011673 | 0.05062611 |
| Suburban Office | 0.0037 | 0.003861 | 0.922886 | 0.62% | 0.007514 | 0.24376062 |
| Industrial Warehouse | 0.0048 | 0.002340 | 0.961092 | 1.20% | 0.010164 | -0.0972425 |
| Industrial R&D | 0.0033 | 0.003964 | 0.910470 | 0.49% | 0.007526 | 0.01788291 |
| Retail Regional Mall | 0.0078 | 0.006030 | 0.702051 | 0.88% | 0.007639 | 0.35086023 |
| Retail Power Center | 0.0042 | 0.003233 | 0.949837 | 0.70% | 0.013793 | -0.3502153 |
| Retail Neighborhood/Community | 0.0041 | 0.002687 | 0.964508 | 0.77% | 0.012323 | -0.1749713 |
| Apartment | 0.0059 | 0.002974 | 0.952818 | 1.67% | 0.010921 | 0.11084363 |
| Hotel | 0.0011 | 0.009333 | 0.695426 | -0.09% | 0.014899 | -0.37701 |
| ***Panel B: MSAs*** | | | | | | |
| Atlanta | 0.0038 | 0.014344 | 0.40646068 | N/A | N/A | N/A |
| Boston | 0.0082 | 0.004557 | 0.9057875 | N/A | N/A | N/A |
| Chicago | 0.0064 | 0.002399 | 0.9748175 | N/A | N/A | N/A |
| Houston | 0.0065 | 0.00244 | 0.97249293 | N/A | N/A | N/A |
| Los Angeles | 0.0075 | 0.002652 | 0.9756944 | N/A | N/A | N/A |
| New York | 0.0068 | 0.002898 | 0.96143015 | N/A | N/A | N/A |
| San Francisco | 0.0064 | 0.003713 | 0.95879156 | N/A | N/A | N/A |
| Washington DC | 0.0066 | 0.003489 | 0.95367916 | N/A | N/A | N/A |

Notes: The national series aggregated across the nine property types extends from 1989Q1 through 2009Q2. Disaggregate property type data began to appear in RERC's *Real Estate Report* in 1992Q2 (Industrial R&D begins in 1992Q3). The MSA series begin in 2000Q3.

Source: RERC

Exhibit 4: Difference of Means Tests, U.S. Property Types and MSAs

| Property Type/MSA | $RT_0$ - ($R_0$ + x) | | $RT_0$ - $R_N$ | |
|---|---|---|---|---|
| | Paired t-Test | Wilcoxon Signed Rank z-Test | Paired t-Test | Wilcoxon Signed Rank z-Test |
| ***Panel A: Property Types*** | **(*x*=.5)** | **(*x*=.5)** | | |
| All Properties (N=82, 55 ) | 1.962 (p=.053) | 1.371 (p=.170) | 6.344 (p=.001) | 4.862 (p=.001) |
| CBD Office (N=50,18) | 4.126 (p=.001) | 2.715 (p=.007) | 1.677 (p=.112) | 1.830 (p=.067) |
| Suburban Office (N=50,18) | 2.031 (p=.048) | 0.501 (p=.614) | 7.059 (p=.001) | 3.726 (p=.001) |
| Industrial Warehouse (N=50,18) | 1.828 (p=.074) | 0.213 (p=.831) | 15.081 (p=.001) | 3.725 (p=.001) |
| Industrial R&D (N=50,19) | 2.068 (p=.044) | 0.903 (p=.367) | 7.697 (p=.001) | 3.824 (p=.001) |
| Retail Regional Mall (N=50,17) | 0.932 (p=.356) | 1.119 (p=.263) | 4.315 (p=.001) | 2.971 (p=.003) |
| Retail Power Center (N=50,18) | 0.169 (p=.866) | 1.123 (p=.260) | 7.421 (p=.001) | 3.617 (p=.001) |
| Retail Neighborhood/Community (N=50,18) | 0.756 (p=.453) | 0.391 (p=.696) | 4.372 (p=.001) | 2.724 (p=.001) |
| Apartment (N=50,23) | 2.040 (p=.047) | 1.598 (p=.110) | 24.263 (p=.001) | 4.201 (p=.001) |
| Hotel (N=50,20) | 3.519 (p=.001) | 3.923 (p=.001) | 10.209 (p=.001) | 3.873 (p=.001) |
| ***Panel B: MSAs*** | **(*x*=.75)** | **(*x*=.75)** | | |
| Atlanta (N=36) | 5.848 (p=.001) | 4.360 (p=.001) | N/A | N/A |
| Boston (N=36) | 0.834 (p=.409) | 0.668 (p=.504) | N/A | N/A |
| Chicago (N=36) | 4.154 (p=.001) | 3.427 (p=.001) | N/A | N/A |
| Houston (N=36) | 3.883 (p=.001) | 3.300 (p=.001) | N/A | N/A |
| Los Angeles (N=36) | 0.105 (p=.917) | 0.338 (p=.735) | N/A | N/A |
| New York (N=36) | 2.465 (p=.019) | 2.734 (p=.006) | N/A | N/A |
| San Francisco (N-36) | 2.541 (p=.015) | 2.742 (p=.006) | N/A | N/A |
| Washington DC (N=36) | 2.174 (p=.037) | 3.167 (p=.002) | N/A | N/A |

Notes: The national series aggregated across the nine property types extends from 1989Q1 through 2009Q2. Disaggregate property type data began to appear in RERC's *Real Estate Report* in 1992Q2, but terminal capitalization rates are not reported until 1997Q1 . The MSA series begin in 2000Q3.

Source: RERC

**Exhibit 5: Descriptive Statistics and Correlations, RERC Data, 1997Q1 - 2009Q2**

| Property Type/ Variable | CBD Office | Suburban Office | Warehouse Industrial | R&D Industrial | Regional Mall Retail | Neighborhood/ Community Retail | Apartment | Hotel | **All Properties** |
|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Statistics by Property Type (N=50,450)** | | | | | | | | | |
| $R_0$ | | | | | | | | | |
| Mean | .081 | .085 | .082 | .087 | .080 | .083 | .077 | .098 | **.084** |
| Std. Dev. | .010 | .010 | .009 | .009 | .009 | .011 | .011 | .012 | **.012** |
| Min/Max | .059/.093 | .064/.097 | .063/.091 | .069/.097 | .063/.098 | .065/.095 | .057/.089 | .073/.117 | **.057/.117** |
| $RT_0$ | | | | | | | | | |
| Mean | .087 | .090 | .087 | .092 | .085 | .088 | .082 | .105 | **.090** |
| Std. Dev. | .009 | .009 | .008 | .008 | .008 | .010 | .010 | .011 | **.011** |
| Min/Max | .068/.098 | .072/.102 | .071/.099 | .076/.102 | .068/.098 | .070/.102 | .065/.093 | .081/.122 | **.065/.122** |
| HOLDP | | | | | | | | | |
| Mean | 8.506 | 8.252 | 8.486 | 8.328 | 8.930 | 8.456 | 7.938 | 7.482 | **8.312** |
| Std. Dev. | .579 | .446 | .512 | .656 | .849 | .610 | .695 | .938 | **.804** |
| Min/Max | 6.10/9.60 | 6.90/9.00 | 6.60/9.50 | 5.40/9.60 | 4.60/10.0 | 6.50/9.50 | 6.30/9.20 | 5.20/8.90 | **4.30/10.0** |
| ICOND | | | | | | | | | |
| Mean | 5.894 | 5.154 | 5.965 | 5.064 | 5.162 | 5.820 | 6.148 | 4.890 | **5.411** |
| Std. Dev. | .825 | .980 | .562 | .814 | .920 | .829 | .673 | 1.302 | **1.044** |
| Min/Max | 3.90/7.30 | 3.10/7.10 | 4.50/7.00 | 3.00/6.70 | 2.70/6.60 | 3.40/6.90 | 3.90/7.40 | 2.10/7.80 | **2.10/7.80** |
| RGROW | | | | | | | | | |
| Mean | .027 | .024 | .025 | .023 | .025 | .025 | .028 | .025 | **.025** |
| Std. Dev. | .009 | .011 | .007 | .009 | .006 | .006 | .006 | .011 | **.008** |
| Min/Max | .007/.042 | .004/.041 | .008/.035 | .001/.037 | .009/.036 | .006/.035 | .015/.036 | .003/.044 | **.001/.044** |
| DISRT | | | | | | | | | |
| Mean | .101 | .105 | .100 | .106 | .102 | .102 | .098 | .122 | **.105** |
| Std. Dev. | .014 | .012 | .012 | .012 | .014 | .013 | .012 | .014 | **.014** |
| Min/Max | .076/.116 | .082/.120 | .078/.114 | .083/.119 | .077/.120 | .079/.117 | .076/.113 | .092/.145 | **.076/.145** |
| SPREAD | | | | | | | | | |
| Mean | .054 | .057 | .052 | .058 | .054 | .054 | .051 | .074 | **.057** |
| Std. Dev. | .011 | .011 | .010 | .011 | .011 | .011 | .010 | .015 | **.013** |
| Min/Max | .025/.074 | .031/.080 | .027/.071 | .032/.082 | .030/.075 | .028/.073 | .025/.068 | .043/.101 | **.025/.101** |

**Panel B: Correlations - All Properties (N=450)**

| | $R_0$ | $RT_0$ | HOLDP | ICOND | RGROW | YIELD | SPREAD |
|---|---|---|---|---|---|---|---|
| $R_0$ | 1.000 | | | | | | |
| $RT_0$ | .989 | 1.000 | | | | | |
| HOLDP | -.410 | -.417 | 1.000 | | | | |
| ICOND | -.210 | -.192 | .091 | 1.000 | | | |
| RGROW | -.220 | -.199 | -.011 | .621 | 1.000 | | |
| DISRT | N/A | N/A | -.425 | -.141 | -.129 | 1.000 | |
| SPREAD | .811 | .809 | -.297 | -.408 | -.532 | .783 | 1.000 |

Notes: $R_0$ is the going-in capitalization rate assigned by RERC survey respondents in period zero, $RT_0$ is the terminal capitalization rate assigned in period zero, HOLDP is the holding period in period zero, ICOND is a score from 1 to 10 indicating the real estate investment conditions in period zero, RGROW is the rental growth rate in period zero, DISRT is the required unlevered IRR in period zero, and SPREAD is the difference between the Moody's Baa bond rate and the 10-year Treasury rate. N/A - Not applicable.

Source: RERC

Exhibit 6: Regression Results

| Dependent Variable (Period)<br><br>Variable | $R_0$ (1997Q1 - 2009Q2) | $RT_0$ (1997Q1 - 2009Q2) | ($RT_0$-$R_0$) (1997Q1 - 2009Q2) | ($RT_0$-$R_N$) (1997Q1 - 2002Q3) |
|---|---|---|---|---|
| Intercept | .029 (6.31)** | .416 (9.01)** | .011 (3.66)** | .117 (3.00)** |
| $R_{-1}$ | .538 (18.20)** | .503 (17.28)** | N/A | N/A |
| TBOND | .193 (4.48)** | .119 (2.85)** | N/A | N/A |
| SPREAD | .282 (6.65)** | .207 (5.06)** | N/A | N/A |
| RGROW | -.135 (5.06)** | -.143 (5.58)** | .133 (.74) | .099 (.43) |
| HOLDP | N/A | N/A | .001 (.84) | .001 (1.00) |
| DISRT | N/A | N/A | -.056 (2.44)** | .981 (3.25)** |
| DTYPE | ✓ | ✓ | ✓ | ✓ |
| DYEAR | ✓ | ✓ | ✓ | ✓ |
| $AdjR^2$ | .962 | .961 | .244 | .278 |
| F-Stat. | 471.45 | 461.98 | 7.03 | 5.04 |
| N | 449 | 449 | 450 | 169 |

Notes: $R_0$ is the going-in capitalization rate assigned by RERC survey respondents in period zero, $RT_0$ is the terminal capitalization rate assigned in period zero, $R_N$ is the going-in capitalization rate for the next holding period assigned in period N, $R_{-1}$ is the dependent variable lagged one quarter, TBOND is the 10-year Treasury bond rate, SPREAD is the difference between the Moody's Baa bond rate and 10-year Treasuries, RGROW is the rental growth rate in period zero, HOLDP is the holding period in period zero, DISRT is the required unlevered IRR in period zero, DTYPE is an indicator variable series for the nine RERC property types, and DYEAR is an indicator variable series for the years 1997 through 2009. Parameters come from OLS which produced nearly identical estimates as TSCS fixed effects (MSAs) procedures, t-statistics are in parentheses, ** indicates significance at the .01 level, and * indicates significance at the .05 level. N/A - Not applicable.

Source: RERC