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INTEREST RATE ELASTICITY OF CAPITALIZATION RATES

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ABSTRACT

The investment real estate market in the United States experienced tremendous growth and robust returns in the first half of this decade followed by a severe decline in the second half as evidenced by declining property values and sub-par returns. There were many causes for the decline in the real estate investment market. This paper explores one and asks the question: How susceptible are real estate returns to changes in interest rates in the broader economy? Or, put another way, what is the interest rate elasticity of capitalization rates? Utilizing methods from the valuation of fixed-income securities, this paper demonstrates the applicability of a methodology developed by Conner and Liang (2005) to analyze the impact of changes in market rates on the capitalization rates of real estate and shows how their technique can be used by practitioners in a specific market.

I. INTRODUCTION

The investment real estate market in the United States experienced tremendous growth and robust returns in the first half of this decade followed by a severe decline in the second half as evidenced by declining property values and sub-par returns. Property owners initially experienced double-digit appreciation, rental incomes were pushed up with the increasing demand for rental space, and cheap credit allowed investors to jump into direct property ownership. But by 2007 the cycle had turned, and the boom turned to bust causing one to ponder the safety of real estate as a long-term investment? There were many causes for the decline in the real estate investment market. However, this paper explores just one: How susceptible are real estate returns to changes in interest rates in the broader economy?

This paper looks at the relationship between movements in general market interest rates and the capitalization rate [cap rate]; current income divided by market price of the asset. Or, stated differently, we explore the interest rate elasticity of cap rates. The cap rate reflects the implied multiple on a given property and is a widely used valuation metric in real estate. Although this paper does not attempt to test the relationship, Conner and Liang (2005) found a positive relationship between market interest rates and cap rates, or, stated differently, a negative relationship between

market interest rates and the multiple on a given property. By utilizing methods from the valuation of fixed-income securities, examining the components of real estate returns, and by making a few assumptions, it is possible to model the influence of broader interest rate changes on real estate investment risk premiums. This methodology has been developed in other studies, Conner and Liang (2005) and Kaiser (2004), and their work is discussed further in this paper in the literature review section. This paper expands on their work by examining actual returns and transaction cap rates on Seattle area investment properties and demonstrates the applicability of their duration measure in analyzing the impact of changes in market rates on the cap rates for real estate.

In practice, the fixed-income concepts of bond duration and convexity can be used to approximate the change in price of a bond as the result of changes in the interest rates. In a similar fashion, real estate cap rates and interest rates should be related. Conner and Liang (2005) discuss several reasons why the real estate market is so conducive to examination with fixed-income methods. Due to the capital-intensive nature of the real estate industry, the cost of financing any project is based largely on interest rates in the debt markets. More importantly for this study, however, is the fact that real estate investments do have several bond-qualities that make them perform similarly to fixed-income instruments. These qualities will be explored in more depth later in this study.

This paper is organized as follows: The paper begins with a literature review followed by some background and the mathematics of bond valuation, with particular attention paid to the theory behind duration and convexity. The purpose is to provide a framework of understanding that can be transferred and utilized in the valuation of real estate investments. The next section examines valuation methods in real estate in order to set the stage for further exploration into the influence of interest rates on investment property returns. The connection between real estate and bond metrics will be described, with particular attention paid to the fixed income characteristics of investment real estate. This part also discusses several assumptions that underlie the study. The next section discusses the methodology developed by Conner and Liang (2005) and demonstrates the applicability of their model in showing the correlation existing between market interest rate and cap rate movements in a specific market. Finally, some conclusions, limitations and suggestions for further research are provided.

II. LITERATURE REVIEW

Previous articles have looked at the similarities between bond and real estate investments as well as the relationship between interest rates and cap rates. Ambrose

and Nourse (1993) develop and test an analytical model of commercial capitalization rates using the band of investment technique. Their results indicate that differences across property types are important in evaluating cap rates and suggest that cap rates are negatively related to stock earnings/price ratios and positively related to expected inflation as proxied by the interest rate spread. Hendershott and MacGregor (2005) also present a model of cap rates and explain office and retail cap rates in an error correction framework. They show that cap rates are negatively related to stock dividend/price ratios and positively related to expected real estate growth. While these two articles utilize sophisticated approaches that allow for differences in property type, geographic area and changing economic conditions to investigate the relationship between cap rates and required returns, this paper focuses on models that use methods from the valuation of fixed-income securities to investigate the same relationship. While acknowledging the importance of the prior studies, the intent of this paper is to utilize models developed by Kaiser (2004) and Conner and Liang (2005) and demonstrate their ability to indicate the sensitivity between market interest rates and real estate returns.

Kaiser (2004) makes mention of bond duration in the context of cash flow stability when discussing real estate as a surrogate for bonds in the asset valuation and allocation process. He suggests that real estate should be given serious consideration as a replacement vehicle for bonds given its superior cash yields, lower volatility and potential returns. Conner and Liang (2005) apply the concept of duration to a hypothetical property and the NCREIF Index for different real property types. They use a methodology similar to the one used in this paper to show how bond mathematics applies to real estate. They create a model for estimating the impact of higher interest rates on real estate values.

This study differs from these two papers, as well as other studies, in several respects. First, it provides a more comprehensive explanation of the fixed-income analytics underlying the use of duration in real estate. It focuses on the similar characteristics of bonds and real estate and explores the differing certainties of cash flows from different real estate asset classes. Secondly, it introduces the concept of convexity to account for larger changes in interest rates. And thirdly, and most importantly, it examines actual closed transactions and transaction cap rates to derive real returns on actual properties in one geographical area and in one asset class. This paper attempts to establish a relationship between market interest rate movements and cap rate movements as they occur in the actual marketplace (as opposed to hypothetical properties or broad indexes that may have little predictive ability due to the geographical nature of real estate).

III. BACKGROUND AND BOND MATHEMATICS

The cap rate of a real estate asset can be described as the current income divided by the market price of the asset or the income-to-value ratio and is similar to the relationship described by the “current yield” on a bond. Specifically, the cap rate is equal to the net operating income divided by the value, where net operating income is gross potential income less vacancy and collection loss allowance and less operating expenses excluding financing costs and income taxes. The cap rate is simply the discount rate on the property’s net operating income or the required rate of return on an investment.

This relationship is very important in the financial analysis of an asset, as the discount rate is a key determinant of value representing the risk premium required by investors. The higher the discount rate or cap rate, the more return an investor requires as compensation for the risk of making an investment. In a similar fashion, a low cap rate indicates that investors are willing to pay a relatively large amount per dollar of cash flow, while a high capitalization rate indicates the reverse. Thus, general market interest rates and cap rates should be positively correlated as they both embody investor expectations regarding risk and ultimately the value of an asset.

While on the one hand cap rates and market interest rates are similar in concept, they are also different. First, with the cap rate, income growth must be considered. Hendershott and MacGregor (2005) conclude that the discount rate and income growth expectations are the key components affecting cap rates. For the properties in this study, operating income growth ranged from 0% per annum up to 7.67% per annum. Over a ten year holding period, this implies that the property with 0% growth had the exact same net income in year 10 as in year 0, and the property with 7.67% growth had a net income that roughly doubled. Investor expectations about the growth rates for rental income, therefore, are critical in determining what sort of valuation can be placed on the property. For example, a property that sells for the same cap rate as its purchase cap rate will be worth twice as much if the rental income doubles. Thus, the return on the property is much higher if an investor expects to be able to increase rents throughout the holding period. It is worth noting that Kaiser (2004), after examining eighty years of real estate returns, found real estate cash flows to have been remarkably stable, ranging between 3.5% and 6% of current values showing that owners have been able to consistently increase rents over the past century. Regardless, the expectations of rental growth are tied inextricably to the vacancy trends and market demand for rental space and savvy investors will factor those considerations into their analysis of the potential for rental growth.

Second, a concern that affects the valuation of investment real estate is general investor sentiment towards real estate at a given time. Although investor sentiment is difficult to measure and quantify in terms of its impact on real estate investment values, it can exert a powerful influence on asset values. Investors view placing their money into one asset as an opportunity cost versus other assets, and the general market sentiment regarding real estate versus other assets therefore can be a very powerful driver of value. In an environment where real estate is “in favor” and market sentiment is generally positive, investors will require lower risk premiums and be willing to pay higher multiples (lower capitalization rates) for the same assets. The reverse is also true. Higher cap rates and higher rates of return over the life of the asset will be required to attract investors to real estate if it is viewed as a more dangerous or less favorable investment. While these changes in the effective risk premiums may not be driven by fundamental changes in the broader economy or reflected in changes in the risk-free rate of return, they are in fact very real and critical in valuing a property.

The primary functional measure of a bond’s return is its Yield-to-Maturity, or “YTM.” This measurement accounts for the discounted cash flows of the fixed interest (or coupon) payments determined at the bond’s initial pricing and fixed repayment of principle (or face value) at a future date. The timing of payments plays a significant role in the discounting of future cash flows, so the term to maturity is likewise considered in the YTM calculation. As a model for pricing bonds in the market, YTM is actually quite effective, relatively simple to calculate, and widely used among investors. However, there is a significant shortcoming in the simple YTM pricing model that must be accounted for when considering a bond’s value.

The problem with YTM is that it fails to consider the counteracting effects of reinvestment risk and price (or market) risk. Reinvestment risk derives from the assumption that all future cash inflows can be reinvested at the discount rate, or in bond nomenclature, the YTM. In a volatile interest rate environment, the yield of the cash thrown off by a project will not always represent a feasible reinvestment rate. For example, a capital improvement project that returns 15% per annum can likely not have its cash inflows reinvested at a 15% rate; a reduced reinvestment rate is required.

The accompanying shortcoming of the YTM model involves the price (or market) risk. By changing the dependent variable in the YTM equation, the price of a bond in the market is calculated based on the independent variables of coupon rate, the number and timing of interest and principle payments, and the prevailing YTM required for the bond in the market. The calculation looks like this:

$$P_0 = \sum_{t=1}^T \frac{C}{(1+r)^t} + \frac{F}{(1+r)^T} \quad (1)$$

Where:

P_0 is the market price of the bond

C is the periodic cash flow payments (fixed as coupon rate)

F is the terminal repayment of principal plus final periodic cash flow

T is the term to maturity of bond

t is the term to maturity of interval payments

r is the required rate of return (in the case of a bond, the YTM)

As a result, the price of a bond fluctuates according to marginal changes in the YTM by adjusting the dependent variable portion of the equation; the price. This also explains why bond prices fluctuate to match required returns.

When taken together in determining the potential expected returns on a bond, the factors of reinvestment risk and price risk oppose each other. A basic rule of bond pricing dictates that as market interest rates rise (fall), bond prices will fall (rise). For example, consider a situation where interest rates have recently undergone a significant decline. The bondholder will see an increase in the market price of his bond. This increase in price provides an opportunity to realize capital gains by selling the bond and participating in some “profit taking.”

However, there is a downside effect as a corollary of the decreased interest rate. This negative impact arises from the reinvestment risk. There are three sources of income from bonds: current income (in the form of interest payments), capital appreciation (in the form of market price fluctuations), and “interest on interest” (resulting from the reinvestment of cash flows from the bond presumably at the YTM). As the price of the bond increases, the income from a potential realization of capital appreciation on the bond should increase. However, the ability to reinvest and earn “interest on interest” diminishes severely with lower interest rates. At any point in time, a bond holder can presumably reinvest at the current YTM. If the current YTM drops, however, the reinvestment at a much lower rate adversely affects the total income of the bond. The reinvestment risk and the price risk have an offsetting effect. By the same token, an increase in interest rates will result in a favorable adjustment of reinvestment possibilities and a decrease in prices, which again results in an offsetting effect.

The duration metric allows for an equalization of the reinvestment risk and the price risk. Duration measures how the price of a bond will react to different interest

rate movements. It provides a better picture of how likely it is that a current YTM will produce the expected income. A bond's duration describes how long the term on a bond must be such that the offsetting price risk and reinvestment risk are exactly at parity based on the maturity, coupon rate, payment periods, and YTM. As a result, the bond should effectively yield exactly its YTM. The shorter the duration on a given bond, the less "risky" its returns are and the more accurately one can predict its actual YTM. The duration is directly linked to the maturity and indirectly linked to coupon and yield. The formula for a basic Macaulay Duration is:

$$D = \sum_{i=1}^n \frac{P(i)t(i)}{V} \quad (2)$$

Where:

D is the Macaulay duration

n is the number of total payments

$P(i)$ is the present value of coupon payment i or principle payment

$t(i)$ is the time until payment date in years

V is the current market price of the bond

The formula indicates that the time until the payment of any cash flow is explicitly considered, thus weighting each subsequent cash flow with greater value and increasing duration. Likewise, an increase in the YTM of the bond, acting as the discount rate for the present value $P(i)$ calculation, will reduce the present value and the duration. Thus, duration is the time-weighted average of the bond's discounted payments as a proportion of the bond's price. The Macaulay Duration alone, however, does not actually simulate the true movements of the price-yield relationship on a bond.

The modified duration metric allows a more accurate measure of this effect. A bond's price volatility is a function of its term to maturity and its coupon. However, a somewhat ambiguous relationship between bond price volatility and maturity arises when we try to estimate the movement in a bond's price as a direct result of interest rate movements. Duration helps us to approximate that relationship. However, duration is limited in its predictive ability as it represents a linear relationship, while the actual price-yield relationship of a bond is convex. As long as prevailing interest rate movements are fairly small (generally between 50 and 100 basis-points), modified duration can determine fairly accurate estimates of price movements on a bond related to interest rate changes.

Arriving at this understanding of duration involves approaching the calculation from a slightly different perspective. The concept of modified duration is used to

express the measurable change in the value of a security in response to a change in interest rates. It accomplishes this by assuming that there will be a 100 basis-point increase in the interest rate (or YTM). The formula for modified duration is as follows:

$$D^* = \frac{\text{Macaulay Duration}}{1 + \frac{r}{n}} \quad (3)$$

Where:

D^* is the modified duration

r is the YTM or interest rate

n is the number of cash flows per year

Modified duration allows for an adjustment of YTM for Macaulay duration and implies a 100 basis-point increase in the interest rate. As a result, the modified duration will always be less than the Macaulay duration. One can determine how much the price of a bond will change given an interest rate movement using the following equation:

$$\frac{\Delta P}{P} = -(100)(D^*)(\Delta r)$$

To calculate the absolute numerical change in price, we can simply multiply this percentage change by the current price of the asset. It directly explains the amount of interest rate risk and allows investors to avoid the problems associated with interest rate fluctuations by immunizing a portfolio of bonds against interest rate risk. However, in this study, the use of the modified duration measure will be more directly related to its ability to extrapolate changes in price from relatively small changes in interest rate.

In order to adjust for the measure of duration and arrive at a true absolute price change we need to take into account both the modified duration and the convexity of an interest rate movement. Due to the curvature of the price/yield function and the linear nature of any given tangent line (as represented by the modified duration), the applicability of modified duration as a measure of the interest rate elasticity of price is limited to relatively minor changes in interest rates. As the interest rate deviates farther from the origin, the difference between the yield curve and the tangent line changes from relatively insignificant to fundamentally important. Convexity allows us to adjust for this change and correct for the error.

However, what convexity calculates is the distance between the tangent line and price-yield curve. In order to convert the year measurement into a dollar fluctuation in price, the change in bond value as a result of convexity is described below:

$$\text{Approximate Dollar Price Change Due to Convexity} = \frac{(\text{Convexity})(\text{Price})(\Delta\text{Yield})}{2}$$

This approximation can be described as the price change not explained by duration and the following formula takes into account both the modified duration and the convexity of an interest rate movement:

$$\Delta B = B \left\{ \frac{C}{2} [(\Delta r)^2] - D^* \Delta r \right\} \quad (4)$$

Where:

B is the bond price

C is the convexity

r is the YTM or interest rate

D^* is the modified duration

Percentage change as calculated in duration and convexity has an equally important yet different application in fixed-income analytics. It measures the bond's price elasticity with respect to its discount rate. This analysis allows one to measure the sensitivity of the price of an asset to a change in the market required rate of return or yield to maturity. It helps an investor to analyze the impact of an exogenous interest rate shift on the returns of the investment and, as a result, serves as a proxy for the risk of the projected returns. As a general rule, the longer the term-to-maturity, the longer the cash flows will be delayed that repay the initial investment. A long maturity bond will therefore exhibit a greater duration and a greater volatility than a short-term investment. Likewise, the lower the coupon, the longer it will take to recover the initial investment, and as a result, a longer duration and greater volatility will affect the bond.

IV. BOND MATH APPLIED TO REAL ESTATE

Real estate investment properties exhibit characteristics that make them perform both like stocks and like bonds in the real world. On the one hand, they pay a large current income in the form of rent as well as laundry, parking, and a variety of other potential servicing receipts. On the other hand, real property has the potential for tremendous appreciation on the land and building value, depending on the real asset class. Put another way, real estate exhibits a fixed income component per the leases on

the property and a residual appreciation or inflation component reflecting the re-leasing of the property at future higher rents.

The bond-like aspect of real estate is based on the assertion that the price of a real property asset reflects the present value of the future cash flows thrown off by the asset. This relationship has been described in the yield-to-maturity calculation for bond pricing and further explored in the duration and convexity measures of dollar price movement and elasticity. The factors of term-to-maturity, coupon rate, and yield to maturity all affect the price of a bond. The same relationships hold true in investment real estate. The term-to-maturity of a real estate investment is not based on a fixed repayment schedule as is noted on the face of a bond, but instead reflects the intended holding period for the asset owner. The coupon rate of a real estate asset can be described as the current income divided by the market price of the asset. This measure is called the capitalization rate, and it will be discussed further. The yield-to-maturity of a real property asset is calculated using the same methodology as the yield-to-maturity on a bond.

It is important to note that the applicability of fixed-income analytics to real estate is based on the assumption that the property has reasonably predictable cash flows and a stable return. Fixed-income analytics do not work well for investments that are either extremely volatile in value or have unpredictable income streams. Most real estate investments fall somewhere between the extremes of an empty building with no income and a fully occupied building with long leases to credit tenants. Clearly, the use of duration and convexity to measure real estate interest rate sensitivity would be most appropriate in the second instance; however, these fundamentals can be applied to other generally stable assets.

1. CAPITALIZATION RATE

As previously stated, the cap rate of an asset is the income-to-value ratio. For the purposes of valuing an investment in real property the cap rate is equal to the net operating income divided by the value and can be represented as:

$$\text{Cap Rate} = \frac{\text{Net Operating Income}}{\text{Value}}$$

This relationship is identical to the relationship described by the “current yield” on a bond. The current yield differs from the “yield-to-maturity” in that the current yield reflects what the coupon rate is as a percentage of the price of a bond. Likewise, the cap rate represents what the net operating income is as a percentage of the price of the property. A simple manipulation of the formula can help us to understand how the cap rate can be used for valuation purposes:

$$\text{Value} = \frac{\text{Net Operating Income}}{\text{Cap Rate}}$$

As written, the capitalization rate is simply the discount rate on the property's net operating income. This relationship is very important in the financial analysis of an asset, as the discount rate is a key determinant of value. As discussed earlier, the discount rate represents the required rate of return on an investment. The higher the discount rate, the more return an investor requires as compensation for the risk of making an investment. Accordingly, a low capitalization rate indicates that investors are willing to pay a relatively large amount per dollar of cash flow, while a high capitalization rate indicates the reverse. A final adjustment to the formulas above allows us to see how the cap rate can be used to derive a multiple of earnings, which is an important tool in valuation:

$$\text{Value} = (\text{Net Operating Income}) \left(\frac{1}{\text{Cap Rate}} \right)$$

For example, assume the following:

$$\begin{aligned} \text{Property Net Operating Income} &= \$100,000 \\ \text{Cap Rate} &= 5\% \end{aligned}$$

$$\text{Value} = (\$100,000) \left(\frac{1}{.05} \right) = \$2,000,000$$

As we see above, the cap rate does not, in effect, discount the property. Rather, it implies a certain multiple of earnings that can be used to value the property. A cap rate of 5% represents a multiple of 20. In other words, an investor who requires a 5% rate of return, using a cap rate valuation method, would be willing to pay \$20 for each \$1 of potential earnings. Stock investors may notice a familiarity with this method. This is not a coincidence, as in the stock market many investors use the price-to-earnings ratio, or P/E whereas in real estate, investors often use the property's capitalization or cap rate.

2. DURATION IN REAL ESTATE

Duration, while certainly not perfect, can be used in the analysis of real estate asset volatility. For bonds, duration can be precisely determined from the face yield, current price, and the remaining term to maturity, with "term" typically being the largest influencing factor. Real estate can similarly be factored, though for most properties the actual average lease term is not different from one property to another. While duration is primarily used for the analysis of leases and the determination of

vacancy risk in real estate, by making a few assumptions, it is possible to measure the interest rate risk and commensurate price volatility of real property. From the measurement of price volatility, a fairly simple adjustment is all that is required to determine the degree to which interest rates respond to changes in the required rate of return on property, or the IRR.

It has been established that the percent change in the price of an asset due to a movement in interest rates can be derived using the combination of modified duration and convexity. This relationship for real estate properties can be shown by restating Equations 2, 3 and 4 except that now B = Property value instead of Bond price, now $P(i)$ = Present value of income stream from property instead of Present value of coupon payment i or principle payment, now V = Current market value of the property instead of Current market price of the bond, and now r = internal rate of return or required rate of return instead of Yield to Maturity.

Thus, the change in the price of a real estate asset can be found according to a few mathematical relationships that are regularly used to value bonds. In order to determine the effect of interest rate movements on the capitalization rate, however, the link between the cap rate and the price of a property must be examined. By the definition described above, the cap rate equals the net operating income divided by the price. The assumption can be made that the net operating income, which functions independently of the market value of the property, will be held constant. As a result, the following relationships arise:

$$C(\text{Cap Rate}) = \frac{\text{Net Operating Income}}{P}$$

and if NOI is held constant, then

$$\frac{\Delta C}{C} = -\frac{\Delta P}{P}$$

Because the statement “the change in price divided by the price” is actually the mathematical description for “percentage change in price,” it can be assumed that the change in the cap rate is the opposite of the change in price as calculated using duration and convexity.

3. ASSUMPTIONS

There are a number of assumptions that must be made in order for the bond duration and convexity concepts to work in the context of real estate. First, it is critical that the discount rate be appropriate for the property in question. Discount rate

selection is more art than science, and is dependent on a number of factors (primarily risk and growth) that are outside the scope of this study. However, the internal rate of return, based on the purchase price and cap rate and the exit price and cap rate, as well as the derived rental income and growth pattern, can be assumed to be the discount rate for this purpose. This is reflective of the yield-to-maturity discount rate for bonds. The YTM is the internal rate of return on a bond, so it follows logically that the internal rate of return for a real property in a fixed-income study would function in the same manner as it does in a pure fixed-income environment.

The discount rate, or IRR, is assumed to be the accepted interest rate for our purposes. And, following this, a 1 to 1 relationship is assumed between movements in relevant benchmark interest rate and the IRR to estimate the impact of a change in the interest rate on cap rates. While this is an assumption, it does have some theoretical underpinnings that make it reasonable. It can be assumed that the discount rate, or IRR, of a property is simply the sum of the risk-free rate of return and the risk premium for the asset. An increase in the risk-free rate, represented by United States Treasury Bills or the Fed Funds Rate, can have three distinct effects on the required rate of return for an asset. Spreads over United States Treasuries are often used when describing risk premiums on real estate, so this can be assumed to be our “interest rate” adjuster. It can cause the interest rate to change by an amount larger than the change to the risk-free rate, by an amount smaller than the change to the risk-free rate, or by an amount equal to the change in the risk-free rate. Assuming that the environment and market conditions surrounding the specific asset have not changed as a result of (or caused the resulting change in) the risk-free rate, it is safe to conclude that the risk premium for the asset will hold constant for different risk-free rates. If this is the case, then a change in the risk-free rate will yield an equal absolute change in the interest rate required on an asset. Thus, a 1 to 1 relationship between changes in market interest rates, such as the risk-free rate, should be equal to changes in the IRR for the purposes of this study. The question of which interest, or risk-free rate should be used as a proxy for “changes in the interest rate” still remains, but the more significant question is not which rate will be used but instead how will the capitalization rate respond to changes in the required rate of return stemming from the change in the appropriate risk-free rate.

Secondly, it is critical that the net operating income be held constant during a changing interest rate environment. Theoretically, this means that the income of the property is independent of market conditions for the purchase and sale of real estate. It would be reasonably safe to assume that in an environment where required rates of return change instantaneously, the rents would not adjust accordingly. Rents usually adjust on a yearly basis (or longer, depending on the prudence of the manager) for apartment buildings. Basically, the assumption is that the rents will increase according

to regular growth pattern regardless of the prevailing market conditions. In reality, though, rental demand affects rent levels rather significantly and there is a definite connection between the health of the housing market, demand for rental space, and the market demand for investment property. The effect of this market change, however large or small, is generally not priced into rental fees charged by managers quick enough to affect our study in any significant manner. Hendershott (2005) expresses frustration at this lag time stating, the slow adjustment to changes in causal variables makes property cap rates difficult to model. The reason that duration can be applied to real estate in a similar fashion to bond valuation is that the cash flows are assumed to be independent of changes in interest rates. Kaiser (2004) notes that real estate cash distribution incomes historically have been remarkably reliable. Drawing on this evidence, allows us to make the assumption that regular cash flows can be anticipated.

A third assumption that must be made in order for duration and convexity to apply for comparative analysis with real estate investments is a constant holding period. As discussed above, the holding period greatly affects the duration and, likewise, the convexity of an asset. By limiting all of the properties studied to a holding period of, say, ten years, this significant variable no longer has an effect on any discrepancy between cap rate movements on different properties. All of the properties examined in this study either have a true ten-year holding period or are adjusted to reflect what their ten-year holding period would be based on actual rental growth rates and cap rates.

The final assumption made in this study is that the cash flows arising from the net income of a property occur only once each year. In reality, income streams typically arrive monthly. However, both for the purposes of this study and for valuation purposes based on capitalization rates, it is often assumed that net income is a once-yearly payment. The effect of changing the payment stream from once-yearly to twelve-times yearly is fairly insignificant in the final adjustment of cap rates to interest rate moves.

V. METHODOLOGY AND RESULTS

For this study, 26 apartment buildings in the Seattle area were used to demonstrate the effect of interest rate movements on capitalization rates. Data pertaining to these properties was found using the Costar database for real estate properties. The properties range in size from 10 units to 238 units and were located within a ten-mile radius of downtown Seattle. Each of the properties was sold at some point between January 1, 2007, and April 1, 2008, and the capitalization rate and net income information was provided in the listing profile. Each property also had an earlier transaction sometime between January 1, 1995 and January 1, 1998.

The actual holding period of each property between the two transactions was calculated in order to discover the actual income growth rates. Properties that did not have an actual ten-year holding period were adjusted either forward or backwards according to their actual income growth and their actual first sale cap rate to arrive at an implied transaction value ten years prior to their second sale. The terminal sale date (occurring in either 2007 or 2008) was not adjusted, but the initial transaction would either be moved forward or backwards (from 1996 to 1997, for example) in order to reach an actual ten-year holding period. In order to calculate the sale price based on this movement, the net income for the new transaction year is divided by the actual capitalization rate from the initial transaction to arrive at an implied purchase price for the property. This price is then used in all of the valuation procedures required to arrive at both the duration and convexity measure. Properties that did, in fact, have a ten-year holding period did not require an adjustment and, accordingly are presented using their actual transaction prices and cap rates. Regardless, their implied values (which reflect the actual values) are still shown for the sake of consistency.

Using the purchase and exit prices and cap rates, the net income in each of the ten years is derived. From the terminal net income and the beginning net income the growth rate in net income based on the number of years in the implied holding period is derived. From this growth rate, the presumed net income in each year can be extrapolated and a cash flow pattern for the property can be established. With a series of cash flows, an actual internal rate of return is then calculated. Using this internal rate of return as a discount rate for the stream of cash flows, the present value of the cash flows is used to determine values for duration, modified duration, and convexity. These values are then used to show changes in price of the real asset as well as the capitalization rates.

The initial assumed interest rate change is 100 basis-points, and a sensitivity analysis is conducted to examine the changes over a change of 100, 200, or 300 basispoints to the positive and the negative. Finally, average basis-point sensitivity for all of the properties in the study is calculated to describe trends and examine the consistency of the results.

Table 1 shows various descriptive statistics for the 26 properties in the study.

Table 2 summarizes the results of this research indicating the interest rate elasticity of capitalization rates for real estate in the Seattle area. As expected, interest rates and cap rates move in the same direction however cap rates are fairly inelastic in the face of market interest rate changes. For the 26 properties examined, a 100 basispoint increase in the required rate of return, or discount rate, resulted in an

average of only a 18.00 basis-point increase in the initial (or purchase) capitalization rate. The range in capitalization rate adjustments for a 100 basis-point increase in the interest rate is 18.73 basis-points, with a maximum adjustment of 29.58 basis-points and a minimum change of 10.85 basis-points. The table also shows the effect on capitalization rates for other levels of change in the discount rate both positive and negative.

TABLE 1
DESCRIPTIVE STATISTICS FOR 26 PROPERTIES

Property	Sale Price	Duration	Modified Duration	Convexity	Return
1	11.50	2.44	2.06	2.99	18.47
2	7.80	2.18	1.97	5.55	10.96
3	4.91	2.68	2.34	4.88	14.59
4	6.45	2.44	2.16	4.96	12.92
5	2.39	2.29	1.99	3.63	14.98
6	1.65	2.51	2.21	4.98	13.18
7	38.06	2.61	2.19	3.04	18.83
8	5.95	2.73	2.35	4.18	16.04
9	3.12	2.34	2.02	3.43	16.04
10	3.09	2.69	2.33	4.29	15.57
11	20.65	2.5	2.11	2.77	18.21
12	14.62	2.99	2.48	3.21	20.35
13	1.33	2.47	2.12	3.66	16.55
14	2.18	2.59	2.24	4.41	15.95
15	12.05	2.40	2.16	6.09	11.12
16	2.94	2.37	2.06	3.79	15.39
17	7.61	3.18	2.78	6.19	14.19
18	3.61	2.07	1.82	3.55	13.78
19	33.53	2.73	2.39	5.42	13.90
20	4.29	2.37	2.07	4.01	14.45
21	7.38	2.18	1.93	4.59	12.67
22	5.93	2.24	1.97	4.27	13.63
23	20.00	2.41	2.08	4.32	15.44
24	1.85	2.49	2.35	11.29	5.70
25	1.73	2.36	2.10	4.98	12.71
26	3.98	3.01	2.54	4.26	17.99
Mean	8.79	2.51	2.19	4.57	14.75
Median	5.42	2.46	2.14	4.28	14.79
Standard Deviation	9.56	0.27	0.21	1.65	2.97

Sale price is in millions of dollars. Returns are in percent.

Table 2 summarizes the results of this research indicating the interest rate elasticity of capitalization rates for real estate in the Seattle area. As expected, interest rates and cap rates move in the same direction however cap rates are fairly inelastic in the face of market interest rate changes. For the 26 properties examined, a 100 basispoint increase in the required rate of return, or discount rate, resulted in an average of only a 18.00 basis-point increase in the initial (or purchase) capitalization rate. The range in capitalization rate adjustments for a 100 basis-point increase in the interest rate is 18.73 basis-points, with a maximum adjustment of 29.58 basis-points and a minimum change of 10.85 basis-points. The table also shows the effect on capitalization rates for other levels of change in the discount rate both positive and negative.

TABLE 2
AVERAGE CAP RATE VOLATILITIES FOR ALL PROPERTIES

Average Δc for All Properties	18.00
Maximum Δc	29.58
Minimum Δc	10.85
Range Δc	18.73
Sensitivity to actual 100 basis point changes.	
Δr	Δc (in basis points)
-300	-56.18
-200	-37.09
-100	-18.36
0	0.00
100	18.00
200	35.63
300	52.90
Estimated sensitivity to hypothetical basis point changes.	

Several conclusions can be drawn from these results that indicate the relative inelasticity of capitalization rates to interest rates or required rates of return. First, the internal rates of return were high across the properties in this study. The most profitable property returned 20.35% per year over the course of the study, and only one property returned less than 10% (at 5.7%). The majority of properties returned somewhere between 13% and 17%, which outpaces returns on the average stock or bond portfolio over the long run. These outsized returns can be attributed to both active rental income growth and, more importantly, a good deal of capital appreciation.

Second, it is likely that for small, short-term interest rate changes, there would be little noticeable adjustments to cap rates for properties. Even a 100 basis-point adjustment to the IRR resulted in only about a 20 basis-point change in the cap rate. An adjustment this insignificant is not likely to cause a drastic change in the valuation of a property nor is it likely to be reflected quickly in the cap rate calculation. A key reason that cap rates are relatively unresponsive to interest rate adjustments of a small proportion is that cap rates tend to respond to longer-term trends in interest rates rather than random short-term movements. Short-term movements are so volatile that real estate markets do not react to these daily, weekly or even monthly adjustments. Another reason for the lack of cap rate responsiveness to short-term changes in interest rates is due to the nature of the real estate market. Real estate is geographically dependent, “trades” in low volumes on any given day and is fairly illiquid. As such, there is not an efficient way to derive a “price index” for real estate, nor for the market to absorb the information regarding each transaction and its unique characteristics to arrive at a change in cap rate trends. Hendershott (2005) notes that,

“in an ideal world, cap rates and rents would be based on transactions of constant-quality (including location) properties with identical lease terms. Of course, such data rarely, if ever, exists”.

Another reason for the relative inelasticity of cap rates to interest rates has to do with the real estate transaction process. Whereas bond investors can simply contact a bond broker, place an order and generally execute a trade in minutes, real estate transactions generally take months to close. If cap rates responded to daily changes in interest rates for real estate, the price would have to be renegotiated literally each day. The effort of tracking these changes, therefore, is simply not worth the marginal benefit the investor would receive from adjusting his offer price accordingly. While large changes in market conditions are of course considered, small changes in market interest rates are largely ignored by real estate investors.

A final reason one would expect a relatively minor adjustments to capitalization rates for the properties in this study has to do with the time period of this research. During the 10 year span of this study (approximately 1997 to 2007) real estate returns were above average. Thus, not surprisingly, the 26 properties in this study exhibited relatively high cap rates at the point of purchase and high yields. Duration and convexity values are impacted by this in that an asset with a high coupon rate or current yield will be less prone to major adjustments in price (or corollary adjustments to capitalization rates) than one with a lower current yield. An asset with a higher yield pays the owner his initial investment back in a shorter period than one with a lower yield. Thus, a smaller impact on capitalization rates due to changes in interest rates would be expected. For example, if the interest rates start at 12%, and move up to 13% (a 100 basis-point increase), the percentage change in the interest rate is only 8.25%. If the cap rate on the same asset, however, started at 4% and moved to 5% (likewise a 100 basispoint increase), the percentage increase in the current yield is a much larger 25%. For a high initial yield-to-maturity and a lower capitalization rate, an increase in market yields will require a smaller adjustment to the cap rate for the property to provide the desired yield-to-maturity. Thus, the higher the yield-to-maturity and the lower the capitalization rate at the time of purchase, the less the capitalization rate will have to adjust as interest rates change.

VI. CONCLUSIONS, LIMITATIONS, AND FURTHER RESEARCH

Regardless of the degree of causality of changes in interest rates on the cap rate, this study indicates that there is a direct relationship. For apartment buildings in the Seattle area held during the 10-year study period, that relationship was roughly 5:1. A 100 basis-point increase in the interest rate led to an approximate 20 basis-point increase in the capitalization rate. It is important to note that these results are not an empirical test of the relationship between market rates and cap rates on a market

wide scale but are simply a demonstration of how practitioners could use this technique in a specific market. Conner and Liang (2005) using a national average apartment building index finds that a 100 basis-point increase in interest rates leads to a 40 basis-point increase in capitalization rates, or a 5:2 relationship. As previously mentioned, the drivers of value in real estate are local in nature and dependent on a number of factors, but it seems clear from this study that large changes in cap rates for apartment properties would only occur if there were significant changes in interest rates. For an average apartment property in Seattle over the 10-year study period to experience an increase in the cap rate of just 1%, it would require an increase in the required rate of return, or IRR, of more than 5%. The market for rental properties clearly demonstrates resistance to large cap rate adjustments except in significantly different market environments. In fact, historically real estate cap rates have been remarkably stable, staying within a 300 basis-point range of 7.5% to 10.5%. This compared to bond interest rates which have moved in a range of over 1000 basis-points during the past half century, Kaiser (2004).

Due to this relative stability of cap rates, real estate investors can, according to duration, theoretically assess the risk of cap rate movements adversely affecting the price of their real property investments. As discussed previously, if the asset earns stable cash flows (or steadily growing cash flows, as anticipated by historical results presented in this study's models and the assumption of increasing rents), and the reinvestment risk has been accounted for using duration, the only major source of risk is price risk. By forecasting future rental income as well as the exit multiple (selling cap rate) the owner hopes to earn on the property, a real estate investor can determine the volatility of the value of their property in the market based on changes in interest rates.

While modeling all of these inputs is difficult and may involve a degree of judgment for certain variables, it does allow the prospective investor to analyze different scenarios and anticipate the future price of his investment. This is very similar to the models run by financial analysts to determine the feasibility and attractiveness of any investment opportunity. By determining the degree to which interest rates affect cap rates, the investor can more accurately measure how changes in macro interest rates (something widely accepted, available, reported and forecasted) will affect cap rates for an asset class in a specific area (something fundamentally important but with greater data collection and measurement issues). The information in this study should, therefore, help the prospective investor make a more educated decision regarding potential acquisitions. Although the relationship between interest rates and cap rates is not perfect and there are measurement issues, this study should provide some guidance for how to think about cap rate risk in terms of interest rate movements.

Further study in this area could help to validate the assumptions inherent in the models or further explore the implications of certain major factors in the analysis. For example, further research could explore the degree to which a lower initial yield might affect cap rate volatility. Or, one could examine the effects of the job market, housing demand, and other major real estate factors on rental incomes and demand for investment properties.

Further research could also empirically test more sophisticated models such as those developed by Ambrose and Nourse (1993), Hendershott and MacGregor (2005) and others. This could overcome the somewhat specific and stylized results of this study that depend on yield to maturity, holding period and cash flows. A change in any of these values will change the duration of the assets used in the tests thus the results in this paper represent the current average and not an elasticity that can be used in all situations. This study also relies on several assumptions that may be unreasonable in practice. For example, an investor would need to know the holding period of the property ex-ante and assume that credit spreads are unrelated to changes in the risk-free rate. Further research could compare how the elasticity measures used in this study perform in comparison to other empirical models.

In sum, although it has some limitations, this study has demonstrated the use of an analytical model for analyzing the interest rate elasticity of capitalization rates for apartment buildings in the Seattle area over a holding period between 1997 and 2008. Valuation is, and will continue to be, as much art as it is science. However, this study provides an example of how the methodology developed by Conner and Liang (2005) can be used by real estate investors to examine the potential price risk that results from capitalization rate movements for real estate assets.

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